STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

# APPLICABLE STANDARDS
# BOOK 3

## FOR DESIGN AND CONSTRUCTION ON STATE HIGHWAY IN

**IN FRESNO COUNTY, IN FRESNO, ON ROUTE 180 BETWEEN ROUTE 41 AND ROUTE 168**

**DISTRICT 06, ROUTE 180**

**CONTRACT NO. 06-0C1104**
**06-Fre-180-R58.4/R60.4**
**Project ID 0600000934**

**Federal Aid Project**
**ACNH-P180(056)N**

**Dated: May 26, 2011**

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# 1 INDEX OF STANDARDS, MANUALS, GUIDELINES AND REFERENCES

# 1 Index of Standards, Manuals, Guidelines and References

Availability Legend:
IS = Industry standard, Contractor's responsibility to acquire.
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| 1 | AASHTO | A Guide for Accommodating Utilities within Highway Right-of-Way | 4th Edition 2005 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=95 | 31 | √ |
| 2 | AASHTO | A Guide for Achieving Flexibility in Highway Design | 1st Edition 2004 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=103 | 154 | √ |
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| 5 | AASHTO | A Guide to Small Sign Support Hardware | June 1998 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1148 | 240 | √ |
| 6 | AASHTO | A Guide to Standardized Highway Barrier Hardware | 2nd Edition 1995 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=161 | 485 | √ |
| 7 | AASHTO | A Guide to Standardized Highway Lighting Pole Hardware | April 1980 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=166 | 65 | √ |
| 8 | AASHTO | A Manual of User Benefit Analysis for Highways | 2nd Edition 2003 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=5 | 306 | |
| 9 | AASHTO | A Policy on Design Standards-Interstate System | 5th Edition 2005 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1175 | 16 | √ |
| 10 | AASHTO | A Policy on Geometric Design of Highways and Streets - "The Green Book" | 4th Edition 2001 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=110 | 919 | √ |

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| 12 | AASHTO | Above and Beyond | January 2008 | IS W | X | X | X | | https://bookstore.transportation.org/Item_details.aspx?id=1188 | 104 | √ |
| 13 | AASHTO | An Informational Guide for a Training Program of Right-of-Way Personnel | 2nd Edition 1975 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=98 | 54 | √ |
| 14 | AASHTO | AWS D1.5M/D1.5:2008 Bridge Welding Code | 2008 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1183 | 411 | √ |
| 15 | AASHTO | Construction Handbook for Bridge Temporary Works with 2008 Interim Revisions | 1st Edition 1995 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=17 | 143 | √ |
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| 17 | AASHTO | Construction Manual for Highway Construction | 4th Edition 1990 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1338 | 240 | √ |
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| 19 | AASHTO | Foundation Investigation Manual | 2nd Edition 1978 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1022 | 197 | √ |
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| 22 | AASHTO | Guide for Commonly Recognized Structural Elements and its 2002 Interim Revisions | December 1997 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=20 | 71 | √ |
| 23 | AASHTO | Guide for Commonly Recognized Structural Elements and its 2002 Interim Revisions | November 2001 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1348 | 65 | √ |
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| 25 | AASHTO | Guide for Design of Pavement Structures and 1998 Supplement | 1993 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=374 | 708 | √ |
| 26 | AASHTO | Guide for High-Occupancy Vehicle (HOV) Facilities | 3rd Edition 2004 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=114 | 233 | |
| 27 | AASHTO | Guide for Park-and-Ride Facilities | 2nd Edition 2004 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=121 | 163 | |
| 28 | AASHTO | Guide for Pavement Friction | 1st Edition 2008 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1351 | 94 | √ |
| 29 | AASHTO | Guide for the Development of Bicycle Facilities | 3rd Edition 1999 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=104 | 93 | |
| 30 | AASHTO | Guide for the Planning, Design, and Operation of Pedestrian Facilities | 1st Edition 2004 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=119 | 143 | |

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| 32 | AASHTO | Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges, 1st Edition with 2005 Interim Revisions | 1st Edition 2005 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1332 | 424 | √ |
| 33 | AASHTO | Guide on Evaluation and Abatement of Traffic Noise | 1993 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=197 | 53 | √ |
| 34 | AASHTO | Guide Specification for Application of Coating Systems with Zinc-Rich Primers to Steel Bridges, S 8.1 - 2006 | 2006 | IS W | X | X | X | | https://bookstore.transportation.org/Item_details.aspx?id=1006 | 56 | |
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| 37 | AASHTO | Guide Specifications for Design and Construction of Segmental Concrete Bridges, 2nd Edition, 2003 Interims-Revisions | 2nd Edition 2003 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=33 | 13 | √ |
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| 39 | AASHTO | Guide Specifications for Design of FRP Pedestrian Bridges | 1st Edition 2008 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1218 | 25 | |

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| 42 | AASHTO | Guide Specifications for Geotextiles in Separate Applications | 1990 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=169 | 47 | |
| 43 | AASHTO | Guide Specifications for Highway Bridge Fabrication with HPS 70W (HPS 485W) Steel | 2nd Edition 2003 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=323 | 21 | |
| 44 | AASHTO | Guide Specifications for Highway Construction | 9th Edition 2008 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1197 | 494 | √ |
| 45 | AASHTO | Guide Specifications for Horizontally Curved Steel Girder Highway Bridges with Design Examples for I-Girder and Box-Girder Bridges | 2003 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=25 | 437 | |
| 46 | AASHTO | Guide Specifications for Polymer Concrete Bridge Deck Overlays | October 1995 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=176 | 73 | |
| 47 | AASHTO | Guide Specifications for Polymer Modified Asphalt | February 1992 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=174 | 28 | √ |
| 48 | AASHTO | Guide Specifications for Seismic Design of Highway Bridges | 1st Edition 1983 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1357 | 133 | √ |
| 49 | AASHTO | Guide Specifications for Seismic Isolation Design, 2nd Edition and 2000 Interim | 2nd Edition 1999 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=44 | 123 | |

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| 51 | AASHTO | Guide Specifications for Shotcrete Repair of Highway Bridges | February 1998 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=178 | 127 | √ |
| 52 | AASHTO | Guide Specifications for Strength Design of Truss Bridges (Load Factor Design) | 1985 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1023 | 10 | |
| 53 | AASHTO | Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges | 1st Edition 1989 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1358 | 34 | |
| 54 | AASHTO | Guide Specifications for Structural Design of Sound Barriers, 1992 Interim | 1992 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=46 | 28 | √ |
| 55 | AASHTO | Guide Specifications for Structural Design of Sound Barriers, 2002 Interim | 2002 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=47 | 13 | √ |
| 56 | AASHTO | Guide Specifications for Structural Design of Sound Barriers, with 1992 and 2002 Interims | 1989 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=48 | 83 | √ |
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| 60 | AASHTO | Guide to Wetland Mitigation Issues for Transportation Designers | September 1996 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=201 | 91 | |

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| 62 | AASHTO | Guidelines for Bridge Management Systems | 1st Edition 1993 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=343 | 47 | |
| 63 | AASHTO | Guidelines for Design Details, G 1.4 - 2006 | December 2006 | IS W | X | X | X | | https://bookstore.transportation.org/free_publications.aspx?ItemID=1009 | 26 | √ |
| 64 | AASHTO | Guidelines for Design for Constructibility, 2nd Edition, G 12.1 - 2003 | 2003 | IS W | X | X | X | | https://bookstore.transportation.org/free_publications.aspx?ItemID=24 | 41 | √ |
| 65 | AASHTO | Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400) | 1st Edision 2001 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=157 | 108 | |
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| 79 | AASHTO | LRFD Bridge Construction Specifications, 2nd Edition with 2006, 2007, and 2008 Interims | 2nd Edition 2004 | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=60 | 885 | √ |
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| 81 | AASHTO | LRFD Bridge Design Specifications, Customary U.S. Units, 4th Edition with 2008 U.S. Edition Interim, and AASHTO LRFD Bridge Design Specifications, SI Units | 4th Edition 2007 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=878 | 3,829 | √ |

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| 86 | AASHTO | Maintenance Manual for Roadways and Bridges | 4th Edition 2007 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1170 | 383 | |
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| 94 | AASHTO | National Transportation Communications for ITS Protocol (NTCIP) | | IS | | | | | https://bookstore.transportation.org/item_details.aspx?ID=291 | 2,135 | √ |
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| 97 | AASHTO | Pavement Deflection Data Exchange: Technical Data Guide | 1998 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=351 | 57 | √ |
| 98 | AASHTO | Pavement Management Guide | 1st Edition 2001 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=352 | 287 | √ |
| 99 | AASHTO | Policy on Land Use and Source Control Aspects of Traffic Noise Attenuation | 1980 | IS | | | | | https://bookstore.transportation.org/Item_details.aspx?id=1021 | 4 | √ |
| 100 | AASHTO | Practitioner's Handbook #1: Maintaining a Project File and Preparing an Administrative Record for a NEPA Study | 2006 | IS W | X | X | X | | https://bookstore.transportation.org/Item_details.aspx?id=398 | 11 | √ |
| 101 | AASHTO | Practitioner's Handbook #10: Using the Transportation Planning Process to Support the NEPA Process | 2008 | IS W | X | X | X | | https://bookstore.transportation.org/Item_details.aspx?id=1199 | 17 | √ |
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| 103 | AASHTO | Practitioner's Handbook #3: Managing the NEPA Process for Toll Lanes and Toll Roads | 2006 | IS W | X | X | X | | https://bookstore.transportation.org/Item_details.aspx?id=400 | 9 | |

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| 105 | AASHTO | Practitioner's Handbook #5: Utilizing Community Advisory Committees for NEPA Studies | 2007 | IS W | X | X | X | | https://bookstore.transportation.org/Item_details.aspx?id=883 | 13 | √ |
| 106 | AASHTO | Practitioner's Handbook #6: Consulting under Section 106 of the National Preservation Act | 2007 | IS W | X | X | X | | https://bookstore.transportation.org/Item_details.aspx?id=888 | 21 | √ |
| 107 | AASHTO | Practitioner's Handbook #7: Defining the Purpose and Need, and Determining the Range of Alternatives for Transportation Projects | 2007 | IS W | X | X | X | | https://bookstore.transportation.org/Item_details.aspx?id=1158 | 19 | √ |
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| 436 | FHWA | Static Testing of Deep Foundations FHWA-SA-91-042 | February 1992 | W | | | | | http://isddc.dot.gov/OLPFiles/FHWA/009769.pdf | 178 | √ |
| 437 | FHWA | Subsurface Investigations FHWA-HI-97-021 | November 1997 | W | | | | | http://isddc.dot.gov/OLPFiles/FHWA/007919.pdf | 314 | √ |
| 438 | FHWA | Summary Report of Research on Permanent Ground Anchor Walls; Volume I FHWA-RD-98-065 | September 1998 | W | | | | | http://ntl.bts.gov/lib/22000/22100/22115/PB99163180.pdf | 126 | √ |
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| 440 | FHWA | Summary Report of Research on Permanent Ground Anchor Walls; Volume III FHWA-RD-98-067 | September 1998 | W | | | | | http://ntl.bts.gov/lib/17000/17300/17358/PB2001101119.pdf | 204 | √ |
| 441 | FHWA | Summary Report of Research on Permanent Ground Anchor Walls; Volume IV FHWA-RD-98-068 | September 1998 | W | | | | | http://ntl.bts.gov/lib/22000/22100/22117/PB99163206.pdf | 92 | √ |

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| 443 | FHWA | Utility Relocation and Accommodation on Federal-Aid Highway FHWA-IF-03-014 | 6th Edition January 2003 | W | | | | | http://www.fhwa.dot.gov/reports/utilguid/if03014.pdf | 100 | √ |
| 444 | FHWA | Geotechnical Engineering Investigation Handbook | 2nd Edition 2005 | IS | | | | | http://ntlsearch.bts.gov/tris/record/tris/01029963.html | 1,068 | √ |
| 445 | ACI | ACI-318-08 Building Code Requirements for Structural Concrete and Commentary (Includes Errata) | 01/01/08 | IS | | | | | http://www.techstreet.com/cgi-bin/detail?product_id=1532965 | 456 | √ |
| 446 | EIA/TIA Collaboration | 455-171A-FOTP-171 | 06/01/01 | IS | | | | | http://store.ihs.com/specsstore/controller?event=DOCUMENT_DETAILS&docId=CTGOPAAAAAAAAAAA | 1 | √ |
| 447 | TIA | 455-59-FOTP-59 | 02/01/00 | IS | | | | | http://electronics.ihs.com/document/abstract/FIZZIAAAAAAAAAAA | 2 | √ |
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| 449 | TIA | 526-14-A-OFSTP-14 | 08/01/98 | IS | | | | | http://standardsdocuments.tiaonline.org/tia-526-14-a-ofstp-14.htm | 2 | √ |
| 450 | Aluminum Association for Alloy | Alluminum Books and Alloys Number 319.0 | Various | IS | | | | | http://www.aluminum.org/AM/Template.cfm?Section=Best_Sellers&Template=/CM/HTMLDisplay.cfm&ContentID=27631 | 3 | √ |

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| 452 | ASTM | American Society of Testing and Materials Standards | 2009 | IS | | | | | http://www.astm.org/BOOKSTORE/BOS/standard_track1.htm | 87,397 | √ |
| 453 | ADAAG | American with Disabilities Act Accessibility Guidelines for Buildings and Facilities | September 2002 | W | | | | | http://www.access-board.gov/adaag/html/adaag.htm | 142 | √ |
| 454 | California Department of Agriculture | California Noxious Weed Law, California Statutes and the current state list prohibited noxious weeds and restricted noxious weeds ("Noxious Plants of California") | 10/20/03 | W | | | | | http://plants.usda.gov/java/noxious?rptType=State&statefips=06 | 9 | √ |
| 455 | Statue | California State Statutes XXXX | | IS | | | | | http://www.leginfo.ca.gov/statute.html | 1 | √ |
| 456 | Cal-OSHA | Cal-OSHA Safety Manual | | IS | | | | | http://www.oshasafety.com/#whatisit | 67 | √ |
| 457 | American Congress on Surveying and Mapping and the American Society of Civil Engineers | Definitions of Surveying and Associated Terms | 1978 | IS | | | | | http://cedb.asce.org/cgi/WWWdisplay.cgi?0500240 | 211 | √ |

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| 459 | EIA | Electronics Industries Alliance (EIA) Standards | Various | IS | | | | | http://electronics.ihs.com/collections/eia/es58f.htm | 2 | √ |
| 460 | US General Services Administration | Federal Color Standard, 595, Rev B | 12/15/89 | W | | | | | http://www.everyspec.com/FED-STD/FED-STD-595B_5532/ | 58 | √ |
| 461 | Federal Geographic Data Committee | FGDC Geospatial Standards | Various | IS | | | | | http://www.fgdc.gov/standards/standards_publications/index_html | 2,207 | √ |
| 462 | EIA/TIA Collaboration | Fiber Optic Test Procedure (FOTP) Standards | Various | IS | | | | | http://standardsdocuments.tiaonline.org/tia_index5.htm | 46 | √ |
| 463 | USGS | Generalized Skew Coefficients for Flood-Frequency Analysis in California, ~~Report 97-4089~~ | | IS | | | | | http://www3.interscience.wiley.com/journal/119579908/abstract?CRETRY=1&SRETRY=0#fn1 | 2 | √ |
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| 466 | American Iron and Steel Institute | Handbook of Steel Drainage and Highway Construction Products | 2007 | W | | | | | http://www.cspi.ca/english_files/_handbook/complete.pdf | 482 | √ |
| 467 | TRB | Highway Capacity Manual | 2000 | IS | | | | | http://books.trbbookstore.org/hcm2ke.aspx | 1,137 | √ |
| 468 | ANSI | Illuminating Engineering Society of North America Roadway Lighting ANSI Approved | 07/01/00 | IS | | | | | http://www.techstreet.com/cgi-bin/detail?product_id=739518 | 62 | √ |
| 469 | NCHRP | Improved Surface Drainage of Pavements on Project I-29 | June 1998 | IS | | | | | http://www.nap.edu/catalog.php?record_id=6357<br><br>http://www.trb.org/news/blurb_detail.asp?id=3046 | 230 | √ |
| 470 | International Code Council (ICC) | International Building Code | 2009 | IS | | | | | http://www.iccsafe.org/e/prodshow.html?prodid=3000L09 | 666 | |
| 471 | ISO | ISO 9000 | 10/16/05 | IS | | | | | http://www.techstreet.com/cgi-bin/detail?product_id=1235078 | 31 | √ |
| 472 | California Environmental Protection Agency | Managing Asbestos Waste | April 2003 | W | | | | | http://www.dtsc.ca.gov/InformationResources/upload/OAD_PBL_Asbestos_FS3.pdf | 6 | √ |

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| 474 | National Fire Protection Agency (NFPA) | National Electric Code Standards | 2008 | IS | | | | | http://www.nfpa.org/catalog/product.asp?pid=7008LL | 838 | √ |
| 475 | NEMA | National Electrical Manufacturers Association (NEMA) Standards | Various | IS | | | | | http://www.nema.org/stds/list-Title.cfm | 30 | √ |
| 476 | US DOT | National ITS Architecture | Various | IS | | | | | http://itsarch.iteris.com/itsarch/html/standard/standard.htm | 20 | √ |
| 477 | NEMA Joint Publication/ Insulated Cable Engineers Association (ICEA) | NEMA WC70-99; WC71; WC74-00;WC74-06 | Various | IS | | | | | http://www.techstreet.com/cgi-bin/detail?product_id=665059<br><br>http://www.techstreet.com/cgi-bin/detail?product_id=722497<br><br>http://www.techstreet.com/cgi-bin/detail?product_id=1503645 | 183 | √ |
| 478 | NEMA Joint Publication / Insulated Cable Engineers Association (ICEA) | NEMA WC57-2004 | 12/20/04 | IS | | | | | http://www.techstreet.com/cgi-bin/detail?product_id=1188871 | 83 | √ |
| 479 | ASCE | Practical Highway Aesthetics | 1977 | IS | | | | | http://cedb.asce.org/cgi/WWWdisplay.cgi?0305116 | 80 | √ |

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| 481 | API | Recommended Practice for Planning, Design, and Constructing Fixed Offshore Platforms – Working Stress Design | 07/01/93 | IS | | | | | http://www.techstreet.com/cgi-bin/detail?product_id=1819 | 225 | √ |
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| 483 | Illuminating Engineering Society of North America | Roadway Lighting, ANSI Approved | 07/01/00 | IS | | | | | http://www.techstreet.com/cgi-bin/detail?product_id=739518 | 61 | √ |
| 484 | USDA | RUS 7 CFR 1755.900 | 02/17/09 | W | | | | | http://www.usda.gov/rus/telecom/publications/publications.htm<br><br>http://www.usda.gov/rus/telecom/publications/pdf_files/1755-4-2004.pdf<br><br>http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=a86b99b8215fc05b2efa0ab57c6557a0&rgn=div8&view=text&node=7:11.1.2.1.24.0.2.55&idno=7 | 379 | √ |
| 485 | USDA | RUS Splicing Standard PC-2, Section 3.3 | 02/27/95 | W | | | | | http://www.usda.gov/rus/telecom/publications/pdf_files/1753f401.pdf | 44 | √ |

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| 487 | ANSI | Standard for Welding Procedure and Performance Qualification | 11/04/04 | IS | | | | | http://www.techstreet.com/cgi-bin/detail?product_id=1217427 | 283 | √ |
| 488 | APWA | Standard Location for Utilities in Public Rights of Way | 1968 | W | | | | | http://www.apwa.net/Documents/ResourceCenter/Locations_of_utilities_in_PROW.pdf | 22 | √ |
| 489 | NCHRP | Synthesis 360, Rock-Socketed Shafts for Highway Structure Foundations | 09/01/06 | W | | | | | http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_360.pdf | 145 | √ |
| 490 | NCHRP | Synthesis 368, Cone Penetration Testing | | W | | | | | http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_syn_368.pdf | 126 | √ |
| 491 | US Army Corps of Engineers (COE) | Wetlands Delineation Manual | January 1987 | W | | | | | http://www.mvn.usace.army.mil/ops/regulatory/wlman87.pdf | 143 | |
| 492 | ISOA | Guide for Plant Appraisal Workbook | 2000 | IS | | | | | https://www.isarmc.org/store/?includes=product_info&category=3&subcategory=11&product=50 | 12 | √ |
| 493 | Institute of Transportation Engineering (ITE) | Enhancing Intersection Safety Through Roundabouts | December 2008 | IS | | | | | http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=IR-127 | 105 | |

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| 494 | Institute of Transportation Engineering (ITE) | Traffic Engineering Handbook | 6th Edition 2009 | IS | | | | | http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=TB-010B | 917 | √ |
| 495 | Institute of Transportation Engineering (ITE) | Transportation Planning Handbook | 3rd Edition | IS | | | | | http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=TB-011B | 866 | |
| 496 | Institute of Transportation Engineering (ITE) | Trip Generation | 8th Edition | IS | | | | | http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=IR-016F | 1,920 | |
| 497 | Institute of Transportation Engineering (ITE) | Urban Street Geometric Design Handbook | December 2008 | IS | | | | | http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=TB-018 | 461 | |
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| 499 | Institute of Transportation Engineering (ITE) | Transportation Impact Analyses for Site Development | January 2006 | IS | | | | | http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=RP-020C | 142 | |

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| 501 | Institute of Transportation Engineering (ITE) | Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities | January 2005 | IS | | | | | http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=RP-036 | 228 | √ |
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| 503 | Institute of Transportation Engineering (ITE) | Trip Generation and Trip Generation Handbook | 2nd Edition & 7th Edition | IS | | | | | http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=GP-001B | 3,821 | |
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| 505 | US Army Corps of Engineers (COE) | Methods Used in Tieback Wall Design and Construction to Prevent Local Anchor Failure, Progressive Anchorage Failure, and Ground Mass Stability Failure | December 2002 | W | | | | | http://itl.erdc.usace.army.mil/pdf/ITL-TR-02- | 184 | √ |

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| 506 | U.S. Geological Survey | Users Manual for Program PEAKFQ, Annual Flood Frequency Analysis Using Bulletin 17B Guidelines | 1/30/1998 | W | | | | | http://www.novaregion.org/DocumentView.asp?DID=236 | 103 | √ |
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# 2 MODIFICATIONS TO DEPARTMENT (CALTRANS) MANUALS

The following notes apply to the Caltrans Manuals used on this Project:

1. The Department (Caltrans) Manuals were created as an internal guidance document for use by various Department (Caltrans) personnel. As such, the Manuals are written as a guidance documents and not as mandatory requirements. For purposes of design-build projects, the Design-Builder shall assume that all provisions of the Manual, including the figures and tables, are mandatory and guidelines shall be assumed to be requirements. All words such as "should," "may," "must," "might," "could," and "can" shall mean "shall" unless the context requires otherwise, as determined in the sole discretion of Department. The Design-Builder shall disregard qualifying words such as "usually," "normally," and "generally." It shall be in Department's sole discretion to determine when the context does not require a provision to be mandatory.
2. Department (Caltrans) Manuals are standard documents for use by Department (Caltrans) personnel. For purposes of design-build projects, the Design-Builder shall assume that all of the provisions of the Standards are requirements.
3. Individual manuals are available in electronic format. All the Department (Caltrans) manuals can be accessed at the following Web Site: http://caltrans-opac.ca.gov/publicat.htm
4. If the department (Caltrans) Manual expires during the course of the Project the Design-Builder shall contact Department to determine if they should continue to use the manual or if it will be replaced.
5. Any references related to pay items or quantities, measurement for payment, method of measurement, basis of payment, extra work, adjustment of unit prices, or similar phrases shall be disregarded by the Design-Builder , since the Contract Price is full compensation for the Work.
6. No changes have been made to provisions in the Manual that do not apply to design-build contracts, but that provide general information (e.g., descriptions of Department (Caltrans) divisions and their duties, descriptions of legal authority, or descriptions of internal Department (Caltrans) procedures); however, in some cases it may not be clear whether rights or responsibilities are applicable to the Design-Builder. If it is unclear whether specific provisions in the Manual are applicable to the Design-Builder, the Design-Builder shall raise the issue with Department and Department shall make that determination in its sole discretion.
7. The Design-Builder shall disregard the paragraphs within the manuals relating to questions. All questions shall be taken to the Department's Contract Manager.
8. All references to the Engineer shall mean the Design-Builder unless otherwise directed by Department.
9. All references to the Agency shall mean Department (Caltrans), unless noted otherwise.
10. All references to Caltrans shall mean the Design-Builder, unless otherwise noted.
11. All references to Caltrans offices and personnel shall mean the Design-Builder's similar offices and personnel.
12. When the Manual refers to an action being necessary or needed, the Design-Builder shall construe the action as required unless the context requires otherwise, as determined in the sole discretion of Department.

13. In addition, phrases relating to items such as activity[ies] that "will be" conducted, that are "most easily accomplished by", that "are recommended", that "is usually necessary", that "should preferably be" done, that "might require", that "is necessary" or "as necessary", that "are" (or "is") "required" or "done" shall be construed to be mandatory requirements unless the context requires otherwise, as determined in the sole discretion of Department. Phrases relating to problems with activity[ies] that should not be conducted, such as "is not normally used," "is not good practice," "should never be done," "cannot be used," or "should be avoided" shall be construed as prohibited. It shall be in Department's sole discretion to determine when the context either requires or does not require a provision to be mandatory.
14. Where the notes refer to items that are indicated in the plans or special provisions or required in the plans or special provisions, the plans or special provisions shall mean the Design-Builder's plans or special provisions.
15. Where the notes refer to the Engineer, they shall mean the Design-Builder unless otherwise specified below.
16. When the Manual refers to other manuals, the version of these manuals applicable to this design-build project is the version current at the time of the date of this Invitation. For Bid (IFB) unless modified by Addendum or Change Order.
17. References to approved products or materials shall mean Approved by Caltrans.
18. References to payment, pay items and quantities are hereby deleted.
19. All references to the Inspector, the Field Inspector, the Project Engineer, the Engineer, the Materials Engineer, the District Materials Engineer, the Survey Crew, the Project Supervisor, the Agency Certified Technician, the Certified Plant Technician, and the Representative of the Office of Materials shall mean the Design-Builder, unless noted otherwise.
20. All references to the Department (Caltrans) facilities, including the Office of Materials Laboratory, Central Laboratory, Cement Laboratory, Concrete & Metals Laboratory, Aggregate Laboratory, Chemical Laboratory, Mix Design Laboratory, District Laboratory, and the Laboratory shall mean the Design-Builder's similar Laboratory facilities, unless noted otherwise.
21. The Design-Builder shall use forms as required to report the same information and in the same format as the Caltrans forms shown in the Manuals.
22. The Design-Builder shall complete all laboratory testing at a Department certified and approved facility with current AASHTO Materials Reference Laboratory (AMRL) certification.

# 3 MODIFICATIONS TO TECHNICAL MEMORANDA (NOT USED)

# 4 DESIGN-BUILD MODIFICATIONS TO THE CALTRANS STANDARD SPECIFICATIONS MAY 2006 EDITION

## General

These Contract Provisions are a revised version of Caltrans's Standard Specifications – May 2006 Edition and contain requirements generally applicable to the Work to be performed by Design-Builder. In certain cases provisions in the Standard Specifications have been superseded by other provisions of the Contract Documents. For ease of reference, this document uses the same section numbers as the Standard Specifications and identifies provisions of the Contract Documents that have replaced or modified the standard clauses. If there are conflicts between the "General" Modifications and the Specific Modifications below, the Specific Modifications have precedence over the General Modifications. If the Design-Builder believes that a modification is unclear, the Design-Builder shall have the obligation to raise the issue with Department. Regardless of whether the Design-Builder raises the issue, Department shall always have the right to notify the Design-Builder if the Design-Builder is interpreting the modification incorrectly. Any references to other standards, codes, or criteria, or to the latest version of other standards, codes, or criteria in the Technical Provisions of the Contract Documents shall mean the latest version as of the Request for Proposals (RFP) issue date. Those standard specifications that are left blank are not modified in this Modification document, but they may be modified by Special Provisions or other Contract Documents. All Sections are incorporated herein, except as otherwise provided in the Contract Documents, and with the following general and specific exceptions:

***General Exceptions:***

1. When these Specifications refer to "Measurement for Payment," "Method of Measurement," or "Payment Quantities," such language shall be disregarded. It is not the intent of the Design-Build Contract that the various components of the Work will be measured for payment. Final payment will be at the Contract Price for the completed Project irrespective of the quantities of the various components incorporated in the Work.
2. When these Specifications refer to "basis of payment," "unit prices," or "adjustments of unit prices," such references and language shall be disregarded, except unit prices as identified in the Technical Provisions, applicable to disincentives for Nonconforming Work or incentives for surface ride quality shall be either the specific dollar amount set forth in the standard specifications or a unit price proposed by the Design-Builder and Approved by Department.
3. When these Specifications refer to "extra work," "compensation for," "at the Department's expense," "quantity adjustments," "equivalent quantities," or similar phrases, such references shall be disregarded. It is intended that the payment of the Contract Price will be full compensation for all Work performed pursuant to the Design-Build Contract unless specific provisions for additional payments are contained in the Contract Documents. An exception to this general exclusion will be the provisions of Sections 10 thru 95, as modified by the Special Provisions, relating to incentives for surface ride quality and disincentives for Nonconforming Work.
4. When these specifications refer to the term "Special Provision," such term shall mean Contract Documents.
5. When these specifications refer to the term "incidental" such term shall mean that the costs shall be included in the Design-Builder's Price Proposal.

# A. Sections 1 thru 9 – General Provisions– Specific Modifications

## *Section 1 Definitions and Terms*

Provisions regarding Definitions and Terms are deleted in their entirety and are replaced with the following:

## *Section 1 General*

1-1 General

1-1.01 General

Section 1 includes general rules of interpretation.

The Department is gradually standardizing the style and language of the specifications. The new style and language includes:

1. Use of:

    1.1. Imperative mood
    1.2. Introductory modifiers
    1.3. Conditional clauses

2. Elimination of:

    2.1. Language variations
    2.2. Definitions for industry-standard terms
    2.3. Redundant specifications
    2.4. Needless cross-references

The use of this new style does not change the meaning of a specification not yet using this style.

Sections 1 through 9 include general specifications applicable to every contract unless specified as applicable under certain conditions.

Sections 10 through 15 include specifications for general construction applicable to every contract unless specified as applicable under certain conditions.

The specifications are written to the Bidder before award and the Contractor after. Before award, interpret sentences written in the imperative mood as starting with "The Bidder must" and interpret "you" as "the Bidder" and "your" as "the Bidder's." After award, interpret sentences written in the imperative mood as starting with "The Contractor must" and interpret "you" as "the Contractor" and "your" as "the Contractor's."

Omission of "a," "an," and "the" is intentional. These articles have been omitted in some specifications for streamlining purposes.

Unless an object or activity is specified to be less than the total, the quantity or amount is all of the object or activity.

A plural term includes the singular.

All items in a list apply unless the items are specified as choices.

Headings are included for the purposes of organization and referencing. Inclusion of a heading with no related content, "Reserved," or "Not Used" does not indicate that no specification exists for that subject; applicable specifications may be covered in a general or referenced specification.

1-2 References

1-2.01 References

Provisions regarding References are hereby deleted in their entirety and are set forth in Section 1 "Contract Components; Interpretation of Contract Documents" of the Contract Documents.

1-3 Abbreviations And Measurement Units

1-3.01 Abbreviations

Provisions regarding Abbreviations are hereby deleted in their entirety and are set forth in Exhibit A "Acronyms And Definitions" of the Contract Documents.

1-3.02 Measurement Units

| **Measurement Units** | |
|---|---|
| Symbols as used in the specifications | Meaning |
| A | amperes |
| ACRE | acre |
| CF | cubic foot |
| CY | cubic yard |
| EA | each |
| g | gram |
| GAL | gallon |
| h | hour |
| ksi | kips per square inch |
| LB | pound |
| LS | lump sum |
| LF | linear foot |
| LNMI | lane mile |
| MFBM | thousand foot board measure |
| MI | mile |
| MSYD | thousand station yard |
| Ω | ohm |
| pcf | pounds per cubic foot |
| s | second |
| STA | 100 feet |
| SQFT | square foot |
| SQYD | square yard |
| TAB | tablet |
| ton | 2,000 pounds |
| V | volt |
| W | watt |
| WDAY | working day |

1-4 Definitions

Provisions regarding Definitions & Glossary are hereby deleted in their entirety and are set forth in Exhibit A "Acronyms And Definitions" of the Contract Documents.

1-5 Districts

**District Composition and Office Addresses**

| District | Counties | Location Address | Mailing Address |
|---|---|---|---|
| 1 | Del Norte (DN), Humboldt (Hum), Lake (Lak), Mendocino (Men) | 1656 UNION ST<br>EUREKA, CA | PO BOX 3700<br>EUREKA CA 95502 |
| 2 | Lassen (Las), Modoc (Mod), Plumas (Plu), Shasta (Sha), Siskiyou (Sis), Tehama (Teh), Trinity (Tri) | 1657 RIVERSIDE DR<br>REDDING, CA | PO BOX 496073<br>REDDING CA 96049-6073 |
| 3 | Butte (But), Colusa (Col), El Dorado (ED), Glenn (Gle), Nevada (Nev), Placer (Pla), Sacramento (Sac), Sierra (Sie), Sutter (Sut), Yolo (Yol), Yuba (Yub) | 703 B ST<br>MARYSVILLE, CA | PO BOX 911<br>MARYSVILLE CA 95901 |
| 4 | Alameda (Ala), Contra Costa (CC), Marin (Mrn), Napa (Nap), San Francisco (SF), San Mateo (SM), Santa Clara (SCl), Solano (Sol), Sonoma (Son) | 111 GRAND AVE<br>OAKLAND, CA | PO BOX 23660<br>OAKLAND CA 94623-0660 |
| 5 | Monterey (Mon), San Benito (SBt), San Luis Obispo (SLO), Santa Barbara (SB), Santa Cruz (SCr) | 50 HIGUERA ST<br>SAN LUIS OBISPO, CA | 50 HIGUERA ST<br>SAN LUIS OBISPO CA 93401-5415 |
| 6 | Fresno (Fre), Kern (Ker), Kings (Kin), Madera (Mad), Tulare (Tul) | 1352 W. OLIVE AVE<br>FRESNO, CA | PO BOX 12616<br>FRESNO CA 93728-2616 |
| 7 | Los Angeles (LA), Ventura (Ven) | 100 S. MAIN ST<br>LOS ANGELES, CA | 100 S MAIN ST<br>LOS ANGELES CA 90012 |
| 8 | Riverside (Riv), San Bernardino (SBd) | 464 W 4TH ST<br>SAN BERNARDINO, CA | 464 W 4TH ST<br>SAN BERNARDINO CA 92401-1400 |
| 9 | Inyo (Iny), Mono (Mno) | 500 S MAIN ST<br>BISHOP, CA | 500 S MAIN ST<br>BISHOP CA 93514-3423 |
| 10 | Alpine (Alp), Amador (Ama), Calaveras (Cal), Mariposa (Mpa), Merced (Mer), San Joaquin (SJ), Stanislaus (Sta), Tuolumne (Tuo) | 1976 E CHARTER WAY<br>STOCKTON, CA | PO BOX 2048<br>STOCKTON CA 95201 |
| 11 | Imperial (Imp), San Diego (SD) | 4050 TAYLOR ST<br>SAN DIEGO, CA | 4050 TAYLOR ST<br>SAN DIEGO CA 92110-2737 |
| 12 | Orange (Ora) | 3347 MICHELSON DR STE 100<br>IRVINE, CA | 3347 MICHELSON DR STE 100<br>IRVINE CA 92612-0661 |

1-6 Web Sites, Addresses, And Telephone Numbers

**Web Sites, Addresses, and Telephone Numbers**

| Agency, Department Unit, or Reference | Web Site | Address | Telephone No. |
|---|---|---|---|
| Bidders' Exchange | www.dot.ca.gov/hq/esc/oe/bidex | MSC 26<br>BIDDERS' EXCHANGE<br>DEPARTMENT OF TRANSPORTATION<br>1727 30TH ST<br>SACRAMENTO CA 95816-7005 | (916) 227-6259 |
| Department | www.dot.ca.gov | | |
| Department of General Services, Office of Small Business and DVBE Services | www.pd.dgs.ca.gov/smbus/default.htm | OFFICE OF SMALL BUSINESS AND DVBE SERVICES<br>DEPARTMENT OF GENERAL SERVICES<br>707 3RD ST<br>WEST SACRAMENTO CA 95605-2811 | (800) 559-5529<br>(916) 375-4940 |
| Department of Industrial Relations | www.dir.ca.gov | | |
| Department of Industrial Relations, Division of Apprenticeship Standards | | 455 GOLDEN GATE AVENUE<br>SAN FRANCISCO, CA 94102 | |
| Division of Accounting, Office of External Accounts Payable | http://www.dot.ca.gov/hq/asc/oap/payments/contact.htm#conpets1 | MAJOR CONSTRUCTION PAYMENT AND INFORMATION UNIT<br>OFFICE OF EXTERNAL ACCOUNTS PAYABLE<br>DIVISION OF ACCOUNTING<br>DEPARTMENT OF TRANSPORTATION<br>P.O. BOX 168043<br>SACRAMENTO, CA 95816-8043 | (916) 227-9013 |
| Office Engineer | | MSC 43<br>OFFICE ENGINEER<br>DEPARTMENT OF TRANSPORTATION<br>1727 30TH ST<br>SACRAMENTO CA 95816-7005 | |
| Office Engineer–Verified Bid Results | http://www.dot.ca.gov/hq/esc/oe/awards/bidsum_html/6week_list.html. | | |

| | | | |
|---|---|---|---|
| Offices of Structure Design, Documents Unit | | MSC 9-4/4I<br>DOCUMENTS UNIT OFFICES OF STRUCTURE DESIGN<br>DEPARTMENT OF TRANSPORTATION<br>1801 30TH ST<br>SACRAMENTO CA 95816-7006 | (916) 227-0716 |
| Publication Distribution Unit | | PUBLICATION UNIT<br>DEPARTMENT OF TRANSPORTATION<br>1900 ROYAL OAKS DRIVE<br>SACRAMENTO CA 95815-3800 | |
| Transportation Laboratory | | MATERIALS AND ENGINEERING TESTING SERVICES AND GEOTECHNICAL SERVICES<br>DEPARTMENT OF TRANSPORTATION<br>5900 FOLSOM BLVD<br>SACRAMENTO CA 95819-4612 | (916) 227-7000 |
| Department's Pre-Qualified Products List | http://www.dot.ca.gov/hq/esc/approved_products_list | | |

### *Section 2 Proposal Requirements and Conditions*

Provisions regarding Proposal Requirements and Conditions & Bidding are deleted in their entirety and are set forth in the RFP and the Contract Documents.

### *Section 3 Award and Execution of Contract*

Provisions regarding Award and Execution of Contract are deleted in their entirety and are set forth in the RFP and the Contract Documents.

### *Section 4 Scope of Work*

4-1.01 Intent of Plans and Specifications

Provisions regarding Intent of Plans and Specifications are hereby deleted in their entirety and are set forth in the RFP and the Contract Documents.

4-1.02 Final Cleaning Up

Provisions regarding Final Cleaning Up are hereby deleted in their entirety and are set forth in Section 20 "Acceptance of Project" of the Contract Documents.

4-1.03 Changes

Provisions regarding Changes such as Increased or Decreased Quantities, Changes in Character of Work and Extra Work, alterations of the Work, changed conditions, differing site conditions, suspension of Work, and significant changes in the Work are hereby deleted in their entirety and are set forth in Section 13 "Changes in the Work" of the Contract Documents.

4-1.03A General

Provisions regarding General regarding alterations of the Work, changed conditions, differing site conditions, suspension of Work, and significant changes in the Work are hereby deleted in their entirety and are set forth in Section 13 "Changes in the Work" of the Contract Documents.

4-1.03B Increased or Decreased Quantities

Provisions regarding Increased or Decreased Quantities are hereby deleted in their entirety.

4-1.03C Changes in Character of Work

Provisions regarding Changes in Character of Work are hereby deleted in their entirety and are set forth in Section 13 "Changes in the Work" of the Contract Documents.

4-1.03D Extra Work

Provisions regarding Extra Work and changes are hereby deleted in their entirety and are set forth in Section 13 "Changes in the Work" of the Contract Documents.

4-1.04 Detours

Provisions regarding Detours are hereby deleted in their entirety and are substituted with the following:

GENERAL

Unless otherwise provided, a road undergoing improvements shall be kept open to all traffic by and at the expense of the Design-Builder. Where so provided in the Contract, traffic shall be directed over an approved detour route. The Design-Builder shall keep the portions of the Project being used by public traffic, whether it is through or local traffic, in such condition that the traffic will be adequately accommodated at all times. The Design-Builder shall provide and maintain temporary approaches, crossings, and intersections, roads, streets, businesses, parking lots, residences, garages, farms, and other abutting property in acceptable condition.

PLANNED DETOURS

Planned detours are those specifically identified in the Technical Provisions and within detour agreements between the jurisdictional authorities. Planned detours may designate a route by naming specific streets to follow, in which case the Design-Builder will be required to provide and install signs, signals, and Maintenance of Traffic (MOT) devices as necessary to establish the route. The Design-Builder must provide, install, and maintain signs, signals, and MOT devices as necessary to close the street or ramp.

DESIGN-BUILDER'S REQUEST FOR DETOUR

The Design-Builder may request that through traffic be detoured. The request shall contain all information needed for justification and shall specify the routes to be established. If arrangements can be made that are satisfactory to the agencies having jurisdiction over the roads to be used, Department may then at its sole discretion establish an approved detour subject to the following conditions: (a) The Design-Builder shall

design, provide, install, maintain, and remove all the necessary traffic control devices on the detour roads. (b)The Design-Builder shall pay all expenses incurred in maintaining and restoring the detour roads, except for snow removal. (c) The Design-Builder shall fulfill the obligations for maintenance of local traffic by furnishing, placing, and maintaining all traffic control devices and other traffic protection measures required on the roads undergoing improvements.

TEMPORARY BYPASSES

All temporary bypass facilities requested by the Design-Builder and accepted by Department shall be constructed, maintained, and removed at the Design-Builder's expense.

4-1.05 Use of Materials Found on the Work

Any materials required to be removed from the Project shall become the property of the Design-Builder and shall be disposed of at an appropriate off-site disposal facility provided by the Design-Builder unless otherwise provided in the Contract Documents

## *Section 5 Control of Work*

5-1.01 Authority of the Engineer

Provisions regarding Authority of the Engineer are hereby deleted in their entirety and are set forth in Section 5 "Control of Work" of the Contract Documents. Department has the authority by written order to suspend the Work wholly or in part for the reasons delineated in Section 15 "Termination for Convenience" of the Contract Documents. Failure to enforce a contract provision does not waive enforcement of any contract provision.

5-1.02 Plans and Working Drawings

Provisions regarding Plans and Working Drawings, shop drawings, and other construction documents are hereby deleted in their entirety and are set forth in the Technical Provisions, and the Engineering Documents and requirements applicable to specific portions of the Work may be identified with particularity in such sections.

5-1.02A Excavation Safety Plans

Provisions regarding Excavation Safety Plans are applicable to this project.

5-1.03 Conformity with Contract Documents and Allowable Deviations

The provisions regarding Conformity with Contract Documents and Allowable Deviations are revised as follows:

All Work performed and all materials furnished shall conform to the Contract Documents.

All work performed and all materials furnished shall be in conformance with the lines, grades, cross-sections, dimensions, and material requirements, including tolerances, required by the Contract Documents. If Department finds that the material or the finished product in which the material is used is not in conformance with the Contract Documents, Department will decide whether the Nonconforming Work will be allowed to remain in place, or whether it must be removed and replaced or otherwise corrected as a condition for Final Acceptance.

Plan dimensions and specification values are to be considered as the target value to be strived for and complied with as the design value from which deviations (within tolerances) may be allowed. If any changes to the Contract Document requirements are ordered or authorized by Department, the revised values shall

govern. It is the intent of the Contract requirements that the materials and workmanship shall be uniform in character and shall conform to the prescribed target value or to the middle portion of the tolerance range.

The purpose of the tolerance range is to accommodate occasional minor variations from the median zone that are unavoidable for practical reasons. When a maximum or minimum value is specified, the production and processing of material and the performance of the Work shall be so controlled that the material or workmanship will not be of borderline quality or dimension. Department will allow an industry standard tolerance where working tolerances are not specified.

Sections 10 thru 95 of these specifications provide guidelines, tolerances, and adjustments for many cases of Nonconforming Work. When the Design-Builder or Department finds that the materials furnished, the Work performed, or the finished product does not conform to the requirements of the Contract Documents, including the adjustments set forth in Sections 10 thru 95, but Department determines, in its sole discretion, that reasonably acceptable Work has been produced, Department will determine the extent the Work will be Accepted and remain in place. If Accepted, (1) the Design-Builder shall document the basis for Acceptance based on Department's determination by Change Order, which will provide for an appropriate reduction in the Contract price for such Work or materials not otherwise provided for in this subsection, (2) Department will notify the Design-Builder in writing that the Contract unit price will be reduced in accordance with this subsection, or (3) in lieu of a price reduction, Department may permit correction or replacement of the finished product, provided the correction or replacement does not adversely affect the Work. When such requirements specify a disincentive payment adjustment based on a unit price, the unit price shall be as specified in the applicable specification, and if no unit price is specified, the unit price shall be comparable to bid unit prices for similar work in the area.

The Design-Builder shall have the right to remove and replace the Nonconforming Work in lieu of accepting a price reduction provided the correction or replacement does not adversely affect the Work. However, it is in Department's sole discretion to determine whether a price reduction may be made in lieu of correction or replacement of Nonconforming Work. The reduction in Contract price shall take place as provided in this Section 5, "Control of Work" based upon the Approved unit price. Design-Builder shall prepare the Change Order in accordance with Section 13 "Changes in the Work" of the Contract Documents.

When either the Design-Builder or Caltrans finds that the materials furnished, Work performed, or the finished product are not in conformity with the Contract Documents and Department determines, in its sole discretion, that it has resulted in an inferior or unsatisfactory product, the Work or materials shall be removed and replaced or otherwise corrected at the expense of the Design-Builder.

When no other basis for Acceptance is set forth in the Contract Documents covering Work that is not fully acceptable but that is allowed to remain in place, the Design-Builder shall document Department's basis of Acceptance and payment by Contract modification or change order, which will provide for an appropriate adjustment in payment for the Nonconforming Work as justified by Department's engineering determinations of the reasonable value of the Work performed.

5-1.04 Coordination and Interpretation of Plans, Standard Specifications, and Special Provisions

Replace "5-1.04 Coordination and Interpretation of Plans, Standard Specifications, and Sepcial Provisions" with "5-1.04 Contract Components". Provisions regarding Contract Components are hereby deleted in their entirety. Section 1 "Contract Components; Interpretation of Contract Documents" and the Technical Provisions set forth the order of priority of the various Contract Documents.

5-1.05 Order of Work

Provisions regarding Order of Work are hereby deleted in their entirety.

5-1.055 Subcontracting

5-1.055A General

No subcontract releases you from the contract or relieves you of your responsibility for a subcontractor's work.

If you violate Pub Cont Code § 4100 et seq., the Department may exercise the remedies provided under Pub Cont Code § 4110. The Department may refer the violation to the Contractors State License Board as provided under Pub Cont Code § 4111.

Except for a building-construction non-federal-aid contract, perform work equaling at least 30 percent of the value of the original total bid with your employees and with equipment owned or rented by you, with or without operators.

Each subcontract must comply with the contract.

The Department encourages you to include a dispute resolution process in each subcontract.

Each subcontractor must have an active and valid State contractor's license with a classification appropriate for the work to be performed (Bus & Prof Code, § 7000 et seq.).

Submit copies of subcontracts upon request.

Before subcontracted work starts, submit a Subcontracting Request form.

Do not use a debarred contractor; a current list of debarred contractors is available at the Department of Industrial Relations' Web site.

Upon request, immediately remove and not again use a subcontractor who fails to prosecute the work satisfactorily.

5-1.06 Superintendence

Provisions regarding Superintendence are hereby deleted in their entirety. Provisions regarding responsibilities of Design-Builder and requirements for competent management are set forth in Section 2 “Obligations of Design-Builder” of the Contract Documents.

5-1.07 Lines and Grades

Provisions regarding Lines and Grades are hereby deleted in their entirety.

5-1.08 Inspection

Provisions regarding Inspection are applicable to this project.

5-1.09 Removal of Rejected and Unauthorized Work

Provisions regarding Removal of Rejected and Unauthorized Work are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents

5-1.10 Equipment and Plants

Replace “Section 5-1.10 Equipment and Plants” with “Section 5-1.10 Equipment”. Provisions regarding Equipment are hereby deleted in their entirety and are set forth in Section 2 “Obligations of Design-Builder” and Section 10 “Risk of Loss” of the Contract Documents.

5-1.11 Alternative Equipment

Provisions regarding Alternative Equipment are applicable to this project

5-1.115 Alternative Methods of Construction

Provisions regarding Alternative Methods of Construction Equipment are hereby deleted in their entirety.

5-1.116 Differing Site Conditions

Provisions regarding Differing Site Conditions (23 CFR 635.109) are hereby deleted in their entirety and are set forth in Section 5 "Control of Work" of the Contract Documents.

5-1.12 Character of Workers

Provisions regarding Character of Workers are hereby deleted in their entirety and are set forth Section 7 "Equal Employment Opportunity; Subcontracts; Labor"; of the Contract Documents.

5-1.13 Final Inspection

Provisions regarding interim completion and Final Inspection are hereby deleted in their entirety and are set forth in Section 20 "Acceptance of Project" of the Contract Documents.

5-1.14 Cost Reduction Incentive

Provisions regarding Cost Reduction Incentive are hereby deleted in their entirety.

5-1.15 (Blank)

5-1.16 (Blank)

5-1.17 (Blank)

5-1.18 Property and Facility Preservation

5-1.18A General

Preserve property and facilities, including:

1. Adjacent property
2. Department's instrumentation
3. ESAs
4. Lands administered by other agencies
5. Railroads and railroad equipment
6. Roadside vegetation not to be removed
7. Utilities
8. Waterways

Immediately report damage to the Engineer.

If you cause damage, you are responsible.

Install sheet piling, cribbing, bulkheads, shores, or other supports necessary to support existing facilities or support material carrying the facilities.

Dispose of temporary facilities when they are no longer needed.

If you damage plants not to be removed:

1. Dispose of them outside the right of way unless the Engineer allows you to reduce them to chips and spread the chips within the highway at locations designated by the Engineer

2. Replace them

Replace plants with plants of the same species.

Replace trees with 24-inch-box trees.

Replace shrubs with No. 15 container shrubs.

Replace ground cover plants with plants from flats. Replace Carpobrutus ground cover plants with plants from cuttings. Plant ground cover plants 1 foot on center.

If a plant establishment period is specified, replace plants before the start of the plant establishment period; otherwise, replace plants at least 30 days before Contract acceptance.

Water each plant immediately after planting and saturate the backfill soil around and below the roots or ball of earth around the roots of each plant. Water as necessary to maintain plants in a healthy condition until Contract acceptance.

The Department may make a temporary repair to restore service to a damaged facility.

If working on or adjacent to railroad property, do not interfere with railroad operations.

For an excavation on or affecting railroad property, submit work plans showing the system to be used to protect railroad facilities. Allow 65 days for the Engineer's review of the plans. Do not perform work based on the plans until the Engineer notifies you they are accepted.

5-1.18B Nonhighway Facilities (Including Utilities)

The Department may rearrange a nonhighway facility during the Contract. Rearrangement of a nonhighway facility includes installation, relocation, alteration, or removal of the facility.The Department may authorize facility owners and their agents to enter the highway to perform rearrangement work for their facilities or to make connections or repairs to their property. Coordinate activities to avoid delays.

Notify the Engineer at least 3 business days before you contact the regional notification center under Govt Code § 4216 et seq. Failure to contact the notification center prohibits excavation.

Before starting work that could damage or interfere with underground infrastructure, locate the infrastructure described in the Contract, including laterals and other appurtenances, and determine the presence of other underground infrastructure inferred from visible facilities such as buildings, meters, or junction boxes.

Notify the Engineer if the infrastructure described in the Contract cannot be found. If after giving the notice, you find the infrastructure in a substantially different location than described, finding the infrastructure is paid for as extra work as specified in Section 4-1.03D, "Extra Work."

Underground infrastructure described in the Contract may be in different locations than described, and additional infrastructure may exist.

Upon discovering an underground main or trunk line not described in the Contract, immediately notify the Engineer and the infrastructure owner. The Engineer orders the locating and protecting of the infrastructure. The locating and protecting is paid for as extra work as specified in Section 4-1.03D, "Extra Work." If ordered, repair infrastructure damage. If the damage is not due to your negligence, the repair is paid for as extra work as specified in Section 4-1.03D, "Extra Work."

If necessary underground infrastructure rearrangement is not described in the Contract, the Engineer may order you to perform the work. The rearrangement is paid for as extra work as specified in Section 4-1.03D, "Extra Work."

If you want infrastructure rearrangement different from that described in the Contract:

1. Notify the Engineer
2. Make an arrangement with the infrastructure owner
3. Obtain authorization for the rearrangement
4. The Department does not adjust time or payment for rearrangement different from the Contract
5. Pay the infrastructure owner any additional cost

Immediately notify the Engineer of a delay due to the presence of main line underground infrastructure not described in the Contract or in a substantially different location or due to rearrangement different from the Contract. The Department pays for one of these delays in the same manner as specified for a right of way delay in Section 8-1.09, "Right of Way Delays."

## *Section 6 Control of Material*

6-1 General,

6-1.0 Source of Supply and Quality of Materials

Provisions regarding Source of Supply and Quality of Materials are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents.

6-1.02 State Furnished Materials

Provisions regarding State Furnished Materials are applicable to this project.

6-1.03 Storage of Materials

Provisions regarding Storage of Materials are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents.

6-1.04 Defective Materials

Provisions regarding Defective Materials are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents.

6-1.05 Trade Names and Alternatives

Provisions regarding Trade Names and Alternatives are hereby deleted in their entirety.

6-1.06 Plant Inspection

Provisions regarding Plant Inspection are applicable to this project.

6-1.07 Certificates of Compliance

Provisions regarding Certificates of Compliance are applicable to this project.

6-1.08 Foreign Materials

Provisions regarding Foreign Materials are applicable to this project. Delete the second paragraph.

6-1.085 Buy America (23 CFR 635.410)

For a Federal-aid contract, furnish steel and iron materials to be incorporated into the work that are produced in the United States except:

1. Foreign pig iron and processed, pelletized, and reduced iron ore may be used in the domestic production of the steel and iron materials [60 Fed Reg 15478 (03/24/1995)]

2. If the total combined cost of the materials does not exceed the greater of 0.1 percent of the total bid or $2,500, material produced outside the United States may be used

Production includes:

1. Processing steel and iron materials, including smelting or other processes that alter the physical form or shape (such as rolling, extruding, machining, bending, grinding, and drilling) or chemical composition

2. Coating application, including epoxy coating, galvanizing, and painting, that protects or enhances the value of steel and iron materials

For steel and iron materials to be incorporated into the work, submit a Certificate of Compliance under Section 6-1.07, "Certificates of Compliance," of the Standard Specifications that certifies all production processes occurred in the United States except for the above exceptions.

6-1.087 Buy America (Pub Res Code § 42703(d))

Furnish crumb rubber to be incorporated into the work that is produced in the United States and is derived from waste tires taken from vehicles owned and operated in the United States.

For crumb rubber to be incorporated into the work, submit a Certificate of Compliance under Section 6-1.07, "Certificates of Compliance," of the Standard Specifications that certifies only crumb rubber manufactured in the United States and derived from waste tires taken from vehicles owned and operated in the United States is used.

6-1.09 State Specification Numbers

Provisions regarding State Specification Numbers are applicable

6-2 Local Materials,

6-2.01 General

Provisions regarding General are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents.

6-2.02 Possible Local Material Sources

Provisions regarding Possible Local Material Sources are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents.

6-2.03 Mandatory Local Material Sources

Provisions regarding Mandatory Local Material Sources are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents.

6-3 Testing,

6-3.01 General

Provisions regarding General are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents.

6-3.02 Testing by Contractor

Provisions regarding Testing by Contractor are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents. Provisions regarding quality control and quality assurance are hereby deleted in their entirety and are set forth in the Technical Provisions. The provisions regarding Caltrans oversight of the Work are hereby deleted in their entirety and are set forth in Section 5 “Control of Work” of the Contract Documents. Unless otherwise designated, when AASHTO, ASTM, FSS, AWS, CRSI, UL, and other specifications, standards, methods, tests, or practices are cited in these Specifications, the reference shall be to the latest edition as revised or updated by approved supplements or interim editions published and issued as of the RFP issue date unless otherwise indicated. By mutual agreement, the referenced provisions may govern as updated to the time of application.

## *Section 7 Legal Relations and Responsibility*

7-1.01 Laws to be Observed

Provisions regarding Laws to be Observed are deleted in their entirety and are replaced with the following:

Comply with laws, regulations, orders, decrees, and PLACs applicable to the project. Indemnify and defend the State against any claim or liability arising from the violation of a law, regulation, order, decree, or PLAC by you or your employees. Immediately report to the Engineer in writing a discrepancy or inconsistency between the contract and a law, regulation, order, decree, or PLAC.

7-1.01A Labor Code Requirements

Provisions regarding Labor Code Requirements are applicable to this project. Replace the first clause with the following:

Work on the job site must comply with Labor Code §§ 1727 and 1770-1815 and 8 CA Code of Regs § 16000 et seq. Work includes roadside production and processing of materials.

7-1.01A(1) Hours of Labor

Provisions regarding Hours of Labor are applicable to this project.

7-1.01A(2) Prevailing Wages

Provisions regarding Prevailing Wages are applicable to this project with the modifications noted below.

Replace item 3 in the first paragraph with the following:

3. Upon becoming aware of the subcontractor's failure to pay the specified prevailing rate of wages to the subcontractor's workers, the Contractor must diligently take corrective action to stop or rectify the failure, including withholding sufficient funds due the subcontractor for work performed on the public works project.

Replace the second paragraph with the following:

Pursuant to Section 1775 of the Labor Code, the Division of Labor Standards Enforcement must notify the Contractor on a public works project within 15 days of the receipt by the Division of Labor Standards Enforcement of a complaint of the failure of a subcontractor on that public works project to pay workers the general prevailing rate of per diem wages. If the Division of Labor Standards Enforcement determines that employees of a subcontractor were not paid the general prevailing rate of per diem wages and if the Department did not withhold sufficient money under the contract to pay those employees the balance of wages owed under the general prevailing rate of per diem wages, the Contractor must withhold an amount of moneys due the subcontractor sufficient to pay those employees the general prevailing rate of per diem wages if requested by the Division of Labor Standards Enforcement. The Contractor must pay any money withheld from and owed to a subcontractor upon receipt of notification by the Division of Labor Standards Enforcement that the wage complaint has been resolved. If notice of the resolution of the wage complaint has not been received by the Contractor within 180 days of the filing of a valid notice of completion or acceptance of the public works project, whichever occurs later, the Contractor must pay all moneys withheld from the subcontractor to the Department. The Department withholds these moneys pending the final decision of an enforcement action.

Replace the seventh paragraph with the following:

Changes in general prevailing wage determinations apply to the contract when the Director of Industrial Relations has issued them at least 10 days before release of the RFP (Labor Code § 1773.6 and 8 CA Code of Regs 16204).

7-1.01A(2)(a) Travel and Subsistence Payments

Provisions regarding Travel and Subsistence Payments are applicable to this project.

7-1.01A(3) Payroll Records

Provisions regarding Payroll Records are applicable to this project with the modifications noted below.

Replace the second paragraph with the following:

The Department withholds the penalties specified in subdivision (g) of Labor Code § 1776 for noncompliance with the requirements in Section 1776.

Replace the fourth paragraph with the following:

The Department withholds for delinquent or inadequate payroll records (Labor Code § 1771.5). If the Contractor has not submitted an adequate payroll record by the month's 15th day for the period ending on or before the 1st of that month, the Department withholds 10 percent of the monthly progress estimate, exclusive of mobilization. The Department does not withhold more than $10,000 or less than $1,000.

Delete the fifth paragraph.

7-1.01A(4) Labor Nondiscrimination

Provisions regarding Labor Nondiscrimination are applicable to this project.

7-1.01A(5) Apprentices

Provisions regarding Apprentices are applicable to this project.

7-1.01A(6) (Blank)

7-1.01A(7) (Blank)

7-1.01B Fair Labor Standards Act

Provisions regarding Fair Labor Standards Act are applicable to this project.

7-1.01C Contractor’s Licensing Laws

Provisions regarding Contractor’s Licensing Laws are applicable to this project.

7-1.01D Vehicle Code

Provisions regarding Vehicle Code are applicable to this project.

7-1.01E Trench Safety

Provisions regarding Trench Safety are applicable to this project.

7-1.01F Air Pollution Control

Provisions regarding Air Pollution Control are deleted in their entirety and are replaced with the following:

7-1.01F Environmental Stewardship

Comply with Section 14. “Environmental Stewardship” of the Amended Standard Specifications

7-1.01G Water Pollution

Provisions regarding Water Pollution are applicable to this project.

7-1.01H Use of Pesticides

Provisions regarding Use of Pesticides are applicable to this project.

7-1.01I (Blank)

7-1.01J Assignment of Antitrust Action

Provisions regarding Assignment of Antitrust Actions are applicable to this project.

7-1.02 Load Limitations

Provisions regarding Load Limitations are applicable to this project with the modifications noted below.

Replace the fourth sentence in the second paragraph with the following:

Trucks used to haul treated base, portland cement concrete, or hot mix asphalt shall enter onto the base to dump at the nearest practical entry point ahead of spreading equipment.

Add the following between the fourth and the fifth paragraph:

Loads imposed on existing, new, or partially completed structures shall not exceed the load carrying capacity of the structure or any portion of the structure as determined by AASHTO LRFD with interims and California Amendments, Design Strength Limit State II. The compressive strength of concrete ($f'_c$) to be used in computing the load carrying capacity shall be the smaller of the following:

1. Actual compressive strength at the time of loading

2. Value of $f'_c$ shown on the plans for that portion of the structure or 2.5 times the value of $f_c$ (extreme fiber compressive stress in concrete at service loads) shown on the plans for portions of the structure where no $f'_c$ is shown

7-1.03 Payment of Taxes

Provisions regarding Payment of Taxes are deleted in their entirety and are set forth in Section 11 “Payment” of the Contract Documents.

7-1.04 Permits and Licenses

Provisions regarding Permits and Licenses are deleted in their entirety and are set forth in Section 2 “Obligations of Design-Builder” and are set forth in the Technical Provisions of the Contract Documents.

7-1.05 Patents

Provisions regarding Patents are deleted in their entirety and are set forth in Section 18 “Indemnification” of the Contract Documents.

7-1.06 Safety and Health Provisions

Provisions regarding Safety and Health Provisions are deleted in their entirety and are set forth in Section 16, “Default” of the Contract Documents.

7-1.07 (Blank)

Replace the section including the heading with the following:

7-1.07 Lead Compliance Plan

Prepare a work plan to prevent or minimize worker exposure to lead while managing and handling earth materials, paint system debris, traffic stripe residue, and pavement marking residue containing lead.

Regulations containing specific Cal/OSHA requirements when working with lead include 8 CA Code of Regs § 1532.1.

The plan must contain the items listed in 8 CA Code of Regs § 1532.1(e)(2)(B). Before submittal, a CIH must sign and seal the plan. Submit the plan at least 7 days before starting any activity that presents the potential for lead exposure. The Engineer notifies you of the acceptability of the plan within 4 business days of receipt.

Before starting any activity that presents the potential for lead exposure to employees who have no prior training, including State employees, provide a safety training program to these employees that complies with 8 CA Code of Regs § 1532.1 and your lead compliance program.

Submit copies of air monitoring or job site inspection reports made by or under the direction of the CIH under 8 CA Code of Regs § 1532.1 within 10 days after the date of monitoring or inspection.

Supply personal protective equipment, training, and washing facilities required by your lead compliance plan for 5 State employees.

The Contract Price includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in preparing and implementing the plan as specified in this section.

7-1.08 Public Convenience

Provisions regarding Public Convenience are applicable to this project, with the modifications noted below, except when these Specifications refer to “extra work,” “compensation for,” “at the Department’s expense,” “quantity adjustments,” “equivalent quantities,” or similar phrases, such references shall be disregarded. It is the intent that the payment of the Contract Price will be full compensation for all Work performed pursuant to the Design-Build Contract unless specific provisions for additional payments are contained in the Contract Documents.

Replace the section with the following:

Compliance with the provisions of this section does not relieve you of your responsibility for public safety.

Construction activities must not inconvenience the public or abutting property owners. Schedule and conduct work to avoid unnecessary inconvenience to the public and abutting property owners. Avoid undue delay in construction activities to reduce the public's exposure to construction.

Where possible, route traffic on new or existing paved surfaces.

Maintain convenient access to driveways, houses, and buildings. When the abutting property owner's access across the right of way line is to be eliminated or replaced under the contract, the existing access must not be closed until the replacement access facilities are usable. Construct temporary approaches to crossings and intersecting highways.

Provide a reasonably smooth and even surface for use by traffic at all time during excavation of roadways and construction of embankments. Before other grading activities, place fill at culverts and bridges to allow traffic to cross. If ordered, excavate roadway cuts in layers and construct embankments in partial widths at a time alternating construction from one side to the other and routing traffic over the side opposite the one under construction. Install or construct culverts on only 1/2 the width of the traveled way at a time; keep the traveled way portion being used by traffic open and unobstructed until the opposite side of the traveled way is ready for use by traffic.

Upon completion of rough grading or placing any subsequent layer, bring the surface of the roadbed to a smooth and even condition, free of humps and depressions and satisfactory for the use of the public.

After subgrade preparation for a specified layer of material has been completed, repair any damage to the roadbed or completed subgrade, including damage due to use by the public.

While subgrade and paving activities are underway, allow the public to use the shoulders. If half-width paving methods are used, allow the public to use the side of the roadbed opposite the one under construction. If enough width is available, keep open a passageway wide enough to accommodate at least 2 lanes of traffic at locations where subgrade and paving activities are underway. Shape shoulders or reshape subgrade as necessary to accommodate traffic during subgrade preparation and paving activities.

Apply water or dust palliative for the prevention or alleviation of dust nuisance.

Install signs, lights, flares, temporary railing (Type K), barricades and other facilities to direct traffic. Furnish flaggers whenever necessary to direct the movement of the public through or around the work.

You will be required to pay the cost of replacing or repairing all facilities installed under extra work for the convenience or direction or warning of the public which are lost while in your custody, or are damaged by your operations to such an extent as to require replacement or repair.

The Engineer may order or consent to your request to open a completed section of surfacing, pavement, or structure roadway surface for public use. You will not be compensated for any delay to your construction activities caused by the public. This does not relieve you from any other contractual responsibility.

7-1.09 Public Safety

Provisions regarding Public Safety are applicable to this project, with the modifications noted below, except when these Specifications refer to Section 5-1.02 Plans and Working Drawings. Provisions regarding plans, working drawings, shop drawings, and other construction documents are hereby deleted in their entirety and are set forth in the Technical Provisions, and the Engineering Documents and requirements applicable to specific portions of the Work may be identified with particularity in such sections.

Replace the section with the following:

You are responsible to provide for public safety.

Do not construct a temporary facility that interferes with the safe passage of traffic.

Control dust resulting from the work, inside and outside the right-of-way.

Move workers, equipment, and materials without endangering traffic.

Whenever your operations create a condition hazardous to the public, furnish, erect and maintain those fences, temporary railing, barricades, lights, signs, and other devices and take any other necessary protective measures to prevent damage or injury to the public.

Any fences, temporary railing, barricades, lights, signs, or other devices furnished, erected and maintained by you are in addition to those for which payment is provided elsewhere in the specifications.

Provide flaggers whenever necessary to ensure that the public is given safe guidance through the work zone. Except as ordered, at locations where traffic is being routed through construction under one-way controls, move your equipment in compliance with the one-way controls.

Use of signs, lights, flags, or other protective devices must conform with the California MUTCD and as ordered. Signs, lights, flags or other protective devices must not obscure the visibility of, nor conflict in intent, meaning and function of either existing signs, lights and traffic control devices or any construction area signs or traffic control devices.

Keep existing traffic signals and highway lighting in operation. Other entities perform routine maintenance of these facilities during the work.

Cover signs that direct traffic to a closed area. Providing, maintaining, and removing the covers on construction area signs is paid as extra work under Section 4-1.03D, "Extra Work."

Install temporary illumination in a manner which the illumination and the illumination equipment does not interfere with public safety. The installation of general roadway illumination does not relieve you from furnishing and maintaining any protective devices.

Equipment must enter and leave the highway via existing ramps and crossovers and must move in the direction of public traffic. All movements of workmen and construction equipment on or across lanes open to public traffic must be performed in a manner that will not endanger the public. Your vehicles or other mobile equipment leaving an open traffic lane to enter the construction area, must slow down gradually in advance of the location of the turnoff to give traffic following an opportunity to slow down. When leaving a work area and entering a roadway carrying public traffic, your vehicles and equipment must yield to public traffic.

Immediately remove hauling spillage from roadway lanes or shoulders open to traffic. When hauling on roadways, trim loads and remove material from shelf areas to minimize spillage.

Notify the Engineer not less than 20 days and not more than 90 days before the anticipated start of an activity that will change the vertical or horizontal clearance available to public traffic, including shoulders.

If vertical clearance is temporarily reduced to 15.5 feet or less, place low clearance warning signs in accordance with the California MUTCD and as ordered. Signs must comply with the dimensions, color, and legend requirements of the California MUTCD and these specifications except that the signs must have black letters and numbers on an orange retroreflective background. W12-2P signs must be illuminated so that the signs are clearly visible.

Pave or provide full width continuous and cleared wood walks for pedestrian openings through falsework. Protect pedestrians from falling objects and curing water for concrete. Extend overhead protection for pedestrians not less than 4 feet beyond the edge of the bridge deck. Illuminate all pedestrian openings through falsework. Temporary pedestrian facilities must comply with the American with Disabilities Act of 1990 (ADA).

Do not store vehicles, material, or equipment in a way that:

1. Creates a hazard to the public
2. Obstructs traffic control devices

Do not install or place temporary facilities used to perform the work which interfere with the free and safe passage of public traffic.

If you appear to be neglectful or negligent in furnishing warning devices and taking protective measures, the Engineer may direct your attention to the existence of a hazard and the necessary warning devices must be furnished and installed and protective measures taken by you. If the Engineer points out the inadequacy of warning devices and protective measures, that action on the part of the Engineer does not relieve you from your responsibility for public safety or abrogate the obligation to furnish and pay for these devices and measures.

Install temporary railing (Type K) or other approved protection system under the following conditions:

1. Excavations: Where the near edge of the excavation is within 15 feet from the edge of an open traffic lane

2. Temporarily Unprotected Permanent Obstacles: When the work includes the installation of a fixed obstacle together with a protective system, such as a sign structure together with protective railing, and you elect to install the obstacle before installing the protective system; or you, for your convenience and as authorized, remove a portion of an existing protective railing at an obstacle and do not replace such railing completely the same day

3. Storage Areas: When material or equipment is stored within 15 feet of the edge of an open traffic lane and the storage is not otherwise prohibited by the provisions of these Standard Specifications and the special provisions

4. Height Differentials: When construction operations create a height differential greater than 0.15 feet within 15 feet of the edge of traffic lane

Temporary railing (Type K) does not need to be installed where excavations within 15 feet from edge of an open traffic lane are:

1. Covered with steel plates or concrete covers of adequate thickness to prevent accidental entry by traffic or the public

2. In side slopes, where the downhill slope is 4:1 (horizontal:vertical) or less unless a naturally occurring condition

3. Protected by existing barrier or railing

Offset the approach end of temporary railing (Type K) a minimum of 15 feet from the edge of an open traffic lane. Install the temporary railing on a skew toward the edge of the traffic lane of not more than one foot transversely to 10 feet longitudinally with respect to the edge of the traffic lane. If the 15-foot minimum offset cannot be achieved, the temporary railing must be installed on the 10 to 1 skew to obtain the maximum available offset between the approach end of the railing and the edge of the traffic lane, and an array of temporary crash cushion modules must be installed at the approach end of the temporary railing.

Secure in place temporary railing (Type K) before starting work for which the temporary railing is required.

Where 2 or more lanes in the same direction are adjacent to the area where the work is being performed, including shoulders, the adjacent lane must be closed under any of the following conditions:

1. Work is off the traveled way but within 6 feet of the edge of traveled way, and approach speed is greater than 45 miles per hour

2. Work is off the traveled way but within 3 feet of the edge of traveled way, and approach speed is less than 45 miles per hour

Closure of the adjacent traffic lane is not required when:

1. Performing work behind a barrier

2. Paving, grinding, or grooving

3. Installing, maintaining, or removing traffic control devices except temporary railing (Type K)

Do not reduce an open traffic lane width to less than 10 feet. When traffic cones or delineators are used for temporary edge delineation, the line of cones or delineators is considered the edge of the traveled way.

If a traffic lane is closed with channelizers for excavation work, move the devices to the adjacent edge of the traveled way when not excavating. Space the devices the same as specified for the lane closure.

Do not move or temporarily suspend anything over a traffic lane open to the public unless the public is protected.

7-1.10 Use of Explosives

Provisions regarding Use of Explosives are applicable to this project

7-1.11 Preservation of Property

Provisions regarding Preservation of Property are deleted in their entirety and are replaced with the following:

Comply with Section 5-1.18, "Property and Facility Preservation."

7-1.12 Indemnification and Insurance

Provisions regarding Indemnification and Insurance are deleted in their entirety and are set forth in Section 18 “Indemnification” and Section 9 “Insurance” of the Contract Documents.

7-1.12A Indemnification

Provisions regarding Indemnification are deleted in their entirety and are set forth in Section 18 “Indemnification” of the Contract Documents.

7-1.12B Insurance

Provisions regarding Insurance are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(1) Casualty Insurance

Provisions regarding Casualty Insurance are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(1)(a) Workers’ Compensation and Employer’s Liability Insurance

Provisions regarding Workers’ Compensation and Employer’s Liability Insurance are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(1)(b) Liability Insurance

Provisions regarding Liability Insurance are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(1)(c) Liability Limits/Additional Insureds

Provisions regarding Liability Limits/Additional Insureds are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(2) Automobile Liability Insurance

Provisions regarding Automobile Liability Insurance are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(3) Policy Forms, Endorsements and Certificates

Provisions regarding Policy Forms, Endorsements and Certificates are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(4) Enforcement

Provisions regarding Enforcement are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(5) Self-Insurance

Provisions regarding Self-Insurance are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents.

7-1.12B(6) Miscellaneous

Provisions regarding Miscellaneous are deleted in their entirety and are set forth in Section 9 “Insurance” of the Contract Documents

7-1.125 Legal Actions Against the Department

Provisions regarding Legal Actions Against the Department are applicable to this project with the modifications noted below.

Replace the section with the following:

If legal action is brought against the Department over compliance with a State or Federal law, rule, or regulation applicable to highway work, then:

1. If the Department, in complying with a court order, prohibits you from performing work, the resulting delay is a suspension related to your performance, unless the Department terminates the contract.

2. If a court order other than an order to show cause or the final judgment in the action prohibits the Department from requiring you to perform work, the Department may delete the prohibited work or terminate the contract.

7-1.13 Disposal of Materials Outside the Highway Right of Way

Provisions regarding Disposal of Materials Outside the Highway Right of Way are applicable to this project, with the modifications noted below, except when these Specifications refer to Section 2-1.03 “Examination of Plans, Specifications, Contract, and Site of Work. Provisions regarding plans, working drawings, shop drawings, and other construction documents are hereby deleted in their entirety and are set forth in the Technical Provisions, and the Engineering Documents and requirements applicable to specific portions of the Work may be identified with particularity in such sections.

Delete the fifth and sixth paragraphs.

7-1.14 Cooperation

Provisions regarding Cooperation are applicable to this project.

7-1.15 Relief from Maintenance and Responsibility

Provisions regarding Relief from Maintenance and Responsibility are deleted in their entirety and are set forth in Section 10 “Risk of Loss” of the Contract Documents.

7-1.16 Contractor’s Responsibility for the Work and Materials

Provisions regarding Contractor’s Responsibility for the Work and Materials are deleted in their entirety and are set forth in Section 10 “Risk of Loss” of the Contract Documents.

7-1.165 Damage by Storm, Flood, Tsunami or Earthquake

Provisions regarding Damage by Storm, Flood, Tsunami or Earthquake are deleted in their entirety and are set forth in Section 13 “Changes in the Work” of the Contract Documents.

7-1.17 Acceptance of Contract

Provisions regarding Acceptance of Contract are deleted in their entirety and are set forth in Section 20 “Acceptance of Project” of the Contract Documents.

7-1.18 Property Rights in Materials

Provisions regarding Property Rights in Materials are deleted in their entirety and are set forth in Section 11 “Payment” of the Contract Documents.

7-1.19 Rights in Land and Improvements

Provisions regarding Rights in Land and Improvements are applicable to this project.

7-1.20 Personal Liability

Provisions regarding Personal liability are deleted in their entirety and are set forth in Section 23 “Miscellaneous Provisions” of the Contract Documents.

7-1.21 Repair of Equipment

Provisions regarding Repair of Equipment are deleted in their entirety and are set forth in Section 10 “Risk of Loss” and Section 21 “Warranties” of the Contract Documents.

7-1.22 Material Plants

Provisions regarding Material Plants are deleted in their entirety.

7-1.50 Federal Laws For Federal-Aid Contracts

7-1.50A General

Section 7-1.50, "Federal Laws for Federal-Aid Contracts," includes specifications required in a Federal-aid construction contract and applies to a Federal-aid contract.

Form FHWA-1273 is included in the contract in Section 7-1.50B, "FHWA-1273." Some contract terms on the form are different than those used in other contract parts as shown in the following table:

**FHWA-1273 Terms and Department Equivalencies**

| FHWA-1273 Term | Equivalent Term Used in Other Contract Parts |
|---|---|
| SHA | Department |
| SHA contracting officer | Engineer |
| SHA resident engineer | Engineer |

7-1.50B FHWA-1273

FHWA-1273 Electronic version -- March 10, 1994
with revised Section VI

**REQUIRED CONTRACT PROVISIONS FEDERAL-AID CONSTRUCTION CONTRACTS**

I. General
II. Nondiscrimination
III. Nonsegregated Facilities
IV. Payment of Predetermined Minimum Wage
V. Statements and Payrolls
VI. Record of Materials, Supplies, and Labor
VII. Subletting or Assigning the Contract
VIII. Safety: Accident Prevention
IX. False Statements Concerning Highway Projects
X. Implementation of Clean Air Act and Federal Water Pollution Control Act
XI. Certification Regarding Debarment, Suspension, Ineligibility, and Voluntary Exclusion
XII. Certification Regarding Use of Contract Funds for Lobbying

**ATTACHMENTS**

A. Employment Preference for Appalachian Contracts (included in Appalachian contracts only)

**I. GENERAL**

1. These contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.
2. Except as otherwise provided for in each section, the contractor shall insert in each subcontract all of the stipulations contained in these Required Contract Provisions, and further require their inclusion in any lower tier subcontract or purchase order that may in turn be made. The Required Contract Provisions shall not be incorporated by reference in any case. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with these Required Contract Provisions.
3. A breach of any of the stipulations contained in these Required Contract Provisions shall be sufficient grounds for termination of the contract.
4. A breach of the following clauses of the Required Contract Provisions may also be grounds for debarment as provided in 29 CFR 5.12:

   Section I, paragraph 2;
   Section IV, paragraphs 1, 2, 3, 4, and 7;
   Section V, paragraphs 1 and 2a through 2g.

5. Disputes arising out of the labor standards provisions of Section IV (except paragraph 5) and Section V of these Required Contract Provisions shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the U.S. Department of Labor (DOL) as set forth in 29 CFR 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the DOL, or the contractor's employees or their representatives.
6. **Selection of Labor:** During the performance of this contract, the contractor shall not:

   a. discriminate against labor from any other State, possession, or territory of the United States (except for employment preference for Appalachian contracts, when applicable, as specified in Attachment A), or

b. employ convict labor for any purpose within the limits of the project unless it is labor performed by convicts who are on parole, supervised release, or probation.

## II. NONDISCRIMINATION

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $10,000 or more.)

1. **Equal Employment Opportunity:** Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630 and 41 CFR 60) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under this contract. The Equal Opportunity Construction Contract Specifications set forth under 41 CFR 60-4.3 and the provisions of the American Disabilities Act of 1990 (42 U.S.C. 12101 *et seq.*) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

   a. The contractor will work with the State highway agency (SHA) and the Federal Government in carrying out EEO obligations and in their review of his/her activities under the contract.
   b. The contractor will accept as his operating policy the following statement:

      "It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, preapprenticeship, and/or on-the-job training."

2. **EEO Officer:** The contractor will designate and make known to the SHA contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active contractor program of EEO and who must be assigned adequate authority and responsibility to do so.
3. **Dissemination of Policy:** All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

   a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.
   b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.
   c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minority group employees.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.
e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. **Recruitment:** When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minority groups in the area from which the project work force would normally be derived.

   a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minority group applicants. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group applicants may be referred to the contractor for employment consideration.
   b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, he is expected to observe the provisions of that agreement to the extent that the system permits the contractor's compliance with EEO contract provisions. (The DOL has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Executive Order 11246, as amended.)
   c. The contractor will encourage his present employees to refer minority group applicants for employment. Information and procedures with regard to referring minority group applicants will be discussed with employees.

5. **Personnel Actions:** Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:

   a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.
   b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.
   c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.
   d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with his obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of his avenues of appeal.

6. **Training and Promotion:**

   a. The contractor will assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.
   b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision.
   c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.
   d. The contractor will periodically review the training and promotion potential of minority group and women employees and will encourage eligible employees to apply for such training and promotion.

7. **Unions**: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use his/her best efforts to obtain the cooperation of such unions to increase opportunities for minority groups and women within the unions, and to effect referrals by such unions of minority and female employees. Actions by the contractor either directly or through a contractor's association acting as agent will include the procedures set forth below:

   a. The contractor will use best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.
   b. The contractor will use best efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.
   c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the SHA and shall set forth what efforts have been made to obtain such information.
   d. In the event the union is unable to provide the contractor with a reasonable flow of minority and women referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minority group persons and women. (The DOL has held that it shall be no excuse that the union with which the contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees.) In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these specifications, such contractor shall immediately notify the SHA.

8. **Selection of Subcontractors, Procurement of Materials and Leasing of Equipment:** The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment.

   a. The contractor shall notify all potential subcontractors and suppliers of his/her EEO obligations under this contract.
   b. Disadvantaged business enterprises (DBE), as defined in 49 CFR 23, shall have equal opportunity to compete for and perform subcontracts which the contractor enters into pursuant to this contract. The contractor will use his best efforts to solicit bids from and to utilize DBE subcontractors or subcontractors with meaningful minority group and female representation among their employees. Contractors shall obtain lists of DBE construction firms from SHA personnel.
   c. The contractor will use his best efforts to ensure subcontractor compliance with their EEO obligations.

9. **Records and Reports:** The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following completion of the contract work and shall be available at reasonable times and places for inspection by authorized representatives of the SHA and the FHWA.

   a. The records kept by the contractor shall document the following:

      1. The number of minority and non-minority group members and women employed in each work classification on the project;
      2. The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women;
      3. The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees; and
      4. The progress and efforts being made in securing the services of DBE subcontractors or subcontractors with meaningful minority and female representation among their employees.

   b. The contractors will submit an annual report to the SHA each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data.

## III. NONSEGREGATED FACILITIES

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $10,000 or more.)

a. By submission of this bid, the execution of this contract or subcontract, or the consummation of this material supply agreement or purchase order, as appropriate, the bidder, Federal-aid construction contractor, subcontractor, material supplier, or vendor, as appropriate, certifies that the firm does not maintain or provide for its employees any segregated facilities at any of its establishments, and that the firm does not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The firm agrees that a breach of this certification is a

violation of the EEO provisions of this contract. The firm further certifies that no employee will be denied access to adequate facilities on the basis of sex or disability.

b. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, timeclocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive, or are, in fact, segregated on the basis of race, color, religion, national origin, age or disability, because of habit, local custom, or otherwise. The only exception will be for the disabled when the demands for accessibility override (e.g. disabled parking).

c. The contractor agrees that it has obtained or will obtain identical certification from proposed subcontractors or material suppliers prior to award of subcontracts or consummation of material supply agreements of $10,000 or more and that it will retain such certifications in its files.

## IV. PAYMENT OF PREDETERMINED MINIMUM WAGE

(Applicable to all Federal-aid construction contracts exceeding $2,000 and to all related subcontracts, except for projects located on roadways classified as local roads or rural minor collectors, which are exempt.)

1. **General:**

   a. All mechanics and laborers employed or working upon the site of the work will be paid unconditionally and not less often than once a week and without subsequent deduction or rebate on any account [except such payroll deductions as are permitted by regulations (29 CFR 3) issued by the Secretary of Labor under the Copeland Act (40 U.S.C. 276c)] the full amounts of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment. The payment shall be computed at wage rates not less than those contained in the wage determination of the Secretary of Labor (hereinafter "the wage determination") which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor or its subcontractors and such laborers and mechanics. The wage determination (including any additional classifications and wage rates conformed under paragraph 2 of this Section IV and the DOL poster (WH-1321) or Form FHWA-1495) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers. For the purpose of this Section, contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b) (2) of the Davis- Bacon Act (40 U.S.C. 276a) on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of Section IV, paragraph 3b, hereof. Also, for the purpose of this Section, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs, which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in paragraphs 4 and 5 of this Section IV.

   b. Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein, provided, that the employer’s payroll records accurately set forth the time spent in each classification in which work is performed.

   c. All rulings and interpretations of the Davis-Bacon Act and related acts contained in 29 CFR 1, 3, and 5 are herein incorporated by reference in this contract.

2. **Classification:**

   a. The SHA contracting officer shall require that any class of laborers or mechanics employed under the contract, which is not listed in the wage determination, shall be classified in conformance with the wage determination.
   b. The contracting officer shall approve an additional classification, wage rate and fringe benefits only when the following criteria have been met:

      1. the work to be performed by the additional classification requested is not performed by a classification in the wage determination;
      2. the additional classification is utilized in the area by the construction industry;
      3. the proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination; and
      4. with respect to helpers, when such a classification prevails in the area in which the work is performed.

   c. If the contractor or subcontractors, as appropriate, the laborers and mechanics (if known) to be employed in the additional classification or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the DOL, Administrator of the Wage and Hour Division, Employment Standards Administration, Washington, D.C. 20210. The Wage and Hour Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.
   d. In the event the contractor or subcontractors, as appropriate, the laborers or mechanics to be employed in the additional classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. Said Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.
   e. The wage rate (including fringe benefits where appropriate) determined pursuant to paragraph 2c or 2d of this Section IV shall be paid to all workers performing work in the additional classification from the first day on which work is performed in the classification.

3. **Payment of Fringe Benefits:**

   a. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor or subcontractors, as appropriate, shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly case equivalent thereof.
   b. If the contractor or subcontractor, as appropriate, does not make payments to a trustee or other third person, he/she may consider as a part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, provided, that the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

4. **Apprentices and Trainees (Programs of the U.S. DOL) and Helpers:**

a. Apprentices:

1. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the DOL, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State apprenticeship agency recognized by the Bureau, or if a person is employed in his/her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State apprenticeship agency (where appropriate) to be eligible for probationary employment as an apprentice.
2. The allowable ratio of apprentices to journeyman-level employees on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any employee listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate listed in the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor or subcontractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman-level hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.
3. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeyman-level hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator for the Wage and Hour Division determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.
4. In the event the Bureau of Apprenticeship and Training, or a State apprenticeship agency recognized by the Bureau, withdraws approval of an apprenticeship program, the contractor or subcontractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the comparable work performed by regular employees until an acceptable program is approved.

b. Trainees:

1. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the DOL, Employment and Training Administration.
2. The ratio of trainees to journeyman-level employees on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.
3. Every trainee must be paid at not less than the rate specified in the approved program for his/her level of progress, expressed as a percentage of the journeyman-level hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman-level wage rate on the wage determination which provides for less than full fringe benefits for apprentices, in which case such trainees shall receive the same fringe benefits as apprentices.
4. In the event the Employment and Training Administration withdraws approval of a training program, the contractor or subcontractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Helpers:

Helpers will be permitted to work on a project if the helper classification is specified and defined on the applicable wage determination or is approved pursuant to the conformance procedure set forth in Section IV.2. Any worker listed on a payroll at a helper wage rate, who is not a helper under an approved definition, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed.

5. **Apprentices and Trainees (Programs of the U.S. DOT):**

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

6. **Withholding:**

The SHA shall upon its own action or upon written request of an authorized representative of the DOL withhold, or cause to be withheld, from the contractor or subcontractor under this contract or any other Federal contract with the same prime contractor, or any other Federally-assisted contract subject to Davis-Bacon prevailing wage requirements which is held by the same prime contractor, as much of the accrued payments or advances as may be considered necessary to pay laborers and

mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the SHA contracting officer may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

7. **Overtime Requirements:**

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers, mechanics, watchmen, or guards (including apprentices, trainees, and helpers described in paragraphs 4 and 5 above) shall require or permit any laborer, mechanic, watchman, or guard in any workweek in which he/she is employed on such work, to work in excess of 40 hours in such workweek unless such laborer, mechanic, watchman, or guard receives compensation at a rate not less than one-and-one-half times his/her basic rate of pay for all hours worked in excess of 40 hours in such workweek.

8. **Violation:**

Liability for Unpaid Wages; Liquidated Damages: In the event of any violation of the clause set forth in paragraph 7 above, the contractor and any subcontractor responsible thereof shall be liable to the affected employee for his/her unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory) for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer, mechanic, watchman, or guard employed in violation of the clause set forth in paragraph 7, in the sum of $10 for each calendar day on which such employee was required or permitted to work in excess of the standard work week of 40 hours without payment of the overtime wages required by the clause set forth in paragraph 7.

9. **Withholding for Unpaid Wages and Liquidated Damages:**

The SHA shall upon its own action or upon written request of any authorized representative of the DOL withhold, or cause to be withheld, from any monies payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other Federally-assisted contract subject to the contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph 8 above.

**V. STATEMENTS AND PAYROLLS**

(Applicable to all Federal-aid construction contracts exceeding $2,000 and to all related subcontracts, except for projects located on roadways classified as local roads or rural collectors, which are exempt.)

1. **Compliance with Copeland Regulations (29 CFR 3):**

The contractor shall comply with the Copeland Regulations of the Secretary of Labor which are herein incorporated by reference.

2. **Payrolls and Payroll Records:**

a. Payrolls and basic records relating thereto shall be maintained by the contractor and each subcontractor during the course of the work and preserved for a period of 3 years from the date of completion of the contract for all laborers, mechanics, apprentices, trainees, watchmen, helpers, and guards working at the site of the work.

b. The payroll records shall contain the name, social security number, and address of each such employee; his or her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalent thereof the types described in Section 1(b)(2)(B) of the Davis Bacon Act); daily and weekly number of hours worked; deductions made; and actual wages paid. In addition, for Appalachian contracts, the payroll records shall contain a notation indicating whether the employee does, or does not, normally reside in the labor area as defined in Attachment A, paragraph 1. Whenever the Secretary of Labor, pursuant to Section IV, paragraph 3b, has found that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in Section 1(b)(2)(B) of the Davis Bacon Act, the contractor and each subcontractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, that the plan or program has been communicated in writing to the laborers or mechanics affected, and show the cost anticipated or the actual cost incurred in providing benefits. Contractors or subcontractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprentices and trainees, and ratios and wage rates prescribed in the applicable programs.

c. Each contractor and subcontractor shall furnish, each week in which any contract work is performed, to the SHA resident engineer a payroll of wages paid each of its employees (including apprentices, trainees, and helpers, described in Section IV, paragraphs 4 and 5, and watchmen and guards engaged on work during the preceding weekly payroll period). The payroll submitted shall set out accurately and completely all of the information required to be maintained under paragraph 2b of this Section V. This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal stock number 029- 005-0014-1), U.S. Government Printing Office, Washington, D.C. 20402. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors.

d. Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his/her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

    1. that the payroll for the payroll period contains the information required to be maintained under paragraph 2b of this Section V and that such information is correct and complete;
    2. that such laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in the Regulations, 29 CFR 3;
    3. that each laborer or mechanic has been paid not less that the applicable wage rate and fringe benefits or cash equivalent for the classification of worked performed, as specified in the applicable wage determination incorporated into the contract.

e. The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 2d of this Section V.

f. The falsification of any of the above certifications may subject the contractor to civil or criminal prosecution under 18 U.S.C. 1001 and 31 U.S.C. 231.

g. The contractor or subcontractor shall make the records required under paragraph 2b of this Section V available for inspection, copying, or transcription by authorized representatives of the

SHA, the FHWA, or the DOL, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the SHA, the FHWA, the DOL, or all may, after written notice to the contractor, sponsor, applicant, or owner, take such actions as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

## VI. RECORD OF MATERIALS, SUPPLIES, AND LABOR

(As of May 22, 2007, Form FHWA-47 is no longer required.)

## VII. SUBLETTING OR ASSIGNING THE CONTRACT

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the State. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635).

    a. "Its own organization" shall be construed to include only workers employed and paid directly by the prime contractor and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor, assignee, or agent of the prime contractor.
    b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirements set forth in paragraph 1 of Section VII is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.
3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the SHA contracting officer determines is necessary to assure the performance of the contract.
4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the SHA contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the SHA has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

## VIII. SAFETY: ACCIDENT PREVENTION

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the SHA contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.
2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 333).
3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 333).

## IX. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by Engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, the following notice shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

### NOTICE TO ALL PERSONNEL ENGAGED ON FEDERAL-AID HIGHWAY PROJECTS

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined not more that $10,000 or imprisoned not more than 5 years or both."

## X. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $100,000 or more.)

By submission of this bid or the execution of this contract, or subcontract, as appropriate, the bidder, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any facility that is or will be utilized in the performance of this contract, unless such contract is exempt under the Clean Air Act, as amended (42 U.S.C. 1857 *et seq*., as amended by Pub.L. 91-604), and under the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 *et seq*., as amended by Pub.L. 92-500), Executive Order 11738, and regulations in implementation thereof (40 CFR 15) is not listed, on the date of contract award, on the U.S. Environmental Protection Agency (EPA) List of Violating Facilities pursuant to 40 CFR 15.20.
2. That the firm agrees to comply and remain in compliance with all the requirements of Section 114 of the Clean Air Act and Section 308 of the Federal Water Pollution Control Act and all regulations and guidelines listed thereunder.
3. That the firm shall promptly notify the SHA of the receipt of any communication from the Director, Office of Federal Activities, EPA, indicating that a facility that is or will be utilized for the contract is under consideration to be listed on the EPA List of Violating Facilities.
4. That the firm agrees to include or cause to be included the requirements of paragraph 1 through 4 of this Section X in every nonexempt subcontract, and further agrees to take such action as the government may direct as a means of enforcing such requirements.

## XI. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

1. **Instructions for Certification - Primary Covered Transactions:**

(Applicable to all Federal-aid contracts - 49 CFR 29)

a. By signing and submitting this proposal, the prospective primary participant is providing the certification set out below.
b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective primary participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.
c. The certification in this clause is a material representation of fact upon which reliance was placed when the department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause of default.
d. The prospective primary participant shall provide immediate written notice to the department or agency to whom this proposal is submitted if any time the prospective primary participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
e. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and

Coverage sections of rules implementing Executive Order 12549. You may contact the department or agency to which this proposal is submitted for assistance in obtaining a copy of those regulations.

f. The prospective primary participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

g. The prospective primary participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the nonprocurement portion of the "Lists of Parties Excluded From Federal Procurement or Nonprocurement Programs" (Nonprocurement List) which is compiled by the General Services Administration.

i. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

j. Except for transactions authorized under paragraph f of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

*** * * * ***

**Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Primary Covered Transactions**

1. The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

   a. Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

   b. Have not within a 3-year period preceding this proposal been convicted of or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

c. Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph 1b of this certification; and
d. Have not within a 3-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

2. Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

*** * * * ***

2. **Instructions for Certification - Lower Tier Covered Transactions:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions of $25,000 or more - 49 CFR 29)

a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.
b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.
c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.
d. The terms "covered transaction," "debarred," "suspended," "ineligible," "primary covered transaction," "participant," "person," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.
e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.
f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.
g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.
h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

*** * * * ***

**Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Covered Transactions:**

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

*** * * * ***

## XII. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

(Applicable to all Federal-aid construction contracts and to all related subcontracts which exceed $100,000 - 49 CFR 20)

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

   a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
   b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.
3. The prospective participant also agrees by submitting his or her bid or proposal that he or she shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

7-1.50C Female and Minority Goals

To comply with Section II, "Nondiscrimination," of "Required Contract Provisions Federal-Aid Construction Contracts," the Department is including in Section 7-1.50C, "Female and Minority Goals," female and minority utilization goals for Federal-aid construction contracts and subcontracts that exceed $10,000.

The nationwide goal for female utilization is 6.9 percent.

The goals for minority utilization [45 Fed Reg 65984 (10/3/1980)] are as follows:

Minority Utilization Goals

| Economic Area | | Goal (Percent) |
|---|---|---|
| 174 | Redding CA: | |
| | Non-SMSA Counties: | 6.8 |
| | CA Lassen; CA Modoc; CA Plumas; CA Shasta; CA Siskiyou; CA Tehema | |
| 175 | Eureka, CA | |
| | Non-SMSA Counties: | 6.6 |
| | CA Del Norte; CA Humboldt; CA Trinity | |
| 176 | San Francisco-Oakland-San Jose, CA: | |
| | SMSA Counties: | |
| | 7120 Salinas-Seaside-Monterey, CA | 28.9 |
| | CA Monterey | |
| | 7360 San Francisco-Oakland | 25.6 |
| | CA Alameda; CA Contra Costa; CA Marin; CA San Francisco; CA San Mateo | |
| | 7400 San Jose, CA | |
| | CA Santa Clara, CA | 19.6 |
| | 7485 Santa Cruz, CA | |
| | CA Santa Cruz | 14.9 |
| | 7500 Santa Rosa | |
| | CA Sonoma | 9.1 |
| | 8720 Vallejo-Fairfield-Napa, CA | |
| | CA Napa; CA Solano | 17.1 |
| | Non-SMSA Counties: | |
| | CA Lake; CA Mendocino; CA San Benito | 23.2 |

| | | |
|---|---|---|
| 177 | Sacramento, CA: | |
| | SMSA Counties: | |
| | 6920 Sacramento, CA | 16.1 |
| | CA Placer; CA Sacramento; CA Yolo | |
| | Non-SMSA Counties | 14.3 |
| | CA Butte; CA Colusa; CA El Dorado; CA Glenn; CA Nevada; CA Sierra; CA Sutter; CA Yuba | |
| 178 | Stockton-Modesto, CA: | |
| | SMSA Counties: | |
| | 5170 Modesto, CA | 12.3 |
| | CA Stanislaus | |
| | 8120 Stockton, CA | 24.3 |
| | CA San Joaquin | |
| | Non-SMSA Counties | 19.8 |
| | CA Alpine; CA Amador; CA Calaveras; CA Mariposa; CA Merced; CA Toulumne | |
| 179 | Fresno-Bakersfield, CA | |
| | SMSA Counties: | |
| | 0680 Bakersfield, CA | 19.1 |
| | CA Kern | |
| | 2840 Fresno, CA | 26.1 |
| | CA Fresno | |
| | Non-SMSA Counties: | 23.6 |
| | CA Kings; CA Madera; CA Tulare | |
| 180 | Los Angeles, CA: | |
| | SMSA Counties: | |
| | 0360 Anaheim-Santa Ana-Garden Grove, CA | 11.9 |
| | CA Orange | |
| | 4480 Los Angeles-Long Beach, CA | 28.3 |
| | CA Los Angeles | |
| | 6000 Oxnard-Simi Valley-Ventura, CA | 21.5 |
| | CA Ventura | |
| | 6780 Riverside-San Bernardino-Ontario, CA | 19.0 |
| | CA Riverside; CA San Bernardino | |

| | | |
|---|---|---|
| | 7480 Santa Barbara-Santa Maria-Lompoc, CA | 19.7 |
| | CA Santa Barbara | |
| | Non-SMSA Counties | 24.6 |
| | CA Inyo; CA Mono; CA San Luis Obispo | |
| 181 | San Diego, CA: | |
| | SMSA Counties | |
| | 7320 San Diego, CA | 16.9 |
| | CA San Diego | |
| | Non-SMSA Counties | 18.2 |
| | CA Imperial | |

For each July during which work is performed under the contract, you and each non-material-supplier subcontractor with a subcontract of $10,000 or more must complete Form FHWA PR-1391 (Appendix C to 23 CFR 230). Submit the forms by August 15.

7-1.50D Training

Section 7-1.50D, "Training," applies if a number of trainees or apprentices is specified in the special provisions.

As part of your equal opportunity affirmative action program, provide on-the-job training to develop full journeymen in the types of trades or job classifications involved.

You have primary responsibility for meeting this training requirement.

If you subcontract a contract part, determine how many trainees or apprentices are to be trained by the subcontractor.

Include these training requirements in your subcontract.

Where feasible, 25 percent of apprentices or trainees in each occupation must be in their 1st year of apprenticeship or training.

Distribute the number of apprentices or trainees among the work classifications on the basis of your needs and the availability of journeymen in the various classifications within a reasonable recruitment area.

Before starting work, submit to the Department:

1. Number of apprentices or trainees to be trained for each classification
2. Training program to be used
3. Training starting date for each classification

Obtain the Department's approval for this submitted information before you start work. The Department credits you for each apprentice or trainee you employ on the work who is currently enrolled or becomes enrolled in an approved program.

The primary objective of Section 7-1.50D, "Training," is to train and upgrade minorities and women toward journeymen status. Make every effort to enroll minority and women apprentices or trainees, such as conducting systematic and direct recruitment through public and private sources likely to yield minority and women apprentices or trainees, to the extent they are available within a reasonable recruitment area. Show that you have made the efforts. In making these efforts, do not discriminate against any applicant for training.

Do not employ as an apprentice or trainee an employee:

1. In any classification in which the employee has successfully completed a training course leading to journeyman status or in which the employee has been employed as a journeyman

2. Who is not registered in a program approved by the US Department of Labor, Bureau of Apprenticeship and Training

Ask the employee if the employee has successfully completed a training course leading to journeyman status or has been employed as a journeyman. Your records must show the employee's answers to the questions.

In your training program, establish the minimum length and training type for each classification. The Department and FHWA approves a program if one of the following is met:

1. It is calculated to:

1.1. Meet the your equal employment opportunity responsibilities

1.2. Qualify the average apprentice or trainee for journeyman status in the classification involved by the end of the training period

2. It is registered with the U.S. Department of Labor, Bureau of Apprenticeship and Training and it is administered in a way consistent with the equal employment responsibilities of federal-aid highway construction contracts

Obtain the State's approval for your training program before you start work involving the classification covered by the program.

Provide training in the construction crafts, not in clerk-typist or secretarial-type positions. Training is allowed in lower level management positions such as office engineers, estimators, and timekeepers if the training is oriented toward construction applications. Training is allowed in the laborer classification if significant and meaningful training is provided and approved by the division office. Off-site training is allowed if the training is an integral part of an approved training program and does not make up a significant part of the overall training.

The Department reimburses you 80 cents per hour of training given an employee on this contract under an approved training program:

1. For on-site training

2. For off-site training if the apprentice or trainee is currently employed on a federal-aid project and you do at least one of the following:

2.1. Contribute to the cost of the training

2.2. Provide the instruction to the apprentice or trainee

2.3. Pay the apprentice's or trainee's wages during the off-site training period

3. If you comply with Section 7-1.50D, "Training"

Each apprentice or trainee must:

1. Begin training on the project as soon as feasible after the start of work involving the apprentice's or trainee's skill

2. Remain on the project as long as training opportunities exist in the apprentice's or trainee's work classification or until the apprentice or trainee has completed the training program

Furnish the apprentice or trainee:

1. Copy of the program you will comply with in providing the training

2. Certification showing the type and length of training satisfactorily completed

Maintain records and submit reports documenting your performance under Section 7-1.50D, "Training."

### *Section 8 Prosecution and Progress*

Provisions regarding Section 8 “Prosecution and Progress” are deleted in their entirety and are replaced with the following:

8-1.01 (Blank)

8-1.02 Assignment

Provisions regarding Assignment are deleted in their entirety and are set forth in Section 23 “Miscellaneous Provisions” of the Contract Documents.

8-1.025 Preconstruction Conference

Provisions regarding Preconstruction Conference are deleted in their entirety.

8-1.03 Beginning of Work

Provisions regarding Beginning of Work are deleted in their entirety and are set forth in Section 4 “Time within which Project shall be Completed; Scheduling” of the Contract Documents.

8-1.04 Progress Schedule

Provisions regarding Progress Schedule are deleted in their entirety and are replaced with the following:

8-1.04A General

Reserved

8-1.04B Critical Path Method Schedule

The following definitions apply to critical path method schedules:

**activity**: Task, event, or other project element on a schedule that contributes to completing the project. Activities have a description, start date, finish date, duration, and one or more logic ties.

**baseline schedule**: The initial schedule showing the original work plan beginning on the date of contract approval. This schedule shows no completed work to date and no negative float or negative lag to any activity.

**controlling activity**: Construction activity that extends the scheduled completion date if delayed.

**critical path**: Longest continuous chain of activities for the project that has the least amount of total float of all chains. In general, a delay on the critical path extends the scheduled completion date.

**critical path method (CPM)**: Network based planning technique using activity durations and relationships between activities to calculate a schedule for the entire project.

**revised schedule**: Schedule that incorporates a proposed or past change to logic or activity durations.

**scheduled completion date**: Planned project completion date shown on the current schedule.

**updated schedule**: Current schedule developed from the accepted baseline and any subsequent accepted updated or revised schedules through regular monthly review to incorporate actual past progress.

Before or at the preconstruction conference, submit a CPM baseline schedule.

Submit a monthly updated schedule that includes the status of work completed to date and the work yet to be performed as planned.

On each schedule, show:

1. Planned and actual start and completion date of each work activity, including applicable:

1.1. Submittal development

1.2. Submittal review and approval

1.3. Material procurement

1.4. Contract milestones and constraints

1.5. Equipment and plant setup

1.6. Interfaces with outside entities

1.7. Erection and removal of falsework and shoring

1.8. Test periods

1.9. Major traffic stage change

1.10. Final cleanup

2. Order that you propose to prosecute the work

3. Logical links between the time-scaled work activities

4. All controlling activities

5. Legible description of each activity

6. At least one predecessor and one successor to each activity, except for project start and project end milestones

7. Duration of not less than one working day for each activity

8. Start milestone date as the contract approval date

You may include changes on updated schedules that do not alter the critical path or extend the schedule completion date compared to the current schedule. Changes may include:

1. Adding or deleting activities

2. Changing activity constraints

3. Changing durations

4. Changing logic

If any proposed change in planned work results in altering the critical path or extending the scheduled completion date, submit a revised schedule within 15 days of the proposed change.

For each schedule submittal:

1. Submit a plotted original, time-scaled network diagram on a sheet of at least 8.5" x 11" with a title block and timeline

2. If a computer program is used to make the schedule, submit a read-only compact disc or diskette containing the schedule data. Label the compact disc or diskette with:

2.1. Contract number

2.2. CPM schedule number and date produced

2.3. File name

Full compensation for this work is included in the Contract Prices paid for the items of work involved, and no additional compensation will be allowed therefor.

8-1.05 Temporary Suspension of Work

Provisions regarding Temporary Suspension of Work are deleted in their entirety and are set forth in Section 14 “Suspension of Work” of the Contract Documents.

8-1.06 Time of Completion

Provisions regarding Time of Completion of Work are deleted in their entirety and are set forth in Section 4 “Time within which Project shall be Completed; Scheduling” and Section 20 “Acceptance of Project” of the Contract Documents.

8-1.07 Liquidated Damages

Provisions regarding Liquidated Damages are deleted in their entirety and are set forth in Section 17 “Damages” of the Contract Documents

8-1.08 Termination of Control

Provisions regarding Termination of Control are deleted in their entirety and are set forth in Section 15 “Termination for Convenience” of the Contract Documents

8-1.09 Right of Way Delays

Provisions regarding Right of Way Delays are deleted in their entirety and are set forth in Section 6 “Access to Site; Utility Relocations; Environmental Mitigation”, Section 11 “Payment” and Section 13 “Changes in Work” of the Contract Documents

8-1.10 (Blank)

8-1.11 Termination of Contract

Provisions regarding Termination of Contract are deleted in their entirety and are set forth in Section 15 “Termination for Convenience” of the Contract Documents

## *Section 9 Measurement and Payment*

Provisions regarding Section 9 "Measurement and Payment" are deleted in their entirety and are replaced with the following:

9-1.01 Measurement of Quantities

Provisions regarding measurement of quantities are hereby deleted and replaced with the following: The purpose of measurement of quantities is to identify Quality Control and Verification testing frequency requirements as contained in the Materials Control Schedule and in tracking production rates for monthly payments to the Design-Builder based on percentage complete. All specifications within the Caltrans Standard Specifications for Construction containing sections describing Method of Measurement and Basis of Payment shall have the sections describing Method of Measurement and Basis of Payment deleted. The Design-Builder hereby acknowledges and agrees that the single lump sum Contract Price constitutes full compensation for performance of all of the Work, subject only to those exceptions specified in the Contract Documents.

9-1.02 Scope of Payment

Provisions regarding scope of payment are hereby deleted in their entirety and are set forth in Section 11 "Payment" of the Contract Documents.

9-1.03 Force Account Payment

Provisions regarding Force Account Payment are applicable to this project.

9-1.03A General

For work paid by force account, the Engineer compares the Department's records to your daily force account work report. When you and the Engineer agree on the contents of the daily force account work reports, the Engineer accepts the report and the Department pays for the work. If the records differ, the Department pays for the work based only on the information shown on the Department's records.

If a subcontractor performs work at force account, accept an additional 10 percent markup to the total cost of that work paid at force account, including markups specified in Section 9-1.03, as reimbursement for additional administrative costs.

The markups specified in labor, materials, and equipment include compensation for all delay costs, overhead costs, and profit.

If an item's payment is adjusted for work-character changes, the Department excludes your cost of determining the adjustment.

Payment for owner-operated labor and equipment is made at the market-priced invoice submitted.

9-1.03B Labor

Labor payment is full compensation for the cost of labor used in the direct performance of the work plus a 35 percent markup. Force account labor payment consists of:

1. Employer payment to the worker for:

1.1. Basic hourly wage

1.2. Health and welfare

1.3. Pension

1.4. Vacation

1.5. Training

1.6. Other State and federal recognized fringe benefit payments

2. Labor surcharge percentage in Labor Surcharge and Equipment Rental Rates current during the work paid at force account for:

2.1. Workers' compensation insurance

2.2. Social security

2.3. Medicare

2.4. Federal unemployment insurance

2.5. State unemployment insurance

2.6. State training taxes

3. Subsistence and travel allowances paid to the workers

4. Employer payment to supervisors, if authorized

The 35 percent markup consists of payment for all overhead costs related to labor but not designated as costs of labor used in the direct performance of the work including:

1. Home office overhead

2. Field office overhead

3. Bond costs

4. Profit

5. Labor liability insurance

6. Other fixed or administrative costs that are not costs of labor used in the direct performance of the work

9-1.03C Materials

Material payment is full compensation for materials you furnish and use in the work. The Engineer determines the cost based on the material purchase price, including delivery charges, except:

1. A 15 percent markup is added.

2. Supplier discounts are subtracted whether you took them or not.

3. If the Engineer believes the material purchase prices are excessive, the Department pays the lowest current wholesale price for a similar material quantity.

4. If you procured the materials from a source you wholly or partially own, the determined cost is based on the lower of the:

4.1. Price paid by the purchaser for similar materials from that source on Contract items

4.2. Current wholesale price for those materials

5. If you do not submit a material cost record within 30 days of billing, the determined cost is based on the lowest wholesale price:

5.1. During that period

5.2. In the quantities used

9-1.03D Equipment Rental

9-1.03D(1) General

Equipment rental payment is full compensation for:

1. Rental equipment costs, including moving rental equipment to and from the site of work performed by change order using its own power.

2. Transport equipment costs for rental equipment that cannot be transported economically using its own power. No payment is made during transport for the transported equipment.

3. 15 percent markup.

If you want to return the equipment to a location other than its original location, the payment to move the equipment must not exceed the cost of returning the equipment to its original location. If you use the equipment for work other than work paid by force account, the transportation cost is included in the other work.

Before moving or loading the equipment, obtain authorization for the equipment rental's original location.

The Engineer determines rental costs:

1. Using rates in Labor Surcharge and Equipment Rental Rates:

1.1. By classifying equipment using manufacturer's ratings and manufacturer-approved changes.

1.2. Current during the work paid by force account.

1.3. Regardless of equipment ownership; but the Department uses the rental document rates or minimum rental cost terms if:

1.3.1. Rented from equipment business you do not own.

1.3.2. The Labor Surcharge and Equipment Rental Rates hourly rate is $10.00 per hour or less.

2. Using rates established by the Engineer for equipment not listed in Labor Surcharge and Equipment Rental Rates. You may submit cost information that helps the Engineer establish the rental rate; but the Department uses the rental document rates or minimum rental cost terms if:

2.1. Rented from equipment business you do not own.

2.2. The Engineer establishes a rate of $10.00 per hour or less.

3. Using rates for transport equipment not exceeding the hourly rates charged by established haulers.

Equipment rental rates include the cost of:

1. Fuel

2. Oil

3. Lubrication

4. Supplies

5. Small tools that are not consumed by use

6. Necessary attachments

7. Repairs and maintenance

8. Depreciation

9. Storage

10. Insurance

11. Incidentals

The Department pays for small tools consumed by use. The Engineer determines payment for small tools consumed by use based on Contractor-submitted invoices.

9-1.03D(2) Equipment On the Job Site

For equipment on the job site at the time required to perform work paid by force account, the time paid is the time:

1. To move the equipment to the location of work paid by force account plus an equal amount of time to move the equipment to another location on the job site when the work paid by force account is completed

2. To load and unload equipment

3. Equipment is operated to perform work paid by force account and:

3.1. Hourly rates are paid in 1/2-hour increments

3.2 Daily rates are paid in 1/2-day increments

When rented equipment on the job site is used to perform work at force account not required by the original contract work, the Engineer may authorize rates in excess of those in Labor Surcharge and Equipment Rental Rates if:

1. You submit a request to use rented equipment

2. Equipment is not available from your owned equipment fleet or from your subcontractors

3. Rented equipment is from an independent rental company

4. Proposed equipment rental rate is reasonable

5. Engineer authorizes the equipment source and the rental rate before you use the equipment

The Department pays for fuel consumed during operation of rented equipment not included in the invoiced rental rate.

9-1.03D(3) Equipment Not On the Job Site Required for Original Contract Work

For equipment not on the job site at the time required to perform work paid by force account and required for original Contract work, the time paid is the time the equipment is operated to perform work paid by force account and the time to move the equipment to a location on the job site when the work paid by force account is completed.

The minimum total time paid is:

1. 1 day if daily rates are paid

2. 8 hours if hourly rates are paid

If daily rates are recorded, equipment:

1. Idled is paid as 1/2 day

2. Operated 4 hours or less is paid as 1/2 day

3. Operated 4 hours or more is paid as 1 day

If the minimum total time exceeds 8 hours and if hourly rates are listed, the Department rounds up hours operated to the nearest 1/2-hour increment and pays based on the following table. The table does not apply when equipment is not operated due to breakdowns; in which case rental hours are the hours the equipment was operated.

**Equipment Rental Hours**

| Hours operated | Hours paid |
|---|---|
| 0.0 | 4.00 |
| 0.5 | 4.25 |
| 1.0 | 4.50 |
| 1.5 | 4.75 |
| 2.0 | 5.00 |
| 2.5 | 5.25 |
| 3.0 | 5.50 |
| 3.5 | 5.75 |
| 4.0 | 6.00 |
| 4.5 | 6.25 |
| 5.0 | 6.50 |
| 5.5 | 6.75 |
| 6.0 | 7.00 |
| 6.5 | 7.25 |
| 7.0 | 7.5 |
| 7.5 | 7.75 |
| ≥8.0 | hours used |

9-1.03D(4) Equipment Not On the Job Site Not Required for Original Contract Work

For equipment not on the job site at the time required to perform work paid by force account and not required for original Contract work, the time paid is the time:

1. To move the equipment to the location of work paid by force account plus an equal amount of time to return the equipment to its source when the work paid by force account is completed

2. To load and unload equipment

3. Equipment is operated to perform work paid by force account

For this equipment, the Engineer may authorize rates in excess of those in Labor Surcharge and Equipment Rental Rates subject to the following:

1. Equipment is not available from your normal sources or from one of your subcontractors

2. Proposed equipment rental rate is reasonable

3. Engineer authorizes the equipment source and the rental rate before you use the equipment

9-1.03D(5) Non-Owner-Operated Dump Truck Rental

Submit the rental rate for non-owner-operated dump truck rental. The Engineer determines the payment rate. Payment for non-owner-operated dump truck rental is for the cost of renting a dump truck, including its driver. For the purpose of markup payment only, the non-owner-operated dump truck is rental equipment and the owner is a subcontractor.

9-1.04 Not used

9-1.05 Not used

9-1.06 Not used

9-1.07 Not used

9-1.08 Not used

9-1.09 Clerical Errors

For 3 years after Contract acceptance, estimates and payments are open to correction and adjustment for clerical errors. Either the Department or the Contractor pays to the other the amount due except for clerical errors resulting in an adjustment less than $200; in which case, no payment is made.

9-1.10 Not used

## B. Sections 10 through 95

***General Modifications***

1. On technical issues “The Engineer” shall mean the Design-Builder.

2. On Administrative issues “The Engineer” shall mean Department.

If the Design-Builder believes that a definition of “The Engineer” is unclear, the Design-Builder shall have the obligation to raise the issue with Caltrans. Regardless of whether the Design-Builder raises the issue, Department shall always have the right to notify the Design-Builder if the Design-Builder is interpreting the definition of “The Engineer” incorrectly.

***Specific Modifications***

For any specific modifications on Section 10 through 95, please refer to the Exhibit 4-A, “Amendments to the Standard Specifications – Section 10 to Section 95”.

# EXHIBIT 4-A

Amendments to the Standard Specifications - Section 10 to Section 95

# AMENDMENTS ISSUE DATE: 05-13-11

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## SECTION 10 DUST CONTROL
**(Issued 02-06-09)**

**Replace Section 10 with:**
**SECTION 10 (BLANK)**

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## SECTION 11 MOBILIZATION
**(Issued 06-05-09)**

**Replace Section 11 with:**
**SECTION 11 (BLANK)**

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## SECTION 12 CONSTRUCTION AREA TRAFFIC CONTROL DEVICES
**(Issued 11-07-08)**

**In Section 12-1.01 in the 2nd paragraph, replace the 1st sentence with:**

Attention is directed to Part 6 of the California MUTCD.

**Replace Section 12-2.01 with:**

## 12-2.01 FLAGGERS

Flaggers while on duty and assigned to traffic control or to give warning to the public that the highway is under construction and of any dangerous conditions to be encountered as a result thereof, shall perform their duties and shall be provided with the necessary equipment in conformance with Part 6 of the California MUTCD. The equipment shall be furnished and kept clean and in good repair by the Contractor at the Contractor's expense.

All flaggers shall wear safety apparel meeting the requirements of ANSI/ISEA 107-2004 for Class 2 or 3 garment and complying with 71 Fed Reg 67792.

**In Section 12-3.01 replace the 1st paragraph with:**

In addition to the requirements in Part 6 of the California MUTCD, all devices used by the Contractor in the performance of the work shall conform to the provisions in this Section 12-3.

**In Section 12-3.06 in the 1st paragraph, replace the 2nd sentence with:**

Construction area signs are shown in or referred to in Part 6 of the California MUTCD.

**In Section 12-3.06 in the 4th paragraph, replace the 1st sentence with:**

All construction area signs shall conform to the dimensions, color and legend requirements of the plans, Part 6 of the California MUTCD and these specifications.

**In Section 12-3.06 in the 8th paragraph, replace the 1st sentence with:**

Used signs with the specified sheeting material will be considered satisfactory if they conform to the requirements for visibility and legibility and the colors conform to the requirements in Part 6 of the California MUTCD.

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**SECTION 14 (BLANK)**
**(Issued 06-05-09)**

**Replace Section 14 with:**

# SECTION 14 ENVIRONMENTAL STEWARDSHIP

## 14-1 GENERAL

### 14-1.01 GENERAL

Environmental stewardship includes both environmental compliance and environmental resource management.

If an ESA is shown on the plans:

1. The boundaries shown are approximate; the Department marks the exact boundaries on the ground
2. Do not enter the ESA unless authorized
3. If the ESA is breached, immediately:
   3.1. Secure the area and stop all operations within 60 feet of the ESA boundary
   3.2. Notify the Engineer
4. If the ESA is damaged, the Department determines what efforts are necessary to remedy the damage and who performs the remedy; you are responsible for remedies and charges.

## 14-2 CULTURAL RESOURCES

### 14-2.01 GENERAL

Reserved

### 14-2.02 ARCHAEOLOGICAL RESOURCES

If archaeological resources are discovered at the job site, do not disturb the resources and immediately:

1. Stop all work within a 60-foot radius of the discovery
2. Protect the discovery area
3. Notify the Engineer

The Department investigates. Do not take archaeological resources from the job site. Do not resume work within the discovery area until authorized.

If, in the opinion of the Engineer, completion of the work is delayed or interfered with by reason of an archaeological find, or investigation or recovery of archeological materials, you will be compensated for resulting losses, and an extension of time will be granted, in the same manner as provided for in Section 8-1.09, "Right of Way Delays."

If ordered, furnish resources to assist in the investigation or recovery of archaeological resources. This work will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

### 14-2.03 ARCHAEOLOGICAL MONITORING AREA

Section 14-2.03 applies if an AMA is described in the Contract.

The Department assigns an archaeological monitor to monitor job site activities within the AMA. Do not work within the AMA unless the archeological monitor is present.

The Engineer and the Department archaeological monitor conduct an AMA location field review with you at least 5 business days before start of work. The Department marks the exact boundaries of the AMA on the ground.

If temporary fence (Type ESA) for an AMA is described in the Contract, install temporary fence (Type ESA) to define the boundaries of the AMA during the AMA location field review.

At least 5 business days before starting work within an AMA, submit a schedule of days and hours to be worked for the Engineer's approval. If you require changes in the schedule, submit an update for the Engineer's approval at least 5 business days before any changed work day.

If archaeological resources are discovered within an AMA, comply with Section 14-2.02, "Archaeological Resources."

### 14-2.04 HISTORIC STRUCTURES

Reserved

## 14-3 COMMUNITY IMPACTS AND ENVIRONMENTAL JUSTICE

Reserved

## 14-4 NATIVE AMERICAN CONCERNS

Reserved

## 14-5 AESTHETICS

Reserved

## 14-6 BIOLOGICAL RESOURCES

### 14-6.01 GENERAL

Reserved

### 14-6.02 BIRD PROTECTION

Protect migratory and nongame birds, their occupied nests, and their eggs.

The Department anticipates nesting or attempted nesting from February 15 to September 1.

The federal Migratory Bird Treaty Act, 16 USC § 703–711, and 50 CFR Pt 10 and Fish & Game Code §§ 3503, 3513, and 3800 protect migratory and nongame birds, their occupied nests, and their eggs.

The federal Endangered Species Act of 1973, 16 USC §§ 1531 and 1543, and the California Endangered Species Act, Fish & Game Code §§ 2050–2115.5, prohibit the take of listed species and protect occupied and unoccupied nests of threatened and endangered bird species.

The Bald and Golden Eagle Protection Act, 16 USC § 668, prohibits the destruction of bald and golden eagles and their occupied and unoccupied nests.

If migratory or nongame bird nests are discovered that may be adversely affected by construction activities or an injured or killed bird is found, immediately:

1. Stop all work within a 100-foot radius of the discovery.
2. Notify the Engineer.

The Department investigates. Do not resume work within the specified radius of the discovery until authorized.

When ordered, use exclusion devices, take nesting prevention measures, remove and dispose of partially constructed and unoccupied nests of migratory or nongame birds on a regular basis to prevent their occupation, or perform any combination of these. This work will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

Prevent nest materials from falling into waterways.

Bird protection that causes a delay to the controlling activity is a condition unfavorable to the suitable prosecution of work as specified in Section 8-1.05, "Temporary Suspension of Work."

## 14-7 PALEONTOLOGICAL RESOURCES

If paleontological resources are discovered at the job site, do not disturb the material and immediately:

1. Stop all work within a 60-foot radius of the discovery
2. Protect the area
3. Notify the Engineer

The Department investigates and modifies the dimensions of the protected area if necessary. Do not take paleontological resources from the job site. Do not resume work within the specified radius of the discovery until authorized.

## 14-8 NOISE AND VIBRATION

### 14-8.01 GENERAL

Reserved

### 14-8.02 NOISE CONTROL

Do not exceed 86 dBa at 50 feet from the job site activities from 9 p.m. to 6 a.m.

Equip an internal combustion engine with the manufacturer-recommended muffler. Do not operate an internal combustion engine on the job site without the appropriate muffler.

# 14-9 AIR QUALITY

## 14-9.01 AIR POLLUTION CONTROL

Comply with air pollution control rules, regulations, ordinances, and statutes that apply to work performed under the Contract, including air pollution control rules, regulations, ordinances, and statutes provided in Govt Code § 11017 (Pub Cont Code § 10231).

Do not burn material to be disposed of.

## 14-9.02 DUST CONTROL

Prevent and alleviate dust by applying water, dust palliative, or both under Section 14-9.01.

Apply water under Section 17, "Watering."

Apply dust palliative under Section 18,"Dust Palliative."

If ordered, apply water, dust palliative, or both to control dust caused by public traffic. This work will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

# 14-10 SOLID WASTE DISPOSAL AND RECYCLING

## 14-10.01 SOLID WASTE DISPOSAL AND RECYCLING

Submit an annual Solid Waste Disposal and Recycling Report between January 1 and 15 for each year work is performed under the Contract at any time during the previous calendar year. Show the types and amounts of project-generated solid waste taken to or diverted from landfills or reused on the project from January 1 through December 31 of the previous calendar year.

Submit a final annual Solid Waste Disposal and Recycling Report within 5 business days after Contract acceptance. Show the types and amounts of project-generated solid waste taken to or diverted from landfills or reused on the project from January 1 to Contract acceptance.

For each failure to submit a completed form, the Department withholds $10,000.

# 14-11 HAZARDOUS WASTE AND CONTAMINATION

## 14-11.01 GENERAL

Reserved

## 14-11.02 ASBESTOS AND HAZARDOUS SUBSTANCES

Upon discovery, immediately stop working in and notify the Engineer of areas where asbestos or a hazardous substance is present if the:

1. Contractor reasonably believes the substance is asbestos as defined in Labor Code § 6501.7 or a hazardous substance as defined in Health & Safety Code §§ 25316 and 25317
2. Presence is not described in the Contract
3. Substance has not been made harmless

## 14-12 OTHER INTERAGENCY RELATIONS

Reserved

## 14-13 PAYMENT

Payment for work specified in Section 14 is included in the payment for the bid items involved unless:

1. Bid item for the work is shown in the verified Bid Item List
2. Work is specified as paid for as extra work

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# SECTION 15 EXISTING HIGHWAY FACILITIES
**(Issued 05-01-09)**

**In Section 15-1.02 replace the 1st paragraph with:**

Existing facilities which are to remain in place shall be protected in conformance with the provisions in Sections 5-1.18, "Property and Facility Preservation," and 7-1.12, "Indemnification and Insurance."

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# SECTION 19 EARTHWORK
**(Issued 11-21-08)**

**Replace Section 19-1.02 with:**

## 19-1.02 (BLANK)

**Replace Section 19-1.03 with:**

## 19-1.03 GRADE TOLERANCE

Immediately prior to placing subsequent layers of material thereon, the grading plane shall conform to one of the following:

A. When hot mix asphalt is to be placed on the grading plane, the grading plane at any point shall not vary more than 0.05 foot above or below the grade established by the Engineer.

B. When subbase or base material to be placed on the grading plane is to be paid for by the ton, the grading plane at any point shall not vary more than 0.10 foot above or below the grade established by the Engineer.
C. When the material to be placed on the grading plane is to be paid for by the cubic yard, the grading plane at any point shall be not more than 0.05 foot above the grade established by the Engineer.

**In Section 19-3.025C replace the 1st paragraph with:**

Cementitious material used in soil cement bedding shall conform to the provisions in Section 90-2.01, "Cementitious Materials." Supplementary cementitious material will not be required.

**In Section 19-3.025C replace the 4th paragraph with:**

The aggregate, cementitious material, and water shall be proportioned either by weight or by volume. Soil cement bedding shall contain not less than 282 pounds of cementitious material per cubic yard. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed.

**In Section 19-3.062 replace the 1st paragraph with:**

Slurry cement backfill shall consist of a fluid, workable mixture of aggregate, cementitious material, and water.

**In Section 19-3.062 replace the 5th paragraph with:**

Cementitious material shall conform to the provisions in Section 90-2.01, "Cementitious Materials." Supplementary cementitious material will not be required.

**In Section 19-3.062 replace the 8th paragraph with:**

The aggregate, cementitious material, and water shall be proportioned either by weight or by volume. Slurry cement backfill shall contain not less than 188 pounds of cementitious material per cubic yard. The water content shall be sufficient to produce a fluid, workable mix that will flow and can be pumped without segregation of the aggregate while being placed.

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# SECTION 20 EROSION CONTROL AND HIGHWAY PLANTING
**(Issued 08-17-07)**

**Replace Section 20-2.03 with:**

## 20-2.03 SOIL AMENDMENT

Soil amendment shall comply with the requirements in the California Food and Agricultural Code.

Soil amendment producers shall comply with the following:

1. Be fully permitted to produce compost as specified under the California Integrated Waste Management Board, Local Enforcement Agencies and any other State and Local Agencies that regulate Solid Waste Facilities. If exempt from State permitting requirements, the composting facility must certify that it follows guidelines and procedures for production of compost meeting the environmental health standards of Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7.
2. Be a participant in United States Composting Council's Seal of Testing Assurance program.

Soil amendment shall be composted and may be derived from any single, or mixture of any of the following feedstock materials:

1. Green material consisting of chipped, shredded, or ground vegetation; or clean processed recycled wood products
2. Biosolids
3. Manure
4. Mixed food waste

Soil amendment feedstock materials shall be composted to reduce weed seeds, pathogens and deleterious materials as specified under Title 14, California Code of Regulations, Division 7, Chapter 3.1, Article 7, Section 17868.3.

Soil amendment shall not be derived from mixed municipal solid waste and must be reasonably free of visible contaminates. Soil amendment must not contain paint, petroleum products, pesticides or any other chemical residues harmful to animal life or plant growth. Soil amendment must not possess objectionable odors.

Metal concentrations in soil amendment must not exceed the maximum metal concentrations listed in Title 14, California Code of Regulations, Division 7, Chapter 3.1, Section 17868.2.

Soil amendment must comply with the following:

Physical/Chemical Requirements

| Property | Test Method | Requirement |
|---|---|---|
| pH | *TMECC 04.11-A, Elastometric pH 1:5 Slurry Method, pH Units | 6.0–8.0 |
| Soluble Salts | TMECC 04.10-A, Electrical Conductivity 1:5 Slurry Method dS/m (mmhos/cm) | 0-10.0 |
| Moisture Content | TMECC 03.09-A, Total Solids & Moisture at 70+/- 5 deg C, % Wet Weight Basis | 30–60 |
| Organic Matter Content | TMECC 05.07-A, Loss-On-Ignition Organic Matter Method (LOI), % Dry Weight Basis | 30–65 |
| Maturity | TMECC 05.05-A, Germination and Vigor<br>Seed Emergence<br>Seedling Vigor<br>% Relative to Positive Control | <br>80 or Above<br>80 or Above |
| Stability | TMECC 05.08-B, Carbon Dioxide Evolution Rate mg $CO_2$-C/g OM per day | 8 or below |
| Particle Size | TMECC 02.02-B Sample Sieving for Aggregate Size Classification % Dry Weight Basis | 95% Passing 5/8 inch<br>70% Passing 3/8 inch |
| Pathogen | TMECC 07.01-B, Fecal Coliform Bacteria < 1000 MPN/gram dry wt. | Pass |
| Pathogen | TMECC 07.01-B, Salmonella < 3 MPN/4 grams dry wt. | Pass |
| Physical Contaminants | TMECC 02.02-C, Man Made Inert Removal and Classification:<br>Plastic, Glass and Metal, % > 4mm fraction | Combined Total: < 1.0 |
| Physical Contaminants | TMECC 02.02-C, Man Made Inert Removal and Classification:<br>Sharps (Sewing needles, straight pins and hypodermic needles), % > 4mm fraction | None Detected |

*TMECC refers to "Test Methods for the Examination of Composting and Compost," published by the United States Department of Agriculture and the United States Compost Council (USCC).

Prior to application, the Contractor shall provide the Engineer with a copy of the soil amendment producer's Compost Technical Data Sheet and a copy of the compost producers STA certification. The Compost Technical Data Sheet shall include laboratory analytical test results, directions for product use, and a list of product ingredients.

Prior to application, the Contractor shall provide the Engineer with a Certificate of Compliance in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications.

**In Section 20-2.10 delete the 8th, 9th, and 10th paragraphs.**

**In Section 20-3.04A delete the last paragraph.**

**Replace Section 20-4.055 with:**

## 20-4.055 PRUNING

Pruning of plants shall be consistent with American National Standards Institute (ANSI), "Tree, Shrub and Other Woody Plant Maintenance Standard Practices," ANSI 300 (Part 1)-2001 and "Best Management Practices Tree Pruning," 2002 (ISBN 1-881956318), published by the International Society of Arboriculture, P.O. Boc 3129, Champaign, IL 61826.

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# SECTION 24 LIME STABILIZATION
**(Issued 06-05-09)**

**Replace Section 24 with:**

# SECTION 24 LIME STABILIZED SOIL

## 24-1.01 GENERAL

### 24-1.01A Summary

Section 24 includes specifications for stabilizing soil by mixing lime and water with soil and compacting the mixture to the specified dimensions.

### 24-1.01B Definitions

**lime:** Quicklime made from high-calcium or dolomitic sources specified under ASTM C 51. For high-calcium quicklime, the calcium oxide content must be greater than 90 percent. For dolomitic quicklime, the calcium oxide content must be greater than 55 percent and the combined calcium oxide and magnesium oxide content must be greater than 90 percent.

**mellowing period:** The time between the initial and final mixing to promote initial chemical reactions between lime, water, and soil.

### 24-1.01C Submittals

From 30 to 180 days before use, submit one 10-pound sample of each lime product proposed and from each source.

Submit lime samples in airtight containers under ASTM C 50. Mark the sample date on the container. Include the MSDS and chemical and physical analysis with the submittal.

With the lime samples, submit a Certificate of Compliance from the pre-qualified lime source under Section 6-1.07, "Certificates of Compliance," with a statement certifying the lime furnished is the same as that pre-qualified.

Fifteen days before starting soil stabilization activities, submit for the Engineer's approval a laboratory to perform quality control tests. The laboratory must be qualified under the Department's Independent Assurance Program.

Before you apply lime in slurry form, submit the slurry's lime content for Engineer's approval 25 days before application.

Before performing quality control sampling and testing, submit the time and location the sampling and testing will occur. Submit quality control testing results within 24 hours of receiving the results.

Submit a weighmaster certificate or bill of lading with each load of lime delivered to the jobsite.

## 24-1.01D Quality Control and Assurance

### General

Perform quality control testing in the presence of the Engineer.

Place unique, sequentially numbered lock seals on each load and affix them to trailer blow down valves that are locked open. The bill of lading for each lime delivery must have that specific lock seal number legibly and visibly imprinted.

The Engineer samples each lime delivery truck at the job site and randomly tests them off-site.

### Pre-qualification of Lime Sources

Lime sources must be listed on the Department's pre-qualified products list. The list is available at the METS web site.

The pre-qualified list for lime sources describes the application procedures for inclusion on the list.

### Preparing Soil

After you prepare an area for lime soil stabilization, test the soil to be stabilized every 500 cubic yards for relative compaction under California Test 231 and moisture content under California Test 226, and verify the surface grades.

### Applying Lime

The Engineer determines the final application rate for each lime product proposed from the samples submitted. If the soil being stabilized changes, the Engineer changes the application rate. Based on California Test 373, the Engineer reports the application rates as the percent of lime by dry weight of soil. The Engineer provides the optimum moisture content determined under California Test 373 for each application rate.

Before applying lime, measure the temperature at the ground surface.

If lime in dry form is used, the Engineer verifies the application rate using the drop pan method once per 40,000 square feet stabilized, or twice per day, whichever is greater.

If lime in slurry form is used, report the quantity of slurry placed by measuring the volume of slurry in the holding tank once per 40,000 square feet stabilized, or twice per day, whichever is greater.

**Mixing**

For each day of initial mixing, test the moisture content. Sample the material immediately after initial mixing.

Randomly test the adequacy of the final mixing with a phenolphthalein indicator solution.

During mixing operations, measure the ground temperature at full mixing depth.

After mixing and before compacting, determine maximum density under California Test 216 from composite samples of the mixed material and at each distinct change in material. Test the moisture content of the mixed material under California Test 226. Test the gradation for compliance with "Materials."

**Compaction**

Test relative compaction on a wet weight basis.

After initial compaction, determine in-place density under California Test 231 and moisture content under California Test 226 at the same locations. The testing frequency must be 1 test per 250 cubic yards of lime stabilized soil. Test in 0.50-foot depth intervals.

Before requesting to compact material in layers greater than 0.50 foot, construct a test strip in the production area and demonstrate the test strip passes compaction tests using the proposed thickness. The test strip must contain no more material than 1 day's production. The Engineer tests at not more than 0.50-foot depth intervals regardless of the thickness of your layers.

Construct test pads by scraping away material to the depth ordered by the Engineer. If a compaction test fails corrective action must include the layers of material already placed above the test pad elevation.

**Finish Grading**

Do not proceed with construction activities for subsequent layers of material until the Engineer verifies the final grades of the lime stabilized soil.

**Dispute Resolution**

You and the Engineer must work together to avoid potential conflicts and to resolve disputes regarding test result discrepancies. Notify the Engineer within 5 days of receiving a test result if you dispute the test result.

If you or the Engineer dispute each other's test results, submit written quality control test results and copies of paperwork including worksheets used to determine the disputed test results to the Engineer. An Independent Third Party (ITP) performs referee testing. Before the ITP participates in a dispute resolution, the ITP must be accredited under the Department's Independent Assurance Program. The ITP must be independent of the project. By mutual agreement, the ITP is chosen from:

1. A Department laboratory
2. A Department laboratory in a district or region not in the district or region the project is located
3. The Transportation Laboratory
4. A laboratory not currently employed by you or your lime producer

If split quality control or acceptance samples are not available, the ITP uses any available material representing the disputed material for evaluation.

## 24-1.02 MATERIALS

### 24-1.02A Lime

Lime must comply with ASTM C 977 and the following:

**Lime**

| Quality Characteristic | ASTM | Specification |
|---|---|---|
| Available Calcium and Magnesium Oxide(min., %) | C 25[a] | High Calcium Quicklime: CaO > 90 Dolomitic Quicklime: CaO > 55 and CaO + MgO > 90 |
| Loss on ignition (max., %) | C 25 | 7 (total loss) 5 (carbon dioxide) 2 (free moisture) |
| Slaking rate | C 110 | 30 °C rise in 8 minutes |

Notes:
[a] You may use ASTM C25 or ASTM C1301 and ASTM C1271.

A 0.5-pound sample of lime dry-sieved in a mechanical sieve shaker for 10 minutes ±30 seconds must comply with:

| Sieve Sizes | Percentage Passing |
|---|---|
| 3/8-inch | 98-100 |

Slurry must:

1. Be free of contaminants
2. Contain at least the minimum dry solids
3. Have uniform consistency

If you prepare lime slurry, prepare it at the jobsite.

### 24-1.02B Water

If available, use potable water. Inform the Engineer if a water source other than potable water is used. If not using potable water, water for mixing soil and lime must:

1. Contain no more than 650 parts per million of chlorides as Cl, and no more than 1,300 parts per million of sulfates as $SO_4$
2. Not contain an amount of impurities that will cause a reduction in the strength of the stabilize soil

### 24-1.02C Mixed Material

Take a composite sample from 5 random locations after initial mixing. The moisture content of the composite sample tested under California Test 226 must be a minimum of 3 percent greater than optimum. Determine the moisture versus density relationship of the composite sample material determined under California Test 216, except Part 2, Section E, Paragraph 6 is modified as follows:

> After adjustment of the moisture content, compact each of the remaining test specimens in the mold, then record the water adjustment, tamper reading, and the corresponding adjusted wet density from the chart on Table 1 using the column corresponding to the actual wet weight of the test specimen compacted. Note each of these wet weights on Line I.

The mixed material before compaction excluding rock must comply with:

| Sieve Sizes | Percentage Passing |
|---|---|
| 1" | 98 - 100 |
| No. 4 | 60 - 100 |

### 24-1.02D Curing Treatment

Curing treatment may be any of the following:

1. Water cure
2. Curing seal
3. Moist material blanket

Curing seal must be SS or CSS grade asphaltic emulsion under Section 94, "Asphaltic Emulsions."

## 24-1.03 CONSTRUCTION

### 24-1.03A General

If using different types of lime or lime from more than one source, do not mix them. The Engineer determines separate application rates.

Deliver lime in full loads unless it is the last load needed for a work shift.

Apply lime at ground temperatures above 35 °F. Do not apply lime if you expect the ground temperature to drop below 35 °F before you complete mixing and compacting.

During mixing, maintain the in-place moisture of the soil to be stabilized a minimum 3 percent above the optimum moisture determined under California Test 216 as modified in "Mixed Material." During compaction and finish grading, add water to the surface to prevent drying until the next layer of mixed material is placed, or until you apply curing treatment.

Scarify the surface of lime stabilized soil at least 2 inches between each layer. Do not scarify the final surface of the lime stabilized soil.

Between the time of applying lime and 3 days after applying curing treatment, only allow equipment or vehicles on the soil being stabilized that are essential to the work.

### 24-1.03B Preparing Soil

Except for soil clods, remove rocks or solids larger than 1/3 of the layer thickness. Regardless of the layer thickness, remove rocks and solids greater than 4 inches. Notify the Engineer if you encounter rocks or solids greater than 1/3 of the layer thickness.

Before adding lime, place the soil to be stabilized to within 0.08 foot of the specified lines and grades and compact to not less than 90 percent relative compaction.

### 24-1.03C Applying Lime

Apply lime uniformly over the area to be stabilized using a vane spreader.

The Engineer determines the final application rate. Do not vary from this application rate by more than 5 percent.

Apply lime in dry form. If you request and the Engineer approves, you may apply lime in slurry form.

Lime slurry must be in suspension during application. Apply lime slurry uniformly making successive passes over a measured section or roadway until the specified lime content is reached. Apply the residue from lime slurry over the length of the roadway being processed.

### 24-1.03D Mixing

Lime and soil to be stabilized must be mixed uniformly at least twice to within 0.10 foot of the specified depth at any point. If the mixing depth exceeds the specified depth by more than 10 percent, add lime in proportion to the exceeded depth. The Department does not pay for this added lime.

Mix lime on the same day it is applied. After the initial mixing, allow a mellowing period for at least 36 hours before final mixing. Moisture content during the mellowing period determined under California Test 226 must be at least 3 percent higher than the optimum moisture content. You may add water and mix during the mellowing period.

Remix until the mixture is uniform with no streaks or pockets of lime.

Except for clods larger than 1 inch, mixed material must have a color reaction with sprayed phenolphthalein alcohol indicator solution.

Complete all the mixing work within 7 days of the initial application of lime.

### 24-1.03E Compaction

Begin compacting immediately after final mixing, but not less than 36 hours after the beginning of initial mixing.

Compact by using sheepsfoot or segmented wheel rollers immediately followed by steel drum or pneumatic-tired rollers. Do not use vibratory rollers.

If you request and the Engineer approves, you may compact mixed material in layers greater than 0.50 foot.

If the specified thickness is 0.50 foot or less, compact in one layer. If the specified thickness is more than 0.50 foot, compact in 2 or more layers of approximately equal thickness. The maximum compacted thickness of any one layer must not exceed 0.50 foot unless you first demonstrate your equipment and methods provide uniform distribution of lime and achieve the specified compaction.

Use other compaction methods in areas inaccessible to rollers.

Compact the lime stabilized soil to at least 95 percent relative compaction determined under California Test 216 as modified under "Mixed Material." The relative compaction is determined on a wet weight basis.

### 24-1.03F Finish Grading

Maintain the moisture content of the lime stabilized soil through the entire finish grading operation at a minimum of 3 percent above optimum moisture content.

The finished surface of the lime stabilized soil must not vary more than 0.08 foot above or below the grade established by the Engineer unless the lime stabilized soil is to be covered by material paid for by the cubic yard, in which case the finished surface may not vary above the grade established by the Engineer.

If lime stabilized soil is above the allowable tolerance, trim, remove, and dispose of the excess material. Do not leave loose material on the finished surface. If finish rolling cannot be completed within 2 hours of trimming, defer trimming.

If lime stabilized soil is below the allowable tolerance, you may use trimmed material to fill low areas only if final grading and final compaction occurs within 48 hours of beginning initial compaction. Before placing trimmed material, scarify the surface of the area to be filled at least 2 inches deep.

Finish rolling of trimmed surfaces must be performed with at least 1 complete coverage with steel drum or pneumatic-tired rollers.

### 24-1.03G Curing

**General**

Choose the method of curing.

Apply the chosen cure method within 48 hours of completing the sheepsfoot or segmented wheel compaction. Apply the chosen cure method within the same day of any trimming and finish grading.

**Water Cure**

Water may be used to cure the finished surface before you place a moist material blanket, or apply curing seal. Keep the surface above the optimum moisture content of the lime stabilized soil. Use this method for no more than 3 days, after which you must place a curing seal or moist material blanket.

**Curing Seal**

Curing seal equipment must have a gage indicating the volume of curing seal in the storage tank.

If curing seal is used, apply it:

1. To the finished surface of lime stabilized soil under Section 94-1.06, "Applying," of the Standard Specifications
2. At a rate from 0.10 to 0.20 gallon per square yard. The Engineer determines the exact rate
3. When the lime stabilized soil is at optimum moisture
4. When the ambient temperature is above 40 °F and rising

Repair damaged curing seal the same day the damage occurs.

**Moist Material Blanket**

Moist material blanket consists of moist structural material. Moist material blanket may be a temporary or permanent layer of material of sufficient thickness to prevent drying of the lime stabilized soil. You may use moist material blanket if the lime stabilized soil can bear the weight of construction equipment. Maintain the moist material blanket above the optimum moisture content, as appropriate, until the next structural layer is placed.

## 24-1.04 MEASUREMENT AND PAYMENT

Lime stabilized soil is measured by the square yard determined from horizontal measurements of the planned surface of the lime stabilized soil.

Curing seal is measured under Section 94, "Asphaltic Emulsions." The amount of curing seal used is determined from the gauge specified for the curing equipment.

The contract item prices for the work involved with lime stabilized soil are paid:

1. Per square yard for lime stabilized soil
2. Per ton for lime
3. Per ton for asphaltic emulsion (curing seal)

Payment for the contract items involved with lime stabilized soil includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the lime stabilized soil, complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The Department does not adjust payment for lime.

Quantities of lime wasted or disposed of in a manner not specified, or remaining on hand after completion of the work, will not be paid for. If you use a partial load of lime, weigh the truck and the remaining lime on a scale under Section 9-1.01, "Measurement of Quantities," and submit a weighmaster certificate to the Engineer.

Full compensation for preparing soil to be stabilized is included in the contract price paid per square yard for lime stabilized soil, and no separate payment is made therefor, except removing and disposing of rocks and solids larger 1/3 of the layer thickness and larger than 4 inches from native soil or embankment other than imported borrow is paid for as extra work as provided in Section 4-1.03D, "Extra Work." Removing and disposing of rocks and solids larger than 1/3 of the lift thickness and larger than 4 inches from imported borrow is at your expense.

Full compensation for mixing, compacting, and maintaining the moisture content of the lime stabilized soil is included in the contract price paid per square yard for lime stabilized soil, and no separate payment is made therefor.

Full compensation for applying lime is included in the contract price paid per ton for lime, and no additional compensation is allowed therefor.

If the dispute resolution ITP determines the Engineer's test results are correct, the Engineer deducts the ITP's testing costs from payments. If the ITP determines your test results are correct, the State pays the ITP testing costs.

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## SECTION 25 AGGREGATE SUBBASES
## (Issued 02-16-07)

### In Section 25-1.02A replace the 1st paragraph with:

Aggregate must be clean and free from organic matter and other deleterious substances. Aggregate must consist of any combination of:

1. Broken stone
2. Crushed gravel
3. Natural rough surfaced gravel
4. Sand
5. Up to 100 percent of any combination of processed:

    5.1. Asphalt concrete
    5.2. Portland cement concrete
    5.3. Lean concrete base
    5.4. Cement treated base

**Replace Section 25-1.02B with:**

**25-1.02B Class 4 Aggregate Subbase**

Aggregate must be clean and free from organic matter and other deleterious substances. Aggregate must consist of any combination of:

1. Broken stone
2. Crushed gravel
3. Natural rough surfaced gravel
4. Sand
5. Up to 100 percent of any combination of processed:

    5.1. Asphalt concrete
    5.2. Portland cement concrete
    5.3. Lean concrete base
    5.4. Cement treated base

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## SECTION 26 AGGREGATE BASES
## (Issued 02-16-07)

**In Section 26-1.02A replace the 1st paragraph with:**

Aggregate must be clean and free from organic matter and other deleterious substances. Aggregate must consist of any combination of:

1. Broken stone
2. Crushed gravel
3. Natural rough surfaced gravel
4. Sand
5. Up to 100 percent of any combination of processed:

    5.1. Asphalt concrete
    5.2. Portland cement concrete
    5.3. Lean concrete base
    5.4. Cement treated base

### In Section 26-1.02B replace the 1st paragraph with:

Aggregate must be clean and free from organic matter and other deleterious substances. Aggregate must consist of any combination of:

1. Broken stone
2. Crushed gravel
3. Natural rough surfaced gravel
4. Sand
5. Up to 100 percent of any combination of processed:

    5.1. Asphalt concrete
    5.2. Portland cement concrete
    5.3. Lean concrete base
    5.4. Cement treated base

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## SECTION 27 CEMENT TREATED BASES
## (Issued 07-31-07)

### In Section 27-1.02 replace the 1st paragraph with:

Cement shall be Type II portland cement conforming to the provisions in Section 90-2.01A, "Cement."

### In Section 27-1.02 replace the 3rd paragraph with:

Aggregate for use in Class A cement treated base shall be of such quality that when mixed with cement in an amount not to exceed 5 percent by weight of the dry aggregate and compacted at optimum moisture content, the compressive strength of a sample of the compacted mixture shall not be less than 750 pounds per square inch at 7 days, when tested by California Test 312.

### In Section 27-1.02 replace the 4th paragraph with:

Aggregate for use in Class B cement treated base shall have a Resistance (R-value) of not less than 60 before mixing with cement and a Resistance (R-value) of not less than 80 after mixing with cement in an amount not to exceed 2.5 percent by weight of the dry aggregate.

### In Section 27-1.07 replace the 9th paragraph with:

When surfacing material is hot mix asphalt, the low areas shall be filled with hot mix asphalt conforming to the requirements for the lowest layer of hot mix asphalt to be placed as surfacing. This filling shall be done as a separate operation prior to placing the lowest layer of surfacing, and full compensation for this filling will be considered as included in the contract price paid for cement treated base and no additional compensation will be allowed therefor.

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## SECTION 28 LEAN CONCRETE BASE
## (Issued 05-15-09)

### In Section 28-1.02 replace the 1st paragraph with:

Cement shall be Type II portland cement conforming to the provisions in Section 90-2.01A, "Cement."

### In Section 28-1.02 replace the 6th paragraph with:

Aggregate shall be of such quality that, when mixed with cement in an amount not to exceed 300 pounds per cubic yard, and tested in conformance with the requirements in California Test 548, the compressive strength of a sample will be not less than 700 pounds per square inch at 7 days.

### Replace Section 28-1.05 with:

Placing of lean concrete base shall conform to the provisions for placing concrete pavement in Section 40-3.04, "Placing Concrete," except that the third paragraph in Section 40-3.04A, "General," shall not apply.

Unless otherwise required by the plans or the special provisions, lean concrete base shall be constructed in not less than 12-foot widths separated by construction joints. Lean concrete base constructed monolithically in widths greater than 26 feet shall be constructed with a longitudinal contraction joint offset not more than 3 feet from the centerline of the width being constructed.

Longitudinal contraction joints in lean concrete base shall be constructed in conformance with the provisions in Section 40-3.08E, "Sawing Method."

When concrete pavement is to be placed over lean concrete base, longitudinal construction joints and longitudinal contraction joints in the lean concrete base shall not be within one foot of planned longitudinal contraction joints nor longitudinal construction joints in the concrete pavement.

Lean concrete base shall not be mixed nor placed while the atmospheric temperature is below 35 °F, and shall not be placed on frozen ground.

### In Section 28-1.06 replace the 1st and 2nd paragraphs with:

Lean concrete base shall be spread, compacted, and shaped in conformance with the provisions in Section 40-3.04D, "Stationary Side Form Construction," and Section 40-3.04E, "Slip-Form Construction."

In advance of curing operations, lean concrete base to be surfaced with hot mix asphalt shall be textured with a drag strip of burlap, a broom or a spring steel tine device which will produce scoring in the finished surface. The scoring shall be parallel with the centerline or transverse thereto. The operation shall be performed at a time and in a manner to produce the coarsest texture practical for the method used.

### In Section 28-1.08 replace the 2nd paragraph with:

Hardened lean concrete base with a surface lower than 0.05 foot below the grade established by the Engineer shall be removed and replaced with lean concrete base which complies with these specifications, or if permitted by the Engineer, the low areas shall be filled with pavement material as follows:

1. When pavement material is hot mix asphalt, the low areas shall be filled with hot mix asphalt conforming to the requirements for the lowest layer of hot mix asphalt to be placed as pavement. This shall be done as a separate operation prior to placing the lowest layer of pavement, and full compensation for this filling will be considered as included in the contract price paid per cubic yard for lean concrete base and no additional compensation will be allowed therefor.
2. When pavement material is portland cement concrete, the low areas shall be filled with pavement concrete at the time and in the same operation that the pavement is placed. Full compensation for this filling will be considered as included in the contract price paid per cubic yard for lean concrete base and no additional compensation will be allowed therefor.

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## SECTION 29 TREATED PERMEABLE BASES
## (Issued 05-15-09)

### In Section 29-1.02B replace the 2nd paragraph with:

Cement shall be Type II portland cement conforming to the provisions in Section 90-2.01A, "Cement."

### In Section 29-1.04A replace the 1st paragraph with:

Aggregates and asphalt for asphalt treated permeable base shall be stored, proportioned and mixed in the same manner provided for storing, proportioning and mixing aggregates and asphalt for hot mix asphalt in Section 39-1.08, "Production," except as follows:

1. The aggregate need not be separated into sizes.
2. The temperature of the aggregate before adding the asphalt binder shall be not less than 275° F nor more than 325° F.
3. Asphalt treated permeable base stored in excess of 2 hours shall not be used in the work.
4. The aggregate shall be combined with 2.5 percent paving asphalt by weight of the dry aggregate. After testing samples of the Contractor's proposed aggregate supply, the Engineer may order an increase or decrease in the asphalt content. If an increase or decrease is ordered, and the increase or decrease exceeds the specified amount by more than 0.1 percent by weight of the dry aggregate, the compensation payable to the Contractor for the asphalt treated permeable base will be increased or decreased on the basis of the total increase or decrease in asphalt.
5. The asphalt content of the asphalt mixture will be determined, at the option of the Engineer, by extraction tests in conformance with the requirements in California Test 310 or 362, or will be determined in conformance with the requirements in California Test 379. The bitumen ratio pounds of asphalt per 100 pounds of dry aggregate shall not vary by more than 0.5 pound of asphalt above or 0.5 pound of asphalt below the amount designated by the Engineer. Compliance with this requirement will be determined either by taking samples from trucks at the plant or from the mat behind the paver before rolling. If the sample is taken from the mat behind the paver, the bitumen ratio shall be not less than the amount designated by the Engineer, less 0.7 pound of asphalt per 100 pounds of dry aggregate.

**In Section 29-1.04B replace the 2nd paragraph with:**

Cement treated permeable base shall contain not less than 287 pounds of cement per cubic yard.

**In Section 29-1.05 replace the 1st paragraph with:**

Asphalt treated permeable base shall be spread and compacted as specified for hot mix asphalt under the "Method" construction process in Section 39, "Hot Mix Asphalt," and these specifications.

**In Section 29-1.05 in the 8th paragraph, replace the 2nd sentence with:**

The filter fabric shall conform to the provisions in Section 88-1.02, "Filtration," and shall be placed in conformance with the provisions for placing filter fabric for edge drains in Section 68-3.03, "Installation."

**In Section 29-1.06 replace the 1st and 2nd paragraphs with:**

Cement treated base shall be placed, spread, compacted, and shaped in conformance with the provisions in Section 40-3.04D, "Stationary Side Form Construction," and Section 40-3.04E, "Slip-Form

Construction," except that vibrators shall not be used and the third paragraph in Section 40-3.04A, "General," shall not apply.

### In Section 29-1.06 in the 9th paragraph, replace the 2nd sentence with:

The filter fabric shall conform to the provisions in Section 88-1.02, "Filtration," and shall be placed in conformance with the provisions for placing filter fabric for edge drains in Section 68-3.03, "Installation."

### In Section 29-1.07 replace the 2nd paragraph with:

Hardened treated permeable base with a surface lower than 0.05 foot below the grade established by the Engineer shall be removed and replaced with treated permeable base which complies with these specifications, or if permitted by the Engineer, the low areas shall be filled with pavement material as follows:

1. When pavement material is hot mix asphalt, the low areas shall be filled with hot mix asphalt conforming to the requirements for the lowest layer of hot mix asphalt to be placed as pavement. This shall be done as a separate operation prior to placing the lowest layer of pavement.
2. When pavement material is portland cement concrete, the low areas shall be filled with pavement concrete at the time and in the same operation in which the pavement is placed.
3. Full compensation for filling low areas will be considered as included in the contract price paid per cubic yard for treated permeable base and no additional compensation will be allowed therefor.

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## SECTION 37 BITUMINOUS SEALS
## (Issued 06-05-09)

### In Section 37-1.03 replace the 4th through 6th paragraphs with:

On 2-lane two-way roadways, W8-7 "LOOSE GRAVEL" signs and W13-1 (35) speed advisory signs shall be furnished and placed adjacent to both sides of the traveled way where screenings are being spread on a traffic lane. The first W8-7 sign in each direction shall be placed where traffic first encounters loose screenings, regardless of which lane the screenings are being spread on. The W13-1 (35) signs need not be placed in those areas with posted speed limits of less than 40 MPH. The signs shall be placed at maximum 2,000-foot intervals along each side of the traveled way and at public roads or streets entering the seal coat area as directed by the Engineer.

On multilane roadways (freeways, expressways and multilane conventional highways) where screenings are being spread on a traffic lane, W8-7 "LOOSE GRAVEL" signs and W13-1 (35) speed advisory signs

shall be furnished and placed adjacent to the outside edge of the traveled way nearest to the lane being worked on. The first W8-7 sign shall be placed where the screenings begin with respect to the direction of travel on that lane. The W13-1 (35) signs need not be placed in those areas with posted speed limits of less than 40 MPH. The signs shall be placed at maximum 2,000-foot intervals along the edge of traveled way and at on-ramps, public roads or streets entering the seal coat area as directed by the Engineer.

The W8-7 and W13-1 signs shall be maintained in place at each location until final brooming of the seal coat surface at that location is completed. The W8-7 and W13-1 signs shall conform to the provisions for construction area signs in Section 12, "Construction Area Traffic Control Devices." The signs may be set on temporary portable supports with the W13-1 below the W8-7 or on barricades with the W13-1 sign alternating with the W8-7 sign.

### In Section 37-1.07 replace the 2nd paragraph with:

Rollers shall be oscillating type pneumatic-tired rollers. A minimum of 2 pneumatic-tired rollers conforming to the provisions in Section 39-3.03 "Spreading and Compacting Equipment," shall be furnished.

### In Section 37-1.09 replace the 2nd paragraph with:

The above prices and payments shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in applying seal coat, complete in place, including furnishing, placing, maintaining, and removing W8-7 and W13-1 signs, when required, and temporary supports or barricades for the signs, as shown on the plans, and as specified in these specifications and the special provisions, and as directed by the Engineer.

### In Section 37-2.05 replace the 6th paragraph with:

In addition to conforming to the provisions in Section 5-1.10, "Equipment," the identifying number of mixer-spreader trucks shall be at least 2 inches in height, located on the front and rear of the vehicle.

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## SECTION 39 ASPHALT CONCRETE
## (Issued 06-05-09)

**Replace Section 39 with:**

# SECTION 39 HOT MIX ASPHALT

## 39-1 GENERAL

### 39-1.01 DESCRIPTION

Section 39 includes specifications for producing and placing hot mix asphalt (HMA) by mixing aggregate and asphalt binder at a mixing plant and spreading and compacting the HMA mixture.

The special provisions specify one or more type of HMA, including:

1. Type A
2. Type B
3. Open graded friction course (OGFC). OGFC includes hot mix asphalt (open graded), rubberized hot mix asphalt (open graded) (RHMA-O) and rubberized hot mix asphalt (open graded high binder) (RHMA-O-HB)
4. Rubberized hot mix asphalt (gap graded) (RHMA-G)

The special provisions specify the HMA construction process, including:

1. Standard
2. Method
3. Quality Control / Quality Assurance (QC / QA)

### 39-1.02 MATERIALS

#### 39-1.02A Geosynthetic Pavement Interlayer

Geosynthetic pavement interlayer must comply with the specifications for pavement fabric or paving mat in Section 88-1.07, "Pavement Interlayer."

#### 39-1.02B Tack Coat

Tack coat must comply with the specifications for asphaltic emulsion in Section 94, "Asphaltic Emulsion," or asphalt binder in Section 92, "Asphalts." Choose the type and grade.

Notify the Engineer if you dilute asphaltic emulsion with water. The weight ratio of added water to asphaltic emulsion must not exceed 1 to 1.

Measure added water either by weight or volume in compliance with the specifications for weighing, measuring, and metering devices under Section 9-1.01, "Measurement of Quantities," or you may use water meters from water districts, cities, or counties. If you measure water by volume, apply a conversion factor to determine the correct weight.

With each dilution, submit in writing:

1. The weight ratio of water to bituminous material in the original asphaltic emulsion
2. The weight of asphaltic emulsion before diluting
3. The weight of added water
4. The final dilution weight ratio of water to asphaltic emulsion

### 39-1.02C Asphalt Binder

Asphalt binder in HMA must comply with Section 92, "Asphalts," or Section 39-1.02D, "Asphalt Rubber Binder." The special provisions specify the grade.

Asphalt binder for geosynthetic pavement interlayer must comply with Section 92, "Asphalts." Choose from Grades PG 64-10, PG 64-16, or PG 70-10.

### 39-1.02D Asphalt Rubber Binder

**General**

Use asphalt rubber binder in RHMA-G, RHMA-O, and RHMA-O-HB. Asphalt rubber binder must be a combination of:

1. Asphalt binder
2. Asphalt modifier
3. Crumb rubber modifier (CRM)

The combined asphalt binder and asphalt modifier must be 80.0 ± 2.0 percent by weight of the asphalt rubber binder.

**Asphalt Modifier**

Asphalt modifier must be a resinous, high flash point, and aromatic hydrocarbon, and comply with:

**Asphalt Modifier for Asphalt Rubber Binder**

| Quality Characteristic | ASTM | Specification |
|---|---|---|
| Viscosity, $m^2/s$ (x $10^{-6}$) at 100 °C | D 445 | X ± 3 [a] |
| Flash Point, CL.O.C., °C | D 92 | 207 minimum |
| Molecular Analysis | | |
| Asphaltenes, percent by mass | D 2007 | 0.1 maximum |
| Aromatics, percent by mass | D 2007 | 55 minimum |

Note:
[a] The symbol "X" is the proposed asphalt modifier viscosity. "X" must be between 19 and 36. A change in "X" requires a new asphalt rubber binder design.

Asphalt modifier must be from 2.0 percent to 6.0 percent by weight of the asphalt binder in the asphalt rubber binder.

## Crumb Rubber Modifier

CRM consists of a ground or granulated combination of scrap tire CRM and high natural CRM. CRM must be 75.0 ± 2.0 percent scrap tire CRM and 25.0 ± 2.0 percent high natural CRM by total weight of CRM. Scrap tire CRM must be from any combination of automobile tires, truck tires, or tire buffings.

Sample and test scrap tire CRM and high natural CRM separately. CRM must comply with:

**Crumb Rubber Modifier for Asphalt Rubber Binder**

| Quality Characteristic | Test Method | Specification |
|---|---|---|
| Scrap tire CRM gradation (% passing No. 8 sieve) | LP-10 | 100 |
| High natural CRM gradation (% passing No. 10 sieve) | LP-10 | 100 |
| Wire in CRM (% max.) | LP-10 | 0.01 |
| Fabric in CRM (% max.) | LP-10 | 0.05 |
| CRM particle length (inch max.) [a] | -- | 3/16 |
| CRM specific gravity [a] | CT 208 | 1.1 – 1.2 |
| Natural rubber content in high natural CRM (%) [a] | ASTM D 297 | 40.0 – 48.0 |

Note:
[a] Test at mix design and for Certificate of Compliance.

Only use CRM ground and granulated at ambient temperature. If steel and fiber are cryogenically separated, it must occur before grinding and granulating. Only use cryogenically produced CRM particles that can be ground or granulated and not pass through the grinder or granulator.

CRM must be dry, free-flowing particles that do not stick together. CRM must not cause foaming when combined with the asphalt binder and asphalt modifier. You may add calcium carbonate or talc up to 3 percent by weight of CRM.

## Asphalt Rubber Binder Design and Profile

Submit in writing an asphalt rubber binder design and profile that complies with the asphalt rubber binder specifications. In the design, designate the asphalt, asphalt modifier, and CRM and their proportions. The profile must include the same component sources for the asphalt rubber binder used.

Design the asphalt rubber binder from testing you perform for each quality characteristic and for the reaction temperatures expected during production. The 24-hour (1,440-minute) interaction period determines the design profile. At a minimum, mix asphalt rubber binder components, take samples, and perform and record the following tests:

**Asphalt Rubber Binder Reaction Design Profile**

| Test | Minutes of Reaction [a] | | | | | | | Limits |
|---|---|---|---|---|---|---|---|---|
| | 45 | 60 | 90 | 120 | 240 | 360 | 1440 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cone penetration @ 77 °F, 0.10-mm (ASTM D 217) | X [b] | | | | X | | X | 25 - 70 |
| Resilience @ 77 °F, percent rebound (ASTM D 5329) | X | | | | X | | X | 18 min. |
| Field softening point, °F (ASTM D 36) | X | | | | X | | X | 125 - 165 |
| Viscosity, centipoises (LP-11) | X | X | X | X | X | X | X | 1,500 - 4,000 |

Notes:
[a] Six hours (360 minutes) after CRM addition, reduce the oven temperature to 275 °F for a period of 16 hours. After the 16-hour (1320 minutes) cool-down after CRM addition, reheat the binder to the reaction temperature expected during production for sampling and testing at 24 hours (1440 minutes).
[b] "X" denotes required testing

**Asphalt Rubber Binder**

After interacting for a minimum of 45 minutes, asphalt rubber binder must comply with:

**Asphalt Rubber Binder**

| Quality Characteristic | Test for Quality Control or Acceptance | Test Method | Specification | |
|---|---|---|---|---|
| | | | Minimum | Maximum |
| Cone penetration @ 77 °F, 0.10-mm | Acceptance | ASTM D 217 | 25 | 70 |
| Resilience @ 77 °F, percent rebound | Acceptance | ASTM D 5329 | 18 | -- |
| Field softening point, °F | Acceptance | ASTM D 36 | 125 | 165 |
| Viscosity @ 375 °F, centipoises | Quality Control | LP-11 | 1,500 | 4,000 |

## 39-1.02E Aggregate

Aggregate must be clean and free from deleterious substances. Aggregate:

1. Retained on the No. 4 sieve is coarse
2. Passing the No. 4 sieve is fine
3. Added and passing the No. 30 sieve is supplemental fine, including:

   3.1. Hydrated lime
   3.2. Portland cement
   3.3. Fines from dust collectors

The special provisions specify the aggregate gradation for each HMA type.

The specified aggregate gradation is before the addition of asphalt binder and includes supplemental fines. The Engineer tests for aggregate grading under California Test 202, modified by California Test 105 if there is a difference in specific gravity of 0.2 or more between the coarse and fine parts of different aggregate blends.

Choose a sieve size target value (TV) within each target value limit presented in the aggregate gradation tables.

**Aggregate Gradation**
**(Percentage Passing)**
**HMA Types A and B**

3/4–inch HMA Types A and B

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 1" | 100 | — |
| 3/4" | 90 - 100 | TV ±5 |
| 1/2" | 70 - 90 | TV ±6 |
| No. 4 | 45 - 55 | TV ±7 |
| No. 8 | 32 - 40 | TV ±5 |
| No. 30 | 12 - 21 | TV ±4 |
| No. 200 | 2 - 7 | TV ±2 |

1/2–inch HMA Types A and B

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 3/4" | 100 | — |
| 1/2" | 95 - 99 | TV ±6 |
| 3/8" | 75 - 95 | TV ±6 |
| No. 4 | 55 - 66 | TV ±7 |
| No. 8 | 38 - 49 | TV ±5 |
| No. 30 | 15 - 27 | TV ±4 |
| No. 200 | 2 - 8 | TV ±2 |

3/8–inch HMA Types A and B

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 1/2" | 100 | — |
| 3/8" | 95 - 100 | TV ±6 |
| No. 4 | 58 - 72 | TV ±7 |
| No. 8 | 34 - 48 | TV ±6 |
| No. 30 | 18 - 32 | TV ±5 |
| No. 200 | 2 - 9 | TV ±2 |

No. 4 HMA Types A and B

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 3/8" | 100 | — |
| No. 4 | 95 - 100 | TV ±7 |
| No. 8 | 72 - 77 | TV ±7 |
| No. 30 | 37 - 43 | TV ±7 |
| No. 200 | 2 - 12 | TV ±4 |

**Rubberized Hot Mix Asphalt - Gap Graded (RHMA-G)**

3/4–inch RHMA-G

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 1" | 100 | — |
| 3/4" | 95 - 100 | TV ±5 |
| 1/2" | 83 - 87 | TV ±6 |
| 3/8" | 65 - 70 | TV ±6 |
| No. 4 | 28 - 42 | TV ±7 |
| No. 8 | 14 - 22 | TV ±5 |
| No. 200 | 0 - 6 | TV ±2 |

1/2–inch RHMA-G

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 3/4" | 100 | — |
| 1/2" | 90 - 100 | TV ±6 |
| 3/8" | 83 - 87 | TV ±6 |
| No. 4 | 28 - 42 | TV ±7 |
| No. 8 | 14 - 22 | TV ±5 |
| No. 200 | 0 - 6 | TV ±2 |

**Open Graded Friction Course (OGFC)**

1–inch OGFC

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 1 1/2" | 100 | — |
| 1" | 99 - 100 | TV ±5 |
| 3/4" | 85 - 96 | TV ±5 |
| 1/2" | 55 - 71 | TV ±6 |
| No. 4 | 10 - 25 | TV ±7 |
| No. 8 | 6 - 16 | TV ±5 |
| No. 200 | 1 - 6 | TV ±2 |

1/2–inch OGFC

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 3/4" | 100 | — |
| 1/2" | 95 - 100 | TV ±6 |
| 3/8" | 78 - 89 | TV ±6 |
| No. 4 | 28 - 37 | TV ±7 |
| No. 8 | 7 - 18 | TV ±5 |
| No. 30 | 0 - 10 | TV ±4 |
| No. 200 | 0 - 3 | TV ±2 |

3/8–inch OGFC

| Sieve Sizes | Target Value Limits | Allowable Tolerance |
|---|---|---|
| 1/2" | 100 | — |
| 3/8" | 90 - 100 | TV ±6 |
| No. 4 | 29 - 36 | TV ±7 |
| No. 8 | 7 - 18 | TV ±6 |
| No. 30 | 0 - 10 | TV ±5 |
| No. 200 | 0 - 3 | TV ±2 |

Before the addition of asphalt binder and lime treatment, aggregate must comply with:

**Aggregate Quality**

| Quality Characteristic | Test Method | HMA Type | | | |
|---|---|---|---|---|---|
| | | A | B | RHMA-G | OGFC |
| Percent of crushed particles | CT 205 | | | | |
| Coarse aggregate (% min.) | | | | | |
| One fractured face | | 90 | 25 | -- | 90 |
| Two fractured faces | | 75 | -- | 90 | 75 |
| Fine aggregate (% min) (Passing No. 4 sieve and retained on No. 8 sieve.) One fractured face | | 70 | 20 | 70 | 90 |
| Los Angeles Rattler (% max.) | CT 211 | | | | |
| Loss at 100 Rev. | | 12 | -- | 12 | 12 |
| Loss at 500 Rev. | | 45 | 50 | 40 | 40 |
| Sand equivalent (min.) [a] | CT 217 | 47 | 42 | 47 | -- |
| Fine aggregate angularity (% min.) [b] | AASHTO T 304 Method A | 45 | 45 | 45 | -- |
| Flat and elongated particles (% max. by weight @ 5:1) | ASTM D 4791 | 10 | 10 | 10 | 10 |

Notes:
[a] Reported value must be the average of 3 tests from a single sample.
[b] The Engineer waives this specification if HMA contains less than 10 percent of nonmanufactured sand by weight of total aggregate. Manufactured sand is fine aggregate produced by crushing rock or gravel.

### 39-1.02F Reclaimed Asphalt Pavement

You may produce HMA using reclaimed asphalt pavement (RAP). HMA produced using RAP must comply with the specifications for HMA except aggregate quality specifications do not apply to RAP. You may substitute RAP aggregate for a part of the virgin aggregate in HMA in a quantity not exceeding 15.0 percent of the aggregate blend. Do not use RAP in OGFC and RHMA-G.

Assign the substitution rate of RAP aggregate for virgin aggregate with the job mix formula (JMF) submittal. The JMF must include the percent of RAP used. If you change your assigned RAP aggregate substitution rate by more than 5 percent (within the 15.0 percent limit), submit a new JMF.

Process RAP from asphalt concrete. You may process and stockpile RAP throughout the project's life. Prevent material contamination and segregation. Store RAP in stockpiles on smooth surfaces free of debris and organic material. Processed RAP stockpiles must consist only of homogeneous RAP.

## 39-1.03 HOT MIX ASPHALT MIX DESIGN REQUIREMENTS

### 39-1.03A General

A mix design consists of performing California Test 367 and laboratory procedures on combinations of aggregate gradations and asphalt binder contents to determine the optimum binder content (OBC) and HMA mixture qualities. If RAP is used, use Laboratory Procedure LP-9. The result of the mix design becomes the proposed JMF.

Use Form CEM-3512 to document aggregate quality and mix design data. Use Form CEM-3511 to present the JMF.

Laboratories testing aggregate qualities and preparing the mix design and JMF must be qualified under the Department's Independent Assurance Program. Take samples under California Test 125.

The Engineer reviews the aggregate qualities, mix design, and JMF and verifies and accepts the JMF.

You may change the JMF during production. Do not use the changed JMF until the Engineer accepts it. Except when adjusting the JMF in compliance with Section 39-1.03E, "Job Mix Formula Verification," perform a new mix design and submit in writing a new JMF submittal for changing any of the following:

1. Target asphalt binder percentage
2. Asphalt binder supplier
3. Asphalt rubber binder supplier
4. Component materials used in asphalt rubber binder or percentage of any component materials
5. Combined aggregate gradation
6. Aggregate sources
7. Substitution rate for RAP aggregate of more than 5 percent
8. Any material in the JMF

For OGFC, submit in writing a complete JMF submittal except asphalt binder content. The Engineer determines the asphalt binder content under California Test 368 within 20 days of your complete JMF submittal and provides you a Form CEM-3513.

### 39-1.03B Hot Mix Asphalt Mix Design

Perform a mix design that produces HMA in compliance with:

**Hot Mix Asphalt Mix Design Requirements**

| Quality Characteristic | Test Method | HMA Type | | |
|---|---|---|---|---|
| | | A | B | RHMA-G |
| Air voids content (%) | CT 367[a] | 4.0 | 4.0 | Special Provisions |
| Voids in mineral aggregate (% min.) | LP-2 | | | |
| No. 4 grading | | 17.0 | 17.0 | -- |
| 3/8" grading | | 15.0 | 15.0 | -- |
| 1/2" grading | | 14.0 | 14.0 | 18.0 – 23.0[b] |
| 3/4" grading | | 13.0 | 13.0 | 18.0 – 23.0[b] |
| Voids filled with asphalt (%) | LP-3 | | | |
| No. 4 grading | | 76.0 – 80.0 | 76.0 – 80.0 | Note d |
| 3/8" grading | | 73.0 – 76.0 | 73.0 – 76.0 | |
| 1/2" grading | | 65.0 – 75.0 | 65.0 – 75.0 | |
| 3/4" grading | | 65.0 – 75.0 | 65.0 – 75.0 | |
| Dust proportion | LP-4 | | | |
| No. 4 and 3/8" gradings | | 0.9 – 2.0 | 0.9 – 2.0 | Note d |
| 1/2" and 3/4" gradings | | 0.6 – 1.3 | 0.6 – 1.3 | |
| Stabilometer value (min.) [c] | CT 366 | | | |
| No. 4 and 3/8" gradings | | 30 | 30 | -- |
| 1/2" and 3/4" gradings | | 37 | 35 | 23 |

Notes:

[a] Calculate the air voids content of each specimen using California Test 309 and Lab Procedure LP-1. Modify California Test 367, Paragraph C5, to use the exact air voids content specified in the selection of OBC.
[b] Voids in mineral aggregate for RHMA-G must be within this range.
[c] Modify California Test 304, Part 2.B.2.c: "After compaction in the compactor, cool to 140 °± 5 °F by allowing the briquettes to cool at room temperature for 0.5-hour, then place the briquettes in the oven at 140 °F for a minimum of 2 hours and not more than 3 hours."
[d] Report this value in the JMF submittal.

For stability and air voids content, prepare 3 briquettes at the OBC and test for compliance. Report the average of 3 tests. Prepare new briquettes and test if the range of stability for the 3 briquettes is more than 8 points. The average air void content may vary from the specified air void content by ±0.5 percent.

You may use the briquettes used for stability testing to determine bulk specific gravity under CT 308. If you use the same briquettes and tests using bulk specific gravity fail, you may prepare 3 new briquettes and determine a new bulk specific gravity.

### 39-1.03C Job Mix Formula Submittal

Each JMF submittal must consist of:

1. Proposed JMF on Form CEM-3511
2. Mix design documentation on Form CEM-3512 dated within 12 months of submittal
3. JMF verification on Form CEM-3513, if applicable
4. JMF renewal on Form CEM-3514, if applicable
5. Materials Safety Data Sheets (MSDS) for:

    5.1. Asphalt binder
    5.2. Base asphalt binder used in asphalt rubber binder

5.3. CRM and asphalt modifier used in asphalt rubber binder
5.4. Blended asphalt rubber binder mixture
5.5. Supplemental fine aggregate except fines from dust collectors
5.6. Antistrip additives

If the Engineer requests in writing, sample the following materials in the presence of the Engineer and place in labeled containers weighing no more than 50 pounds each:

1. Coarse, fine, and supplemental fine aggregate from stockpiles, cold feed belts, or hot bins. Samples must include at least 120 pounds for each coarse aggregate, 80 pounds for each fine aggregate, and 10 pounds for each type of supplemental fines. The Department combines these aggregate samples to comply with the JMF target values submitted on Form CEM-3511.
2. RAP from stockpiles or RAP system. Samples must be at least 60 pounds.
3. Asphalt binder from the binder supplier. Samples must be in two 1-quart cylindrical shaped cans with open top and friction lids.
4. Asphalt rubber binder with the components blended in the proportions to be used. Samples must be in four 1-quart cylindrical shaped cans with open top and friction lids.

Notify the Engineer in writing at least 2 business days before sampling materials. For aggregate and RAP, split the samples into at least 4 parts. Submit 3 parts to the Engineer and use 1 part for your testing.

### 39-1.03D Job Mix Formula Review

The Engineer reviews each mix design and proposed JMF within 5 business days from the complete JMF submittal. The review consists of reviewing the mix design procedures and comparing the proposed JMF with the specifications.

The Engineer may verify aggregate qualities during this review period.

### 39-1.03E Job Mix Formula Verification

If you cannot submit a Department-verified JMF on Form CEM-3513 dated within 12 months before HMA production, the Engineer verifies the JMF.

Based on your testing and production experience, you may submit on Form CEM-3511 an adjusted JMF before the Engineer's verification testing. JMF adjustments may include a change in the:

1. Asphalt binder content target value up to ±0.6 percent from the optimum binder content value submitted on Form CEM-3512 except do not adjust the target value for asphalt rubber binder for RHMA-G below 7.0 percent
2. Aggregate gradation target values within the target value limits specified in the aggregate gradation tables

For HMA Type A, Type B, and RHMA-G, the Engineer verifies the JMF from samples taken from HMA produced by the plant to be used. Notify the Engineer in writing at least 2 business days before sampling materials.

In the Engineer's presence and from the same production run, take samples of:

1. Aggregate
2. Asphalt binder
3. RAP
4. HMA

Sample aggregate from cold feed belts or hot bins. Sample RAP from the RAP system. Sample HMA under California Test 125 except if you request in writing and the Engineer approves, you may sample from any of the following locations:

1. The plant
2. A truck
3. A windrow
4. The paver hopper
5. The mat behind the paver

You may sample from a different project including a non-Department project if you make arrangements for the Engineer to be present during sampling.

For aggregate, RAP, and HMA, split the samples into at least 4 parts and label their containers. Submit 3 split parts to the Engineer and use 1 part for your testing.

The Engineer verifies each proposed JMF within 20 days of receiving verification samples. If you request in writing, the Engineer verifies RHMA-G quality requirements within 3 business days of sampling. Verification is testing for compliance with the specifications for:

1. Aggregate quality
2. Aggregate gradation (JMF TV ± tolerance)
3. Asphalt binder content (JMF TV ± tolerance)
4. HMA quality specified in the table Hot Mix Asphalt Mix Design Requirements except:

    4.1. Air voids content (design value ± 2.0 percent)
    4.2. Voids filled with asphalt (report only if an adjustment for asphalt binder content target value is less than or equal to ± 0.3 percent from OBC)
    4.3. Dust proportion (report only if an adjustment for asphalt binder content target value is less than or equal to ± 0.3 percent from OBC)

The Engineer prepares 3 briquettes from a single split sample. To verify the JMF for stability and air voids content, the Engineer tests the 3 briquettes and reports the average of 3 tests. The Engineer prepares new briquettes if the range of stability for the 3 briquettes is more than 8 points.

The Engineer may use the briquettes used for stability testing to determine bulk specific gravity under CT 308. If the Engineer uses the same briquettes and the tests using bulk specific gravity fail, the Engineer prepares 3 new briquettes and determines a new bulk specific gravity.

If the Engineer verifies the JMF, the Engineer provides you a Form CEM-3513.

If the Engineer's tests on plant-produced samples do not verify the JMF, the Engineer notifies you in writing and you must submit a new JMF submittal or submit an adjusted JMF based on your testing. JMF adjustments may include a change in the:

1. Asphalt binder content target value up to ±0.6 percent from the optimum binder content value submitted on Form CEM-3512 except do not adjust the target value for asphalt rubber binder for RHMA-G below 7.0 percent
2. Aggregate gradation target values within the target value limits specified in the aggregate gradation tables

You may adjust the JMF only once due to a failed verification test. An adjusted JMF requires a new Form CEM-3511 and verification of a plant-produced sample.

The Engineer reverifies the JMF if HMA production has stopped for longer than 30 days and the verified JMF is older than 12 months.

For each HMA type and aggregate size specified, the Engineer verifies at the State's expense up to 2 proposed JMF including a JMF adjusted after verification failure. The Engineer deducts $3,000 from payments for each verification exceeding this limit. This deduction does not apply to verifications initiated by the Engineer or if a JMF expires while HMA production is stopped longer than 30 days.

### 39-1.03F Job Mix Formula Renewal

You may request a JMF renewal by submitting the following:

1. Proposed JMF on Form CEM-3511
2. A previously verified JMF documented on Form CEM-3513 dated within 12 months
3. Mix design documentation on Form CEM-3512 used for the previously verified JMF

If the Engineer requests in writing, sample the following materials in the presence of the Engineer and place in labeled containers weighing no more than 50 pounds each:

1. Coarse, fine, and supplemental fine aggregate from stockpiles, cold feed belts, or hot bins. Samples must include at least 120 pounds for each coarse aggregate, 80 pounds for each fine aggregate, and 10 pounds for each type of supplemental fines. The Department combines these aggregate samples to comply with the JMF target values submitted on Form CEM-3511.
2. RAP from stockpiles or RAP system. Samples must be at least 60 pounds.
3. Asphalt binder from the binder supplier. Samples must be in two 1-quart cylindrical shaped cans with open top and friction lids.

4. Asphalt rubber binder with the components blended in the proportions to be used. Samples must be in four 1-quart cylindrical shaped cans with open top and friction lids.

Notify the Engineer in writing at least 2 business days before sampling materials. For aggregate and RAP, split samples into at least 4 parts. Submit 3 parts to the Engineer and use 1 part for your testing.

The Engineer reviews each complete JMF renewal submittal within 5 business days.

The Engineer may verify aggregate qualities during this review period.

Notify the Engineer in writing at least 2 business days before sampling materials. For aggregate, RAP, and HMA, split the samples into at least 4 parts. Submit 3 parts to the Engineer and use 1 part for your testing.

The Engineer verifies the JMF renewal submittal under Section 39-1.03E, "Job Mix Formula Verification," except:

1. The Engineer retains samples until you provide test results for your part on Form CEM-3514.
2. The Engineer tests samples of materials obtained from the HMA production unit after you submit test results that comply with the specifications for the quality characteristics under Section 39-1.03E, "Job Mix Formula Verification."
3. The Engineer verifies each proposed JMF within 30 days of receiving verification samples.
4. You may not adjust the JMF due to a failed verification.
5. For each HMA type and aggregate gradation specified, the Engineer verifies at the State's expense 1 proposed JMF.

If the Engineer verifies the JMF renewal, the Engineer provides you a Form CEM-3513.

### 39-1.03G Job Mix Formula Acceptance

You may start HMA production if:

1. The Engineer's review of the JMF shows compliance with the specifications.
2. The Department has verified the JMF within 12 months before HMA production.
3. The Engineer accepts the verified JMF.

## 39-1.04 CONTRACTOR QUALITY CONTROL

### 39-1.04A General

Establish, maintain, and change a quality control system to ensure materials and work comply with the specifications. Submit quality control test results to the Engineer within 3 days of a request except when QC / QA is specified.

You must identify the HMA sampling location in your Quality Control Plan. During production, take samples under California Test 125 except if you request in writing and the Engineer approves, you may sample HMA from:

1. The plant
2. The truck
3. A windrow
4. The paver hopper
5. The mat behind the paver

### 39-1.04B Prepaving Conference

Meet with the Engineer at a prepaving conference at a mutually agreed time and place. Discuss methods of performing the production and paving work.

### 39-1.04C Asphalt Rubber Binder

Take asphalt rubber binder samples from the feed line connecting the asphalt rubber binder tank to the HMA plant. Sample and test asphalt rubber binder under Laboratory Procedure LP-11.

Test asphalt rubber binder for compliance with the viscosity specifications in Section 39-1.02, "Materials." During asphalt rubber binder production and HMA production using asphalt rubber binder, measure viscosity every hour with not less than 1 reading for each asphalt rubber binder batch. Log measurements with corresponding time and asphalt rubber binder temperature. Submit the log daily in writing.

Submit a Certificate of Compliance under Section 6-1.07, "Certificates of Compliance." With the Certificate of Compliance, submit test results in writing for CRM and asphalt modifier with each truckload delivered to the HMA plant. A Certificate of Compliance for asphalt modifier must not represent more than 5,000 pounds. Use an AASHTO-certified laboratory for testing.

Sample and test gradation and wire and fabric content of CRM once per 10,000 pounds of scrap tire CRM and once per 3,400 pounds of high natural CRM. Sample and test scrap tire CRM and high natural CRM separately.

Submit certified weight slips in writing for the CRM and asphalt modifier furnished.

### 39-1.04D Aggregate

Determine the aggregate moisture content and RAP moisture content in continuous mixing plants at least twice a day during production and adjust the plant controller. Determine the RAP moisture content in batch mixing plants at least twice a day during production and adjust the plant controller.

### 39-1.04E Reclaimed Asphalt Pavement

Perform RAP quality control testing each day.

Sample RAP once daily and determine the RAP aggregate gradation under Laboratory Procedure LP-9 and submit the results to the Engineer in writing with the combined aggregate gradation.

### 39-1.04F Density Cores

To determine density for Standard and QC / QA projects, take 4-inch or 6-inch diameter density cores at least once every 5 business days. Take 1 density core for every 250 tons of HMA from random locations

the Engineer designates. Take density cores in the Engineer's presence and backfill and compact holes with material authorized by the Engineer. Before submitting a density core to the Engineer, mark it with the density core's location and place it in a protective container.

If a density core is damaged, replace it with a density core taken within 1 foot longitudinally from the original density core. Relocate any density core located within 1 foot of a rumble strip to 1 foot transversely away from the rumble strip.

### 39-1.04G Briquettes

Prepare 3 briquettes for each stability and air voids content determination. Report the average of 3 tests. Prepare new briquettes and test if the range of stability for the 3 briquettes is more than 12 points.

You may use the briquettes used for stability testing to determine bulk specific gravity under CT 308. If you use these briquettes and tests using bulk specific gravity fail, you may prepare 3 new briquettes and determine a new bulk specific gravity.

## 39-1.05 ENGINEER'S ACCEPTANCE

The Engineer's acceptance of HMA is specified in the sections for each HMA construction process.

The Engineer samples materials for testing under California Test 125 and the applicable test method except samples may be taken from:

1. The plant from:
   1.1. A truck
   1.2. An automatic sampling device
2. The mat behind the paver

Sampling must be independent of Contractor quality control, statistically-based, and random.

If you request, the Engineer splits samples and provides you with a part.

The Engineer accepts HMA based on:

1. Accepted JMF
2. Accepted QCP for Standard and QC / QA
3. Compliance with the HMA Acceptance tables
4. Acceptance of a lot for QC / QA
5. Visual inspection

The Engineer prepares 3 briquettes for each stability and air voids content determination. The Engineer reports the average of 3 tests. The Engineer prepares new briquettes and test if the range of stability for the 3 briquettes is more than 8 points.

The Engineer may use the briquettes used for stability testing to determine bulk specific gravity under CT 308. If the Engineer uses the same briquettes and the tests using bulk specific gravity fail, the Engineer prepares 3 new briquettes and determines a new bulk specific gravity.

## 39-1.06 DISPUTE RESOLUTION

You and the Engineer must work together to avoid potential conflicts and to resolve disputes regarding test result discrepancies. Notify the Engineer in writing within 5 days of receiving a test result if you dispute the test result.

If you or the Engineer dispute each other's test results, submit written quality control test results and copies of paperwork including worksheets used to determine the disputed test results to the Engineer. An Independent Third Party (ITP) performs referee testing. Before the ITP participates in a dispute resolution, the ITP must be accredited under the Department's Independent Assurance Program. The ITP must be independent of the project. By mutual agreement, the ITP is chosen from:

1. A Department laboratory
2. A Department laboratory in a district or region not in the district or region the project is located
3. The Transportation Laboratory
4. A laboratory not currently employed by you or your HMA producer

If split quality control or acceptance samples are not available, the ITP uses any available material representing the disputed HMA for evaluation.

## 39-1.07 PRODUCTION START-UP EVALUATION

The Engineer evaluates HMA production and placement at production start-up.

Within the first 750 tons produced on the first day of HMA production, in the Engineer's presence and from the same production run, take samples of:

1. Aggregate
2. Asphalt binder
3. RAP
4. HMA

Sample aggregate from cold feed belts or hot bins. Take RAP samples from the RAP system. Sample HMA under California Test 125 except if you request in writing and the Engineer approves, you may sample HMA from:

1. The plant
2. The truck
3. A windrow
4. The paver hopper
5. The mat behind the paver

For aggregate, RAP, and HMA, split the samples into at least 4 parts and label their containers. Submit 3 split parts to the Engineer and keep 1 part.

For Standard and QC / QA projects, you and the Engineer must test the split samples and report test results in writing within 3 business days of sampling. If you proceed before receipt of the test results, the Engineer may consider the HMA placed to be represented by these test results.

For Standard and QC / QA projects, take 4-inch or 6-inch diameter density cores within the first 750 tons on the first day of HMA production. For each density core, the Engineer reports the bulk specific gravity determined under California Test 308, Method A in addition to the percent of maximum theoretical density. You may test for in-place density at the density core locations and include them in your production tests for percent of maximum theoretical density.

## 39-1.08 PRODUCTION

### 39-1.08A General

Produce HMA in a batch mixing plant or a continuous mixing plant. Proportion aggregate by hot or cold feed control.

HMA plants must be Department-qualified. Before production, the HMA plant must have a current qualification under the Department's Materials Plant Quality Program.

During production, you may adjust:

1. Hot or cold feed proportion controls for virgin aggregate and RAP
2. The set point for asphalt binder content

### 39-1.08B Mixing

Mix HMA ingredients into a homogeneous mixture of coated aggregates.

Asphalt binder must be between 275 °F and 375 °F when mixed with aggregate.

Asphalt rubber binder must be between 375 °F and 425 °F when mixed with aggregate.

When mixed with asphalt binder, aggregate must not be more than 325 °F except aggregate for OGFC with unmodified asphalt binder must be not more than 275 °F. Aggregate temperature specifications do not apply when you use RAP.

HMA with or without RAP must not be more than 325 °F.

### 39-1.08C Asphalt Rubber Binder

Deliver scrap tire CRM and high natural CRM in separate bags.

Either proportion and mix asphalt binder, asphalt modifier, and CRM simultaneously or premix the asphalt binder and asphalt modifier before adding CRM. If you premix asphalt binder and asphalt modifier, mix them for at least 20 minutes. When you add CRM, the asphalt binder and asphalt modifier must be between 375 °F and 440 °F.

Do not use asphalt rubber binder during the first 45 minutes of the reaction period. During this period, the asphalt rubber binder mixture must be between 350 °F and the lower of 425 °F or 25 °F below the asphalt binder's flash point indicated in the MSDS.

If any asphalt rubber binder is not used within 4 hours after the reaction period, discontinue heating. If the asphalt rubber binder drops below 375 °F, reheat before use. If you add more scrap tire CRM to the reheated asphalt rubber binder, the binder must undergo a 45-minute reaction period. The added scrap tire CRM must not exceed 10 percent of the total asphalt rubber binder weight. Reheated and reacted asphalt rubber binder must comply with the viscosity specifications for asphalt rubber binder in Section 39-1.02, "Materials." Do not reheat asphalt rubber binder more than twice.

## 39-1.09 SUBGRADE, TACK COAT, AND GEOSYNTHETIC PAVEMENT INTERLAYER

### 39-1.09A General

Prepare subgrade or apply tack coat to surfaces receiving HMA. If specified, place geosynthetic pavement interlayer over a coat of asphalt binder.

### 39-1.09B Subgrade

Subgrade to receive HMA must comply with the compaction and elevation tolerance specifications in the sections for the material involved. Subgrade must be free of loose and extraneous material. If HMA is paved on existing base or pavement, remove loose paving particles, dirt, and other extraneous material by any means including flushing and sweeping.

### 39-1.09C Tack Coat

Apply tack coat:

1. To existing pavement including planed surfaces
2. Between HMA layers
3. To vertical surfaces of:

    3.1. Curbs
    3.2. Gutters
    3.3. Construction joints

Before placing HMA, apply tack coat in 1 application at the minimum residual rate specified for the condition of the underlying surface:

**Tack Coat Application Rates for HMA Type A, Type B, and RHMA-G**

| HMA over: | Minimum Residual Rates (gallons per square yard) | | |
|---|---|---|---|
| | CSS1/CSS1h, SS1/SS1h and QS1h/CQS1h Asphaltic Emulsion | CRS1/CRS2, RS1/RS2 and QS1/CQS1 Asphaltic Emulsion | Asphalt Binder and PMRS2/PMCRS2 and PMRS2h/PMCRS2h Asphaltic Emulsion |
| New HMA (between layers) | 0.02 | 0.03 | 0.02 |
| Existing AC and PCC pavement | 0.03 | 0.04 | 0.03 |
| Planed pavement | 0.05 | 0.06 | 0.04 |

**Tack Coat Application Rates for OGFC**

| OGFC over: | Minimum Residual Rates (gallons per square yard) | | |
|---|---|---|---|
| | CSS1/CSS1h, SS1/SS1h and QS1h/CQS1h Asphaltic Emulsion | CRS1/CRS2, RS1/RS2 and QS1/CQS1 Asphaltic Emulsion | Asphalt Binder and PMRS2/PMCRS2 and PMRS2h/PMCRS2h Asphaltic Emulsion |
| New HMA | 0.03 | 0.04 | 0.03 |
| Existing AC and PCC pavement | 0.05 | 0.06 | 0.04 |
| Planed pavement | 0.06 | 0.07 | 0.05 |

If you dilute asphaltic emulsion, mix until homogeneous before application.

Apply to vertical surfaces with a residual tack coat rate that will thoroughly coat the vertical face without running off.

If you request in writing and the Engineer authorizes, you may:

1. Change tack coat rates
2. Omit tack coat between layers of new HMA during the same work shift if:

    2.1. No dust, dirt, or extraneous material is present
    2.2. The surface is at least 140 °F

Immediately in advance of placing HMA, apply additional tack coat to damaged areas or where loose or extraneous material is removed.

Close areas receiving tack coat to traffic. Do not track tack coat onto pavement surfaces beyond the job site.

Asphalt binder tack coat must be between 285 °F and 350 °F when applied.

### 39-1.09D Geosynthetic Pavement Interlayer

Place geosynthetic pavement interlayer in compliance with the manufacturer's recommendations.

Before placing the geosynthetic pavement interlayer and asphalt binder:

1. Repair cracks 1/4 inch and wider, spalls, and holes in the pavement. The State pays for this repair work under Section 4-1.03D, "Extra Work."
2. Clean the pavement of loose and extraneous material.

Immediately before placing the interlayer, apply 0.25 gallon ± 0.03 gallon of asphalt binder per square yard of interlayer or until the fabric is saturated. Apply asphalt binder the width of the geosynthetic pavement interlayer plus 3 inches on each side. At interlayer overlaps, apply asphalt binder on the lower interlayer the same overlap distance as the upper interlayer.

Align and place the interlayer with no overlapping wrinkles, except a wrinkle that overlaps may remain if it is less than 1/2 inch thick. If the overlapping wrinkle is more than 1/2 inch thick, cut the wrinkle out and overlap the interlayer no more than 2 inches.

The minimum HMA thickness over the interlayer must be 0.12 foot thick including conform tapers. Do not place the interlayer on a wet or frozen surface.

Overlap the interlayer borders between 2 inches and 4 inches. In the direction of paving, overlap the following roll with the preceding roll at any break.

You may use rolling equipment to correct distortions or wrinkles in the interlayer.

If asphalt binder tracked onto the interlayer or brought to the surface by construction equipment causes interlayer displacement, cover it with a small quantity of HMA.

Before placing HMA on the interlayer, do not expose the interlayer to:

1. Traffic except for crossings under traffic control and only after you place a small HMA quantity
2. Sharp turns from construction equipment
3. Damaging elements

Pave HMA on the interlayer during the same work shift.

## 39-1.10 SPREADING AND COMPACTING EQUIPMENT

Paving equipment for spreading must be:

1. Self-propelled
2. Mechanical
3. Equipped with a screed or strike-off assembly that can distribute HMA the full width of a traffic lane
4. Equipped with a full-width compacting device
5. Equipped with automatic screed controls and sensing devices that control the thickness, longitudinal grade, and transverse screed slope

Install and maintain grade and slope references.

The screed must produce a uniform HMA surface texture without tearing, shoving, or gouging.

The paver must not leave marks such as ridges and indentations unless you can eliminate them by rolling.

Rollers must be equipped with a system that prevents HMA from sticking to the wheels. You may use a parting agent that does not damage the HMA or impede the bonding of layers.

In areas inaccessible to spreading and compacting equipment:

1. Spread the HMA by any means to obtain the specified lines, grades and cross sections.
2. Use a pneumatic tamper, plate compactor, or equivalent to achieve thorough compaction.

## 39-1.11 TRANSPORTING, SPREADING, AND COMPACTING

Do not pave HMA on a wet pavement or frozen surface.

You may deposit HMA in a windrow and load it in the paver if:

1. Paver is equipped with a hopper that automatically feeds the screed
2. Loading equipment can pick up the windrowed material and deposit it in the paver hopper without damaging base material
3. Activities for deposit, pick-up, loading, and paving are continuous
4. HMA temperature in the windrow does not fall below 260 °F

You may pave HMA in 1 or more layers on areas less than 5 feet wide and outside the traveled way including shoulders. You may use mechanical equipment other than a paver for these areas. The equipment must produce a uniform smoothness and texture.

HMA handled, spread, or windrowed must not stain the finished surface of any improvement including pavement.

Do not use petroleum products such as kerosene or diesel fuel to release HMA from trucks, spreaders, or compactors.

HMA must be free of:

1. Segregation
2. Coarse or fine aggregate pockets
3. Hardened lumps

Longitudinal joints in the top layer must match specified lane edges. Alternate longitudinal joint offsets in lower layers at least 0.5 foot from each side of the specified lane edges. You may request in writing other longitudinal joint placement patterns.

Until the adjoining through lane's top layer has been paved, do not pave the top layer of:

1. Shoulders
2. Tapers
3. Transitions
4. Road connections
5. Driveways

6. Curve widenings
7. Chain control lanes
8. Turnouts
9. Turn pockets

If the number of lanes change, pave each through lane's top layer before paving a tapering lane's top layer. Simultaneous to paving a through lane's top layer, you may pave an adjoining area's top layer including shoulders. Do not operate spreading equipment on any area's top layer until completing final compaction.

If HMA (leveling) is specified, fill and level irregularities and ruts with HMA before spreading HMA over base, existing surfaces, or bridge decks. You may use mechanical equipment other than a paver for these areas. The equipment must produce a uniform smoothness and texture. HMA used to change an existing surface's cross slope or profile is not HMA (leveling).

If placing HMA against the edge of existing pavement, sawcut or grind the pavement straight and vertical along the joint and remove extraneous material without damaging the surface remaining in place. If placing HMA against the edge of a longitudinal or transverse construction joint and the joint is damaged or not placed to a neat line, sawcut or grind the pavement straight and vertical along the joint and remove extraneous material without damaging the surface remaining in place. Repair or remove and replace damaged pavement at your expense.

Rolling must leave the completed surface compacted and smooth without tearing, cracking, or shoving. Complete finish rolling activities before the pavement surface temperature is:

1. Below 150 °F for HMA with unmodified binder
2. Below 140 °F for HMA with modified binder
3. Below 200 °F for RHMA-G

If a vibratory roller is used as a finish roller, turn the vibrator off.

Do not use a pneumatic tired roller to compact RHMA-G.

For Standard and QC/QA, if a 3/4-inch aggregate grading is specified, you may use a 1/2-inch aggregate grading if the specified paved thickness is from 0.15 foot to 0.20 foot thick.

Spread and compact HMA under Section 39-3.03, "Spreading and Compacting Equipment," and Section 39-3.04, "Transporting, Spreading, and Compacting," for any of the following:

1. Specified paved thickness is less than 0.15 foot.
2. Specified paved thickness is less than 0.20 foot and a 3/4-inch aggregate grading is specified and used.
3. You spread and compact at:

    3.1. Asphalt concrete surfacing replacement areas
    3.2. Leveling courses
    3.3. Areas the Engineer determines conventional compaction and compaction measurement methods are impeded

Do not allow traffic on new HMA pavement until its mid-depth temperature is below 160 °F.

If you request in writing and the Engineer authorizes, you may cool HMA Type A and Type B with water when rolling activities are complete. Apply water under Section 17, "Watering."

Spread sand at a rate between 1 pound and 2 pounds per square yard on new RHMA-G, RHMA-O, and RHMA-O-HB pavement when finish rolling is complete. Sand must be free of clay or organic matter. Sand must comply with Section 90-3.03, "Fine Aggregate Grading." Keep traffic off the pavement until spreading sand is complete.

## 39-1.12 SMOOTHNESS

### 39-1.12A General

Determine HMA smoothness with a profilograph and a straightedge.

Smoothness specifications do not apply to OGFC placed on existing pavement not constructed under the same project.

If portland cement concrete is placed on HMA:

1. Cold plane the HMA finished surface to within specified tolerances if it is higher than the grade specified by the Engineer.
2. Remove and replace HMA if the finished surface is lower than 0.05 foot below the grade specified by the Engineer.

### 39-1.12B Straightedge

The HMA pavement top layer must not vary from the lower edge of a 12-foot long straightedge:

1. More than 0.01 foot when the straight edge is laid parallel with the centerline
2. More than 0.02 foot when the straightedge is laid perpendicular to the centerline and extends from edge to edge of a traffic lane
3. More than 0.02 foot when the straightedge is laid within 24 feet of a pavement conform

### 39-1.12C Profilograph

Under California Test 526, determine the zero (null) blanking band Profile Index ($PI_0$) and must-grinds on the top layer of HMA Type A, Type B, and RHMA-G pavement. Take 2 profiles within each traffic lane, 3 feet from and parallel with the edge of each lane.

A must-grind is a deviation of 0.3 inch or more in a length of 25 feet. You must correct must-grinds.

For OGFC, only determine must-grinds when placed over HMA constructed under the same project. The top layer of the underlying HMA must comply with the smoothness specifications before placing OGFC.

Profile pavement in the Engineer's presence. Choose the time of profiling.

On tangents and horizontal curves with a centerline radius of curvature 2,000 feet or more, the $PI_0$ must be at most 3 inches per 0.1-mile section.

On horizontal curves with a centerline radius of curvature between 1,000 feet and 2,000 feet including pavement within the superelevation transitions, the $PI_0$ must be at most 6 inches per 0.1-mile section.

Before the Engineer accepts HMA pavement for smoothness, submit written final profilograms.

Submit 1 electronic copy of profile information in Microsoft Excel and 1 electronic copy of longitudinal pavement profiles in ".erd" format or other ProVAL compatible format to the Engineer and to:

Smoothness@dot.ca.gov

The following HMA pavement areas do not require a $PI_{0.}$ You must measure these areas with a 12-foot straightedge and determine must-grinds with a profilograph:

1. New HMA with a total thickness less than or equal to 0.25 foot
2. HMA sections of city or county streets and roads, turn lanes and collector lanes that are less than 1,500 feet in length

The following HMA pavement areas do not require a $PI_{0.}$ You must measure these areas with a 12-foot straightedge:

1. Horizontal curves with a centerline radius of curvature less than 1,000 feet including pavement within the superelevation transitions of those curves
2. Within 12 feet of a transverse joint separating the pavement from:

    2.1. Existing pavement not constructed under the same project
    2.2. A bridge deck or approach slab

3. Exit ramp termini, truck weigh stations, and weigh-in-motion areas
4. If steep grades and superelevation rates greater than 6 percent are present on:

    4.1. Ramps
    4.2. Connectors

5. Turn lanes
6. Areas within 15 feet of manholes or drainage transitions
7. Acceleration and deceleration lanes for at-grade intersections
8. Shoulders and miscellaneous areas
9. HMA pavement within 3 feet from and parallel to the construction joints formed between curbs, gutters, or existing pavement

### 39-1.12D Smoothness Correction

If the top layer of HMA Type A, Type B, or RHMA-G pavement does not comply with the smoothness specifications, grind the pavement to within tolerances, remove and replace it, or place a layer of HMA. The Engineer must authorize your choice of correction before the work begins.

Remove and replace the areas of OGFC not in compliance with the must-grind and straightedge specifications, except you may grind OGFC for correcting smoothness:

1. At a transverse joint separating the pavement from pavement not constructed under the same project
2. Within 12 feet of a transverse joint separating the pavement from a bridge deck or approach slab

Corrected HMA pavement areas must be uniform rectangles with edges:

1. Parallel to the nearest HMA pavement edge or lane line
2. Perpendicular to the pavement centerline

Measure the corrected HMA pavement surface with a profilograph and a 12-foot straightedge and correct the pavement to within specified tolerances. If a must-grind area or straightedged pavement cannot be corrected to within specified tolerances, remove and replace the pavement.

On ground areas not overlaid with OGFC, apply fog seal coat under Section 37-1, "Seal Coats."

## 39-1.13 MISCELLANEOUS AREAS AND DIKES

Miscellaneous areas are outside the traveled way and include:

1. Median areas not including inside shoulders
2. Island areas
3. Sidewalks
4. Gutters
5. Gutter flares
6. Ditches
7. Overside drains
8. Aprons at the ends of drainage structures

Spread miscellaneous areas in 1 layer and compact to the specified lines and grades.

For miscellaneous areas and dikes:

1. Do not submit a JMF.
2. Choose the 3/8-inch or 1/2-inch HMA Type A and Type B aggregate gradations.
3. Minimum asphalt binder content must be 6.8 percent for 3/8-inch aggregate and 6.0 percent for 1/2-inch aggregate. If you request in writing and the Engineer authorizes, you may reduce the minimum asphalt binder content.
4. Choose asphalt binder Grade PG 70-10 or the same grade specified for HMA.

# 39-2 STANDARD

## 39-2.01 DESCRIPTION

If HMA is specified as Standard, construct it under Section 39-1, "General," this Section 39-2, "Standard," and Section 39-5, "Measurement and Payment."

## 39-2.02 CONTRACTOR QUALITY CONTROL

### 39-2.02A Quality Control Plan

Establish, implement, and maintain a Quality Control Plan (QCP) for HMA. The QCP must describe the organization and procedures you will use to:

1. Control the quality characteristics
2. Determine when corrective actions are needed (action limits)
3. Implement corrective actions

When you submit the proposed JMF, submit the written QCP. You and the Engineer must discuss the QCP during the prepaving conference.

The QCP must address the elements affecting HMA quality including:

1. Aggregate
2. Asphalt binder
3. Additives
4. Production
5. Paving

The Engineer reviews each QCP within 5 business days from the submittal. Hold HMA production until the Engineer accepts the QCP in writing. The Engineer's QCP acceptance does not mean your compliance with the QCP will result in acceptable HMA. Section 39-1.05, "Engineer's Acceptance," specifies HMA acceptance.

### 39-2.02B Quality Control Testing

Perform sampling and testing at the specified frequency for the following quality characteristics:

**Minimum Quality Control – Standard**

| Quality Characteristic | Test Method | Minimum Sampling and Testing Frequency | HMA Type | | | |
|---|---|---|---|---|---|---|
| | | | A | B | RHMA-G | OGFC |
| Aggregate gradation[a] | CT 202 | 1 per 750 tons and any remaining part | JMF ± Tolerance [b] | JMF ± Tolerance [b] | JMF ± Tolerance [b] | JMF ± Tolerance [b] |
| Sand equivalent (min.) [c] | CT 217 | | 47 | 42 | 47 | -- |
| Asphalt binder content (%) | CT 379 or 382 | | JMF ± 0.45 | JMF ± 0.45 | JMF ± 0.50 | JMF ± 0.50 |
| HMA moisture content (%, max.) | CT 226 or CT 370 | 1 per 2,500 tons but not less than 1 per paving day | 1.0 | 1.0 | 1.0 | 1.0 |
| Percent of maximum theoretical density (%) [d, e] | Quality control plan | 2 per business day (min.) | 91 - 97 | 91 - 97 | 91 - 97 | -- |
| Stabilometer value (min.) [c, f]<br>No. 4 and 3/8" gradings<br>1/2" and 3/4" gradings | CT 366 | One per 4,000 tons or 2 per 5 business days, which-ever is more | <br>30<br>37 | <br>30<br>35 | <br>--<br>23 | <br>--<br>-- |
| Air voids content (%) [c, g] | CT 367 | | 4 ± 2 | 4 ± 2 | Specification ± 2 | -- |
| Aggregate moisture content at continuous mixing plants and RAP moisture content at continuous mixing plants and batch mixing plants [h] | CT 226 or CT 370 | 2 per day during production | -- | -- | -- | -- |
| Percent of crushed particles coarse aggregate (%, min.)<br>One fractured face<br>Two fractured faces<br>Fine aggregate (%, min)<br>(Passing No. 4 sieve and retained on No. 8 sieve.)<br>One fractured face | CT 205 | As necessary and designat-ed in the QCP. At least once per project | <br>90<br>75<br><br>70 | <br>25<br>--<br><br>20 | <br>--<br>90<br><br>70 | <br>90<br>75<br><br>90 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Los Angeles Rattler (%, max.)<br>Loss at 100 rev.<br>Loss at 500 rev. | CT 211 | | <br>12<br>45 | <br>--<br>50 | <br>12<br>40 | <br>12<br>40 |
| Flat and elongated particles (%, max. by weight @ 5:1) | ASTM D 4791 | | Report only | Report only | Report only | Report only |
| Fine aggregate angularity (%, min.) | AASHTO T 304, Method A | | 45 | 45 | 45 | -- |
| Voids filled with asphalt (%) [i]<br>No. 4 grading<br>3/8" grading<br>1/2" grading<br>3/4" grading | LP-3 | | <br>76.0 – 80.0<br>73.0 – 76.0<br>65.0 – 75.0<br>65.0 – 75.0 | <br>76.0 – 80.0<br>73.0 – 76.0<br>65.0 – 75.0<br>65.0 – 75.0 | Report only | -- |
| Voids in mineral aggregate (% min.) [i]<br>No. 4 grading<br>3/8" grading<br>1/2" grading<br>3/4" grading | LP-2 | | <br>17.0<br>15.0<br>14.0<br>13.0 | <br>17.0<br>15.0<br>14.0<br>13.0 | <br>--<br>--<br>18.0 – 23.0 [j]<br>18.0 – 23.0 [j] | -- |
| Dust proportion [i]<br>No. 4 and 3/8" gradings<br>1/2" and 3/4" gradings | LP-4 | | <br>0.9 – 2.0<br><br>0.6 – 1.3 | <br>0.9 – 2.0<br><br>0.6 – 1.3 | Report only | -- |
| Smoothness | Section 39-1.12 | -- | 12-foot straightedge, must-grind, and $PI_0$ | 12-foot straightedge, must-grind, and $PI_0$ | 12-foot straightedge, must-grind, and $PI_0$ | 12-foot straightedge and must-grind |
| Asphalt rubber binder viscosity @ 350 °F, centipoises | Section 39-1.02D | Section 39-1.04C | -- | -- | 1,500 – 4,000 | 1,500 – 4,000 |
| Asphalt modifier | Section 39-1.02D | Section 39-1.04C | -- | -- | Section 39-1.02D | Section 39-1.02D |
| Crumb rubber modifier | Section 39-1.02D | Section 39-1.04C | -- | -- | Section 39-1.02D | Section 39-1.02D |

Notes:
[a] Determine combined aggregate gradation containing RAP under Laboratory Procedure LP-9.
[b] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[c] Report the average of 3 tests from a single split sample.
[d] Required for HMA Type A, Type B, and RHMA-G if the specified paved thickness is at least 0.15 foot.
[e] Determine maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[f] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 140 °F ± 5 °F by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 140 °F for a minimum of 2 hours and not more than 3 hours."
[g] Determine the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[h] For adjusting the plant controller at the HMA plant.
[i] Report only if the adjustment for asphalt binder content target value is less than or equal to ± 0.3 percent from OBC.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

For any single quality characteristic except smoothness, if 2 consecutive quality control test results do not comply with the action limits or specifications:

1. Stop production.
2. Notify the Engineer in writing.
3. Take corrective action.
4. Demonstrate compliance with the specifications before resuming production and placement on the State highway.

## 39-2.03 ENGINEER'S ACCEPTANCE

### 39-2.03A Testing

The Engineer samples for acceptance testing and tests for:

**HMA Acceptance - Standard**

| Quality Characteristic | Test Method | HMA Type | | | |
|---|---|---|---|---|---|
| | | A | B | RHMA-G | OGFC |
| Aggregate gradation [a] | CT 202 | JMF ± Tolerance [c] | JMF ± Tolerance [c] | JMF ± Tolerance [c] | JMF ± Tolerance [c] |
| Sieve / 3/4" / 1/2" / 3/8" | | | | | |
| 1/2" / X [b] / | | | | | |
| 3/8" / | X | | | | |
| No. 4 / | | X | | | |
| No. 8 / X | X | X | | | |
| No. 200 / X | X | X | | | |
| Sand equivalent (min.) [d] | CT 217 | 47 | 42 | 47 | -- |
| Asphalt binder content (%) | CT 379 or 382 | JMF ± 0.45 | JMF ± 0.45 | JMF ± 0.50 | JMF ± 0.50 |
| HMA moisture content (%, max.) | CT 226 or CT 370 | 1.0 | 1.0 | 1.0 | 1.0 |
| Percent of maximum theoretical density (%) [e, f] | CT 375 | 91 – 97 | 91 – 97 | 91 – 97 | -- |
| Stabilometer value (min.) [d, g] | CT 366 | | | | |
| No. 4 and 3/8" gradings | | 30 | 30 | -- | -- |
| 1/2" and 3/4" gradings | | 37 | 35 | 23 | -- |
| Air voids content (%) [d, h] | CT 367 | 4 ± 2 | 4 ± 2 | Specification ± 2 | -- |
| Percent of crushed particles | CT 205 | | | | |
| Coarse aggregate (%, min.) | | | | | |
| One fractured face | | 90 | 25 | -- | 90 |
| Two fractured faces | | 75 | -- | 90 | 75 |
| Fine aggregate (%, min) (Passing No. 4 sieve and retained on No. 8 sieve.) | | | | | |
| One fractured face | | 70 | 20 | 70 | 90 |
| Percent of crushed particles | CT 205 | | | | |
| Coarse aggregate (%, min.) | | | | | |
| One fractured face | | 90 | 25 | -- | 90 |
| Two fractured faces | | 75 | -- | 90 | 75 |
| Los Angeles Rattler (%, max.) | CT 211 | | | | |
| Loss at 100 rev. | | 12 | -- | 12 | 12 |
| Loss at 500 rev. | | 45 | 50 | 40 | 40 |
| Fine aggregate angularity (%, min.) | AASHTO T 304, Method A | 45 | 45 | 45 | -- |
| Flat and elongated particles (%, max. by weight @ 5:1) | ASTM D 4791 | Report only | Report only | Report only | Report only |
| Voids filled with asphalt (%) [i] | LP-3 | | | | |
| No. 4 grading | | 76.0 – 80.0 | 76.0 – 80.0 | Report only | |
| 3/8" grading | | 73.0 – 76.0 | 73.0 – 76.0 | | -- |
| 1/2" grading | | 65.0 – 75.0 | 65.0 – 75.0 | | |
| 3/4" grading | | 65.0 – 75.0 | 65.0 – 75.0 | | |
| Voids in mineral aggregate (% min.) [i] | LP-2 | | | | -- |
| No. 4 grading | | 17.0 | 17.0 | -- | |
| 3/8" grading | | 15.0 | 15.0 | -- | |

| | | | | | |
|---|---|---|---|---|---|
| 1/2" grading<br>3/4" grading | | 14.0<br>13.0 | 14.0<br>13.0 | 18.0 – 23.0 [j]<br>18.0 – 23.0 [j] | |
| Dust proportion [i]<br>No. 4 and 3/8" gradings<br>1/2" and 3/4" gradings | LP-4 | <br>0.9 – 2.0<br>0.6 – 1.3 | <br>0.9 – 2.0<br>0.6 – 1.3 | Report only | -- |
| Smoothness | Section 39-1.12 | 12-foot straightedge, must-grind, and $PI_0$ | 12-foot straightedge, must-grind, and $PI_0$ | 12-foot straightedge, must-grind, and $PI_0$ | 12-foot straightedge and must-grind |
| Asphalt binder | Various | Section 92 | Section 92 | Section 92 | Section 92 |
| Asphalt rubber binder | Various | -- | -- | Section 92-1.02(C) and Section 39-1.02D | Section 92-1.02(C) and Section 39-1.02D |
| Asphalt modifier | Various | -- | -- | Section 39-1.02D | Section 39-1.02D |
| Crumb rubber modifier | Various | -- | -- | Section 39-1.02D | Section 39-1.02D |

[a] The Engineer determines combined aggregate gradations containing RAP under Laboratory Procedure LP-9.
[b] "X" denotes the sieves the Engineer considers for the specified aggregate gradation.
[c] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[d] The Engineer reports the average of 3 tests from a single split sample.
[e] The Engineer determines percent of maximum theoretical density if the specified paved thickness is at least 0.15 foot under California Test 375 except the Engineer uses:

1. California Test 308, Method A, to determine in-place density of each density core instead of using the nuclear gauge in Part 4, "Determining In-Place Density By The Nuclear Density Device."
2. California Test 309 to determine maximum theoretical density instead of calculating test maximum density in Part 5, "Determining Test Maximum Density."

[f] The Engineer determines maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[g] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 140 °F ±5 °F by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 140 °F for a minimum of 2 hours and not more than 3 hours."
[h] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for asphalt binder content target value is less than or equal to ± 0.3 percent from OBC.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

No single test result may represent more than the smaller of 750 tons or 1 day's production.

For any single quality characteristic except smoothness, if 2 consecutive acceptance test results do not comply with the specifications:

1. Stop production.
2. Take corrective action.
3. In the Engineer's presence, take samples and split each sample into 4 parts. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Engineer tests 1 part for compliance with the specifications and reserves and stores 2 parts.

4. Demonstrate compliance with the specifications before resuming production and placement on the State highway.

The Engineer tests the density core you take from each 250 tons of HMA production. The Engineer determines the percent of maximum theoretical density for each density core by determining the density core's density and dividing by the maximum theoretical density.

If the specified total paved thickness is at least 0.15 foot and any layer is less than 0.15 foot, the Engineer determines the percent of maximum theoretical density from density cores taken from the final layer measured the full depth of the total paved HMA thickness.

For percent of maximum theoretical density, the Engineer determines a deduction for each test result outside the specifications in compliance with:

**Reduced Payment Factors for Percent of Maximum Theoretical Density**

| HMA Type A and B and RHMA-G Percent of Maximum Theoretical Density | Reduced Payment Factor | HMA Type A and B and RHMA-G Percent of Maximum Theoretical Density | Reduced Payment Factor |
|---|---|---|---|
| 91.0 | 0.0000 | 97.0 | 0.0000 |
| 90.9 | 0.0125 | 97.1 | 0.0125 |
| 90.8 | 0.0250 | 97.2 | 0.0250 |
| 90.7 | 0.0375 | 97.3 | 0.0375 |
| 90.6 | 0.0500 | 97.4 | 0.0500 |
| 90.5 | 0.0625 | 97.5 | 0.0625 |
| 90.4 | 0.0750 | 97.6 | 0.0750 |
| 90.3 | 0.0875 | 97.7 | 0.0875 |
| 90.2 | 0.1000 | 97.8 | 0.1000 |
| 90.1 | 0.1125 | 97.9 | 0.1125 |
| 90.0 | 0.1250 | 98.0 | 0.1250 |
| 89.9 | 0.1375 | 98.1 | 0.1375 |
| 89.8 | 0.1500 | 98.2 | 0.1500 |
| 89.7 | 0.1625 | 98.3 | 0.1625 |
| 89.6 | 0.1750 | 98.4 | 0.1750 |
| 89.5 | 0.1875 | 98.5 | 0.1875 |
| 89.4 | 0.2000 | 98.6 | 0.2000 |
| 89.3 | 0.2125 | 98.7 | 0.2125 |
| 89.2 | 0.2250 | 98.8 | 0.2250 |
| 89.1 | 0.2375 | 98.9 | 0.2375 |
| 89.0 | 0.2500 | 99.0 | 0.2500 |
| < 89.0 | Remove and Replace | > 99.0 | Remove and Replace |

## 39-2.04 TRANSPORTING, SPREADING, AND COMPACTING

Determine the number of rollers needed to obtain the specified density and surface finish.

# 39-3 METHOD

## 39-3.01 DESCRIPTION

If HMA is specified as Method, construct it under Section 39-1, "General," this Section 39-3, "Method," and Section 39-5, "Measurement and Payment."

## 39-3.02 ENGINEER'S ACCEPTANCE

### 39-3.02A Testing

The Engineer samples for acceptance testing and tests for:

**HMA Acceptance - Method**

| Quality Characteristic | Test Method | HMA Type | | | |
|---|---|---|---|---|---|
| | | A | B | RHMA-G | OGFC |
| Aggregate gradation [a] | CT 202 | JMF ± Tolerance [b] | JMF ± Tolerance [b] | JMF ± Tolerance [b] | JMF ± Tolerance [b] |
| Sand equivalent (min.) [c] | CT 217 | 47 | 42 | 47 | -- |
| Asphalt binder content (%) | CT 379 or 382 | JMF ± 0.45 | JMF ± 0.45 | JMF ± 0.50 | JMF ± 0.50 |
| HMA moisture content (%, max.) | CT 226 or CT 370 | 1.0 | 1.0 | 1.0 | 1.0 |
| Stabilometer value (min.) [c, d] | CT 366 | | | | |
| No. 4 and 3/8" gradings | | 30 | 30 | -- | -- |
| 1/2" and 3/4" gradings | | 37 | 35 | 23 | -- |
| Percent of crushed particles | CT 205 | | | | |
| Coarse aggregate (% min.) | | | | | |
| One fractured face | | 90 | 25 | -- | 90 |
| Two fractured faces | | 75 | -- | 90 | 75 |
| Fine aggregate (% min) (Passing No. 4 sieve and retained on No. 8 sieve.) | | | | | |
| One fractured face | | 70 | 20 | 70 | 90 |
| Los Angeles Rattler (% max.) | CT 211 | | | | |
| Loss at 100 rev. | | 12 | -- | 12 | 12 |
| Loss at 500 rev. | | 45 | 50 | 40 | 40 |
| Air voids content (%) [c, e] | CT 367 | 4 ± 2 | 4 ± 2 | Specification ± 2 | -- |
| Fine aggregate angularity (% min.) | AASHTO T 304, Method A | 45 | 45 | 45 | -- |
| Flat and elongated particles (% max. by weight @ 5:1) | ASTM D 4791 | Report only | Report only | Report only | Report only |
| Voids filled with asphalt (%) [f] | LP-3 | | | Report only | |
| No. 4 grading | | 76.0 – 80.0 | 76.0 – 80.0 | | -- |
| 3/8" grading | | 73.0 – 76.0 | 73.0 – 76.0 | | |
| 1/2" grading | | 65.0 – 75.0 | 65.0 – 75.0 | | |
| 3/4" grading | | 65.0 – 75.0 | 65.0 – 75.0 | | |
| Voids in mineral aggregate (% min.) [f] | LP-2 | | | | |
| No. 4 grading | | 17.0 | 17.0 | -- | -- |
| 3/8" grading | | 15.0 | 15.0 | -- | |
| 1/2" grading | | 14.0 | 14.0 | 18.0 – 23.0 [g] | |
| 3/4" grading | | 13.0 | 13.0 | 18.0 – 23.0 [g] | |
| Dust proportion [f] | LP-4 | | | | |
| No. 4 and 3/8" gradings | | 0.9 – 2.0 | 0.9 – 2.0 | Report only | -- |
| 1/2" and 3/4" gradings | | 0.6 – 1.3 | 0.6 – 1.3 | | |
| Smoothness | Section 39-1.12 | 12-foot straightedge | 12-foot straightedge | 12-foot straightedge | 12-foot straightedge |

| | | | | | |
|---|---|---|---|---|---|
| | | and must-grind | and must-grind | and must-grind | and must-grind |
| Asphalt binder | Various | Section 92 | Section 92 | Section 92 | Section 92 |
| Asphalt rubber binder | Various | -- | -- | Section 92-1.02(C) and Section 39-1.02D | Section 92-1.02(C) and Section 39-1.02D |
| Asphalt modifier | Various | -- | -- | Section 39-1.02D | Section 39-1.02D |
| Crumb rubber modifier | Various | -- | -- | Section 39-1.02D | Section 39-1.02D |

[a] The Engineer determines combined aggregate gradations containing RAP under Laboratory Procedure LP-9.
[b] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[c] The Engineer reports the average of 3 tests from a single split sample.
[d] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 140 °F ±5 °F by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 140 °F for a minimum of 2 hours and not more than 3 hours."
[e] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[f] Report only if the adjustment for asphalt binder content target value is less than or equal to ± 0.3 percent from OBC.
[g] Voids in mineral aggregate for RHMA-G must be within this range.

No single test result may represent more than the smaller of 750 tons or 1 day's production.

For any single quality characteristic except smoothness, if 2 consecutive acceptance test results do not comply with the specifications:

1. Stop production.
2. Take corrective action.
3. In the Engineer's presence, take samples and split each sample into 4 parts. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Engineer tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement on the State highway.

## 39-3.03 SPREADING AND COMPACTING EQUIPMENT

Each paver spreading HMA Type A and Type B must be followed by 3 rollers:

1. One vibratory roller specifically designed to compact HMA. The roller must be capable of at least 2,500 vibrations per minute and must be equipped with amplitude and frequency controls. The roller's gross static weight must be at least 7.5 tons.
2. One oscillating type pneumatic-tired roller at least 4 feet wide. Pneumatic tires must be of equal size, diameter, type, and ply. The tires must be inflated to 60 psi minimum and maintained so that the air pressure does not vary more than 5 psi.
3. One steel-tired, 2-axle tandem roller. The roller's gross static weight must be at least 7.5 tons.

Each roller must have a separate operator. Rollers must be self-propelled and reversible.

Compact RHMA-G under the specifications for compacting HMA Type A and Type B except do not use pneumatic-tired rollers.

Compact OGFC with steel-tired, 2-axle tandem rollers. If placing over 300 tons of OGFC per hour, use at least 3 rollers for each paver. If placing less than 300 tons of OGFC per hour, use at least 2 rollers for each paver. Each roller must weigh between 126 pounds to 172 pounds per linear inch of drum width. Turn the vibrator off.

## 39-3.04 TRANSPORTING, SPREADING, AND COMPACTING

Pave HMA in maximum 0.25-foot thick compacted layers.

If the surface to be paved is both in sunlight and shade, pavement surface temperatures are taken in the shade.

Spread HMA Type A and Type B only if atmospheric and surface temperatures are:

**Minimum Atmospheric and Surface Temperatures**

| Compacted Layer Thickness, feet | Atmospheric,° F | | Surface,° F | |
|---|---|---|---|---|
| | Unmodified Asphalt Binder | Modified Asphalt Binder[a] | Unmodified Asphalt Binder | Modified Asphalt Binder [a] |
| < 0.15 | 55 | 50 | 60 | 55 |
| 0.15 – 0.25 | 45 | 45 | 50 | 50 |

Note:
[a] Except asphalt rubber binder.

If the asphalt binder for HMA Type A and Type B is:

1. Unmodified asphalt binder, complete:

   1.1. First coverage of breakdown compaction before the surface temperature drops below 250 °F
   1.2. Breakdown and intermediate compaction before the surface temperature drops below 200 °F
   1.3. Finish compaction before the surface temperature drops below 150 °F

2. Modified asphalt binder, complete:

   2.1. First coverage of breakdown compaction before the surface temperature drops below 240 °F
   2.2. Breakdown and intermediate compaction before the surface temperature drops below 180 °F
   2.3. Finish compaction before the surface temperature drops below 140 °F

For RHMA-G:

1. Only spread and compact if the atmospheric temperature is at least 55 °F and the surface temperature is at least 60 °F.
2. Complete the first coverage of breakdown compaction before the surface temperature drops below 280 °F.
3. Complete breakdown and intermediate compaction before the surface temperature drops below 250 °F.
4. Complete finish compaction before the surface temperature drops below 200 °F.
5. If the atmospheric temperature is below 70 °F, cover loads in trucks with tarpaulins. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For OGFC with unmodified asphalt binder:

1. Only spread and compact if the atmospheric temperature is at least 55 °F and the surface temperature is at least 60 °F.
2. Complete first coverage using 2 rollers before the surface temperature drops below 240 °F.
3. Complete all compaction before the surface temperature drops below 200 °F.
4. If the atmospheric temperature is below 70 °F, cover loads in trucks with tarpaulins. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For OGFC with modified asphalt binder except asphalt rubber binder:

1. Only spread and compact if the atmospheric temperature is at least 50 °F and the surface temperature is at least 50 °F.
2. Complete first coverage using 2 rollers before the surface temperature drops below 240 °F.
3. Complete all compaction before the surface temperature drops below 180 °F.
4. If the atmospheric temperature is below 70 °F, cover loads in trucks with tarpaulins. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For RHMA-O and RHMA-O-HB:

1. Only spread and compact if the atmospheric temperature is at least 55 °F and surface temperature is at least 60 °F.
2 Complete the 1st coverage using 2 rollers before the surface temperature drops below 280 °F.
3. Complete compaction before the surface temperature drops below 250 °F.

4. If the atmospheric temperature is below 70 °F, cover loads in trucks with tarpaulins. The tarpaulins must completely cover the exposed load until the mixture is transferred to the paver's hopper or to the pavement surface.

For RHMA-G and OGFC, tarpaulins are not required if the time from discharge to truck until transfer to the paver's hopper or the pavement surface is less than 30 minutes.

HMA compaction coverage is the number of passes needed to cover the paving width. A pass is 1 roller's movement parallel to the paving in either direction. Overlapping passes are part of the coverage being made and are not a subsequent coverage. Do not start a coverage until completing the prior coverage.

Start rolling at the lower edge and progress toward the highest part.

Perform breakdown compaction of each layer of HMA Type A, Type B, and RHMA-G with 3 coverages using a vibratory roller. The speed of the vibratory roller in miles per hour must not exceed the vibrations per minute divided by 1,000. If the HMA layer thickness is less than 0.08 foot, turn the vibrator off. The Engineer may order fewer coverages if the HMA layer thickness is less than 0.15 foot.

Perform intermediate compaction of each layer of HMA Type A and Type B with 3 coverages using a pneumatic-tired roller at a speed not to exceed 5 mph.

Perform finish compaction of HMA Type A, Type B, and RHMA-G with 1 coverage using a steel-tired roller.

Compact OGFC with 2 coverages using steel-tired rollers.

## 39-4 QUALITY CONTROL / QUALITY ASSURANCE

### 39-4.01 DESCRIPTION

If HMA is specified as Quality Control / Quality Assurance, construct it under Section 39-1, "General," this Section 39-4, "Quality Control / Quality Assurance," and Section 39-5, "Measurement and Payment."

### 39-4.02 GENERAL

The QC / QA construction process consists of:

1. Establishing, maintaining, and changing if needed a quality control system providing assurance the HMA complies with the specifications
2. Sampling and testing at specified intervals, or sublots, to demonstrate compliance and to control process
3. The Engineer sampling and testing at specified intervals to verify testing process and HMA quality
4. The Engineer using test results, statistical evaluation of verified quality control tests, and inspection to accept HMA for payment

A lot is a quantity of HMA. The Engineer designates a new lot when:

1. 20 sublots are complete
2. The JMF changes

3. Production stops for more than 30 days

Each lot consists of no more than 20 sublots. A sublot is 750 tons except HMA paved at day's end greater than 250 tons is a sublot. If HMA paved at day's end is less than 250 tons, you may either make this quantity a sublot or include it in the previous sublot's test results for statistical evaluation.

## 39-4.03 CONTRACTOR QUALITY CONTROL

### 39-4.03A General

Use a composite quality factor, $QF_C$, and individual quality factors, $QF_{QCi}$, to control your process and evaluate your quality control program. For quality characteristics without quality factors, use your quality control plan's action limits to control process.

Control HMA quality including:

1. Materials
2. Proportioning
3. Spreading and compacting
4. Finished roadway surface

Develop, implement, and maintain a quality control program that includes:

1. Inspection
2. Sampling
3. Testing

### 39-4.03B Quality Control Plan

With the JMF submittal, submit a written Quality Control Plan (QCP). The QCP must comply with the Department's Quality Control Manual for Hot Mix Asphalt Production and Placement. Discuss the QCP with the Engineer during the prepaving conference.

The Engineer reviews each QCP within 5 business days from the submittal. Hold HMA production until the Engineer accepts the QCP in writing. The Engineer's QCP acceptance does not mean your compliance with the QCP will result in acceptable HMA. Section 39-1.05, "Engineer's Acceptance," specifies HMA acceptance.

The QCP must include the name and qualifications of a Quality Control Manager. The Quality Control Manager administers the QCP and during paving must be at the job site within 3 hours of receiving notice. The Quality Control Manager must not be any of the following on the project:

1. Foreman
2. Production or paving crewmember
3. Inspector
4. Tester

The QCP must include action limits and details of corrective action you will take if a test result for any quality characteristic falls outside an action limit.

As work progresses, you must submit a written QCP supplement to change quality control procedures, personnel, tester qualification status, or laboratory accreditation status.

### 39-4.03C Quality Control Inspection, Sampling, And Testing

Sample, test, inspect, and manage HMA quality control.

Provide a roadway inspector while HMA paving activities are in progress. Provide a plant inspector during HMA production.

Inspectors must comply with the Department's Quality Control Manual for Hot Mix Asphalt Production and Placement.

Provide a testing laboratory and personnel for quality control testing. Provide the Engineer unrestricted access to the quality control activities. Before providing services for the project, the Engineer reviews, accredits, and qualifies the testing laboratory and personnel under the Department's Independent Assurance Program.

The minimum random sampling and testing for quality control is:

**Minimum Quality Control – QC / QA**

| Quality Characteristic | Test Method | Minimum Sampling and Testing Frequency | HMA Type | | | Location of Sampling | Max. Reporting Time Allowance |
|---|---|---|---|---|---|---|---|
| | | | A | B | RHMA-G | | |
| Aggregate gradation [a] | CT 202 | 1 per 750 tons | JMF ± Tolerance [b] | JMF ± Tolerance [b] | JMF ± Tolerance [b] | CT 125 | 24 hours |
| Asphalt binder content (%) | CT 379 or 382 | | JMF ±0.45 | JMF ±0.45 | JMF ±0.5 | Loose Mix Behind Paver See CT 125 | |
| Percent of maximum theoretical density (%) [c, d] | QC Plan | | 92 - 96 | 92 - 96 | 91 - 96 | QC Plan | |
| Aggregate moisture content at continuous mixing plants and RAP moisture content at continuous mixing plants and batch mixing plants [e] | CT 226 or CT 370 | 2 per day during production | -- | -- | -- | Stockpiles or cold feed belts | -- |
| Sand equivalent (min.) [f] | CT 217 | 1 per 750 tons | 47 | 42 | 47 | CT 125 | 24 hours |
| HMA moisture content (%,max.) | CT 226 or CT 370 | 1 per 2,500 tons but not less than 1 per paving day | 1.0 | 1.0 | 1.0 | Loose Mix Behind Paver See CT 125 | 24 hours |
| Stabilometer Value (min.) [f, g]<br>No. 4 and 3/8" gradings<br>1/2" and 3/4" gradings | CT 366 | 1 per 4,000 tons or 2 per 5 business days, whichever is more | 30<br>37 | 30<br>35 | --<br>23 | | 48 hours |
| Air voids content (%)[f, h] | CT 367 | | 4 ± 2 | 4 ± 2 | Specification ± 2 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Percent of crushed particles coarse aggregate (% min.)<br>One fractured face<br>Two fractured faces<br>Fine aggregate (% min)<br>(Passing No. 4 sieve and retained on No. 8 sieve.)<br>One fractured face | CT 205 | As neces-sary and designat-ed in QCP. At least once per project. | 90<br>75<br>70 | 25<br>--<br>20 | --<br>90<br>70 | CT 125 | 48 hours |
| Los Angeles Rattler (% max.)<br>Loss at 100 rev.<br>Loss at 500 rev. | CT 211 | | 12<br>45 | --<br>50 | 12<br>40 | CT 125 | |
| Fine aggregate angularity (% min.) | AASHTO T 304, Method A | | 45 | 45 | 45 | CT 125 | |
| Flat and elongated particle (% max. by weight @ 5:1) | ASTM D 4791 | | Report only | Report only | Report only | CT 125 | |
| Voids filled with asphalt (%) [i]<br>No. 4 grading<br>3/8" grading<br>1/2" grading<br>3/4" grading | LP-3 | | 76.0 – 80.0<br>73.0 – 76.0<br>65.0 – 75.0<br>65.0 – 75.0 | 76.0 – 80.0<br>73.0 – 76.0<br>65.0 – 75.0<br>65.0 – 75.0 | Report only | LP-3 | |
| Voids in mineral aggregate (% min.) [i]<br>No. 4 grading<br>3/8" grading<br>1/2" grading<br>3/4" grading | LP-2 | | 17.0<br>15.0<br>14.0<br>13.0 | 17.0<br>15.0<br>14.0<br>13.0 | --<br>--<br>18.0 – 23.0[j]<br>18.0 – 23.0[j] | LP-2 | |
| Dust proportion [i]<br>No. 4 and 3/8" gradings<br>1/2" and 3/4" gradings | LP-4 | | 0.9 – 2.0<br>0.6 – 1.3 | 0.9 – 2.0<br>0.6 – 1.3 | Report only | LP-4 | |
| Smoothness | Section 39-1.12 | -- | 12-foot straight-edge, must-grind, and $PI_0$ | 12-foot straight-edge, must-grind, and $PI_0$ | 12-foot straight-edge, must-grind, and $PI_0$ | -- | |
| Asphalt rubber binder viscosity @ 350 °F, centipoises | Section 39-1.02D | -- | -- | -- | 1,500 – 4,000 | Section 39-1.02D | 24 hours |
| Crumb rubber modifier | Section 39-1.02D | -- | -- | -- | Section 39-1.02D | Section 39-1.02D | 48 hours |

Notes:

[a] Determine combined aggregate gradation containing RAP under Laboratory Procedure LP-9.
[b] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[c] Required for HMA Type A, Type B, and RHMA-G if the specified paved thickness is at least 0.15 foot.
[d] Determine maximum theoretical density (California Test 309) at the frequency specified for test maximum density under California Test 375, Part 5 D.
[e] For adjusting the plant controller at the HMA plant.
[f] Report the average of 3 tests from a single split sample.
[g] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 140 °F ± 5 °F by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 140 °F for a minimum of 2 hours and not more than 3 hours."
[h] Determine the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for asphalt binder content target value is less than or equal to ± 0.3 percent from OBC.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

Within the specified reporting time, submit written test results including:

1. Sampling location, quantity, and time
2. Testing results
3. Supporting data and calculations

If test results for any quality characteristic are beyond the action limits in the QCP, take corrective actions. Document the corrective actions taken in the inspection records under Section 39-4.03E, "Records of Inspection and Testing."

Stop production, notify the Engineer in writing, take corrective action, and demonstrate compliance with the specifications before resuming production and placement on the State highway if:

1. A lot's composite quality factor, $Q_{FC}$, or an individual quality factor, $QF_{QCi}$ for i = 3, 4, or 5, is below 0.90 determined under Section 39-4.03F, "Statistical Evaluation"
2. An individual quality factor, $QF_{QCi}$ for i = 1 or 2, is below 0.75
3. Quality characteristics for which a quality factor, $QF_{QCi}$, is not determined has 2 consecutive acceptance or quality control tests not in compliance with the specifications

### 39-4.03D Charts And Records

Record sampling and testing results for quality control on forms provided in the "Quality Control Manual for Hot Mix Asphalt," or on forms you submit with the QCP. The QCP must also include form posting locations and submittal times.

Submit quality control test results using the Department's statistical evaluation program, HMAPay, available at

www.dot.ca.gov/hq/construc/hma/index.htm

### 39-4.03E Records Of Inspection And Testing

During HMA production, submit in writing a daily:

1. HMA Construction Daily Record of Inspection. Also make this record available at the HMA plant and job site each day.
2. HMA Inspection and Testing Summary. Include in the summary:

    2.1. Test forms with the testers' signatures and Quality Control Manager's initials.
    2.2. Inspection forms with the inspectors' signatures and Quality Control Manager's initials.
    2.3. A list and explanation of deviations from the specifications or regular practices.
    2.4. A signed statement by the Quality Control Manager that says:

    "It is hereby certified that the information contained in this record is accurate, and that information, tests, or calculations documented herein comply with the specifications of the contract and the standards set forth in the testing procedures. Exceptions to this certification are documented as part of this record."

Retain for inspection the records generated as part of quality control including inspection, sampling, and testing for at least 3 years after final acceptance.

### 39-4.03F Statistical Evaluation

**General**

Determine a lot's composite quality factor, $QF_C$, and the individual quality factors, $QF_{QCi}$. Perform statistical evaluation calculations to determine these quality factors based on quality control test results for:

1. Aggregate gradation
2. Asphalt binder content
3. Percent of maximum theoretical density

The Engineer grants a waiver and you must use 1.0 as the individual quality factor for percent of maximum theoretical density, $QF_{QC5}$, for HMA paved in:

1. Areas where the specified paved thickness is less than 0.15 foot
2. Areas where the specified paved thickness is less than 0.20 foot and a 3/4-inch grading is specified and used
3. Dig outs
4. Leveling courses
5. Areas where, in the opinion of the Engineer, compaction or compaction measurement by conventional methods is impeded

**Statistical Evaluation Calculations**

Use the Variability-Unknown / Standard Deviation Method to determine the percentage of a lot not in compliance with the specifications. The number of significant figures used in the calculations must comply with AASHTO R-11, Absolute Method.

Determine the percentage of work not in compliance with the specification limits for each quality characteristic as follows:

1. Calculate the arithmetic mean ( $\overline{X}$ ) of the test values

$$\overline{X} = \frac{\Sigma x}{n}$$

where:

x = individual test values
n = number of test values

2. Calculate the standard deviation

$$s = \sqrt{\frac{n\,(\Sigma x^2)-(\Sigma x)^2}{n(n-1)}}$$

where:

$\sum(x^2)$ = sum of the squares of individual test values
$(\sum x)^2$ = sum of the individual test values squared
n = number of test values

3. Calculate the upper quality index (Qu)

$$Q_u = \frac{USL - \overline{X}}{s}$$

where:

USL = target value plus the production tolerance or upper specification limit
s = standard deviation
$\overline{X}$ = arithmetic mean

4. Calculate the lower quality index (QL);

$$Q_L = \frac{\overline{X} - LSL}{s}$$

where:

LSL = target value minus production tolerance or lower specification limit
s = standard deviation
$\overline{X}$ = arithmetic mean

5. From the table, Upper Quality Index $Q_U$ or Lower Quality Index $Q_L$, of this Section 39-4.03F, "Statistical Evaluation", determine $P_U$ ;

where:

$P_U$ = the estimated percentage of work outside the USL.
$P_U = 0$, when USL is not specified.

6. From the table, Upper Quality Index $Q_U$ or Lower Quality Index $Q_L$, of this Section 39-4.03F, "Statistical Evaluation," determine $P_L$;

where:

$P_L$ = the estimated percentage of work outside the LSL.
$P_L = 0$, when LSL is not specified.

7. Calculate the total estimated percentage of work outside the USL and LSL, percent defective

Percent defective $= P_U + P_L$

$P_U$ and $P_L$ are determined from:

| $P_U$ or $P_L$ | Upper Quality Index $Q_U$ or Lower Quality Index $Q_L$ | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample Size (n) | | | | | | | | | | | | |
| | 5 | 6 | 7 | 8 | 9 | 10-11 | 12-14 | 15-17 | 18-22 | 23-29 | 30-42 | 43-66 | >66 |
| 0 | 1.72 | 1.88 | 1.99 | 2.07 | 2.13 | 2.20 | 2.28 | 2.34 | 2.39 | 2.44 | 2.48 | 2.51 | 2.56 |
| 1 | 1.64 | 1.75 | 1.82 | 1.88 | 1.91 | 1.96 | 2.01 | 2.04 | 2.07 | 2.09 | 2.12 | 2.14 | 2.16 |
| 2 | 1.58 | 1.66 | 1.72 | 1.75 | 1.78 | 1.81 | 1.84 | 1.87 | 1.89 | 1.91 | 1.93 | 1.94 | 1.95 |
| 3 | 1.52 | 1.59 | 1.63 | 1.66 | 1.68 | 1.71 | 1.73 | 1.75 | 1.76 | 1.78 | 1.79 | 1.80 | 1.81 |
| 4 | 1.47 | 1.52 | 1.56 | 1.58 | 1.60 | 1.62 | 1.64 | 1.65 | 1.66 | 1.67 | 1.68 | 1.69 | 1.70 |
| 5 | 1.42 | 1.47 | 1.49 | 1.51 | 1.52 | 1.54 | 1.55 | 1.56 | 1.57 | 1.58 | 1.59 | 1.59 | 1.60 |
| 6 | 1.38 | 1.41 | 1.43 | 1.45 | 1.46 | 1.47 | 1.48 | 1.49 | 1.50 | 1.50 | 1.51 | 1.51 | 1.52 |
| 7 | 1.33 | 1.36 | 1.38 | 1.39 | 1.40 | 1.41 | 1.41 | 1.42 | 1.43 | 1.43 | 1.44 | 1.44 | 1.44 |
| 8 | 1.29 | 1.31 | 1.33 | 1.33 | 1.34 | 1.35 | 1.35 | 1.36 | 1.36 | 1.37 | 1.37 | 1.37 | 1.38 |
| 9 | 1.25 | 1.27 | 1.28 | 1.28 | 1.29 | 1.29 | 1.30 | 1.30 | 1.30 | 1.31 | 1.31 | 1.31 | 1.31 |
| 10 | 1.21 | 1.23 | 1.23 | 1.24 | 1.24 | 1.24 | 1.25 | 1.25 | 1.25 | 1.25 | 1.25 | 1.26 | 1.26 |
| 11 | 1.18 | 1.18 | 1.19 | 1.19 | 1.19 | 1.19 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 |
| 12 | 1.14 | 1.14 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 | 1.15 |
| 13 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.10 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 |
| 14 | 1.07 | 1.07 | 1.07 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 | 1.06 |
| 15 | 1.03 | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 |
| 16 | 1.00 | 0.99 | 0.99 | 0.99 | 0.99 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |
| 17 | 0.97 | 0.96 | 0.95 | 0.95 | 0.95 | 0.95 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| 18 | 0.93 | 0.92 | 0.92 | 0.92 | 0.91 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| 19 | 0.90 | 0.89 | 0.88 | 0.88 | 0.88 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |
| 20 | 0.87 | 0.86 | 0.85 | 0.85 | 0.84 | 0.84 | 0.84 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 | 0.83 |
| 21 | 0.84 | 0.82 | 0.82 | 0.81 | 0.81 | 0.81 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.79 |
| 22 | 0.81 | 0.79 | 0.79 | 0.78 | 0.78 | 0.77 | 0.77 | 0.77 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 |
| 23 | 0.77 | 0.76 | 0.75 | 0.75 | 0.74 | 0.74 | 0.74 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 | 0.73 |
| 24 | 0.74 | 0.73 | 0.72 | 0.72 | 0.71 | 0.71 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| 25 | 0.71 | 0.70 | 0.69 | 0.69 | 0.68 | 0.68 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.66 |
| 26 | 0.68 | 0.67 | 0.67 | 0.65 | 0.65 | 0.65 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.63 |
| 27 | 0.65 | 0.64 | 0.63 | 0.62 | 0.62 | 0.62 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.60 |
| 28 | 0.62 | 0.61 | 0.60 | 0.59 | 0.59 | 0.59 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.57 |
| 29 | 0.59 | 0.58 | 0.57 | 0.57 | 0.56 | 0.56 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.54 |
| 30 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 |
| 31 | 0.53 | 0.52 | 0.51 | 0.51 | 0.50 | 0.50 | 0.50 | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 |
| 32 | 0.50 | 0.49 | 0.48 | 0.48 | 0.48 | 0.47 | 0.47 | 0.47 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |
| 33 | 0.47 | 0.48 | 0.45 | 0.45 | 0.45 | 0.44 | 0.44 | 0.44 | 0.44 | 0.43 | 0.43 | 0.43 | 0.43 |
| 34 | 0.45 | 0.43 | 0.43 | 0.42 | 0.42 | 0.42 | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 | 0.40 |
| 35 | 0.42 | 0.40 | 0.40 | 0.39 | 0.39 | 0.39 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 | 0.38 |
| 36 | 0.39 | 0.38 | 0.37 | 0.37 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| 37 | 0.36 | 0.35 | 0.34 | 0.34 | 0.34 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.33 | 0.32 |
| 38 | 0.33 | 0.32 | 0.32 | 0.31 | 0.31 | 0.31 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| 39 | 0.30 | 0.30 | 0.29 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 |
| 40 | 0.28 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 41 | 0.25 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| 42 | 0.23 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| 43 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 |
| 44 | 0.16 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| 45 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| 46 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| 47 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| 48 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| 49 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| 50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

1. If the value of $Q_U$ or $Q_L$ does not correspond to a value in the table, use the next lower value.
2. If $Q_U$ or $Q_L$ are negative values, $P_U$ or $P_L$ is equal to 100 minus the table value for $P_U$ or $P_L$.

## Quality Factor Determination

Determine individual quality factors, $QF_{QCi}$, using percent defective = $P_U + P_L$ and:

**Quality Factors**

| Quality Factor | Maximum Allowable Percent Defective ($P_U + P_L$) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample Size (n) | | | | | | | | | | | | |
| | 5 | 6 | 7 | 8 | 9 | 10-11 | 12-14 | 15-17 | 18-22 | 23-29 | 30-42 | 43-66 | >66 |
| 1.05 | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1.04 | | | 0 | 1 | 3 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | 3 |
| 1.03 | | 0 | 2 | 4 | 6 | 8 | 7 | 7 | 6 | 5 | 5 | 4 | 4 |
| 1.02 | | 1 | 3 | 6 | 9 | 11 | 10 | 9 | 8 | 7 | 7 | 6 | 6 |
| 1.01 | 0 | 2 | 5 | 8 | 11 | 13 | 12 | 11 | 10 | 9 | 8 | 8 | 7 |
| 1.00 | 22 | 20 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 |
| 0.99 | 24 | 22 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 11 | 10 | 9 |
| 0.98 | 26 | 24 | 22 | 21 | 20 | 19 | 18 | 16 | 15 | 14 | 13 | 12 | 10 |
| 0.97 | 28 | 26 | 24 | 23 | 22 | 21 | 19 | 18 | 17 | 16 | 14 | 13 | 12 |
| 0.96 | 30 | 28 | 26 | 25 | 24 | 22 | 21 | 19 | 18 | 17 | 16 | 14 | 13 |
| 0.95 | 32 | 29 | 28 | 26 | 25 | 24 | 22 | 21 | 20 | 18 | 17 | 16 | 14 |
| 0.94 | 33 | 31 | 29 | 28 | 27 | 25 | 24 | 22 | 21 | 20 | 18 | 17 | 15 |
| 0.93 | 35 | 33 | 31 | 29 | 28 | 27 | 25 | 24 | 22 | 21 | 20 | 18 | 16 |
| 0.92 | 37 | 34 | 32 | 31 | 30 | 28 | 27 | 25 | 24 | 22 | 21 | 19 | 18 |
| 0.91 | 38 | 36 | 34 | 32 | 31 | 30 | 28 | 26 | 25 | 24 | 22 | 21 | 19 |
| 0.90 | 39 | 37 | 35 | 34 | 33 | 31 | 29 | 28 | 26 | 25 | 23 | 22 | 20 |
| 0.89 | 41 | 38 | 37 | 35 | 34 | 32 | 31 | 29 | 28 | 26 | 25 | 23 | 21 |
| 0.88 | 42 | 40 | 38 | 36 | 35 | 34 | 32 | 30 | 29 | 27 | 26 | 24 | 22 |
| 0.87 | 43 | 41 | 39 | 38 | 37 | 35 | 33 | 32 | 30 | 29 | 27 | 25 | 23 |
| 0.86 | 45 | 42 | 41 | 39 | 38 | 36 | 34 | 33 | 31 | 30 | 28 | 26 | 24 |
| 0.85 | 46 | 44 | 42 | 40 | 39 | 38 | 36 | 34 | 33 | 31 | 29 | 28 | 25 |
| 0.84 | 47 | 45 | 43 | 42 | 40 | 39 | 37 | 35 | 34 | 32 | 30 | 29 | 27 |
| 0.83 | 49 | 46 | 44 | 43 | 42 | 40 | 38 | 36 | 35 | 33 | 31 | 30 | 28 |
| 0.82 | 50 | 47 | 46 | 44 | 43 | 41 | 39 | 38 | 36 | 34 | 33 | 31 | 29 |
| 0.81 | 51 | 49 | 47 | 45 | 44 | 42 | 41 | 39 | 37 | 36 | 34 | 32 | 30 |
| 0.80 | 52 | 50 | 48 | 46 | 45 | 44 | 42 | 40 | 38 | 37 | 35 | 33 | 31 |
| 0.79 | 54 | 51 | 49 | 48 | 46 | 45 | 43 | 41 | 39 | 38 | 36 | 34 | 32 |
| 0.78 | 55 | 52 | 50 | 49 | 48 | 46 | 44 | 42 | 41 | 39 | 37 | 35 | 33 |
| 0.77 | 56 | 54 | 52 | 50 | 49 | 47 | 45 | 43 | 42 | 40 | 38 | 36 | 34 |
| 0.76 | 57 | 55 | 53 | 51 | 50 | 48 | 46 | 44 | 43 | 41 | 39 | 37 | 35 |
| 0.75 | 58 | 56 | 54 | 52 | 51 | 49 | 47 | 46 | 44 | 42 | 40 | 38 | 36 |
| | 60 | 57 | 55 | 53 | 52 | 51 | 48 | 47 | 45 | 43 | 41 | 40 | 37 |
| | 61 | 58 | 56 | 55 | 53 | 52 | 50 | 48 | 46 | 44 | 43 | 41 | 38 |
| Reject | 62 | 59 | 57 | 56 | 54 | 53 | 51 | 49 | 47 | 45 | 44 | 42 | 39 |
| | 63 | 61 | 58 | 57 | 55 | 54 | 52 | 50 | 48 | 47 | 45 | 43 | 40 |
| | 64 | 62 | 60 | 58 | 57 | 55 | 53 | 51 | 49 | 48 | 46 | 44 | 41 |
| Reject Values Greater Than Those Shown Above | | | | | | | | | | | | | |

Notes:
1. To obtain a quality factor when the estimated percent outside specification limits from table, "Upper Quality Index $Q_U$ or Lower Quality Index $Q_L$," does not correspond to a value in the table, use the next larger value.

Compute the composite of single quality factors, $QF_C$, for a lot using:

$$QF_C = \sum_{i=1}^{5} w_i \, QF_{QC_i}$$

where:

$QF_C$ = the composite quality factor for the lot rounded to 2 decimal places.
$QF_{QCi}$ = the quality factor for the individual quality characteristic.
w = the weighting factor listed in the table HMA Acceptance – QC / QA.
*i* = the quality characteristic index number in the table HMA Acceptance – QC / QA.

## 39-4.04 ENGINEER'S QUALITY ASSURANCE

### 39-4.04A General

The Engineer assures quality by:

1. Reviewing mix designs and proposed JMF
2. Inspecting procedures
3. Conducting oversight of quality control inspection and records
4. Verification sampling and testing during production and paving

### 39-4.04B Verification Sampling And Testing

**General**

The Engineer samples:

1. Aggregate to verify gradation
2. HMA to verify asphalt binder content

**Verification**

For aggregate gradation and asphalt binder content, the ratio of verification testing frequency to the minimum quality control testing frequency is 1:5. The Engineer performs at least 3 verification tests per lot.

Using the t-test, the Engineer compares quality control tests results for aggregate gradation and asphalt binder content with corresponding verification test results. The Engineer uses the average and standard deviation of up to 20 sequential sublots for the comparison. The Engineer uses production start-up evaluation tests to represent the first sublot. When there are less than 20 sequential sublots, the Engineer uses the maximum number of sequential sublots available. The 21st sublot becomes the 1st sublot (n = 1) in the next lot.

The t-value for a group of test data is computed as follows:

$$t = \frac{\left|\overline{X}_c - \overline{X}_v\right|}{S_p\sqrt{\frac{1}{n_c} + \frac{1}{n_v}}} \quad \text{and} \quad S_p^2 = \frac{S_c^2(n_c - 1) + S_v^2(n_v - 1)}{n_c + n_v - 2}$$

where:

$n_c$ = Number of quality control tests (2 minimum, 20 maximum).
$n_v$ = Number of verification tests (minimum of 1 required).
$\overline{X}_c$ = Mean of quality control tests.
$\overline{X}_v$ = Mean of verification tests.
$S_p$ = Pooled standard deviation (When $n_v = 1$, $S_p = S_c$).
$S_c$ = Standard deviation of quality control tests.
$S_v$ = Standard deviation of verification tests (when $n_v > 1$).

The comparison of quality control test results and the verification test results is at a level of significance of $\alpha = 0.025$. The Engineer computes t and compares it to the critical t-value, $t_{crit}$, from:

**Critical T-Value**

| Degrees of freedom ($n_c$+$n_v$-2) | $t_{crit}$ (for $\alpha$ = 0.025) | Degrees of freedom ($n_c$+$n_v$-2) | $t_{crit}$ (for $\alpha$ = 0.025) |
|---|---|---|---|
| 1 | 24.452 | 18 | 2.445 |
| 2 | 6.205 | 19 | 2.433 |
| 3 | 4.177 | 20 | 2.423 |
| 4 | 3.495 | 21 | 2.414 |
| 5 | 3.163 | 22 | 2.405 |
| 6 | 2.969 | 23 | 2.398 |
| 7 | 2.841 | 24 | 2.391 |
| 8 | 2.752 | 25 | 2.385 |
| 9 | 2.685 | 26 | 2.379 |
| 10 | 2.634 | 27 | 2.373 |
| 11 | 2.593 | 28 | 2.368 |
| 12 | 2.560 | 29 | 2.364 |
| 13 | 2.533 | 30 | 2.360 |
| 14 | 2.510 | 40 | 2.329 |
| 15 | 2.490 | 60 | 2.299 |
| 16 | 2.473 | 120 | 2.270 |
| 17 | 2.458 | ∞ | 2.241 |

If the t-value computed is less than or equal to $t_{crit}$, quality control test results are verified.

If the t-value computed is greater than $t_{crit}$ and both $\overline{X}_v$ and $\overline{X}_c$ comply with acceptance specifications, the quality control tests are verified. You may continue to produce and place HMA with the following allowable differences:

1. $\left|\overline{X}_v - \overline{X}_c\right| \leq 1.0$ percent for any grading
2. $\left|\overline{X}_v - \overline{X}_c\right| \leq 0.1$ percent for asphalt binder content

If the t-value computed is greater than $t_{crit}$ and the $\left|\overline{X}_v - \overline{X}_c\right|$ for grading and asphalt binder content are greater than the allowable differences, quality control test results are not verified and:

1. The Engineer notifies you in writing.
2. You and the Engineer must investigate why the difference exist.
3. If the reason for the difference cannot be found and corrected, the Engineer's test results are used for acceptance and pay.

## 39-4.05 ENGINEER'S ACCEPTANCE

### 39-4.05A Testing

The Engineer samples for acceptance testing and tests for:

**HMA Acceptance – QC / QA**

| Index (i) | Quality Characteristic | | | | Weight-ing Factor (w) | Test Method | HMA Type | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | A | B | RHMA-G |
| | | Aggregate gradation [a] | | | | | | | |
| | Sieve | 3/4" | 1/2" | 3/8" | | | | | |
| 1 | 1/2" | X [b] | -- | -- | 0.05 | CT 202 | JMF ± Tolerance [c] | | |
| 1 | 3/8" | -- | X | -- | 0.05 | | | | |
| 1 | No. 4 | -- | -- | X | 0.05 | | | | |
| 2 | No. 8 | X | X | X | 0.10 | | | | |
| 3 | No. 200 | X | X | X | 0.15 | | | | |
| 4 | Asphalt binder content (%) | | | | 0.30 | CT 379 or 382 | JMF ± 0.45 | JMF ± 0.45 | JMF ± 0.5 |
| 5 | Percent of maximum theoretical density (%) [d, e] | | | | 0.40 | CT 375 | 92 – 96 | 92 – 96 | 91 – 96 |
| | Sand equivalent (min.) [f] | | | | | CT 217 | 47 | 42 | 47 |
| | Stabilometer value (min.) [f., g]<br>No. 4 and 3/8" gradings<br>1/2" and 3/4" gradings | | | | | CT 366 | <br>30<br>37 | <br>30<br>35 | <br>--<br>23 |
| | Air voids content (%)[f, h] | | | | | CT 367 | 4 ± 2 | 4 ± 2 | Specifica-tion ± 2 |
| | Percent of crushed particles coarse aggregate (% min.)<br>One fractured face<br>Two fractured faces<br>Fine aggregate (% min)<br>(Passing No. 4 sieve and retained on No. 8 sieve.)<br>One fractured face | | | | | CT 205 | <br>90<br>70<br><br><br>70 | <br>25<br>--<br><br><br>20 | <br>--<br>90<br><br><br>70 |
| | HMA moisture content (%, max.) | | | | | CT 226 or CT 370 | 1.0 | 1.0 | 1.0 |
| | Los Angeles Rattler (% max.)<br>Loss at 100 rev.<br>Loss at 500 rev. | | | | | CT 211 | <br>12<br>45 | <br>--<br>50 | <br>12<br>45 |
| | Fine aggregate angularity (% min.) | | | | | AASHTO T 304, Method A | 45 | 45 | 45 |
| | Flat and elongated particle (% max. by weight @ 5:1) | | | | | ASTM D 4791 | Report only | Report only | Report only |
| | Voids in mineral aggregate (% min.) [i]<br>No. 4 grading<br>3/8" grading<br>1/2" grading<br>3/4" grading | | | | | LP-2 | <br>17.0<br>15.0<br>14.0<br>13.0 | <br>17.0<br>15.0<br>14.0<br>13.0 | (Note j)<br>--<br>--<br>18.0 - 23.0<br>18.0 - 23.0 |
| | Voids filled with asphalt (%) [i]<br>No. 4 grading<br>3/8" grading<br>1/2" grading<br>3/4" grading | | | | | LP-3 | <br>76.0 - 80.0<br>73.0 - 76.0<br>65.0 - 75.0<br>65.0 - 75.0 | <br>76.0 - 80.0<br>73.0 - 76.0<br>65.0 - 75.0<br>65.0 - 75.0 | Report only |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Dust proportion [i]<br>No. 4 and 3/8" gradings<br>1/2" and 3/4" gradings | | LP-4 | <br>0.9 - 2.0<br>0.6 - 1.3 | <br>0.9 – 2.0<br>0.6 – 1.3 | Report only |
| | Smoothness | | Section 39-1.12 | 12-foot straight-edge, must-grind, and $PI_0$ | 12-foot straight-edge, must-grind, and $PI_0$ | 12-foot straight-edge, must-grind, and $PI_0$ |
| | Asphalt binder | | Various | Section 92 | Section 92 | Section 92 |
| | Asphalt rubber binder | | Various | -- | -- | Section 92-1.02(C) and Section 39-1.02D |
| | Asphalt modifier | | Various | -- | -- | Section 39-1.02D |
| | Crumb rubber modifier | | Various | -- | -- | Section 39-1.02D |

Notes:
[a] The Engineer determines combined aggregate gradations containing RAP under Laboratory Procedure LP-9.
[b] "X" denotes the sieves the Engineer considers for the specified aggregate gradation.
[c] The tolerances must comply with the allowable tolerances in Section 39-1.02E, "Aggregate."
[d] The Engineer determines percent of maximum theoretical density if the specified paved thickness is at least 0.15 foot under California Test 375 except the Engineer uses:

1. California Test 308, Method A, to determine in-place density of each density core instead of using the nuclear gauge in Part 4, "Determining In-Place Density By The Nuclear Density Device."
2. California Test 309 to determine maximum theoretical density instead of calculating test maximum density in Part 5, "Determining Test Maximum Density."

[e] The Engineer determines maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[f] The Engineer reports the average of 3 tests from a single split sample.
[g] Modify California Test 304, Part 2.B.2.c: "After compaction in the mechanical compactor, cool to 140 °F ± 5 °F by allowing the briquettes to cool at room temperature for 0.5 hour, then place the briquettes in the oven at 140 °F for a minimum of 2 hours and not more than 3 hours."
[h] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for asphalt binder content target value is less than or equal to ± 0.3 percent from OBC.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

The Engineer determines the percent of maximum theoretical density from the average density of 3 density cores you take from every 750 tons of production or part thereof divided by the maximum theoretical density.

If the specified total paved thickness is at least 0.15 foot and any layer is less than 0.15 foot, the Engineer determines the percent of maximum theoretical density from density cores taken from the final layer measured the full depth of the total paved HMA thickness.

The Engineer stops production and terminates a lot if:

1. The lot's composite quality factor, $Q_{FC}$, or an individual quality factor, $QF_{QCi}$ for i = 3, 4, or 5, is below 0.90 determined under Section 39-4.03F, "Statistical Evaluation"
2. An individual quality factor, $QF_{QCi}$ for i = 1 or 2, is below 0.75
3. Quality characteristics for which a quality factor, $QF_{QCi}$, is not determined has 2 consecutive acceptance or quality control tests not in compliance with the specifications

For any single quality characteristic for which a quality factor, $QF_{QCi}$, is not determined, except smoothness, if 2 consecutive acceptance test results do not comply with specifications:

1. Stop production.
2. Take corrective action.
3. In the Engineer's presence, take samples and split each sample into 4 parts. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Engineer tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement on the State highway.

## 39-4.05B Statistical Evaluation, Determination Of Quality Factors And Acceptance

**Statistical Evaluation and Determination of Quality Factors**

To determine the individual quality factor, $QF_{QCi,}$ for any quality factor i = 1 through 5 or a lot's composite quality factor, $QF_C$, for acceptance and payment adjustment, the Engineer uses the evaluation specifications under Section 39-4.03F, "Statistical Evaluation," and:

1. Verified quality control test results for aggregate gradation
2. Verified quality control test results for asphalt binder content
3. The Engineer's test results for percent of maximum theoretical density

**Lot Acceptance Based on Quality Factors**

The Engineer accepts a lot based on the quality factors determined for aggregate gradation and asphalt binder content, $QF_{QCi}$ for i = 1 through 4, using the total number of verified quality control test result values and the total percent defective ($P_U + P_L$).

The Engineer accepts a lot based on the quality factor determined for maximum theoretical density, $QF_{QC5}$, using the total number of test result values from density cores and the total percent defective ($P_U + P_L$).

The Engineer calculates the quality factor for the lot, $QF_C$, which is a composite of weighted individual quality factors, $QF_{QCi}$, determined for each quality characteristic in the HMA Acceptance – QC / QA table in Section 39-4.05A, "Testing."

The Engineer accepts a lot based on quality factors if:

1. The current composite quality factor, $QF_C$, is 0.90 or greater
2. Each individual quality factor, $QF_{QCi}$ for i = 3, 4, and 5, is 0.90 or greater
3. Each individual quality factor, $QF_{QCi}$ for i = 1 and 2, is 0.75 or greater

No single quality characteristic test may represent more than the smaller of 750 tons or 1 day's production.

**Payment Adjustment**

If a lot is accepted, the Engineer adjusts payment with the following formula:

$$PA = \sum_{i=1}^{n} HMACP * wi * \left[QF_{QCi} * (HMATT - WHMATTi) + WHMATTi\right] - \left(HMACP * HMATT\right)$$

where:

| | |
|---|---|
| PA = | Payment adjustment rounded to 2 decimal places. |
| *HMACP* = | HMA contract price. |
| *HMATT* = | HMA total tons represented in the lot. |
| $WHMATT_i$ = | Total tons of waived quality characteristic HMA. |
| $QF_{QCi}$ = | Running quality factor for the individual quality characteristic. $QF_{QCi}$ for i = 1 through 4 must be from verified Contractor's QC results. $QF_{QC5}$ must be determined from the Engineer's results on density cores taken for percent of maximum theoretical density determination. |
| *w* = | Weighting factor listed in the HMA acceptance table. |
| *i* = | Quality characteristic index number in the HMA acceptance table. |

If the payment adjustment is a negative value, the Engineer deducts this amount from payment. If the payment adjustment is a positive value, the Engineer adds this amount to payment.

The 21st sublot becomes the 1st sublot (n = 1) in the next lot. When the 21st sequential sublot becomes the 1st sublot, the previous 20 sequential sublots become a lot for which the Engineer determines a quality factor. The Engineer uses this quality factor to pay for the HMA in the lot. If the next lot consists of less than 8 sublots, these sublots must be added to the previous lot for quality factor determination using 21 to 27 sublots.

### 39-4.05C Dispute Resolution

For a lot, if you or the Engineer dispute any quality factor, $QF_{QCi}$, or verification test result, every sublot in that lot must be retested.

Referee tests must be performed under the specifications for acceptance testing.

Any quality factor, $QF_{QCi}$, must be determined using the referee tests.

For any quality factor, $QF_{QCi}$, for i = 1 through 5, dispute resolution:

1. If the difference between the quality factors for $QF_{QCi}$ using the referee test result and the disputed test result is less than or equal to 0.01, the original test result is correct.

2. If the difference between the quality factor for $QF_{QCi}$ using the referee test result and the disputed test result is more than 0.01, the quality factor determined from the referee tests supersedes the previously determined quality factor.

## 39-5 MEASUREMENT AND PAYMENT

### 39-5.01 MEASUREMENT

The contract item for HMA is measured by weight. The weight of each HMA mixture designated in the Engineer's Estimate must be the combined mixture weight.

If tack coat, asphalt binder, and asphaltic emulsion are paid with separate contract items, their contract items are measured under Section 92, "Asphalts," or Section 94, "Asphaltic Emulsions," as the case may be.

If recorded batch weights are printed automatically, the contract item for HMA is measured by using the printed batch weights, provided:

1. Total aggregate and supplemental fine aggregate weight per batch is printed. If supplemental fine aggregate is weighed cumulatively with the aggregate, the total aggregate batch weight must include the supplemental fine aggregate weight.
2. Total asphalt binder weight per batch is printed.
3. Each truckload's zero tolerance weight is printed before weighing the first batch and after weighing the last batch.
4. Time, date, mix number, load number and truck identification is correlated with a load slip.
5. A copy of the recorded batch weights is certified by a licensed weighmaster and submitted to the Engineer.

The contract item for placing HMA dike is measured by the linear foot along the completed length. The contract item for placing HMA in miscellaneous areas is measured as the in-place compacted area in square yards. In addition to the quantities measured on a linear foot or square yard basis, the HMA for dike and miscellaneous areas are measured by weight.

The contract item for geosynthetic pavement interlayer is measured by the square yard for the actual pavement area covered.

### 39-5.02 PAYMENT

The contract prices paid per ton for hot mix asphalt as designated in the Engineer's Estimate include full compensation for furnishing all labor, materials, tools, equipment, and incidentals for doing all the work involved in constructing hot mix asphalt, complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

If HMA is specified to comply with Section 39-4, "Quality Control / Quality Assurance," the Engineer adjusts payment under that section.

Full compensation for the Quality Control Plan and prepaving conference is included in the contract prices paid per ton for hot mix asphalt as designated in the Engineer's Estimate and no additional compensation will be allowed therefor.

Full compensation for performing and submitting mix designs and for Contractor sampling, testing, inspection, testing facilities, and preparation and submittal of results is included in the contract prices paid per ton for HMA as designated in the Engineer's Estimate and no additional compensation will be allowed therefor.

Full compensation for reclaimed asphalt pavement is included in the contract prices paid per ton for HMA as designated in the Engineer's Estimate and no additional compensation will be allowed therefor.

The contract price paid per ton for hot mix asphalt (leveling) includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals for doing all the work involved in hot mix asphalt (leveling), complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The State pays for HMA dike at the contract price per linear foot for place HMA dike and by the ton for HMA. The contract prices paid per linear foot for place hot mix asphalt dike as designated in the Engineer's Estimate include full compensation for furnishing all labor, tools, equipment, and incidentals, and for doing all the work involved in placing HMA dike, complete in place, including excavation, backfill, and preparation of the area to receive the dike, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The State pays for HMA specified to be a miscellaneous area at the contract price per square yard for place hot mix asphalt (miscellaneous area) and per ton for hot mix asphalt. The contract price paid per square yard for place hot mix asphalt (miscellaneous area) includes full compensation for furnishing all labor, tools, equipment, and incidentals, and for doing all the work involved in placing HMA (miscellaneous area) complete in place, including excavation, backfill, and preparation of the area to receive HMA (miscellaneous area), as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

If the Quality Control / Quality Assurance construction process is specified, HMA placed in dikes and miscellaneous areas is paid for at the contract price per ton for hot mix asphalt under Section 39-4, "Quality Control / Quality Assurance." Section 39-4.05B, "Statistical Evaluation, Determination of Quality Factors and Acceptance," does not apply to HMA placed in dikes and miscellaneous areas.

If there are no contract items for place hot mix asphalt dike and place hot mix asphalt (miscellaneous area) and the work is specified, full compensation for constructing HMA dikes and HMA (miscellaneous areas) including excavation, backfill, and preparation of the area to receive HMA dike or HMA (miscellaneous area) is included in the contract price paid per ton for the hot mix asphalt designated in the Engineer's Estimate and no separate payment will be made therefor.

The contract price paid per square yard for geosynthetic pavement interlayer includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in placing geosynthetic pavement interlayer, complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The contract price paid per ton for paving asphalt (binder, geosynthetic pavement interlayer) includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying paving asphalt (binder, geosynthetic pavement interlayer), complete in place, including spreading sand to cover exposed binder material, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

Full compensation for small quantities of HMA placed on geosynthetic pavement interlayer to prevent displacement during construction is included in the contract price paid per ton for the HMA being paved over the interlayer and no separate payment will be made therefor.

The contract price paid per ton for tack coat includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying tack coat, complete in place, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The Engineer does not adjust payment for increases or decreases in the quantities for tack coat, regardless of the reason for the increase or decrease. Section 4-1.03B, "Increased or Decreased Quantities," does not apply to the items for tack coat.

Full compensation for performing smoothness testing, submitting written and electronic copies of tests, and performing corrective work including applying fog seal coat is included in the contract price paid per ton for the HMA designated in the Engineer's Estimate and no separate payment will be made therefor.

Full compensation for spreading sand on RHMA-G, RHMA-O, and RHMA-O-HB surfaces and for sweeping and removing excess sand is included in the contract price paid per ton for rubberized hot mix asphalt as designated in the Engineer's Estimate and no separate payment will be made therefor.

If the Engineer fails to comply with a specification within a specified time, and if, in the opinion of the Engineer, work completion is delayed because of the failure, the Engineer adjusts payment and contract time under Section 8-1.09, "Right of Way Delays."

If the dispute resolution ITP determines the Engineer's test results are correct, the Engineer deducts the ITP's testing costs from payments. If the ITP determines your test results are correct, the State pays the ITP's testing costs. If, in the Engineer's opinion, work completion is delayed because of incorrect Engineer test results, the Engineer adjusts payment and contract time under Section 8-1.09, "Right of Way Delays."

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## SECTION 40 PORTLAND CEMENT CONCRETE PAVEMENT
## (Issued 06-05-09)

## Replace Section 40 with:
## SECTION 40 CONCRETE PAVEMENT

## 40-1 GENERAL

### 40-1.01 SUMMARY

Section 40 includes specifications for constructing concrete pavement on a prepared subgrade.

## 40-1.02 SUBMITTALS

### 40-1.02A Certificates of Compliance

Submit Certificates of Compliance under Section 6-1.07, "Certificates of Compliance." Include a test result report for any specified test with certification that test was performed within 12 months before the tested material's use.

Submit Certificates of Compliance for:

1. Tie bars
2. Threaded tie bar splice couplers
3. Dowel bars
4. Tie bar baskets
5. Dowel bar baskets
6. Chemical adhesive (drill and bond)
7. Silicone joint sealant
8. Asphalt rubber joint sealant
9. Preformed compression seal
10. Backer rods. Include the manufacturer's statement of compatibility with the sealant to be used.
11. Joint filler material
12. Curing compound. For each delivery to the job site, submit a copy of the Certificate of Compliance to the Engineer and the Transportation Laboratory. Each Certificate of Compliance must not represent more than 10,000 gallons and must include a test result report for:

    12.1. Moisture loss at 24 hours under California Test 534
    12.2. Reflectance under ASTM E 1347
    12.3. Viscosity under ASTM D 2196
    12.4. Nonvolatile content under ASTM D 3723
    12.5. Pigment content under ASTM D 3723

13. Epoxy powder coating

### 40-1.02B Curing Compound Samples

Submit split curing compound samples to the Transportation Laboratory.

### 40-1.02C Drilled Corings

Submit each core taken for Engineer's acceptance in a plastic bag. Mark each core with a location description.

### 40-1.02D Independent Third Party Air Content Testing Laboratory

Before testing, submit for the Engineer's approval the name of a laboratory that will test drilled core specimens for air content in cases of dispute.

### 40-1.02E Dowel Bars

Before placing dowel bars, submit a procedure for identifying transverse contraction joint locations relative to the dowel bars' longitudinal center and a procedure for consolidating concrete around the dowel bars.

### 40-1.02F Concrete Field Qualification

Submit field qualification data and test reports including:

1. Mixing date
2. Mixing equipment and procedures used
3. Batch volume in cubic yards
4. Type and source of ingredients used
5. Penetration of the concrete
6. Air content of the plastic concrete
7. Age and strength at time of concrete beam testing

Field qualification test reports must be certified with a signature by an official in responsible charge of the laboratory performing the tests.

### 40-1.02G Frequency Measuring Device (Tachometer)

Submit calibration documentation and operational guidelines for frequency measuring devices for concrete consolidation vibrators.

### 40-1.02H Manufacturer's Recommendations and Instructions

If used and at least 15 days before delivery to the job site, submit manufacturer's recommendations and instructions for storage and installation of:

1. Threaded tie bar splice couplers
2. Chemical adhesive (drill and bond)
3. Silicone liquid sealant
4. Asphalt rubber liquid sealant
5. Preformed compression seals
6. Joint filler material

### 40-1.02I Mix Proportions

At least 15 days before starting testing for mix proportions under California Test 559, submit a copy of the AASHTO accreditation for your laboratory determining the mix proportions. At least 30 days before starting field qualification, submit under California Test 559 the proposed concrete mix proportions, the corresponding mix identifications, and laboratory test reports including the modulus of rupture for each trial mixture at 10, 21, 28, and 42 days.

### 40-1.02J Preformed Compression Seal

Submit the manufacturer's data sheet used to develop the recommended preformed compression seal based on the joint dimensions.

### 40-1.02K Concrete Pavement Early Age Crack Mitigation System

At least 24 hours before each paving shift, submit:

1. Early age stress and strength predictions
2. Scheduled sawing and curing activities
3. Contingency plan if volunteer cracking occurs

At least 24 hours before paving, meet with the Engineer to review the submittals for the early age crack mitigation system.

During paving, update the system with current weather data obtained from a portable weather station. Before paving concrete pavement with these updates, submit new stress and strength predictions and curing and sawing activity schedules.

### 40-1.02L Profilograms

Submit profilograms within 5 business days of initial profiling and within 2 business days of profiling corrected sections.

Submit 1 electronic copy of profile information in ".erd" format or other ProVAL compatible format to the Engineer and to:

Smoothness@dot.ca.gov

Submit the original of final profilograms before the Engineer accepts the contract.

Submitted profilograms become the Department's property.

### 40-1.02M Protecting Concrete Pavement During Cold Weather

Submit a plan for protecting concrete pavement when the average ambient daily temperature is below 40 °F and daytime ambient temperature is less than 50 °F during the initial 72 hours after paving.

### 40-1.02N Quality Control Charts

Submit updated quality control charts each paving day.

### 40-1.02O Quality Control Plan

At least 30 days before the start of field qualification, submit a concrete pavement quality control plan (QCP).

## 40-1.03 QUALITY CONTROL AND ASSURANCE

### 40-1.03A Contractor Quality Control Plan

Establish, implement, and maintain a QCP for concrete pavement. The QCP must describe the organization and procedures you use to:

1. Control the production process
2. Determine if changes to the production process are needed
3. Implement changes

The QCP must address the elements affecting concrete pavement quality including:

1. Mix proportions
2. Aggregate gradation
3. Materials quality
4. Stockpile management
5. Line and grade control
6. Proportioning
7. Mixing and transportation
8. Placing and consolidation
9. Contraction and construction joints
10. Dowel bar placement, alignment, and anchorage
11. Tie bar placement
12. Modulus of rupture
13. Finishing and curing
14. Surface smoothness
15. Joint sealant and compression seal installation

The QCP must include details of corrective action to be taken if any process is out of control. As a minimum, a process is out of control if any of the following occurs:

1. For fine and coarse aggregate gradation, 2 consecutive running averages of 4 tests are outside the specification limits
2. For fine and coarse aggregates, the moisture content of either aggregate changes by more than 0.5 percentage point from any reading
3. For individual penetration or air content measurements:

    3.1. One point falls outside the suspension limit line
    3.2. Two points in a row fall outside the action limit line

Stop production and take corrective action for out of control processes except fine and coarse aggregate moisture content or the Engineer rejects subsequent material.

### 40-1.03B Quality Control Testing

Select random locations and perform sampling and testing in compliance with:

**Quality Control Testing**

| Test | Frequency | Test Method |
|---|---|---|
| Cleanness value | 2 per day | CT 227 |
| Sand equivalent | 2 per day | CT 217 |
| Aggregate gradation | 2 per day | CT 202 |
| Air content (freeze thaw) [a] | 1 per hour | CT 504 |
| Air content (non-freeze thaw) | 1 per 4 hours | CT 504 |
| Density | 1 per 4 hours | CT 518 |
| Penetration | 1 per 4 hours | CT 533 |
| Calibration of moisture meter [b, c] | 1 per day | CT 223 or CT 226 |

Notes:
[a] If air entrainment is specified, make at least 1 air content measurement per hour. If air entrainment is not specified, make at least 1 air content measurement per 4 hours.
[b] Make at least 1 measurement of moisture content per week to check the calibration of an electronically actuated moisture meter.
[c] Random location sampling and testing is not applicable.

If air entrainment is specified, the testing laboratory and tester must be qualified under the Department's Independent Assurance Manual. The manual is available from the Transportation Laboratory.

### 40-1.03C Control Charts

Maintain control charts to identify potential problems and assignable causes. Post a copy of each control chart at a location determined by the Engineer.

Individual measurement control charts must use the target values in the mix proportions as indicators of central tendency.

Develop linear control charts for:

1. Cleanness value
2. Sand equivalent
3. Fine and coarse aggregate gradation
4. Air content
5. Penetration

Control charts must include:

1. Contract number

2. Mix proportions
3. Test number
4. Each test parameter
5. Action and suspension limits
6. Specification limits
7. Quality control test results

For fine and coarse aggregate gradation control charts, record the running average of the previous 4 consecutive gradation tests for each sieve and superimpose the specification limits.

For penetration and air content control charts, record the individual measurements and superimpose the following action and suspension limits:

**Penetration and Air Content Action and Suspension Limits**

| Control Parameter | Individual Measurements | |
|---|---|---|
| | Action Limit | Suspension Limit |
| Penetration, CT 533 | 1 inch | 1-1/2 inch |
| Air content, CT 504 | ±1.0 percent | ±1.5 percent |

### 40-1.03D Contractor's Laboratory

Use a laboratory that complies with ASTM C 1077 to determine the mix proportions for concrete pavement. The laboratory must have a current AASHTO accreditation for:

1. AASHTO T 97 or ASTM C 78
2. ASTM C 192/C 192M

### 40-1.03E Joint Sealant and Compression Seal Installation Training

Before installing joint sealant or compression seals, arrange for a representative from the joint sealant or compression seal manufacturer to provide training on the cleaning and preparation of the joint and installing the sealant or seal. Until your personnel and the Department's personnel have been trained, do not install joint sealant or compression seals.

### 40-1.03F Frequency Measuring Device (Tachometer)

Before each day's concrete pavement placement and at intervals not to exceed 4 hours of production, test and record vibration frequency and amplitude for concrete consolidation vibrators.

### 40-1.03G Early Age Concrete Pavement Crack Mitigation System

Develop and implement a system for predicting concrete pavement stresses and strength during the initial 72 hours after paving. The system must include:

1. Subscribing to a weather service to obtain forecasts for wind speed, ambient temperatures, humidity, and cloud cover

2. Portable weather station with anemometer, temperature and humidity sensors, located at the paving site
3. Early age concrete pavement stress and strength prediction computer program
4. Analyzing, monitoring, updating, and reporting the system's predictions

### 40-1.03H Curing Compound

Sample curing compound from shipping containers at the manufacturer's source of supply. Split the samples.

### 40-1.03I Concrete Pavement Smoothness

Within 10 days after paving, measure the Profile Index ($PI_0$) of the concrete pavement surface using a zero (null) blanking band under California Test 526.

For the following concrete pavement areas, the Engineer does not require a profilograph and you must test and correct high points determined by a 12-foot straightedge placed parallel with and perpendicular to the centerline:

1. Horizontal curves with a centerline radius of curvature less than 1,000 feet including concrete pavement within the superelevation transitions of those curves.
2. Exit ramp termini, truck weigh stations, and weigh-in-motion areas
3. Where steep grades and superelevation rates greater than 6 percent are present on:

    3.1. Ramps
    3.2. Connectors

4. Turn lanes and areas around manholes or drainage transitions
5. Acceleration and deceleration lanes for at-grade intersections
6. Shoulders and miscellaneous gore areas

Use a California Profilograph or equivalent to determine the concrete pavement profile. If the profilograph uses a mechanical recorder, use an electronic scanner to reduce the profilogram.

The profilograph operator must be qualified under the Department's Independent Assurance Manual. The manual is available from the Transportation Laboratory.

### 40-1.03J Profilograph Test Procedure

Notify the Engineer at least 2 business days before performing profilograph testing. Each day before performing profilograph testing, notify the Engineer of the start location. Perform profilograph testing in the Engineer's presence.

Before starting profilograph testing, remove foreign objects from the concrete pavement surface.

Before starting profilograph testing, calibrate the profilograph in the Engineer's presence. If the Engineer chooses not to be present during profilograph testing, you may perform the testing with the Engineer's written approval. Note the Engineer's absence on the profilogram.

Determine $PI_0$ values for the final concrete pavement surface of each 0.1-mile section of a traffic lane. Take 2 profiles within each traffic lane, 3 feet from and parallel with the edge of each lane. Each section's $PI_0$ is the average of the $PI_0$ values for the measurements within that traffic lane. A section that is less than 0.01 mile and is the result of an interruption to continuous concrete pavement surface must comply with the $PI_0$ specifications for a full section. Adjust the $PI_0$ for a partial section to reflect a full section.

Use stationing to locate vertical deviations greater than 0.3 inches. The profilogram stationing must be the same as the project stationing. Note 0.1-mile segments on the profilogram.

Label the profilogram with:

1. Contract number
2. County and route number
3. Stationing
4. Operator's name
5. Test date
6. Test number
7. Traffic direction
8. Traffic lane (numbered from left to right in direction of travel)
9. Test wheel path (left or right in direction of travel)
10. Test direction
11. Paving direction

### 40-1.03K Smoothness Corrective Action

Correct concrete pavement not complying with the Engineer's acceptance specifications for smoothness by grinding under Section 42-2, "Grinding."

Do not grind before:

1. Ten days after concrete pavement placement
2. The concrete has developed a modulus of rupture of at least 550 psi

Grind the entire lane width. When completed, the lane width must be uniform in texture and appearance. Square the corrected area's start and end normal to the paved surface's centerline.

Retest sections where corrections were made.

### 40-1.03L Engineer's Acceptance

**General**

The Engineer accepts concrete pavement based on the Department's testing for the following concrete pavement quality characteristics. A single test represents no more than the quantity specified:

**Concrete Pavement Acceptance**

| Quality Characteristic | Quantity | Test |
|---|---|---|
| 28-day modulus of rupture | 1,000 cubic yards | CT 523 |
| Thickness | 1,200 square yards for primary area measurements | CT 531 |
| Dowel bar placement | 700 square yards | Measurement |
| Tie bar placement | 4,000 square yards | Measurement |
| Coefficient of friction | One day's paving | CT 342 |
| Air content (freeze-thaw) [a] | One day's paving | CT 504 |

Note:
[a] Air content tests must be performed under California Test 504 if air entrainment is specified.

At the Department's option, the Engineer also accepts concrete pavement based on your or the Department's testing for smoothness. A single test represents no more than 0.1 mile.

The Engineer considers other concrete pavement quality characteristics in determining final acceptance. The Engineer's acceptance of modulus of rupture, thickness, dowel bar and tie bar placement, coefficient of friction, smoothness, and air content does not constitute final concrete pavement acceptance.

**Modulus of Rupture**

The Engineer accepts concrete pavement for modulus of rupture on a lot basis. The minimum modulus of rupture for each lot is 570 psi at 28 days.

For each lot of concrete for concrete pavement:

1. Quantity must not exceed 1,000 cubic yards.
2. Department determines the modulus of rupture of test beams aged 10 days and 28 days.
3. Department calculates the modulus of rupture by averaging the individual test results of 2 beams aged for 28 days.
4. Difference in the individual test results of beams aged 28 days must not exceed 12 percent when tested by Method 1, or 16 percent when tested by Method 2. The Engineer calculates the difference relative to the average of the 2 test results.

The Department provides molds and machines for modulus of rupture acceptance testing. Provide material and labor the Engineer may require.

**Concrete Pavement Smoothness**

If the Department tests for smoothness, the tests are performed under Section 40-1.03I, "Concrete Pavement Smoothness."

The Engineer accepts concrete pavement for smoothness in compliance with the following:

1. For tangents and horizontal curves having a centerline radius of curvature 2,000 feet or more, the $PI_0$ must be at most 3 inches per 0.1-mile section.

2. For horizontal curves having a centerline radius of curvature from 1,000 to 2,000 feet including concrete pavement within the superelevation transitions of those curves, the $PI_0$ must be at most 6 inches per 0.1-mile section.
3. If using a profilograph to measure smoothness, the surface must not have individual high points greater than 0.3 inch.
4. If using a straightedge to measure smoothness, the surface must be within 0.02 foot of the straightedge's lower edge.

Profile index specifications apply to existing pavement within 50 feet of the transverse joint separating new concrete pavement and the existing pavement.

If the Department's profilograph test results do not match yours, the Engineer may order you to recalibrate your profilograph equipment and perform a retest. If your test results are inaccurate due to operator error, the Engineer may disqualify your profilograph operator. If the Engineer determines your test results are inaccurate, the Engineer does not make adjustments to payment or contract time for recalibrating, retesting, and delays.

**Concrete Pavement Thickness**

The Engineer accepts concrete pavement for thickness based on coring in the primary area, which is the area placed in 1 day for each thickness. Concrete pavement thickness must not be deficient by more than 0.05 foot.

After corrective grinding has been completed, core concrete pavement in the primary area under Section 40-3.16, "Obtaining Drilled Cores," at locations determined by the Engineer and in the Engineer's presence. The core specimen diameter must be 4 inches. To identify the limits of concrete pavement deficient in thickness by more than 0.05 foot, you may divide primary areas into secondary areas. Specifications that may affect concrete pavement thickness such as allowable tolerances for subgrade construction do not change the thickness specified for concrete pavement.

In each primary area, the Engineer measures concrete pavement thickness every 1,200 square yards and any remaining area. The Engineer measures cores under California Test 531 to the nearest 0.01 foot. Core at least 1 foot from existing, contiguous, and parallel concrete pavement not constructed as part of this contract.

You may request the Engineer make additional thickness measurements and use them to determine the average thickness variation. The Engineer determines the locations with random sampling methods.

If each thickness measurement in a primary area is less than 0.05 foot deficient, the Engineer calculates the average thickness deficiency in that primary area. The Engineer uses 0.02 foot for a thickness difference more than 0.02 foot over the specified thickness.

For each thickness measurement in a primary area deficient by more than 0.05 foot, the Engineer determines a secondary area where the thickness deficiency is more than 0.05 foot. The Engineer determines this secondary area by measuring the thickness of each concrete pavement slab adjacent to the measurement found to be more than 0.05 foot deficient. The Engineer continues to measure the thickness until an area that is bound by slabs with thickness deficient by 0.05 foot or less is determined.

Slabs without bar reinforcement are defined as the areas bound by longitudinal and transverse joints and concrete pavement edges. Slabs with bar reinforcement are defined as the areas bound by longitudinal joints and concrete pavement edges and 15-foot lengths. Secondary area thickness measurements in a slab determine that entire slab's thickness.

The Engineer measures the remaining primary area thickness after removing the secondary areas from consideration for determining the average thickness deficiency.

The Engineer determines the slabs to remove and replace.

**Required Use of Air-Entraining Admixtures**

If air-entraining admixtures are specified, the Engineer may choose to accept concrete pavement for air content based on your air content quality control tests. The Engineer decides to use your air content quality control tests based on a *t*-test that determines the difference in the means of your test and the Engineer's verification tests. The Engineer calculates the t-value of the test data as follows:

$$t = \frac{\left|\overline{X}_c - \overline{X}_v\right|}{S_p\sqrt{\frac{1}{n_c} + \frac{1}{n_v}}} \quad \text{and} \quad S_p^2 = \frac{S_c^2(n_c - 1) + S_v^2(n_v - 1)}{n_c + n_v - 2}$$

where:

$n_c$ = Number of your quality control tests (minimum of 2 required)
$n_v$ = Number of verification tests (minimum of 1 required)
$\overline{X}_c$ = Mean of your quality control tests
$\overline{X}_v$ = Mean of the verification tests
$S_p$ = Pooled standard deviation
(When $n_v = 1$, $S_p = S_c$)
$S_c$ = Standard deviation of your quality control tests
$S_v$ = Standard deviation of the verification tests (when $n_v > 1$)

The Engineer compares your quality control test results with the Department's verification test results at a level of significance of $\alpha = 0.01$. The Engineer compares the *t*-value to $t_{crit}$, determined from:

**$t_{crit}$**

| degrees of freedom ($n_c$+$n_v$-2) | $t_{crit}$ (for $\alpha$ = 0.01) |
|---|---|
| 1 | 63.657 |
| 2 | 9.925 |
| 3 | 5.841 |
| 4 | 4.604 |
| 5 | 4.032 |
| 6 | 3.707 |
| 7 | 3.499 |
| 8 | 3.355 |
| 9 | 3.250 |
| 10 | 3.169 |

If the *t*-value calculated is less than or equal to $t_{crit}$, your quality control test results are verified. If the *t*-value calculated is greater than $t_{crit}$, quality control test results are not verified.

If your quality control test results are not verified, core at least 3 specimens from concrete pavement under Section 40-3.16, "Obtaining Drilled Cores." The Engineer selects the core locations. Your approved third party independent testing laboratory must test these specimens for air content under ASTM C 457. The Engineer compares these test results with your quality control test results using the *t*-test method. If your quality control test results are verified based on this comparison, the Engineer uses the quality control test results for acceptance of concrete pavement for air content. If your quality control test results are not verified based on this comparison, the Engineer uses the air content of core specimens determined under ASTM C 457 for acceptance.

**Dowel Bar and Tie Bar Placement**

The Engineer uses core specimens to evaluate and accept concrete pavement for:

1. Dowel bar placement
2. Tie bar placement
3. Concrete consolidation

Obtain cores under Section 40-3.16, "Obtaining Drilled Cores." The Engineer determines the core locations. Each core must have a nominal diameter of 4 inches. Core each day's paving within 2 business days in compliance with:

1. One test for every 700 square yards of doweled concrete pavement or remaining fraction of that area. Each dowel bar test consists of 2 cores, 1 on each dowel bar end to expose both ends and allow measurement.
2. One test for every 4,000 square yards of concrete pavement with tie bars or remaining fraction of that area

If the tests indicate dowel or tie bars are not placed within the specified tolerances or if there are air voids around the dowel or tie bars, core additional specimens to determine the limits of unacceptable work.

The Engineer determines the slabs to remove and replace.

If the Engineer approves your request, slabs may remain in place with an adjustment in payment for:

1. Dowel bars with centers from ±2 inches to ±3 inches from the saw cut of a transverse contraction joint or with deficient concrete consolidation around the dowel bars
2. Tie bars placed outside their specified placement and position or with deficient concrete consolidation around the tie bars

**Bar Reinforcing Steel**

The Engineer accepts concrete pavement for bar reinforcing steel based on inspection before concrete placement.

**Curing Compound**

The Engineer accepts curing compound based on test results submitted with the Certificate of Compliance for moisture loss, reflectance, viscosity, nonvolatile content, and pigment content. Curing compound sampled from shipping containers from the manufacturer's supply source or from the job site must match these test results within the specified tolerances listed in the precision and bias statements for the test methods.

## 40-2 MATERIALS

### 40-2.01 CONCRETE

#### 40-2.01A General

Concrete must comply with Section 90, "Portland Cement Concrete."

#### 40-2.01B Aggregate

The specifications for reduction in Operating Range and Contract Compliance for cleanness value and sand equivalent specified under Section 90-2.02A, "Coarse Aggregate," and Section 90-2.02B, "Fine Aggregate," do not apply to concrete pavement.

Combined aggregate gradings must comply with Section 90-3, "Aggregate Gradings," and the difference between the percent passing the 3/8-inch sieve and the percent passing the No. 8 sieve must not be less than 16 percent of the total aggregate.

#### 40-2.01C Cementitious Material

Concrete for concrete pavement must contain from 505 pounds to 675 pounds cementitious material per cubic yard. The specifications for reducing cementitious material content in Section 90-4.05, "Optional Use of Chemical Admixtures," do not apply to concrete pavement.

#### 40-2.01D Mix Proportions

Your laboratory determining mix proportions must determine the minimum cementitious materials content or the maximum water to cementitious materials ratio under California Test 559 and:

1. You must make trial mixtures no more than 24 months before field qualification.
2. Modulus of rupture used to determine the minimum cementitious materials content or maximum water to cementitious materials ratio must be 570 psi at 28 days age and 650 psi at 42 days age.
3. Your laboratory must determine an increase in the cementitious materials content or a decrease in the water to cementitious materials ratio from the trial mixtures to ensure concrete pavement complies with the specifications.

If changing an aggregate supply source or the mix proportions, produce a trial batch and field-qualify the new concrete. The Engineer does not adjust contract time for performing sampling, testing, and qualifying new mix proportions or changing an aggregate supply source.

### 40-2.01E Field Qualification

Proposed mix proportions must be field qualified before you place concrete pavement. Use an American Concrete Institute (ACI) certified "Concrete Laboratory Technician, Grade I" to perform field qualification tests and calculations.

The Engineer accepts field qualification if five beams made and tested under California Test 523 comply with the following:

1. At a minimum, beams are tested at 10, 21, and 28 days of age
2. At your choice of age not later than 28 days, no single beam's modulus of rupture is less than 550 psi and the average modulus of rupture is at least 570 psi

## 40-2.02 TIE BARS

Unless specified as smooth, tie bars must be deformed.

Deformed tie bars must be:

1. Deformed steel reinforcing bars under any of the following:

    1.1. ASTM A 615/A 615M, Grade 40 or 60
    1.2. ASTM A 996/A 996M
    1.3. ASTM A 706/A 706M

2. Epoxy-coated under Section 52-1.02B, "Epoxy-coated Reinforcement," and the following:

    2.1. Epoxy-coated tie bars must comply with either ASTM A 775/ A 775M or ASTM A 934/ A 934 M.
    2.2. Epoxy coating under ASTM A 934/ A 934M must be purple or gray.

Smooth tie bars must be:

1. Plain, round, and smooth steel under ASTM A 615/A 615M, Grade 40 or 60
2. Epoxy-coated under Section 52-1.02B, "Epoxy-coated Reinforcement," and the following:

    2.1. Epoxy-coated smooth tie bars must comply with ASTM A 884/A 884M, Class A, Type 1 or Type 2.
    2.2. Epoxy coating under ASTM A 884/A 884 M, Class A, Type 2 must be purple or gray.
    2.3. Bend test does not apply.

Fabricate, sample, and handle epoxy-coated smooth and deformed tie bars at the job site under ASTM D 3963/D 3963M and Section 52-1.02B, "Epoxy-coated Reinforcement."

Do not bend epoxy-coated tie bars.

## 40-2.03 DOWEL BARS

### 40-2.03A General

Dowel bars must be:

1. Plain, round, and smooth steel under ASTM A 615/A 615M, Grade 40 or 60
2. Epoxy-coated under Section 52-1.02B, "Epoxy-coated Reinforcement," and the following:

    2.1 Epoxy-coated dowel bars must comply with ASTM A 884/A 884M, Class A, Type 1 or Type 2.
    2.2. Epoxy coating under ASTM A 884/ A 884M, Class A, Type 2 must be purple or gray.
    2.3. Specifications for bend test do not apply.

Fabricate, sample, and handle epoxy-coated dowel bars at the job site under ASTM D 3963/D 3963M and Section 52-1.02B, "Epoxy-coated Reinforcement," except each sample must be 18 inches long. Sample each load delivered to the job site.

### 40-2.03B Dowel Bar Lubricant

Dowel bar lubricant must be petroleum paraffin-based or curing compound. Paraffin-based lubricant must be Dayton Superior DSC BB-Coat or Valvoline Tectyl 506 or an approved equal and must be factory-applied. Curing compound must be curing compound (3) under Section 90-7.01B, "Curing Compound Method," of the Standard Specifications.

## 40-2.04 CURING COMPOUND

Curing compound must be curing compound (1) or (2) with white pigment under Section 90-7.01B, "Curing Compound Method."

Reflectance must be at least 60 percent when tested under ASTM E 1347.

## 40-2.05 CHEMICAL ADHESIVE (DRILL AND BOND)

Chemical adhesive for drilling and bonding dowels and tie bars must be prequalified. A list of prequalified chemical adhesives is available on the Department's Materials Engineering and Testing Services website. The prequalified list indicates the appropriate chemical adhesive system for the concrete temperature and installation conditions.

Each chemical adhesive system must clearly and permanently show the manufacturer's name, model number of the system, manufacturing date, lot number, shelf life or expiration date, and current International Conference of Building Officials (ICBO) Evaluation Report number. Each chemical adhesive carton must include the manufacturer's recommended installation procedures and warning or precautions required by State or Federal laws and regulations.

## 40-2.06 DOWEL AND TIE BAR BASKETS

Dowel and tie bar baskets must be:

1. Minimum W10 wire size number under ASTM A 82/A 82M
2. Either U-frame or A-frame shape
3. Welded under Section 7.4 of ASTM A 185/A 185M

You may epoxy-coat dowel and tie bar baskets under Section 52-1.02B, "Epoxy-coated Reinforcement," and the following:

1. Epoxy-coated dowel and tie bar baskets must comply with ASTM A 884/A 884M, Class A, Type 1 or Type 2.
2. Epoxy-coating under ASTM A 884/ A 884M, Class A, Type 2 must be purple or gray.

Handle epoxy-coated dowel and tie-bar baskets at the manufacturing plant and job site under ASTM D 3963/D 3963M and Section 52-1.02B, "Epoxy-coated Reinforcement."

Fasteners must be driven fasteners under ASTM F 1667. Fasteners on lean concrete base or asphalt concrete must have a minimum shank diameter of 3/16 inch and a minimum shank length of 2 1/2 inches. For asphalt treated permeable base or cement treated permeable base, the shank diameter must be at least 3/16 inch and the shank length must be at least 5 inches.

Fasteners, clips, and washers must have a minimum 0.2-mil thick zinc coating applied either by electroplating or galvanizing.

## 40-2.07 BACKER RODS

Backer rods must be Type 1 under ASTM D 5249. Backer rod diameter must be at least 25 percent greater than the sawcut joint width. Backer rod material must be expanded, crosslinked, closed-cell polyethylene foam. No bond or adverse reaction may occur between the backer rod and sealant.

## 40-2.08 JOINT FILLER MATERIAL

Joint filler for isolation joints must be preformed expansion joint filler for concrete (bituminous type) under ASTM D 994.

## 40-2.09 HYDRAULIC CEMENT GROUT (NON-SHRINK)

Hydraulic cement grout (non-shrink) must comply with ASTM C 1107/ C 1107M. Use clean, uniform, rounded aggregate filler to extend the grout. Aggregate filler must not exceed 60 percent of the grout mass or the maximum recommended by the manufacturer, whichever is less. Aggregate filler moisture content must not exceed 0.5 percent. Aggregate filler must comply with:

**Aggregate Filler Grading**

| Sieve Size | Percentage Passing |
|---|---|
| 1/2-inch | 100 |
| 3/8-inch | 85 - 100 |
| No. 4 | 10 - 30 |
| No. 8 | 0 - 10 |
| No. 16 | 0 - 5 |

## 40-2.10 BAR REINFORCEMENT

Bar reinforcement must comply with Section 52, "Reinforcement."

## 40-2.11 JOINT SEALANT

### 40-2.11A General

Do not use hot-pour sealant that will melt the backer rod.

### 40-2.11B Silicone Joint Sealant

Silicone joint sealant must be low modulus furnished in a one-part silicone formulation. Do not use acid cure sealant. Silicone joint sealant must be compatible with the surface it is applied to and comply with:

**Silicone Joint Sealant**

| Property | Test Method | Specification |
|---|---|---|
| Tensile stress, 150% elongation, 7-day cure at 77 °F ± 2 °F and 45% to 55% R.H. [e] | ASTM D 412 (Die C) | 45 psi max. |
| Flow at 77 °F ± °F | ASTM C 639 [a] | Must not flow from channel |
| Extrusion Rate at 77 °F ± 2 °F | ASTM C 603 [b] | 3 to 9 oz/min. |
| Specific Gravity | ASTM D 792 Method A | 1.01 to 1.51 |
| Durometer Hardness, at 0 °F, Shore A, cured 7 days at 77 °F ±2 °F | ASTM C 661 | 10 to 25 |
| Ozone and Ultraviolet Resistance, after 5,000 hours | ASTM C 793 | No chalking, cracking or bond loss |
| Tack-free at 77 °F ±2 °F and 45% to 55% R.H.[e] | ASTM C 679 | Less than 75 minutes |
| Elongation, 7 day cure at 77 °F ±2 °F and 45% to 55% R.H. [e] | ASTM D 412 (Die C) | 500 percent min. |
| Set to Touch, at 77 °F ±2 °F and 45% to 55% R.H. [e] | ASTM D 1640 | Less than 75 minutes |
| Shelf Life, from date of shipment | — | 6 months min. |
| Bond, to concrete mortar-concrete briquettes, air cured 7 days at 77 °F ±2 °F | AASHTO T 132 [c] | 50 psi min. |
| Movement Capability and Adhesion, 100% extension at 0 °F after, air cured 7 days at 77 °F ±2 °F , and followed by 7 days in water at 77 °F ±2 °F | ASTM C 719[d] | No adhesive or cohesive failure after 5 cycles |

Notes:
[a] ASTM C 639 Modified (15 percent slope channel A).
[b] ASTM C 603, through 0.12-inch opening at 50 psi.
[c] Mold briquettes under AASHTO T 132, saw in half and bond with a 0.60-inch maximum thickness of sealant and test under AASHTO T 132. Briquettes must be dried to constant mass at 212 °F ±10 °F.
[d] Prepare 12" x 1" x 3" concrete blocks under ASTM C 719. Use a sawed face for bond surface. Seal 2 inches of block leaving 0.50 inch on each end of specimen unsealed. The depth of sealant must be 0.40 inch and the width 0.50 inch.
[e] R.H. equals relative humidity.

After application, silicone joint sealant must not flow on grades up to 15 percent.

### 40-2.11C Asphalt Rubber Joint Sealant

Asphalt rubber joint sealant must:

1. Be a mixture of paving asphalt and ground rubber containing not less than 22 percent ground rubber by weight. One hundred percent of ground rubber must pass a No. 8 sieve. Ground rubber must be vulcanized or a combination of vulcanized and devulcanized materials.
2. Comply with ASTM D 6690, Type II except:

    2.1. The cone penetration requirement must not exceed 120 at 77 F, 5 ounces, 5 seconds.
    2.2. The resilience requirement must be a minimum 50 percent recovery when tested at 77 F.

3. Have a Ring and Ball softening point of 135 °F minimum when tested under AASHTO T 53.
4. Be capable of being melted and applied to cracks and joints at temperatures below 400 °F.
5. Not be applied when the concrete pavement surface temperature is below 50 °F.

### 40-2.11D Preformed Compression Joint Seals

Preformed compression joint seals must comply with ASTM D 2628. Lubricant adhesive used with the seals must comply with ASTM D 2835. Preformed compression joint seals must have 5 or 6 cells, except seals for Type A2 and Type B joints may have 4 cells. Install preformed compression joint seals in compliance with the manufacturer's recommendations. Show evidence that the seals are compressed from 40 to 50 percent for the joint width and depth.

## 40-2.12 WATER

Water for core drilling must be from a local domestic water supply. Water must not contain:

1. More than 1,000 parts per million of chlorides as CL
2. More than 1,300 parts per million of sulfates as $S0_4$
3. Impurities in a quantity to cause concrete discoloration or surface etching

# 40-3 CONSTRUCTION

## 40-3.01 WATER SUPPLY

Before placing concrete pavement, develop enough water supply for the work.

## 40-3.02 SUBGRADE PREPARATION

Immediately before placing concrete, the subgrade to receive concrete pavement must be:

1. In compliance with the specified compaction and elevation tolerances
2. Free of loose and extraneous material
3. Uniformly moist, but free of standing or flowing water
4. Excavated for thickened parts of concrete pavement end anchors with no disturbed compaction outside the end anchor dimensions

If cement treated permeable base is specified, cover the base surface with asphaltic emulsion before placing concrete pavement. Apply the asphaltic emulsion uniformly at a rate of 0.1 gallons per square yard. Asphaltic emulsion must comply with anionic slow-setting type, SS1h grade in Section 94, "Asphaltic Emulsions." Repair damaged asphaltic emulsion before placing concrete pavement.

## 40-3.03 PROPORTIONING

Proportion aggregate and bulk cementitious materials under Section 90-5, "Proportioning."

## 40-3.04 PLACING CONCRETE

### 40-3.04A General

Place concrete pavement with stationary side forms or slip-form paving equipment.

Place consecutive concrete loads within 30 minutes of each other. Construct a transverse construction joint when concrete placement is interrupted by more than 30 minutes. The transverse construction joint must coincide with the next contraction joint location, or you must remove fresh concrete pavement to the preceding transverse joint location.

Place concrete pavement in full slab widths separated by construction joints or monolithically in multiples of full lane widths with a longitudinal contraction joint at each traffic lane line.

Do not retemper concrete.

If the concrete pavement surface width is constructed as specified, you may construct concrete pavement sides on a batter not flatter than 6:1 (vertical:horizontal).

### 40-3.04B Concrete Pavement Widening

If concrete pavement is placed adjacent to existing pavement not constructed as part of the contract, grind the existing concrete pavement lane or shoulder adjacent to the new concrete pavement. Perform the grinding before new concrete pavement is placed. The new concrete pavement must match the elevation of the existing concrete pavement after grinding. Grind existing concrete pavement under Section 42-2, "Grinding," except profile index must comply with the pavement smoothness specifications in Section 40-1.03, "Quality Control and Assurance."

Use paving equipment with padded crawler tracks or rubber-tired wheels on the existing concrete pavement with enough offset to avoid breaking or cracking the existing concrete pavement's edge.

### 40-3.04C Concrete Pavement Transition Panel

For concrete pavement placed in a transition panel, texture the surface with a drag strip of burlap, a broom, or a spring steel tine device that produces scoring in the finished surface. The scoring must be either parallel with or transverse to the centerline. For the method you choose, texture at the time that produces the coarsest texture.

### 40-3.04D Stationary Side Form Construction

Stationary side forms must be straight and without defects including warps, bends, and indentations. Side forms must be metal except at end closures and transverse construction joints where other materials may be used.

You may build up side forms by attaching a section to the top or bottom. If attached to the top of metal forms, the attached section must be metal.

The side form's base width must be at least 80 percent of the specified concrete pavement thickness.

Side forms including interlocking connections with adjoining forms must be rigid enough to prevent springing from subgrading and paving equipment and concrete pressure.

Construct subgrade to final grade before placing side forms. Side forms must bear fully on the foundation throughout their length and base width. Place side forms to the specified grade and alignment of the finished concrete pavement's edge. Support side forms during concrete placing, compacting, and finishing.

After subgrade work is complete and immediately before placing concrete, true side forms and set to line and grade for a distance that avoids delays due to form adjustment.

Clean and oil side forms before each use.

Side forms must remain in place for at least 1 day after placing concrete and until the concrete pavement edge no longer requires protection from the forms.

Spread, screed, shape, and consolidate concrete with 1 or more machines. The machine must uniformly distribute and consolidate the concrete. The machines must operate to place the concrete pavement to the specified cross section with minimal hand work.

Consolidate the concrete without segregation. If vibrators are used:

1. The vibration rate must be at least 3,500 cycles per minute for surface vibrators and 5,000 cycles per minute for internal vibrators
2. Amplitude of vibration must cause perceptible concrete surface movement at least 1 foot from the vibrating element
3. Use a calibrated tachometer for measuring frequency of vibration
4. Vibrators must not rest on side forms or new concrete pavement
5. Power to vibrators must automatically cease when forward or backward motion of the paving machine is stopped

Use high-frequency internal vibrators within 15 minutes of depositing concrete on the subgrade to uniformly consolidate the concrete across the paving width including adjacent to forms. Do not use vibrators to shift the mass of concrete.

### 40-3.04E Slip-Form Construction

If slip-form construction is used, spread, screed, shape, and consolidate concrete to the specified cross section with slip-form machines and minimal hand work. Slip-form paving machines must be equipped with traveling side forms and must not segregate the concrete.

Do not deviate from the specified concrete pavement alignment by more than 0.1 foot.

Slip-form paving machines must use high frequency internal vibrators to consolidate concrete. You may mount vibrators with their axes parallel or normal to the concrete pavement alignment. If mounted with axes parallel to the concrete pavement alignment, space vibrators no more than 2.5 feet measured center to center. If mounted with axes normal to the concrete pavement alignment, space the vibrators with a maximum 0.5-foot lateral clearance between individual vibrators.

Each vibrator must have a vibration rate from 5,000 cycles per minute to 8,000 cycles per minute. The amplitude of vibration must cause perceptible concrete surface movement at least 1 foot from the vibrating element. Use a calibrated tachometer to measure frequency of vibration.

## 40-3.05 TIE BAR PLACEMENT

Place tie bars:

1. Perpendicular to the longitudinal concrete pavement joint
2. Parallel with the concrete pavement surface at mid-slab depth
3. Not less than 1/2-inch below the saw cut depth of joints
4. With not less than 2 inches clearance from the concrete pavement's surface and bottom
5. With embedment length tolerance of ±2 inches
6. For smooth tie bars, with horizontal and vertical skew not more than 1/2 inch per foot of bar length

Install tie bars at longitudinal joints by 1 of the following methods:

1. Drill concrete and bond tie bars with chemical adhesive in compliance with the manufacturer's instructions. Clean and dry drilled holes before placing chemical adhesive and tie bars. After inserting tie bars into chemical adhesive, support the bars to prevent movement during curing. If the Engineer rejects a tie bar installation, cut the tie bar flush with the joint face and coat the exposed end of the tie bar with chemical adhesive under Section 40-2, "Materials." Offset new holes 3 inches horizontally from the rejected hole's center.
2. Insert tie bars into plastic slip-formed concrete before finishing. Inserted tie bars must have full contact between the bar and the concrete. If tie bars are inserted through the plastic concrete surface, eliminate evidence of the insertion by reworking the concrete over the tie bars.
3. Use threaded tie bar splice couplers fabricated from deformed bar reinforcement free of external welding or machining.
4. Use tie bar baskets. Anchor baskets at least 200 feet in advance of the concrete placement activity. If you request a waiver, describe the construction limitations or restricted access preventing the advanced anchoring. After the baskets are anchored and before the concrete is placed, cut and remove temporary spacer wires and demonstrate the tie bars do not move from their specified depth and alignment during concrete placement. Use fasteners to anchor tie bar baskets.

If tie bars are not placed correctly, stop paving activities until you demonstrate to the Engineer correction of the cause.

## 40-3.06 DOWEL BAR PLACEMENT

Center dowel bars within 2 inches in the longitudinal direction on transverse contraction joints or construction joints.

If using curing compound as lubricant, apply the curing compound to dowels in 2 separate applications. Lubricate each dowel bar entirely with bond breaker before placement. The last application must be

applied not more than 8 hours before placing the dowel bars. Apply each curing compound application at a rate of 1 gallon per 150 square feet.

If dowel bars are placed by mechanical insertion, eliminate evidence of the insertion by reworking the concrete over the dowel bars. If drilling and bonding dowel bars at construction joints, use a grout retention ring.

If using dowel bar baskets, anchor them with fasteners.

Use at least 10 fasteners for basket sections greater than 12 feet and less than or equal to 16 feet. Baskets must be anchored at least 200 feet in advance of the concrete placement activity unless the Engineer approves your waiver request. If requesting a waiver, describe the construction limitations or restricted access preventing the advanced anchoring. After the baskets are anchored and before the concrete is placed, cut and remove temporary spacer wires and demonstrate the dowel bars do not move from their specified depth and alignment during concrete placement.

Place dowel bars in compliance with:

**Dowel Bar Tolerances**

| Dimension | Tolerance |
|---|---|
| Horizontal offset | ±1 inch |
| Longitudinal translation | ±2 inches |
| Horizontal skew | 3/8 inch, max |
| Vertical skew | 3/8 inch, max |
| Vertical depth | The minimum distance below the concrete pavement surface must be:<br><br>DB = d/3 + 1/2 inch<br><br>where:<br>DB = vertical distance in inches, measured from concrete pavement surface to any point along the top of dowel bar<br>d = concrete pavement thickness in inches<br><br>The maximum distance below the depth shown on the plans must be 0.05 foot. |

If dowel bars are not placed correctly, stop paving activities until you demonstrate to the Engineer correction of the cause.

Remove and replace the concrete pavement 3 feet on either side of a joint with a rejected dowel bar.

## 40-3.07 BAR REINFORCEMENT

Place bar reinforcement under Section 52, "Reinforcement." Bar reinforcement must be more than 1/2 inch below the saw cut depth at concrete pavement joints.

## 40-3.08 JOINTS

### 40-3.08A General

Concrete pavement joints consist of:

1. Longitudinal and transverse construction joints
2. Longitudinal and transverse contraction joints
3. Isolation joints

Construction joints must be normal to the concrete pavement surface.

Until contract acceptance and except for joint filler material, keep joints free of foreign material including soil, gravel, concrete, or asphalt mix.

Volunteer cracks are cracks not coincident with constructed joints.

Repair concrete pavement damaged during joint construction under Section 40-3.17B, "Repair of Spalls, Raveling, and Tearing."

Do not bend tie bars or reinforcement in existing concrete pavement joints.

### 40-3.08B Construction Joints

Construction joints form where fresh concrete is placed against hardened concrete, existing pavements, or structures.

Before placing concrete at construction joints, apply a curing compound under Section 90-7.01B, "Curing Compound Method," to the vertical surface of existing or hardened concrete and allow it to dry.

Use a metal or wooden bulkhead to form transverse construction joints. If dowel bars are specified, the bulkhead must allow dowel bar installation.

### 40-3.08C Contraction Joints

In multilane monolithic concrete pavement, use the sawing method to construct longitudinal contraction joints. Construct transverse contraction joints by the sawing method.

Construct transverse contraction joints within 1 foot of their specified spacing. If a slab length of less than 5 feet would be formed, adjust the transverse contraction joint spacing.

Construct transverse contraction joints across the full concrete pavement width regardless of the number or types of longitudinal joints crossed. In areas of converging and diverging pavements, space transverse contraction joints so their alignment is continuous across the full width where converging and diverging pavements are contiguous. Longitudinal contraction joints must be parallel with the concrete pavement centerline. Transverse and longitudinal contraction joints must not deviate by more than 0.1 foot from either side of a 12-foot straight line, except for longitudinal joints parallel to a curving centerline.

### 40-3.08D Isolation Joints

Construct isolation joints by saw cutting a minimum 1/8-inch width to full concrete pavement depth at the existing concrete pavement's edge and removing the concrete to expose a flat vertical surface. Before

placing concrete, secure joint filler material that prevents new concrete from adhering to the existing concrete face.

Dispose of concrete saw cutting residue under Section 7-1.13, "Disposal of Materials Outside the Highway Right of Way."

### 40-3.08E Sawing Method

The sawing method is cutting a groove in the concrete pavement with a power driven concrete saw. Grooves for longitudinal and transverse contraction joints must be the minimum width possible for the type of saw used. If necessary, the top of the joint must be sawn wider to provide space for joint sealant. Immediately wash slurry from the joint with water under 100 psi maximum pressure.

Saw longitudinal and transverse contraction joints before volunteer cracking occurs and after the concrete is hard enough to saw without spalling, raveling, or tearing.

To keep foreign material out of grooves before joint sealant or compression seal installation, you may use joint filler in sawed contraction joints. Joint filler must not react adversely with the concrete or cause concrete pavement damage. After sawing and washing a joint, install joint filler material that keeps moisture in the adjacent concrete during the 72 hours after paving. If you install joint filler material, the specifications for spraying the sawed joint with additional curing compound under Section 40-3.13, "Curing," do not apply. If using absorptive filler material, moisten the filler immediately before or after installation.

## 40-3.09 JOINT SEALANT AND COMPRESSION SEAL INSTALLATION

### 40-3.09A General

At least 7 days after concrete pavement placement and not more than 4 hours before installing joint sealant or compression seal materials, use dry sand blasting and other methods to clean the joint walls of objectionable material such as soil, asphalt, curing compound, paint, and rust. The maximum sand blasting nozzle diameter must be 1/4 inch. The minimum pressure must be 90 psi. Sand blast each side of the joint at least once, in at least 2 separate passes. Hold the nozzle at an angle to the joint from 1 to 2 inches from the concrete pavement. Using a vacuum, collect sand, dust, and loose material at least 2 inches on each side of the joint. Remove surface moisture and dampness at the joints with compressed air that may be moderately hot.

Before you install joint sealant or compression seal, the joint wall must be free of moisture, residue, or film.

If grinding or grooving over or adjacent to sealed joints, remove joint sealant or compression seal materials and dispose of them under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way." After grinding or grooving, replace the joint sealant or compression seal materials.

### 40-3.09B Liquid Sealant

Do not install liquid sealant in construction joints.

Install backer rods when the concrete pavement temperature is above the air dew point and when the air temperature is at least 40 °F.

Install liquid sealant immediately after installing the backer rod. Install sealant using a mechanical device with a nozzle shaped to introduce the sealant from inside the joint. Extrude sealant evenly and with

continuous contact with the joint walls. Recess the sealant surface after placement. Remove excess sealant from the concrete pavement surface.

Do not allow traffic over sealed joints until the sealant is set.

### 40-3.09C Preformed Compression Seal

Do not install preformed compression seal in construction or isolation joints.

Install longitudinal seals before transverse seals. Longitudinal seals must be continuous except at intersections with transverse seals. Install transverse seals in 1 continuous piece for the entire transverse length of concrete pavement. With a sharp instrument, cut across the longitudinal seal at the intersection with transverse construction joints. If the longitudinal seal does not relax enough to properly install the transverse seal, trim the longitudinal seal to form a tight seal between the 2 joints.

Use a machine specifically designed for preformed compression seal installation. The machine must install the seal:

1. To the specified depth
2. To make continuous contact with the joint walls
3. Without cutting, nicking, or twisting the seal
4. With less than 4 percent stretch

Lay a length of preformed compression seal material cut to the exact length of the pavement joint to be sealed. The Engineer measures this length. After you install the length of preformed compression joint sealant, the Engineer measures the excess amount of material at the joint end. The Engineer divides the excess amount length by the original measured length to determine the percentage of stretch.

## 40-3.10 SHOULDER RUMBLE STRIP

If specified, construct shoulder rumble strips by rolling or grinding indentations in new concrete pavement.

Select the method and equipment for constructing ground-in indentations.

Do not construct shoulder rumble strips on structures or approach slabs.

Construct rumble strips within 2 inches of the specified alignment. Roller or grinding equipment must be equipped with a sighting device enabling the operator to maintain the rumble strip alignment.

Indentations must not vary from the specified dimensions by more than 1/16 inch in depth or more than 10 percent in length and width.

The Engineer orders grinding or removal and replacement of noncompliant rumble strips to bring them within specified tolerances. Ground surface areas must be neat and uniform in appearance.

The grinding equipment must be equipped with a vacuum attachment to remove residue.

Dispose of removed material under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way."

## 40-3.11 PRELIMINARY FINISHING

### 40-3.11A General

Preliminary finishing must produce a smooth and true-to-grade finish. After preliminary finishing, mark each day's concrete pavement with a stamp. The stamp must be approved by the Engineer before paving starts. The stamp must be approximately 1' x 2' in size. The stamp must form a uniform mark from 1/8 to 1/4 inch deep. Locate the mark 20 feet ± 5 feet from the transverse construction joint formed at each day's start of paving and 1 foot ± 0.25 foot from the concrete pavement's outside edge. The stamp mark must show the month, day, and year of placement and the station of the transverse construction joint. Orient the stamp mark so it can be read from the concrete pavement's outside edge.

Do not apply more water to the concrete pavement surface than can evaporate before float finishing and texturing are completed.

Allow enough time to complete finishing activities during daylight. Work may continue after daylight if the Engineer approves lighting you provide.

### 40-3.11B Stationary Side Form Finishing

If stationary side form construction is used, give the concrete a preliminary finish by the machine float method or the hand method.

If using the machine float method:

1. Use self-propelled machine floats.
2. Determine the number of machine floats required to perform the work at a rate equal to the concrete delivery rate. When the time from concrete placement to machine float finishing exceeds 30 minutes, stop concrete delivery . When machine floats are in proper position, you may resume concrete delivery and paving.
3. Machine floats must run on side forms or adjacent concrete pavement lanes. If running on adjacent concrete pavement, protect the adjacent concrete pavement surface under Section 40-3.15, "Protecting Concrete Pavement."
4. Floats must be hardwood, steel, or steel-shod wood. Floats must be equipped with devices that adjust the under side to a true flat surface.

If using the hand method, finish concrete smooth and true to grade with manually operated floats or powered finishing machines.

### 40-3.11C Slip-Form Finishing

If slip-form construction is used, the slip-form paver must give the concrete pavement a preliminary finish. You may supplement the slip-form paver with machine floats.

Before the concrete hardens, correct concrete pavement edge slump in excess of 0.02 foot exclusive of edge rounding.

## 40-3.12 FINAL FINISHING

After completing preliminary finishing, round the edges of the initial paving widths to a 0.04-foot radius. Round transverse and longitudinal construction joints to a 0.02-foot radius.

Before curing, texture the pavement. Perform initial texturing with a burlap drag or broom device that produces striations parallel to the centerline. Perform final texturing with a steel-tined device that produces grooves parallel with the centerline.

Construct longitudinal grooves with a self-propelled machine designed specifically for grooving and texturing concrete pavement. The machine must have tracks to maintain constant speed, provide traction, and maintain accurate tracking along the pavement surface. The machine must have a single row of rectangular spring steel tines. The tines must be from 3/32 to 1/8 inch wide, on 3/4-inch centers, and must have enough length, thickness, and resilience to form grooves approximately 3/16 inch wide. The machine must have horizontal and vertical controls. The machine must apply constant down pressure on the pavement surface during texturing. The machines must not cause ravels.

Construct grooves over the entire pavement width in a single pass except do not construct grooves 3 inches from the concrete pavement edges and longitudinal joints. Final texture must be uniform and smooth. Use a guide to properly align the grooves. Grooves must be parallel and aligned to the pavement edge across the pavement width. Grooves must be from 1/8 to 3/16 inch deep and 3/16 inch wide after concrete has hardened.

For irregular areas and areas inaccessible to the grooving machine, you may hand-construct grooves in compliance with the hand method under Section 40-3.11B, "Stationary Side Form Finishing." Hand-constructed grooves must comply with the specifications for machine-constructed grooves.

Initial and final texturing must produce a coefficient of friction of at least 0.30 when tested under California Test 342. Notify the Engineer when the concrete pavement is scheduled to be opened to traffic. Allow at least 25 days for the Department to test for coefficient of friction from the later of:

1. Seven days after concrete placement
2. When the concrete pavement has attained a modulus of rupture of 550 psi

Do not open the concrete pavement to traffic unless the coefficient of friction is at least 0.30.

Correct concrete pavement not complying with the Engineer's acceptance criteria for coefficient of friction by grooving or grinding under Section 42, "Groove and Grind Pavement."

Do not grind before:

1. Ten days after concrete pavement placement
2. Concrete has developed a modulus of rupture of at least 550 psi

Before opening to traffic, allow at least 25 days for the Department to retest sections for coefficient of friction after corrections are made.

## 40-3.13 CURING

Cure the concrete pavement's exposed area with waterproof membrane or curing compound (1) or (2) under Section 90-7.01, "Methods of Curing." When side forms are removed within 72 hours of the start of curing, also cure the concrete pavement edges.

If curing compound is used, apply it with mechanical sprayers. Reapply curing compound to sawcuts and disturbed areas.

## 40-3.14 EARLY USE OF CONCRETE PAVEMENT

If requesting early use of concrete pavement:

1. Furnish molds and machines for modulus of rupture testing
2. Sample concrete
3. Fabricate beam specimens
4. Test for modulus of rupture under California Test 523

When you request early use, concrete pavement must have a modulus of rupture of at least 350 psi. Protect concrete pavement under Section 40-3.15, "Protecting Concrete Pavement."

## 40-3.15 PROTECTING CONCRETE PAVEMENT

Protect concrete pavement under Section 90-8, "Protecting Concrete."

Maintain the concrete pavement temperature at not less than 40 °F for the initial 72 hours.

Protect the concrete pavement surface from activities that cause damage and reduce texture and coefficient of friction. Do not allow soil, gravel, petroleum products, concrete, or asphalt mixes on the concrete pavement surface.

Construct crossings for traffic convenience. If the Engineer approves your request, you may use Type III portland cement in the concrete for crossings. Do not open crossings until the Department determines by California Test 523 the concrete pavement's modulus of rupture is at least 550 psi.

Do not open concrete pavement to traffic or use equipment on the concrete pavement for 10 days after paving or before the concrete has attained a modulus of rupture of 550 psi except:

1. If the equipment is for sawing contraction joints
2. If the Engineer approves your request, one side of paving equipment's tracks may be on the concrete pavement after a modulus of rupture of 350 psi has been attained, provided:

    2.1. Unit pressure exerted on the concrete pavement by the paver does not exceed 20 psi
    2.2. You change the paving equipment tracks to prevent damage or the paving equipment tracks travel on protective material such as planks
    2.3. No part of the track is closer than 1 foot from the concrete pavement's edge

If concrete pavement damage including visible cracking occurs, stop operating paving equipment on the concrete pavement and repair the damage.

## 40-3.16 OBTAINING DRILLED CORES

Drill concrete pavement cores under ASTM C 42/ C 42M. Core drilling equipment must use diamond impregnated bits.

Clean, dry, and fill core holes with hydraulic cement grout (non-shrink) or pavement concrete. Coat the core hole walls with epoxy under the specifications for epoxy adhesive for bonding new concrete to old concrete in Section 95, "Epoxy." The backfill must match the adjacent concrete pavement surface elevation and texture.

Do not allow residue from core drilling to fall on traffic, flow across shoulders or lanes occupied by traffic, or flow into drainage facilities including gutters.

## 40-3.17 REPAIR, REMOVAL, AND REPLACEMENT

### 40-3.17A General

Working cracks are full-depth cracks essentially parallel to a planned contraction joint beneath which a contraction crack has not formed. If the Engineer orders, take 4-inch nominal diameter cores on designated cracks under Section 40-3.16, "Obtaining Drilled Cores."

### 40-3.17B Repair of Spalls, Raveling, and Tearing

Before concrete pavement is open to traffic, repair spalls, raveling, and tearing in sawed joints. Make repairs in compliance with the following:

1. Saw a rectangular area with a diamond-impregnated blade at least 2 inches deep.
2. Remove unsound and damaged concrete between the saw cut and the joint and to the saw cut's depth. Do not use a pneumatic hammer heavier than 15 pounds. Do not damage concrete pavement to remain in place.
3. Dispose of removed concrete pavement under Section 7-1.13, "Disposal of Materials Outside the Highway Right of Way."
4. Clean the repair area's exposed surfaces with high pressure abrasive water blasting. Further clean and dry the exposed surfaces with compressed air free of moisture and oil.
5. Apply epoxy as specified for epoxy resin adhesive for bonding new concrete to old concrete under Section 95, "Epoxy." Apply the epoxy with a stiff bristle brush.
6. Apply a portland cement concrete or mortar patch immediately following the epoxy application. Install an insert to prevent bonding of the sides of planned joints.

Repair spalls if they are:

1. Deeper than 0.05 foot
2. Wider than 0.04 foot
3. Longer than 0.3 foot

### 40-3.17C Route and Seal Working Cracks

Treat working cracks within 0.5 foot of either side of a planned contraction joint in compliance with the following:

1. Route and seal the crack with epoxy resin in compliance with the following:

    1.1. Use a powered rotary router mounted on wheels, with a vertical shaft and a routing spindle that casters as it moves along the crack
    1.2. Form a reservoir 3/4 inch deep by 3/8 inch wide in the crack
    1.3. Use equipment that does not cause raveling or spalling
    1.4. Place liquid sealant

2. Treat the contraction joint adjacent to the working crack in compliance with the following:

    2.1. Use epoxy resin under ASTM C 881/C 881M, Type IV, Grade 2 for Type B joints and secondary saw cuts for Type A1 and Type A2 joints
    2.2. Pressure inject epoxy resin under ASTM C 881/C881M, Type IV, Grade 1 for narrow saw cuts including initial saw cuts for Type A1 and Type A2 joints

If a working crack intersects a contraction joint, route and seal the working crack and seal the contraction joint as specified for installing liquid sealant under Section 40-3.09, "Joint Seal and Joint Sealant Installation."

### 40-3.17D Removal and Replacement of Slabs

As specified, remove and replace slabs or partial slabs for:

1. Insufficient thickness
2. Dowel bar misalignment
3. Working cracks more than 0.5 foot from a planned contraction joint

## 40-4 MEASUREMENT AND PAYMENT

### 40-4.01 MEASUREMENT

The contract item for concrete pavement as designated in the Verified Bid Item List is measured by the cubic yard. The Engineer calculates the pay quantity volume based on the plan dimensions. The Engineer does not measure concrete pavement placed outside those dimensions unless it was ordered by the Engineer.

The contract items for sealing joints as designated in the Verified Bid Item List are measured by the linear foot.

The contract item for shoulder rumble strips is measured by the station along each shoulder on which the rumble strips are constructed without deductions for gaps between indentations.

## 40-4.02 PAYMENT

The contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing the concrete pavement, complete in place including bar reinforcement, tie bars, dowel bars, anchors, and fasteners, as shown on the plans and as specified in these specifications and the special provisions, and as directed by the Engineer.

The Engineer adjusts payment for each primary area deficient in average thickness in compliance with the following:

**Pay Adjustments for Deficient Thickness**

| Average Thickness Deficiency (foot) | Deficiency Adjustment ($/yd$^2$) |
|---|---|
| 0.01 | 0.90 |
| 0.02 | 2.30 |
| 0.03 | 4.10 |
| 0.04 | 6.40 |
| 0.05 | 9.11 |

If the average thickness deficiency is less than 0.01 foot, the Engineer does not adjust payment for thickness deficiency. If the average thickness deficiency is more than 0.01 foot, the Engineer rounds to the nearest 0.01 foot and uses the adjustment table.

Full compensation for core drilling and backfilling the cores ordered by the Engineer for measuring concrete pavement thickness and determining full-depth cracks is included in the contract price paid per cubic yard for concrete pavement as designated in the Engineer's Estimate and no additional compensation will be allowed therefor. The Department does not pay for additional concrete pavement thickness measurements requested by the Contractor.

The Department does not pay for the portion of concrete that penetrates treated permeable base.

Full compensation for the quality control plan is included in the contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List and no separate payment will be made therefor.

Full compensation for furnishing and applying asphaltic emulsion on cement treated permeable base is included in the contract price paid per cubic yard for concrete pavement as designated in the Engineer's Estimate and no separate payment will be made therefor.

Full compensation for repairing joints is included in the contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List and no separate payment will be made therefor.

Full compensation for furnishing, calibrating, and operating profilograph equipment for Profile Index, for submitting profilograms, and for performing corrective work is included in the contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List and no separate payment will be made therefor.

Full compensation for grooving and grinding for final finishing is included in the contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List and no separate payment will be made therefor.

Full compensation for removing and replacing joint material for grooving and grinding is included in the contract price per cubic yard for concrete pavement as designated in the Verified Bid Item List and no separate payment will be made therefor.

Full compensation for removing and replacing slabs is included in the contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List and no separate payment will be made therefor.

Full compensation for drilling holes and bonding tie bars with chemical adhesive is included in the contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List and no additional compensation will be allowed therefor.

Full compensation for repairing damage caused by operating paving equipment on new concrete pavement is included in the contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List and no separate payment will be made therefor.

The material and work necessary for the construction of crossings for public convenience, and their subsequent removal and disposal, will be paid for at the contract prices for the items of work involved and if there are no contract items for the work involved, payment for concrete pavement crossings will be made by extra work as specified in Section 4-1.03D, "Extra Work."

The Department will reduce payments to the Contractor by $56.12 per square yard for concrete pavement slabs allowed to remain in place represented by cores indicating dowel bars placed with their centers from ±2 inches to ±3 inches from the saw cut of a transverse contraction joint

The Engineer will calculate the reduced payment using the slab dimensions adjacent to and inclusive of the joints with misplaced dowel bars. This reduced payment is in addition to other specified payment reductions.

The Department will reduce payments to the Contractor by $59.56 per square yard for concrete pavement allowed to remain in place represented by cores indicating either of the following:

1. Tie bars placed outside their specified placement and position tolerances
2. Bar reinforcement placed outside their specified placement and position tolerances

The Engineer will calculate the reduced payment using the slab dimensions adjacent to and inclusive of the joints with misplaced tie bars. This reduced payment is in addition to other specified payment reductions.

Full compensation for core drilling for checking dowel or tie bar alignment and backfilling the cores is included in the contract price paid per cubic yard for concrete pavement as designated in the Engineer's Estimate and no additional compensation will be allowed therefor.

If the initial cores show that dowel bars or tie bars are out of tolerance for alignment and the Engineer orders additional dowel or tie bar coring, full compensation for drilling the additional cores is included in the contract price paid per cubic yard for concrete pavement as designated in the Verified Bid Item List and no additional compensation will be allowed therefor.

If the initial cores show that dowel bars or tie bars are within alignment tolerances and the Engineer orders more dowel or tie bar coring, the additional cores will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

The Department will not pay for additional coring to check dowel or tie bar alignment you request.

Full compensation for performing profilograph tests, furnishing the profilograms and electronic files to the Engineer, and for performing corrective work is included in the contract price paid per cubic yard for the type of concrete pavement as designated in the Verified Bid Item List and no additional compensation will be allowed therefor.

The contract prices paid per linear foot for seal pavement joint, seal isolation joint, and seal longitudinal isolation joint include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in sealing pavement joints and sealing isolation joints, complete in place, as shown on the plans, and as specified in these specifications and the special provisions, and as directed by the Engineer.

The contract price paid per station for shoulder rumble strip includes full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in constructing the rumble strip complete in place, as shown on the plans, as specified in these Standard Specifications and as directed by the Engineer.

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## SECTION 41 PAVEMENT SUBSEALING AND JACKING
## (Issued 01-05-07)

### In Section 41-1.02 replace the 2nd and 3rd paragraphs with:

Cement for grout shall be Type II portland cement conforming to the provisions in Section 90-2.01A, "Cement."

Fly ash shall conform to the requirements in AASHTO Designation: M 295 for either Class C or for Class F. The brand of fly ash used in the work shall conform to the provisions for approval of admixture brands in Section 90-4.03, "Admixture Approval."

### In Section 41-1.02 replace the 5th paragraph with:

Chemical admixtures and calcium chloride may be used. Chemical admixtures in the grout mix shall conform to the provisions in Section 90-4, "Admixtures." Calcium chloride shall conform to ASTM Designation: D 98.

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## SECTION 42 GROOVE AND GRIND PAVEMENT
## (Issued 05-15-09)

### In Section 42-2.02 replace the 3rd paragraph with:

Existing portland cement concrete pavement not constructed as part of the project shall be ground as follows:

Grinding shall be performed so that the pavement surface on both sides of all transverse joints and cracks has essentially the same depth of texture and does not vary from a true plane enough to permit a 0.006-foot thick shim 0.25-foot wide to pass under a 3-foot straightedge adjacent to either side of the joint or crack when the straightedge is laid on the pavement parallel to centerline with its midpoint at the joint or crack. After grinding has been completed, the pavement shall conform to the straightedge and profile requirements specified in Section 40-1.03, "Quality Control and Assurance."
Abnormally depressed areas due to subsidence or other localized causes will be excluded from testing with the profilograph and 12-foot straightedge specified in Section 40-1.03. The accumulated total of the excluded areas shall not exceed 5 percent of the total area to be ground. Profilograph testing shall end 25 feet prior to excluded areas and shall resume 25 feet following the excluded areas.

### In Section 42-2.03 replace the 2nd paragraph with:

Replacement concrete paving shall conform to the provisions in Section 40, "Concrete Pavement." Replacement pavement may be spread and shaped by any suitable powered finishing machines, supplemented by handwork as necessary. Consolidation of the concrete shall be by means of high-frequency internal vibrators within 15 minutes after the concrete is deposited on the subgrade. Vibrating shall be done with care and in such manner to assure adequate consolidation adjacent to forms and uniformly across the full paving width. Use of vibrators for extensive shifting of the mass of concrete will not be permitted. Methods of spreading, shaping and compacting that result in segregation, voids or rock pockets shall be discontinued, and the Contractor shall adopt methods which will produce dense homogeneous pavement conforming to the required cross section. Finishing may be performed by hand method, as specified in Section 40-3.11B, "Stationary Side Form Finishing."

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## SECTION 49 PILING
## (Issued 12-19-08)

## In Section 49-1.03 replace the 4th paragraph with:

Modification to the specified installation methods and specified pile tip elevation will not be considered at locations where settlement, tension demands, or lateral load demands control design pile tip elevations or when the plans state that specified pile tip elevation shall not be revised.

## In Section 49-1.03 in the 6th paragraph, replace the 1st sentence with:

Indicator compression pile load testing shall conform to the requirements in ASTM Designation: D 1143-81.

## In Section 49-1.03 in the 7th paragraph, replace the 1st sentence with:

Indicator tension pile load testing shall conform to the requirements in ASTM Designation: D 3689-90.

## In Section 49-1.03 replace the 9th paragraph with:

The Contractor shall furnish piling of sufficient length to obtain the specified tip elevation shown on the plans or specified in the special provisions.

## In Section 49-1.04 replace the 6th paragraph with:

The Contractor may use additional cementitious material in the concrete for the load test and anchor piles.

## In Section 49-6.01 replace the 1st paragraph with:

The length of timber, steel, and precast prestressed concrete piles, and of cast-in-place concrete piles consisting of driven shells filled with concrete, shall be measured along the longest side, from the tip elevation shown on the plans to the plane of pile cut-off.

## In Section 49-6.02 add:

When pile tips are revised by the Engineer for timber, steel, and precast prestressed concrete piles, and for cast-in-place concrete piles consisting of driven shells filled with concrete, the additional length required, including all materials, equipment, and labor for furnishing, splicing, and installing the piling, will be paid for as extra work as provided in Section 4-1.03D, "Extra Work."

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# SECTION 50 PRESTRESSING CONCRETE
## (Issued 06-05-09)

### In Section 50-1.05 replace the 1st paragraph with:

Prestressing steel shall be high-tensile wire conforming to the requirements in ASTM Designation: A 421, including Supplement I; high-tensile seven-wire strand conforming to the requirements in ASTM Designation: A 416; or uncoated deformed (Type II) high-strength steel bars conforming to the requirements in ASTM Designation: A 722, including all supplementary requirements. The maximum weight requirement of ASTM Designation: A 722 will not apply.

### In Section 50-1.05 in the 3rd paragraph, delete item A.

### In Section 50-1.07 replace the 2nd paragraph with:

Ducts shall be fabricated with either welded or interlocked seams. Galvanizing of the welded seam will not be required. Ducts shall have sufficient strength to maintain their correct alignment during placing of concrete. Joints between sections of duct shall be positive metallic connections which do not result in angle changes at the joints. Waterproof tape shall be used at the connections. Ducts shall be bent without crimping or flattening. Transition couplings connecting the ducts to anchoring devices shall be either ferrous metal or polyolefin. Ferrous metal transition couplings need not be galvanized.

### In Section 50-1.07 replace the 7th paragraph with:

All ducts with a total length of 400 feet or more shall be vented. Vents shall be placed at intervals of not more than 400 feet and shall be located within 6 feet of every high point in the duct profile. Vents shall be 1/2 inch minimum diameter standard pipe or suitable plastic pipe. Connections to ducts shall be made with metallic or plastic structural fasteners. Plastic components, if selected, shall not react with the concrete or enhance corrosion of the prestressing steel and shall be free of water soluble chlorides. The vents shall be mortar tight, taped as necessary, and shall provide means for injection of grout through the vents and for sealing the vents. Ends of vents shall be removed one inch below the roadway surface after grouting has been completed.

### In Section 50-1.08 in the 11th paragraph, replace item B with:

B. When the concrete is designated by class or cementitious material content, either the concrete compressive strength shall have reached the strength shown on the plans at the time of stressing or at least 28 days shall have elapsed since the last concrete to be prestressed has been placed, whichever occurs first.

### In Section 50-1.09 replace the 2nd and 3rd paragraphs with:

Grout shall consist of cement and water and may contain an admixture if approved by the Engineer.

Cement shall conform to the provisions in Section 90-2.01A, "Cement."

### In Section 50-1.11 replace the 1st paragraph with:

No separate payment will be made for pretensioning precast concrete members. Payment for pretensioning precast concrete members shall be considered as included in the contract price paid for furnish precast members as provided for in Section 51, "Concrete Structures."

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## SECTION 51 CONCRETE STRUCTURES
## (Issued 07-30-10)

### In Section 51-1.05 in the 11th paragraph, replace the 1st sentence with:

Form panels for exposed surfaces shall be furnished and placed in uniform widths of not less than 3 feet and in uniform lengths of not less than 6 feet, except at the end of continuously formed surfaces where the final panel length required is less than 6 feet.

### In Section 51-1.06C in the 11th paragraph, replace the 1st sentence with:

Falsework for box culverts and other structures with decks lower than the roadway pavement and with span lengths of 14 feet or less shall not be released until the last placed concrete has attained a compressive strength of 1,600 psi, provided that curing of the concrete is not interrupted.

### In Section 51-1.11 replace the 6th paragraph with:

Construction methods and equipment employed by the Contractor shall conform to the provisions in Section 7-1.02, "Load Limitations."

### In Section 51-1.12D replace the 4th paragraph with:

Expanded polystyrene shall be a commercially available polystyrene board. Expanded polystyrene shall have a minimum flexural strength of 35 psi determined in conformance with the requirements in ASTM Designation: C 203 and a compressive yield strength of between 16 and 40 psi at 5 percent compression.

Surfaces of expanded polystyrene against which concrete is placed shall be faced with hardboard. Hardboard shall be 1/8 inch minimum thickness, conforming to ANSI A135.4, any class. Other facing materials may be used provided they furnish equivalent protection. Boards shall be held in place by nails, waterproof adhesive, or other means approved by the Engineer.

## In Section 51-1.12F replace the 3rd paragraph with:

Type A and AL joint seals shall consist of a groove in the concrete that is filled with field-mixed silicone sealant.

## In Section 51-1.12F in the 6th paragraph, replace the table with:

| Movement Rating (MR) | Seal Type |
|---|---|
| MR ≤ 1 inch | Type A or Type B |
| 1 inch < MR ≤ 2 inches | Type B |
| 2 inches < MR ≤ 4 inches | Joint Seal Assembly (Strip Seal) |
| MR > 4 inches | Joint Seal Assembly (Modular Unit) or Seismic Joint |

## In Section 51-1.12F(3)(a) replace the 1st and 2nd paragraphs with:

The sealant must consist of a 2-component silicone sealant that will withstand up to ±50 percent movement.

Silicone sealants must be tested under California Test 435 and must comply with the following:

| Specification | Requirement |
|---|---|
| Modulus at 150 percent elongation | 8-75 psi |
| Recovery | 21/32 inch max. |
| Notch Test | Notched or loss of bond 1/4 inch, max. |
| Water Resistance | Notched or loss of bond 1/4 inch, max. |
| Ultraviolet Exposure<br>ASTM Designation: G 154, Table X2.1,Cycle 2. | No more than slight checking or cracking. |
| Cone Penetration | 4.5-12.0 mm |

## In Section 51-1.12F(3)(a) delete the 3rd and 8th paragraphs.

**In Section 51-1.12F(3)(a) replace the 10th paragraph with:**

A Certificate of Compliance accompanied by a certified test report must be furnished for each batch of silicone sealant in conformance with the provisions in Section 6-1.07, "Certificates of Compliance."

**In Section 51-1.12F(3)(b) replace the 2nd paragraph with:**

The preformed elastomeric joint seal must conform to the requirements in ASTM D 2628 and the following:

1. The seal must consist of a multichannel, nonporous, homogeneous material furnished in a finished extruded form.
2. The minimum depth of the seal measured at the contact surface must be at least 95 percent of the minimum uncompressed width of the seal as designated by the manufacturer.
3. When tested in conformance with the requirements in California Test 673 for Type B seals, joint seals must provide a movement rating (MR) of not less than that shown on the plans.
4. The top and bottom edges of the joint seal must maintain continuous contact with the sides of the groove over the entire range of joint movement.
5. The seal must be furnished full length for each joint with no more than 1 shop splice in any 60-foot length of seal.
6. The Contractor must demonstrate the adequacy of the procedures to be used in the work before installing seals in the joints.
7. One field splice per joint may be made at locations and by methods approved by the Engineer. The seals are to be manufactured full length for the intended joint, then cut at the approved splice section and rematched before splicing. The Contractor must submit splicing details prepared by the joint seal manufacturer for approval before beginning splicing work.
8. Shop splices and field splices must have no visible offset of exterior surfaces and must show no evidence of bond failure.
9. At all open ends of the seal that would admit water or debris, each cell must be filled to a depth of 3 inches with commercial quality open cell polyurethane foam or closed by other means subject to approval by the Engineer.

**In Section 51-1.12F(3)(b) replace the 7th paragraph with:**

The joint seal must be installed full length for each joint with equipment that does not twist or distort the seal, elongate the seal longitudinally, or otherwise cause damage to the seal or to the concrete forming the groove.

**In Section 51-1.12F(3)(b) in the 11th paragraph, replace the 1st sentence with:**

Samples of the prefabricated joint seals, not less than 3 feet in length, will be taken by the Engineer from each lot of material.

### In Section 51-1.12H(1) in the 6th paragraph, replace the 4th and 5th sentences with:

Each ply of fabric shall have a breaking strength of not less than 800 pounds per inch of width in each thread direction when 3" x 36" samples are tested on split drum grips. The bond between double plies shall have a minimum peel strength of 20 pounds per inch.

### In Section 51-1.12H(1) in the 8th paragraph in the table, replace the hardness (Type A) requirements with:

| | | |
|---|---|---|
| Hardness (Type A) | D 2240 with 2kg mass. | 55 ±5 |

### In Section 51-1.12H(2) in the 1st paragraph in item A, replace the 1st and 2nd sentences with:

The bearings shall consist of alternating steel laminates and internal elastomer laminates with top and bottom elastomer covers. Steel laminates shall have a nominal thickness of 0.075 inch (14 gage).

### In Section 51-1.13 replace the 2nd, 3rd, and 4th paragraphs with:

Surfaces of fresh concrete at horizontal construction joints shall be thoroughly consolidated without completely removing surface irregularities. Additionally, surfaces of fresh concrete at horizontal construction joints between girder stems and decks shall be roughened to at least a 1/4-inch amplitude.

Construction joint surfaces shall be cleaned of surface laitance, curing compound, and other foreign materials using abrasive blast methods before fresh concrete is placed against the joint surface.

Construction joint surfaces shall be flushed with water and allowed to dry to a surface dry condition immediately before placing concrete.

### In Section 51-1.135 replace the 1st paragraph with:

Mortar shall be composed of cementitious material, sand, and water proportioned and mixed as specified in this Section 51-1.135.

### In Section 51-1.135 replace the 3rd paragraph with:

The proportion of cementitious material to sand, measured by volume, shall be 1 to 2 unless otherwise specified.

**In Section 51-1.17 in 4th paragraph, replace the 3rd sentence with:**

The surfaces shall have a profile trace showing no high points in excess of 0.25 inch, and the portions of the surfaces within the traveled way shall have a profile count of 5 or less in any 100 foot section.

**Add:**

### 51-1.17A Deck Crack Treatment

The Contractor shall use all means necessary to minimize the development of shrinkage cracks.

The Contractor shall remove all equipment and materials from the deck and clean the surface as necessary for the Engineer to measure the surface crack intensity. Surface crack intensity will be determined by the Engineer after completion of concrete cure, before prestressing, and before the release of falsework. In any 500 square foot portion of deck within the limits of the new concrete deck, should the intensity of cracking be such that there are more than 50 feet of cracks whose width at any location exceeds 0.02 inch, the deck shall be treated with a high molecular weight methacrylate (HMWM) resin system. The area of deck to be treated shall have a width that extends for the entire width of new deck inside the concrete barriers and a length that extends at least 5 feet beyond the furthest single continuous crack outside the 500 square foot portion, measured from where that crack exceeds 0.02 inch in width, as determined by the Engineer.

Deck crack treatment shall include furnishing, testing, and applying the HMWM resin system, with sand and absorbent material. If grinding is required, deck crack treatment shall take place before grinding.

### 51-1.17A(1) Submittals

Submit a HMWM resin system placement plan. When HMWM resin is to be applied within 100 feet of a residence, business, or public space including sidewalks under a structure, also submit a public safety plan. Submit plans under Section 5-1.02, "Plans and Working Drawings," of the Standard Specifications. The review time is 15 days.

The HMWM resin system placement plan must include:

1. Schedule of work and testing for each bridge
2. Description of equipment for applying HMWM resin
3. Range of gel time and final cure time for HMWM resin
4. Absorbent material to be used
5. Description of equipment for applying and removing excess sand and absorbent material
6. Procedure for removing HMWM resin from the deck, including equipment
7. Storage and handling of HMWM resin components and absorbent material
8. Disposal of excess HMWM resin and containers

The public safety plan must include:

1. A public notification letter with a list of delivery and posting addresses. The letter must state HMWM resin work locations, dates, times, and what to expect. Deliver the letter to

residences and businesses within 100 feet of HMWM resin work locations and to local fire and police officials at least 7 days before starting work. Post the letter at the job site.

2. An airborne emissions monitoring plan prepared and executed by a certified industrial hygienist (CIH) certified in comprehensive practice by the American Board of Industrial Hygiene. The plan must have at least 4 monitoring points including the mixing point, application point, and point of nearest public contact. Monitor airborne emissions during HMWM resin work and submit emissions monitoring results after completing the work.
3. An action plan for protection of the public when airborne emissions levels exceed permissible levels.
4. A copy of the CIH's certification.

If the measures proposed in the safety plan are inadequate to provide for public safety associated with the use of HMWM resin, the Engineer will reject the plan and direct the Contractor to revise the plan. Directions for revisions will be in writing and include detailed comments. The Engineer will notify the Contractor of the approval or rejection of a submitted or revised plan within 15 days of receipt of that plan.

### 51-1.17A(2) Quality Control and Assurance

Submit samples of HMWM resin components 15 days before use under Section 6-3, "Testing," of the Standard Specifications. Notify the Engineer 15 days before delivery of HMWM resin components in containers over 55 gallons to the job site.

Complete a test area before starting work. Results from airborne emissions monitoring of the test area must be submitted to the Engineer before starting production work.

The test area must:

1. Be approximately 500 square feet
2. Be placed within the project limits outside the traveled way at an approved location
3. Be constructed using the same equipment as the production work
4. Replicate field conditions for the production work
5. Demonstrate proposed means and methods meet the acceptance criteria
6. Demonstrate production work will be completed within the time allowed
7. Demonstrate suitability of the airborne emissions monitoring plan

The test area will be acceptable if:

1. The treated deck surface is tack free and non-oily
2. The sand cover adheres and resists brushing by hand
3. Excess sand and absorbent material has been removed
4. The coefficient of friction is at least 0.35 when tested under California Test 342

### 51-1.17A(3) Materials

HMWM resin system consists of a resin, promoter, and initiator. HMWM resin must be low odor and comply with the following:

**HMWM Resin**

| Property | Requirement | Test Method |
|---|---|---|
| Volatile Content* | 30 percent, maximum | ASTM D 2369 |
| Viscosity* | 25 cP, maximum, (Brookfield RVT with UL adaptor, 50 RPM at 77°F) | ASTM D 2196 |
| Specific Gravity* | 0.90 minimum, at 77°F | ASTM D 1475 |
| Flash Point* | 180°F, minimum | ASTM D 3278 |
| Vapor Pressure* | 1.0 mm Hg, maximum, at 77°F | ASTM D 323 |
| Tack-free Time | 400 minutes, maximum, at 25°C | Specimens prepared per California Test 551 |
| PCC Saturated Surface-Dry Bond Strength | 3.5 MPa, minimum at 24 hours and 21 ± 1°C | California Test 551 |

* Test must be performed before adding initiator.

Sand for abrasive sand finish must:

1. Be commercial quality dry blast sand
2. Have at least 95 percent pass the No. 8 sieve and at least 95 percent retained on the No. 20 sieve when tested under California Test 205

Absorbent material must be diatomaceous earth, abrasive blast dust, or substitute recommended by the HMWM resin supplier and approved by the Engineer.

### 51-1.17A(4) Construction

HMWM resin system applied by machine must be:

1. Combined in volumetric streams of promoted resin to initiated resin by static in-line mixers
2. Applied without atomization

HMWM resin system may be applied manually. Limit the quantity of resin mixed for manual application to 5 gallons at a time.

Prepare the area to be treated by abrasive blasting. Curing compound, surface contaminants, and foreign material must be removed from the bridge deck surface. Sweep the deck surface clean after abrasive blasting and blow loose material from cracks using high-pressure air.

The deck surface must be dry when abrasive blast cleaning is performed. When abrasive blast cleaning within 10 feet of public traffic, remove dust and residue from abrasive blast cleaning using a vacuum attachment operating concurrently with blasting equipment . If the deck surface becomes contaminated before placing HMWM, abrasive blast clean the contaminated area and sweep the deck clean.

The deck must be dry before applying HMWM resin. The concrete surface must be at least 50 degrees F and at most 100 degrees F. Relative humidity must be expected to be at most 85 percent during the work shift.

Thoroughly mix all components of the HMWM resin system. Apply HMWM resin to the deck surface within 5 minutes of mixing at approximately 90 sq ft per gallon. The Engineer determines the exact application rate. The resin gel time must be between 40 and 90 minutes. HMWM resin that thickens during application is rejected.

Spread the HMWM resin system uniformly. Completely cover surfaces to be treated and fill all cracks. Redistribute excess resin using squeegees or brooms within 10 minutes of application. For textured or grooved deck surfaces, excess resin must be removed from the texture indentations.

Apply the abrasive sand finish of at least 2 pounds per square yard or until saturation as determined by the Engineer no sooner than 20 minutes after applying resin. Apply absorbent material before opening lane to traffic. Remove excess sand and absorbent material by vacuuming or power sweeping.

Traffic or equipment will be allowed on the overlay after the Engineer has determined:

1. The treated deck surface is tack free and non-oily
2. The sand cover adheres and resists brushing by hand
3. Excess sand and absorbent material has been removed
4. No material will be tracked beyond limits of treatment by traffic

## In Section 51-1.18C replace the 2nd paragraph with:

When Class 2 surface finish (gun finish) is specified, ordinary surface finish shall first be completed. The concrete surfaces shall then be abrasive blasted to a rough texture and thoroughly washed down with water. While the washed surfaces are damp, but not wet, a finish coating of machine applied mortar, approximately 1/4 inch thick, shall be applied in not less than 2 passes. The coating shall be pneumatically applied and shall consist of either (1) sand, cementitious material, and water mechanically mixed prior to its introduction to the nozzle, or (2) premixed sand and cementitious material to which water is added prior to its expulsion from the nozzle. The use of admixtures shall be subject to the approval of the Engineer as provided in Section 90, "Portland Cement Concrete." Unless otherwise specified, supplementary cementitious materials will not be required. The proportion of cementitious material to sand shall be not less than one to 4, unless otherwise directed by the Engineer. Sand shall be of a grading suitable for the purpose intended. The machines shall be operated and the coating shall be applied in conformance with standard practice. The coating shall be firmly bonded to the concrete surfaces on which it is applied.

## In Section 51-1.18C replace the 5th paragraph with:

When surfaces to be finished are in pedestrian undercrossings, the sand shall be silica sand and the cementitious material shall be standard white portland cement.

### In Section 51-1.23, add:

Full compensation for deck crack treatment, including the public safety plan, shall be considered as included in the contract price paid per cubic yard for structural concrete, bridge, and no additional compensation will be allowed therefor.

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## SECTION 52 REINFORCEMENT
## (Issued 06-05-09)

### In Section 52-1.02(B) between the 3rd and 4th paragraphs, add:

The epoxy powder coating shall be selected from the Department's Pre-Qualified Products List.

### In Section 52-1.02(B) replace the 14th paragraph with:

Except for lap splices, splices for epoxy-coated reinforcement shall be coated with a corrosion protection covering that is selected from the Department's Pre-Qualified Products List. The covering shall be installed in accordance with the manufacturer's recommendations.

### In Section 52-1.07 in the 11th paragraph, replace the table with:

| Height Zone (H) (Feet above ground) | Wind Pressure Value (psf) |
|---|---|
| $H \leq 30$ | 20 |
| $30 < H \leq 50$ | 25 |
| $50 < H \leq 100$ | 30 |
| $H > 100$ | 35 |

### In Section 52-1.08B(1) replace the 1st paragraph with:

Mechanical splices to be used in the work shall be selected from the Department's Pre-Qualified Products List.

**In Section 52-1.08B(1) in the 2nd paragraph, replace the table with:**

| Reinforcing Bar Number | Total Slip |
|---|---|
| 4 | 0.020-inch |
| 5 | 0.020-inch |
| 6 | 0.020-inch |
| 7 | 0.028-inch |
| 8 | 0.028-inch |
| 9 | 0.028-inch |
| 10 | 0.036-inch |
| 11 | 0.036-inch |
| 14 | 0.048-inch |
| 18 | 0.060-inch |

**In Section 52-1.08B(1), in the 6th paragraph, delete item C.**

**In Section 52-1.08B(2) in the 6th paragraph, replace the subparagraph with:**

The minimum preheat and interpass temperatures shall be 400º F for Grade 40 bars and 600º F for Grade 60 bars. Immediately after completing the welding, at least 6 inches of the bar on each side of the splice shall be covered by an insulated wrapping to control the rate of cooling. The insulated wrapping shall remain in place until the bar has cooled below 200º F.

**Replace Section 52-1.08B(3) with:**

### 52-1.08B(3) Resistance Butt Welds

Shop produced resistance butt welds shall be produced by a fabricator who is selected from the Department's Pre-Qualified Products List.

A Certificate of Compliance conforming to the provisions in Section 6-1.07, "Certificates of Compliance," shall be furnished for each shipment of splice material. The Certificate of Compliance shall include heat number, lot number and mill certificates.

**In Section 52-1.08C replace the 3rd paragraph with:**

Testing on prequalification and production sample splices shall be performed at an approved independent testing laboratory. The laboratory shall not be employed or compensated by any subcontractor, or by other persons or entities hired by subcontractors who will provide other services or materials for the project.

The independent testing laboratory shall be selected from the Department's Pre-Qualified Products List.

**In Section 52-1.08C replace the 5th paragraph with:**

Prequalification and production sample splices and testing shall conform to California Test 670 and these specifications.

**In Section 52-1.08C delete the 6th paragraph.**

**In Section 52-1.08C replace the 8th paragraph with:**

Each sample splice, as defined herein, shall be identified as representing either a prequalification or production test sample splice.

**In Section 52-1.08C in the 10th paragraph, delete the last sentence.**

**Replace Section 52-1.08C(1) with:**

### 52-1.08C(1) Splice Prequalification Report

Before using any service splices or ultimate butt splices in the work, the Contractor shall submit a Splice Prequalification Report. The report shall include the following:

A. A copy of the manufacturer's product literature giving complete data on the splice material and installation procedures.
B. Names of the operators who will be performing the splicing.
C. Descriptions of the positions, locations, equipment, and procedures that will be used in the work.
D. Certifications from the fabricator for prequalification of operators and procedures based on sample tests performed no more than 2 years before submitting the report. Each operator shall be certified by performing 2 sample splices for each bar size of each splice type that the operator will be performing in the work. For deformation-dependent types of splice devices, each operator shall be certified by performing 2 additional samples for each bar size and deformation pattern that will be used in the work.

Prequalification sample splices shall be tested by an approved independent testing laboratory and shall conform to the appropriate production test criteria and slip requirements specified herein. When epoxy-coated reinforcement is required, resistance butt welded sample splices shall have the weld flash removed by the same procedure as will be used in the work, before coating and testing. The Splice Prequalification Report shall include the certified test results for all prequalification sample splices.

The QCM shall review and approve the Splice Prequalification Report before submitting it to the Engineer for approval. The Contractor shall allow 2 weeks for the review and approval of a complete report before performing any service splicing or ultimate butt splicing in the work.

**In Section 52-1.08C(2)(a) replace the 1st, 2nd, 3rd, 4th, and 5th paragraphs with:**

Production tests shall be performed by an approved independent testing laboratory for all service splices used in the work. A production test shall consist of testing 4 sample splices prepared for each lot of completed splices. The samples shall be prepared by the Contractor using the same splice material, position, operators, location, and equipment, and following the same procedure as used in the work.

At least one week before testing, the Contractor shall notify the Engineer in writing of the date and location where the testing of the samples will be performed.

The 4 samples from each production test shall be securely bundled together and identified with a completed sample identification card before shipment to the approved independent testing laboratory. The card will be furnished by the Engineer. Bundles of samples containing fewer than 4 samples of splices shall not be tested.

Before performing any tensile tests on production test sample splices, one of the 4 samples shall be tested for, and shall conform to, the requirements for total slip in Section 52-1.08B(1), "Mechanical Splices." Should this sample not meet the total slip requirements, one retest, in which the 3 remaining samples are tested for total slip, will be allowed. Should any of the 3 remaining samples not conform to the total slip requirements, all splices in the lot represented by this production test will be rejected.

If 3 or more sample splices from a production test conform to the provisions in this Section 52-1.08C(2), "Service Splice Test Criteria," all splices in the lot represented by this production test will be considered acceptable.

## Replace Section 52-1.08C(2)(b) with:

### 52-1.08C(2)(b) Quality Assurance Test Requirements for Service Splices

In addition to the required production tests, the Contractor shall concurrently prepare 4 service quality assurance sample splices for:

A. The first production test performed.
B. One of every 5 subsequent production tests, or fraction thereof, randomly selected by the Engineer.

These service quality assurance sample splices shall be prepared in the same manner as specified herein for service production sample splices.

The service quality assurance sample splices shall be shipped to the Transportation Laboratory for quality assurance testing. Each set of 4 sample splices shall be securely bundled together and identified by location and contract number with weatherproof markings before shipment. Bundles containing fewer than 4 samples of splices will not be tested. Sample splices not accompanied by the supporting documentation required in Section 52-1.08B(1), "Mechanical Splices," for mechanical splices, or in Section 52-1.08B(3), "Resistance Butt Welds," for resistance butt welds, will not be tested.

Quality assurance testing will be performed in conformance with the requirements for service production sample splices in Section 52-1.08C(2)(a), "Production Test Requirements for Service Splices."

## Replace Section 52-1.08C(3) with:

### 52-1.08C(3) Ultimate Butt Splice Test Criteria

Ultimate production and quality assurance sample splices shall be tensile tested in conformance with the requirements described in ASTM Designation: A 370 and California Test 670.

Each sample splice shall be identified as representing a prequalification, production, or quality assurance sample splice.

The portion of hoop reinforcing bar, removed to obtain a sample splice, shall be replaced using a prequalified ultimate mechanical butt splice, or the hoop shall be replaced in kind.

Reinforcing bars, other than hoops, from which sample splices are removed, shall be repaired using ultimate mechanical butt splices conforming to the provisions in Section 52-1.08C(1), "Splice Prequalification Report," or the bars shall be replaced in kind. These bars shall be repaired or replaced such that no splices are located in any "No Splice Zone" shown on the plans.

Ultimate production and quality assurance sample splices shall rupture either: 1) in the reinforcing bar but outside of the affected zone, provided that the sample splice has visible necking or 2) anywhere, provided that the sample splice has achieved the strain requirement for necking.

When tested in conformance with the requirements in California Test 670, "Necking (Option I)," the visible necking shall be such that there is a visible decrease in the sample's cross-sectional area at the point of rupture.

When tested in conformance with the requirements in California Test 670, "Necking (Option II)," the strain requirement for necking shall be such that the largest measured strain is not less than 6 percent for No. 11 and larger bars, or not less than 9 percent for No. 10 and smaller bars.

The affected zone is the portion of the reinforcing bar where any properties of the bar, including the physical, metallurgical, or material characteristics, have been altered by fabrication or installation of the splice. The weld and one inch adjacent to the weld will be considered part of the affected zone.

## In Section 52-1.08C(3)(a) replace the 1st paragraph with:

Production tests shall be performed for all ultimate butt splices used in the work. A production test shall consist of testing 4 sample splices removed from each lot of completed splices.

## In Section 52-1.08C(3)(a) replace the 3rd paragraph with:

After notification has been received, the Engineer will randomly select the 4 sample splices to be removed from the lot and place tamper-proof markings or seals on them. These ultimate production sample splices shall be removed by the Contractor, and tested by an approved independent testing laboratory.

## In Section 52-1.08(C)(3)(a) replace the 5th, 6th, and 7th paragraphs with:

A sample splice will be rejected if a tamper-proof marking or seal is disturbed before testing.

The 4 sample splices from each production test shall be securely bundled together and identified with a completed sample identification card before shipment to the approved independent testing laboratory. The card will be furnished by the Engineer. Bundles of samples containing fewer than 4 sample splices shall not be tested.

Before performing any tensile tests on production test sample splices, one of the 4 sample splices shall be tested for, and shall conform to, the requirements for total slip in Section 52-1.08B(1), "Mechanical Splices." Should this sample splice not meet these requirements, one retest, in which the 3 remaining sample splices are tested for total slip, will be allowed. Should any of the 3 remaining sample splices not conform to these requirements, all splices in the lot represented by this production test will be rejected.

## Replace Section 52-1.08C(3)(b) with:

### 52-1.08C(3)(b) Quality Assurance Test Requirements for Ultimate Butt Splices

In addition to the required production tests, the Contractor shall concurrently prepare 4 ultimate quality assurance sample splices for:

A. The first production test performed.
B. One of every 5 subsequent production tests, or fraction thereof, randomly selected by the Engineer.

These ultimate quality assurance sample splices shall be prepared in the same manner as specified herein for ultimate production sample splices.

The ultimate quality assurance sample splices shall be shipped to the Transportation Laboratory for quality assurance testing. Each set of 4 sample splices shall be securely bundled together and identified by location and contract number with weatherproof markings before shipment. Bundles containing fewer than 4 samples of splices will not be tested. Sample splices not accompanied by the supporting documentation required in Section 52-1.08B(1), "Mechanical Splices," for mechanical splices, or in Section 52-1.08B(3), "Resistance Butt Welds," for resistance butt welds, will not be tested.

Quality assurance testing will be performed in conformance with the requirements for ultimate production sample splices in Section 52-1.08C(3)(a), "Production Test Requirements for Ultimate Butt Splices."

## Replace Section 52-1.08D with:

A Production Test Report for all testing performed on each lot shall be prepared by the approved independent testing laboratory performing the testing and submitted to the QCM for review and approval. The report shall be signed by an engineer who represents the laboratory and is registered as a Civil Engineer in the State of California. The report shall include, as a minimum, the following information for each test: contract number, bridge number, lot number and location, bar size, type of splice, length of mechanical splice, length of test specimen, physical condition of test sample splice, any notable defects, total measured slip, and ultimate tensile strength of each splice. In addition, the report shall include location of visible necking area and largest measured strain for ultimate butt splices.

The QCM must review, approve, and forward each Production Test Report to the Engineer for review before the splices represented by the report are encased in concrete. The Engineer will have 3 working days to review each Production Test Report and respond in writing after a complete report has been received. Should the Contractor elect to encase any splices before receiving notification from the Engineer, it is expressly understood that the Contractor will not be relieved of the responsibility for incorporating material in the work that conforms to the requirements of the plans and specifications. Material not conforming to these requirements will be subject to rejection.

Quality assurance test results for each bundle of 4 samples of splices will be reported in writing to the Contractor within 3 working days after receipt of the bundle by the Transportation Laboratory. In the event that more than one bundle is received on the same day, 2 additional working days shall be allowed for providing test results for each additional bundle received. A test report will be made for each bundle received. Should the Contractor elect to encase splices before receiving notification from the Engineer, it is expressly understood that the Contractor will not be relieved of the responsibility for incorporating material in the work that conforms to the requirements of the plans and specifications. Material not conforming to these requirements will be subject to rejection.

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## SECTION 53 SHOTCRETE
## (Issued 11-02-07)

### In Section 53-1.01 replace the 3rd paragraph with:

The dry-mix process shall consist of delivering dry mixed aggregate and cementitious material pneumatically or mechanically to the nozzle body and adding water and mixing the materials in the nozzle body. The wet-mix process shall consist of delivering mixed aggregate, cement, and water pneumatically to the nozzle and adding any admixture at the nozzle.

### In Section 53-1.02 replace the 1st through 4th paragraphs with:

Cementitious material, fine aggregate, and mixing water shall conform to the provisions in Section 90, "Portland Cement Concrete."

Shotcrete to be mixed and applied by the dry-mix process shall consist of one part cementitious material to not more than 4.5 parts fine aggregate, thoroughly mixed in a dry state before being charged into the machine. Measurement may be either by volume or by weight. The fine aggregate shall contain not more than 6 percent moisture by weight.

Shotcrete to be mixed and applied by the wet-mix process shall consist of cementitious material, fine aggregate, and water and shall contain not less than 632 pounds of cementitious material per cubic yard. A maximum of 30 percent pea gravel may be substituted for fine aggregate. The maximum size of pea gravel shall be such that 100 percent passes the 1/2 inch screen and at least 90 percent passes the 3/8 inch screen.

Admixtures may be added to shotcrete and shall conform to the provisions in Section 90-4, "Admixtures."

### In Section 53-1.04 in the 3rd paragraph, replace item C with:

C. Aggregate and cementitious material that have been mixed for more than 45 minutes shall not be used unless otherwise permitted by the Engineer.

**Replace Section 53-1.07 with:**

## 53-1.07 MEASUREMENT

Quantities of shotcrete will be measured by the cubic yard computed from measurements, along the slope, of actual areas placed and the theoretical thickness shown on the plans. The Department does not pay for shotcrete placed outside the dimensions shown on the plans or to fill low foundation.

**Replace Section 53-1.08 with:**

## 53-1.08 PAYMENT

The contract price paid per cubic yard for shotcrete shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in placing shotcrete, including preparing the foundation, wire reinforcement, structure backfill, joint filling material, and if required by the plans, drains with sacked pervious backfill material, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

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# SECTION 55 STEEL STRUCTURES
**(Issued 05-02-08**

**In Section 55-1.05 replace the 3rd paragraph with:**

Construction methods and equipment employed by the Contractor shall conform to the provisions in Section 7-1.02, "Load Limitations."

**In Section 55-2.01 in the 5th paragraph in the table, replace the CVN impact value for Grade HPS 50W with:**

| | |
|---|---|
| Grade HPS 50W* (4 inches and under in thickness) | 20 at 10 ºF |

**In Section 55-3.05 replace the 1st paragraph with:**

Surfaces of bearing and base plates and other metal surfaces that are to come in contact with each other or with ground concrete surfaces or with asbestos sheet packing shall be flat to within 1/32-inch tolerance in 12 inches and to within 1/16-inch tolerance overall. Surfaces of bearing and base plates and other metal bearing surfaces that are to come in contact with preformed fabric pads, elastomeric bearing pads, or mortar shall be flat to within 1/8-inch tolerance in 12 inches and to within 3/16-inch tolerance overall.

**In Section 55-3.10 in the 1st paragraph, replace item B with:**

B. Internal threads shall conform to the requirements in ASTM Designation: A 563.

**In Section 55-3.19 replace the 3rd paragraph with:**

Immediately before setting bearing assemblies or masonry plates directly on ground concrete surfaces, the Contractor shall thoroughly clean the surfaces of the concrete and the metal to be in contact and shall apply a coating of nonsag polysulfide or polyurethane caulking conforming to the requirements in ASTM Designation: C 920 to contact areas to provide full bedding.

**In Section 55-3.19 replace the 5th paragraph with:**

Mortar to be placed below masonry plates or bearing plates of the bearing assemblies and in anchor bolt sleeves or canisters shall conform to the provisions in Section 51-1.135, "Mortar," except that the proportion of cementitious material to sand shall be 1:3.

**In Section 55-4.01 in the 1st paragraph, replace item D with:**

D. To determine the pay quantities of galvanized metal, the weight to be added to the calculated weight of the base metal for the galvanizing will be determined from the table of weights of zinc coatings specified in ASTM Designation: A 153/A 153M.

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## SECTION 56 SIGNS
## (Issued 03-16-07)

**In Section 56-1.03 replace the 5th paragraph with:**

Clips, eyes, or removable brackets shall be affixed to all signs and all posts and shall be used to secure the sign during shipping and for lifting and moving during erection as necessary to prevent damage to the finished galvanized or painted surfaces. Brackets on tubular sign structures shall be removed after erection. Details of the devices shall be shown on the working drawings.

**In Section 56-1.10 replace the 4th paragraph with:**

The contract price paid per pound for install sign structure of the type or types designated in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment

and incidentals, and for doing all the work involved in installing sign structures, complete in place, including installing anchor bolt assemblies, removable sign panel frames, and sign panels and performing any welding, painting or galvanizing required during installation, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

### In Section 56-2.03 replace the 4th paragraph with:

Backfill material for metal posts shall consist of minor concrete conforming to the provisions in Section 90-10, "Minor Concrete," and shall contain not less than 463 pounds of cementitious material per cubic yard.

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## SECTION 59 PAINTING
## (Issued 06-05-09)

### In Section 59-1.03 replace the 3rd paragraph with:

Painting shall be done in a neat and workmanlike manner. Unless otherwise specified, paint shall be applied by brush, or spray, or roller, or any combination of these methods. Gun extensions shall not be used.

### In Section 59-2.01 replace the 2nd paragraph with:

Unless otherwise specified, no painting Contractors or subcontractors will be permitted to perform work without having the following current "SSPC: The Society for Protective Coatings" (formerly the Steel Structures Painting Council) certifications in good standing throughout the duration of the contract:

A. For cleaning and painting structural steel in the field, certification in conformance with the requirements in Qualification Procedure No. 1, "Standard Procedure For Evaluating Painting Contractors (Field Application to Complex Industrial Structures)" (SSPC-QP 1).
B. For removing paint from structural steel, certification in conformance with the requirements in Qualification Procedure No. 2, "Standard Procedure for the Qualification of Painting Contractors (Field Removal of Hazardous Coatings from Complex Structures)" (SSPC-QP 2, Category A).
C. For cleaning and painting structural steel in a permanent painting facility, certification in conformance with the requirements in Qualification Procedure No. 3, "Standard Procedure For Evaluating Qualifications of Shop Painting Applicators" (SSPC-QP 3, Enclosed Shop Facility). The AISC's Sophisticated Paint Endorsement (SPE) quality

program, Certification P-1 Enclosed, will be considered equivalent to SSPC-QP 3, Enclosed Shop Facility.

### In Section 59-2.12 replace the 3rd and 4th paragraphs with:

Contact surfaces of stiffeners, railings, built up members or open seam exceeding 6 mils in width that would retain moisture, shall be caulked with polysulfide or polyurethane sealing compound conforming to the requirements in ASTM Designation: C 920, Type S, Grade NS, Class 25, Use O, or other approved material.

The dry film thickness of the paint will be measured in place with a calibrated Type 2 magnetic film thickness gage in conformance with the requirements in SSPC-PA 2, "Measurement of Dry Coating Thickness with Magnetic Gages," of the "SSPC: The Society for Protective Coatings," except that there shall be no limit to the number or location of spot measurements to verify compliance with specified thickness requirements.

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## SECTION 64 PLASTIC PIPE
## (Issued 06-05-09)

### In Section 64-1.02 replace the 5th paragraph with:

HDPE compounds used in the manufacture of corrugated polyethylene pipe and fittings shall comply with AASHTO M 294 except that the mix shall contain not less than 2 nor greater than 4 percent well dispersed carbon black. HDPE compounds used in the manufacture of ribbed profile wall polyethylene pipe shall comply with ASTM F 894 except that Type E ultraviolet stabilizers shall not be allowed and carbon black shall be well dispersed in an amount not less than 2 percent nor greater than 4 percent.

Manufacturers of corrugated polyethylene pipe shall:

1. Participate in the National Transportation Product Evaluation Control Program (NTPEP) for each plant supplying corrugated polyethylene pipe and fittings for the project.
2. Conduct and maintain a quality control program under NTPEP.
3. Submit a copy to the Engineer of manufacturing plant audits and NTPEP test results from the current cycle of NTPEP testing for all pipe diameters supplied.

Type D corrugated polyethylene pipe is not allowed. Corrugated polyethylene pipe greater than 60 inches in nominal diameter is not allowed.

### In Section 64-1.05 replace the 1st paragraph with:

Excavation, backfill, and shaped bedding shall comply with Section 19-3, "Structure Excavation and Backfill," except the following:

1. At locations where pipe is to be backfilled with concrete, the backfill shall comply with Section 64-1.06, "Concrete Backfill."
2. Corrugated polyethylene pipe that is greater than 48 inches in nominal diameter but not exceeding 60 inches in nominal diameter shall be backfilled with either controlled low strength material under the special provisions or slurry cement backfill under Section 19-3.062, "Slurry Cement Backfill."
3. Where cementitious or flowable backfill is used for structure backfill, the backfill shall be placed to a level not less than 12 inches above the crown of the pipe.

### In Section 64-1.06 replace the 1st paragraph with:

At locations where pipe is to be backfilled with concrete as shown on the plans, the concrete backfill shall be constructed of minor concrete or Class 4 concrete conforming to the provisions in Section 90, "Portland Cement Concrete." Minor concrete shall contain not less than 380 pounds of cementitious material per cubic yard. The concrete to be used will be designated in the contract item or shown on the plans.

### In Section 64-1.06 replace the 3rd paragraph with:

The surface of the concrete backfill shall be broomed with a heavy broom to produce a uniform rough surface if hot mix asphalt is to be placed directly thereon.

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## SECTION 65 REINFORCED CONCRETE PIPE
## (Issued 11-30-10)

### In Section 65-1.02 replace the 1st paragraph with:

Cementitious material and aggregate shall conform to the provisions in Section 90-2, "Materials" except that grading requirements shall not apply to the aggregate. Use of supplemental cementitious material shall conform to AASHTO Designation: M 170.

**In Section 65-1.02A(1) in the 11th paragraph, replace item c with:**

c. Cementitious material and aggregate for non-reinforced concrete pipe shall conform to the provisions in Section 65-1.02, "Materials."

**In Section 65-1.035 replace the 1st paragraph with:**

At locations where pipe is to be backfilled with concrete as shown on the plans, the concrete backfill shall be constructed of minor concrete or Class 4 concrete in conformance with the provisions in Section 90, "Portland Cement Concrete." Minor concrete shall contain not less than 380 pounds of cementitious material per cubic yard. The concrete to be used will be designated in the contract item.

**In Section 65-1.035 replace the 3rd paragraph with:**

The surface of the concrete backfill shall be broomed with a heavy broom to produce a uniform rough surface if hot mix asphalt is to be placed directly thereon.

**In Section 65-1.06 in the 2nd paragraph, replace the 1st subparagraph with:**

Cement Mortar. - Mortar shall be composed of one part cementitious material and 2 parts sand by volume. Supplementary cementitious material will not be required.

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## SECTION 66 CORRUGATED METAL PIPE
## (Issued 07-31-07)

**In Section 66-1.045 replace the 1st paragraph with:**

At locations where pipe is to be backfilled with concrete as shown on the plans, the concrete backfill shall be constructed of minor concrete or Class 4 concrete conforming to the provisions in Section 90, "Portland Cement Concrete." Minor concrete shall contain not less than 380 pounds of cementitious material per cubic yard. The concrete to be used will be designated in the contract item or shown on the plans.

**In Section 66-1.045 replace the 3rd paragraph with:**

The surface of the concrete backfill shall be broomed with a heavy broom to produce a uniform rough surface if hot mix asphalt is to be placed directly thereon.

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## SECTION 68 SUBSURFACE DRAINS
## (Issued 07-31-07)

### In Section 68-3.02D replace the 1st and 2nd paragraphs with:

Concrete for splash pads shall be produced from minor concrete conforming to the provisions in Section 90-10, "Minor Concrete." Minor concrete shall contain not less than 470 pounds of cementitious material per cubic yard.

Mortar placed where edge drain outlets and vents connect to drainage pipe and existing drainage inlets shall conform to the provisions in Section 51-1.135, "Mortar."

### In Section 68-3.03 replace the 13th paragraph with:

Cement treated permeable material, which is not covered with hot mix asphalt within 12 hours after compaction of the permeable material, shall be cured by either sprinkling the material with a fine spray of water every 4 hours during daylight hours or covering the material with a white polyethylene sheet, not less than 6 mils thick. The above curing requirements shall begin at 7:00 a.m. on the morning following compaction of the cement treated permeable material and continue for the next 72 hours or until the material is covered with hot mix asphalt, whichever is less. The cement treated permeable material shall not be sprayed with water during the first 12 hours after compacting, but may be covered with the polyethylene sheet during the first 12 hours or prior to the beginning of the cure period.

### In Section 68-3.03 replace the 17th and 18th paragraphs with:

Hot mix asphalt for backfilling trenches in existing paved areas shall be produced from commercial quality aggregates and asphalt and mixed at a central mixing plant. The aggregate shall conform to the 3/4 inch grading, or the 1/2 inch grading for Type A and Type B hot mix asphalt specified in Section 39-1.02E, "Aggregate." The amount of asphalt binder to be mixed with the aggregate shall be between 4 percent and 7 percent by weight of the dry aggregate, as determined by the Engineer.

Hot mix asphalt backfill shall be spread and compacted in approximately 2 equal layers by methods that will produce a hot mix asphalt surfacing of uniform smoothness, texture and density. Each layer shall be compacted before the temperature of the mixture drops below 250 ºF. Prior to placing the hot mix asphalt backfill, a tack coat of asphaltic emulsion conforming to the provisions in Section 94, "Asphaltic Emulsions," shall be applied to the vertical edges of existing pavement at an approximate rate of 0.05 gallon per square yard.

### In Section 68-3.03 replace the 20th paragraph with:

Type A pavement markers conforming to the details shown on the plans and the provisions in Section 85, "Pavement Markers," shall be placed on paved shoulders or dikes at outlet, vent and cleanout locations as directed by the Engineer. The waiting period for placing pavement markers on new hot mix asphalt surfacing will not apply.

### Replace Section 68-3.05 with:

## 68-3.05 PAYMENT

The contract price paid per linear foot for plastic pipe (edge drain) of the size or sizes shown in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in installing edge drains complete in place, including excavation (and removal of any concrete deposits that may occur along the lower edge of the concrete pavement in Type 1 installations) and hot mix asphalt backfill for Type 1 edge drain installation, tack coat, filter fabric, and treated permeable material, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

The contract price paid per linear foot for plastic pipe (edge drain outlet) of the size or sizes shown in the Engineer's Estimate shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in installing edge drain outlets, vents and cleanouts complete in place, including outlet and vent covers, expansion plugs, pavement markers, concrete splash pads, connecting outlets and vents to drainage facilities, and excavation and backfill [aggregate base, hot mix asphalt, tack coat, and native material] for outlets, vents, and cleanouts to be installed in embankments and existing shoulders, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

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# SECTION 69 OVERSIDE DRAINS
## (Issued 07-31-07)

### In Section 69-1.01 replace the 1st paragraph with:

This work shall consist of furnishing and installing entrance tapers, pipe downdrains, tapered inlets, flume downdrains, anchor assemblies, reducers, slip joints and hot mix asphalt overside drains to collect and carry surface drainage down the roadway slopes as shown on the plans or as directed by the Engineer and as specified in these specifications and the special provisions.

**Replace Section 69-1.02D with:**

**69-1.02D Hot Mix Asphalt**

Hot mix asphalt for overside drains shall conform to the provisions in Section 39-1.13, "Miscellaneous Areas."

**Replace Section 69-1.04 with:**

**69-1.04 HOT MIX ASPHALT OVERSIDE DRAINS**

Hot mix asphalt overside drains shall be constructed as shown on the plans or as directed by the Engineer. The hot mix asphalt shall be placed in conformance with the provisions in Section 39-1.13, "Miscellaneous Areas."

**In Section 69-1.06 replace the 2nd paragraph with:**

Quantities of hot mix asphalt placed for overside drains will be paid for as provided in Section 39-5, "Measurement and Payment," for hot mix asphalt placed in miscellaneous areas.

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## SECTION 70 MISCELLANEOUS FACILITIES
## (Issued 11-30-10)

**In Section 70-1.02C replace the 2nd paragraph with:**

Precast concrete flared end sections shall conform to the requirements for Class III Reinforced Concrete Pipe in AASHTO Designation: M 170M. Cementitious materials and aggregate shall conform to the provisions in Section 90-2, "Materials," except that grading requirements shall not apply to the aggregate. Use of supplementary cementitious material shall conform to the requirements in AASHTO Designation: M 170. The area of steel reinforcement per linear foot of flared end section shall be at least equal to the minimum steel requirements for circular reinforcement in circular pipe for the internal diameter of the circular portion of the flared end section. The basis of acceptance of the precast concrete flared end section shall conform to the requirements of Section 5.1.2 of AASHTO Designation: M 170.

**In Section 70-1.02H replace the 1st paragraph with:**

Precast concrete pipe risers and pipe reducers, and precast concrete pipe sections, adjustment rings and tapered sections for pipe energy dissipators, pipe inlets and pipe manholes shall conform to the requirements in AASHTO Designation: M 199M/M 199, except that the cementitious material and

aggregate shall conform to the provisions in Section 90-2, "Materials," except that grading requirements shall not apply to the aggregate. Use of supplementary cementitious material shall conform to the requirements in AASHTO Designation: M 170.

**In Section 70-1.03 replace the 2nd paragraph with:**

Cutoff walls for precast concrete flared end sections shall be constructed of minor concrete conforming to the provisions in Section 90-10, "Minor Concrete." Minor concrete shall contain not less than 470 pounds of cementitious material per cubic yard.

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## SECTION 72 SLOPE PROTECTION
**(Issued 03-13-09)**

**In Section 72-4.04 replace the 6th paragraph with:**

Pervious backfill material, if required by the plans, shall be placed as shown. A securely tied sack containing one cubic foot of pervious backfill material shall be placed at each weep hole and drain hole. The sack material shall conform to the requirements for filter fabric in Section 88-1.02, "Filtration."

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## SECTION 73 CONCRETE CURBS AND SIDEWALKS
**(Issued 06-05-09)**

**In Section 73-1.01 in the 2nd paragraph, replace item 2 with:**

2. Minor concrete shall contain not less than 463 pounds of cementitious material per cubic yard except that when extruded or slip-formed curbs are constructed using 3/8-inch maximum size aggregate, minor concrete shall contain not less than 505 pounds of cementitious material per cubic yard.

**In Section 73-1.06 replace the 15th paragraph with:**

Where hot mix asphalt or portland cement concrete pavements are to be placed around or adjacent to manholes, pipe inlets or other miscellaneous structures in sidewalk, gutter depression, island paving, curb ramps or driveway areas, the structures shall not be constructed to final grade until after the pavements have been constructed for a reasonable distance on each side of the structures.

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## SECTION 74 PUMPING PLANT EQUIPMENT
**(Issued 07-01-08)**

**In Section 74-1.02 delete the 2nd paragraph.**

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## SECTION 75 MISCELLANEOUS METAL
**(Issued 06-05-09)**

**In Section 75-1.03 replace the 13th paragraph with:**

Concrete anchorage devices shall be mechanical expansion or resin capsule types installed in drilled holes or cast-in-place insert types. The anchorage devices shall be selected from the Department's Pre-Qualified Products List. The qualification requirements for concrete anchorage devices may be obtained from the Pre-Qualified Products List Web site.

The anchorage devices shall be a complete system, including threaded studs, hex nuts, and cut washers. Thread dimensions for externally threaded concrete anchorage devices prior to zinc coating shall conform to the requirements in ASME Standard: B1.1 having Class 2A tolerances or ASME Standard: B1.13M having Grade 6g tolerances. Thread dimensions for internally threaded concrete anchorage devices shall conform to the requirements in ASTM A 563.

**In Section 75-1.03 replace the 18th paragraph with:**

Mechanical expansion anchors shall, when installed in accordance with the manufacturer's instructions and these specifications and tested in conformance with the requirements in California Test 681, withstand the application of a sustained tension test load of at least the following values for at least 48 hours with a movement not greater than 0.035 inch:

| Stud Diameter (inches) | Sustained Tension Test Load (pounds) |
|---|---|
| *3/4 | 5,000 |
| 5/8 | 4,100 |
| 1/2 | 3,200 |
| 3/8 | 2,100 |
| 1/4 | 1,000 |

* Maximum stud diameter permitted for mechanical expansion anchors.

Resin capsule anchors shall, when installed in accordance with the manufacturer's instructions and these specifications and tested in conformance with the requirements in California Test 681, withstand the application of a sustained tension test load of at least the following values for at least 48 hours with a movement not greater than 0.010 inch:

| Stud Diameter (inches) | Sustained Tension Test Load (pounds) |
|---|---|
| 1-1/4 | 31,000 |
| 1 | 17,900 |
| 7/8 | 14,400 |
| 3/4 | 5,000 |
| 5/8 | 4,100 |
| 1/2 | 3,200 |
| 3/8 | 2,100 |
| 1/4 | 1,000 |

At least 25 days before use, the Contractor shall submit one sample of each resin capsule anchor per lot to the Transportation Laboratory for testing. A lot of resin capsule anchors is 100 units, or fraction thereof, of the same brand and product name.

## In Section 75-1.03 replace the 20th paragraph with:

A Certificate of Compliance for concrete anchorage devices shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance."

## In Section 75-1.03 replace the 24th paragraph with:

Sealing compound, for caulking and adhesive sealing, shall be a polysulfide or polyurethane material conforming to the requirements in ASTM Designation: C 920, Type S, Grade NS, Class 25, Use O.

**In Section 75-1.035 in the 3rd paragraph, replace the 1st sentence with:**

Cables shall be 3/4 inch preformed, 6 x 19, wire strand core or independent wire rope core (IWRC), galvanized in conformance with the requirements in Federal Specification RR-W-410, right regular lay, manufactured of improved plow steel with a minimum breaking strength of 23 tons.

**In Section 75-1.035 in the 4th paragraph, replace item C with:**

C. Nuts shall conform to the requirements in ASTM Designation: A 563 including Appendix X1, except lubrication is not required.

**In Section 75-1.035 replace the 12th paragraph with:**

Concrete for filling cable drum units shall conform to the provisions in Section 90-10, "Minor Concrete," or at the option of the Contractor, may be a mix with 3/8-inch maximum size aggregate and not less than 675 pounds of cementitious material per cubic yard.

**In Section 75-1.05 replace the 6th paragraph with:**

Galvanizing of iron and steel hardware and nuts and bolts, when specified or shown on the plans, shall conform to the requirements in ASTM Designation: A 153/A 153M, except whenever threaded studs, bolts, nuts, and washers are specified to conform to the requirements in ASTM Designation: A 307, A 325, A 449, A 563, or F 436 and zinc coating is required, they shall be hot-dip zinc coated or mechanically zinc coated in conformance with the requirements in the ASTM Designations. Unless otherwise specified, galvanizing shall be performed after fabrication.

**In Section 75-1.05 replace the 8th paragraph with:**

Tapping of nuts or other internally threaded parts to be used with zinc coated bolts, anchor bars or studs shall be done after galvanizing and shall conform to the requirements for thread dimensions and overtapping allowances in ASTM Designation: A 563.

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## SECTION 80 FENCES
## (Issued 01-05-07)

**In Section 80-3.01F replace the 4th paragraph with:**

Portland cement concrete for metal post and brace footings and for deadmen shall be minor concrete conforming to the provisions in Section 90-10, "Minor Concrete." Minor concrete shall contain not less than 470 pounds of cementitious material per cubic yard.

### In Section 80-4.01C replace the 4th paragraph with:

Portland cement concrete for metal post and for deadmen shall be produced from minor concrete conforming to the provisions in Section 90-10, "Minor Concrete." Minor concrete shall contain not less than 470 pounds of cementitious material per cubic yard.

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## SECTION 83 RAILINGS AND BARRIERS
## (Issued 04-03-09)

### In Section 83-1.02 replace the 7th paragraph with:

Mortar shall conform to the provisions in Section 51-1.135, "Mortar," and shall consist of one part by volume of cementitious material and 3 parts of clean sand.

### In Section 83-1.02B in the 24th paragraph in the 8th subparagraph, replace the 1st sentence with:

Anchor cable shall be 3/4 inch preformed, 6 x 19, wire strand core or independent wire rope core (IWRC), galvanized in conformance with the requirements in Federal Specification RR-W-410, right regular lay, manufactured of improved plow steel with a minimum breaking strength of 23 tons.

### In Section 83-1.02E in the 6th paragraph, replace the 2nd sentence with:

Cable shall be galvanized in conformance with the requirements in Federal Specification RR-W-410.

### In Section 83-1.02I replace the 5th paragraph with:

Where shown on the plans, cables used in the frame shall be 5/16 inch in diameter, wire rope, with a minimum breaking strength of 5,000 pounds and shall be galvanized in conformance with the requirements in Federal Specification RR-W-410.

### In Section 83-1.02I replace the 14th paragraph with:

Chain link fabric shall be 11-gage conforming to one of the following:

1. AASHTO Designation: M181, Type I, Class C
2. AASHTO Designation: M181, Type IV, Class A
3. ASTM F 1345, Class 2

**In Section 83-2.02D(1) replace the 5th paragraph with:**

When concrete barriers are to be constructed on existing structures, the dowels shall be bonded in holes drilled in the existing concrete. Drilling of holes and bonding of dowels shall conform to the following:

1. The bonding materials shall be either magnesium phosphate concrete, modified high alumina based concrete or portland cement based concrete. Magnesium phosphate concrete shall be either single component (water activated) or dual component (with a prepackaged liquid activator). Modified high alumina based concrete and portland cement based concrete shall be water activated. Bonding materials shall conform to the following requirements:

| Property | Test Method | Requirements |
|---|---|---|
| Compressive Strength | | |
| at 3 hours, MPa | California Test 551 | 21 min. |
| at 24 hours, MPa | California Test 551 | 35 min. |
| Flexure Strength | | |
| at 24 hours, MPa | California Test 551 | 3.5 min. |
| Bond Strength: at 24 hours | | |
| SSD Concrete, MPa | California Test 551 | 2.1 min. |
| Dry Concrete, MPa | California Test 551 | 2.8 min. |
| Water Absorption, % | California Test 551 | 10 max. |
| Abrasion Resistance | | |
| at 24 hours, grams | California Test 550 | 25 max. |
| Drying Shrinkage at 4 days, % | ASTM Designation: C 596 | 0.13 max. |
| Soluble Chlorides by weight, % | California Test 422 | 0.05 max. |
| Water Soluble Sulfates by weight, % | California Test 417 | 0.25 max. |

2. Magnesium phosphate concrete shall be formulated for minimum initial set time of 15 minutes and minimum final set time of 25 minutes at 70° F. The materials, prior to use, shall be stored in a cool, dry environment.
3. Mix water used with water activated material shall conform to the provisions in Section 90-2.03, "Water."
4. The quantity of water for single component type or liquid activator (for dual component type) to be blended with the dry component, shall be within the limits recommended by the manufacturer and shall be the least amount required to produce a pourable batter.
5. Addition of retarders, when required and approved by the Engineer, shall be in conformance with the manufacturer's recommendations.

6. Before using concrete material that has not been previously approved, a minimum of 45 pounds shall be submitted to the Engineer for testing. The Contractor shall allow 45 days for the testing. Each shipment of concrete material that has been previously approved shall be accompanied by a Certificate of Compliance as provided in Section 6-1.07, "Certificates of Compliance."
7. Magnesium phosphate concrete shall not be mixed in containers or worked with tools containing zinc, cadmium, aluminum or copper metals. Modified high alumina based concrete shall not be mixed in containers or worked with tools containing aluminum.
8. The surface of any dowel coated with zinc or cadmium shall be coated with a colored lacquer before installation of the dowel. The lacquer shall be allowed to dry thoroughly before embedment of the dowels.
9. The holes shall be drilled by methods that will not shatter or damage the concrete adjacent to the hole. The diameter of the drilled hole shall be $^1/_2$ inch larger than the nominal diameter of the dowels.
10. The drilled holes shall be clean and dry at the time of placing the bonding material and the steel dowels. Bonding material and dowel shall completely fill the drilled hole. The surface temperature shall be 40° F or above when the bonding material is placed.
11. After bonding, dowels shall remain undisturbed for a minimum of 3 hours or until the bonding material has reached a strength sufficient to support the dowels. Dowels that are improperly bonded, as determined by the Engineer, shall be removed. The holes shall be cleaned or new holes shall be drilled and the dowels replaced and securely bonded to the concrete. Removing, redrilling and replacing improperly bonded dowels shall be performed at the Contractor's expense. Modified high alumina based concrete and portland cement based concrete shall be cured in conformance with the provisions in Section 90-7.01B, "Curing Compound Method," of the Standard Specifications. Magnesium phosphate concrete shall not be cured.

**In Section 83-2.02D(2) in the 1st paragraph, replace item b with:**

b. If the 3/8-inch maximum size aggregate grading is used to construct extruded or slip-formed concrete barriers, the cementitious material content of the minor concrete shall be not less than 675 pounds per cubic yard.

**In Section 83-2.02D(2) replace the 3rd paragraph with:**

The concrete paving between the tops of the 2 walls of concrete barrier (Types 50E, 60E, 60GE, and 60SE) and the optional concrete slab at the base between the 2 walls of concrete barrier (Types 50E, 60E, 60GE, and 60SE) shall be constructed of minor concrete conforming to the provisions of Section 90-10, "Minor Concrete," except that the minor concrete shall contain not less than 505 pounds of cementitious material per cubic yard.

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## SECTION 85 PAVEMENT MARKERS
## (Issued 07-31-07)

### In Section 85-1.06 replace the 6th paragraph with:

Pavement markers shall not be placed on new hot mix asphalt surfacing or seal coat until the surfacing or seal coat has been opened to public traffic for a period of not less than 7 days when hot melt bituminous adhesive is used, and not less than 14 days when epoxy adhesive is used.

### In Section 85-1.06 in the 14th paragraph, replace the 2nd sentence with:

Cleaning shall be done by blast cleaning on all surfaces regardless of age or type, except that blast cleaning of clean, new hot mix asphalt and clean, new seal coat surfaces will not be required when hot melt bituminous adhesive is used.

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## SECTION 86 SIGNALS, LIGHTING AND ELECTRICAL SYSTEMS
## (Issued 06-05-09)

### Replace Section 86 with:
## SECTION 86 ELECTRICAL SYSTEMS
## 86-1 GENERAL

### 86-1.01 DESCRIPTION

Section 86 includes specifications for installing, modifying, and removing:

1. Traffic signal
2. Interconnect system
3. Ramp metering system
4. Flashing beacon system
5. Lighting system
6. Sign illumination system
7. Traffic monitoring station
8. Communication system
9. Electrical equipment in structure
10. Falsework lighting

Comply with Part 4 of the California MUTCD. Nothing in this Section 86 is to be construed as to reduce the minimum standards in this manual.

The locations of electrical system elements are approximate; the Engineer will approve final location.

## 86-1.015 DEFINITIONS

Definitions pertain only to Section 86, "Electrical Systems."

**actuation:** The action of a vehicle or pedestrian causing a detector to create a call in that phase or movement to request right of way.

**channel:** Discrete information path.

**controller assembly:** Controller unit and auxiliary equipment housed in a rainproof cabinet to control a system's operations.

**controller unit:** Part of the controller assembly performing the basic timing and logic functions.

**detector:** Device indicating passage or presence of vehicles or pedestrians.

**electrolier:** Complete assembly of lighting standard and luminaire.

**flasher:** Device to open and close signal circuits at a repetitive rate.

**flashing beacon control assembly:** Switches, circuit breakers, terminal blocks, flasher, wiring, and necessary electrical components all housed in a single enclosure to properly operate a beacon.

**inductive loop detector:** Detector capable of being actuated by inductance change caused by vehicle passing or standing over the loop.

**lighting standard:** Pole and mast arm supporting the luminaire.

**luminaire:** Consists of housing, reflector, refractor or lens, lamp socket, integral ballast, terminal strip, and lamp.

**magnetic detector:** Detector capable of being actuated by induced voltage caused by vehicle passing through the earth's magnetic field.

**powder coating:** A coating applied electrostatically using UV-stable polyester triglycidyl isocyanurate exterior grade powder

**pre-timed controller assembly:** Operates traffic signals under a predetermined cycle length.

**signal face:** As defined in the California MUTCD.

**signal head:** As defined in the California MUTCD.

**signal indication:** As defined in the California MUTCD.

**signal section:** As defined in the California MUTCD.

**signal standard:** Pole and mast arm supporting one or more signal faces with or without a luminaire mast arm.

**traffic-actuated controller assembly:** Operates traffic signals under the varying demands of traffic as registered by detector actuation.

**traffic phase:** Signal phase as defined in the California MUTCD.

**vehicle:** As defined in the California Vehicle Code.

**86-1.02 REGULATIONS AND CODE**Electrical equipment must comply with one or more of the following:

1. EIA
2. ETL
3. NEMA
4. NETA
5. UL

Materials and workmanship must comply with:

1. ANSI
2. ASTM
3. 8 CA Code of Regs § 2299 et seq.
4. FCC
5. ITE
6. NEC
7. Public Utilities Commission, General Order No. 95, "Rules for Overhead Electrical Line Construction"
8. Public Utilities Commission, General Order No. 128, "Rules for Construction of Underground Electric Supply and Communication Systems"

## 86-1.03 COST BREAK-DOWN

Determine quantities required to complete work. Submit the quantities as part of the cost breakdown.

The sum of the amounts for the units of work listed in the cost breakdown must equal the contract lump sum price bid for the work. Include overhead and profit for each unit of work listed in the cost breakdown. If mobilization is a bid item, include bond premium, temporary construction facilities, and material plants into the mobilization bid item, otherwise, include in each unit of work listed in the cost breakdown. Do not include costs for traffic control system in the cost breakdown.

The cost breakdown may be used to determine partial payment and to calculate payment adjustments for additional costs incurred due to a change order. If a change order increases or decreases the quantities, payment adjustment may be determined under Section 4-1.03B, "Increased or Decreased Quantities."

The cost breakdown must include type, size, and installation method for:

1. Foundations
2. Standards and poles
3. Conduit
4. Pull boxes
5. Conductors
6. Service equipment enclosures
7. Telephone demarcation cabinet
8. Signal heads and hardware

9. Pedestrian signal heads and hardware
10. Pedestrian push buttons
11. Loop detectors
12. Luminaires and lighting fixtures

## 86-1.04 EQUIPMENT LIST AND DRAWINGS

Within 15 days of contract approval, submit for review a list of equipment and materials that you propose to install. Comply with Section 5-1.02, "Plans and Working Drawings." The list must include:

1. Name of manufacturer
2. Dimension
3. Item identification number
4. List of components

The list must be supplemented by other data as required, including:

1. Schematic wiring diagrams
2. Scale drawings of cabinets showing location and spacing of shelves, terminal blocks, and equipment, including dimensioning
3. Operation manual

Submit 2 copies of the above data. The Engineer will review within 15 days.

Electrical equipment that is manufactured as detailed on the plans will not require detailed drawings and diagrams.

Furnish 3 sets of computer-generated cabinet schematic wiring diagrams.

The cabinet schematic wiring diagram must be placed in a heavy duty plastic envelope and attached to the inside of the door of each cabinet.

Prepare diagrams, plans, and drawings using graphic symbols in IEEE 315, "Graphic Symbols for Electrical and Electronic Diagrams."

## 86-1.05 CERTIFICATE OF COMPLIANCE

Submit a Certificate of Compliance for all electrical material and equipment to the Engineer under Section 6-1.07, "Certificates of Compliance."

## 86-1.06 MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

Keep existing electrical system or approved temporary replacement in working order during the progress of the work. Shutdown is allowed for alteration or removal of the system. Traffic signal shutdown must be limited to normal working hours. Lighting system shutdown must not interfere with the regular lighting schedule.

Notify the Engineer before performing work on the existing system.

Notify the local traffic enforcement agency before traffic signal shutdown.

If existing or temporary system must be modified, work not shown on the plans or specified in the special provisions, but required to keep the system in working order will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

The State or local agency will:

1. Continue the operation and maintenance of existing electrical facilities
2. Continue to provide electrical energy to operate existing electrical facilities
3. Repair or replace existing facilities damaged by public traffic
4. Pay for electrical energy to operate existing or new facilities undergoing the functional tests described in Section 86-2.14C, "Functional Testing"

Verify location and depth of existing detectors, conduits, pull boxes, and other electrical facilities before using tools or equipment that may damage those facilities or interfere with an electrical system.

Notify the Engineer immediately if existing facility is damaged by your activities. Repair or replace damaged facility promptly. If you fail to complete the repair or replacement, promptly, the State will repair or replace and deduct the costs.

Damaged detectors must be replaced within 24 hours at your expense. If you fail to complete the repair within 24 hours, the State will repair and deduct the repair costs.

If roadway remains open to traffic while an existing lighting system is modified:

1. Keep existing system in working order
2. Make final connection so the modified circuit is in operation by nightfall

Keep temporary electrical installations in working order until no longer required. Remove temporary installations as specified in Section 86-7, "Removing, Reinstalling or Salvaging Electrical Equipment."

These provisions do not void your responsibilities as specified in Section 7-1.12, "Indemnification and Insurance," and Section 7-1.16, "Contractor's Responsibility for the Work and Materials."

During traffic signal system shutdown, place W3-1a, "STOP AHEAD," and R1-1, "STOP," signs in each direction to direct traffic through the intersection. For 2-lane approaches, place 2 R1-1 signs.

W3-1a and R1-1 signs must comply with Section 12-3.06, "Construction Area Signs." Use a minimum size of 30 inches for the R1-1 sign.

Cover signal faces when the system is shut down overnight. Cover temporary W3-1a and R1-1 signs when the system is turned on.

## 86-1.07 SCHEDULING OF WORK

Except service installation and service equipment enclosure, do not work above ground until all materials are on hand to complete electrical work at each location. Schedule work to allow each system to be completed and ready for operation before opening the corresponding section of the roadway to traffic.

If street lighting exists or is installed in conjunction with traffic signals, do not turn on the signals until the street lighting is energized.

Traffic signals will not be placed in operation until the roadways to be controlled are open to public traffic.

Lighting and traffic signals, including flashing operation, will not be placed in operation before starting the functional test period specified in Section 86-2.14, "Testing."

Do not pull conductors into conduit until:

1. Pull boxes are set to grade
2. Metallic conduit is bonded

In vehicular undercrossings, soffit lights must be in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures must be in operation before opening the structure to pedestrian traffic.

If the Engineer orders soffit lights or lighting for pedestrian structures to be activated before permanent power service is available, the cost of installing and removing temporary power service will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

The initial traffic signal turn-on must be made between 9:00 a.m. and 2:00 p.m. Before the initial turn-on, all equipment, including pedestrian signals, pedestrian push buttons, vehicle detectors, lighting, signs, and pavement delineation must be installed and in working order. Direct louvers, visors, and signal faces to maximize visibility.

Start functional tests on any working day except Friday or the day before a legal holiday. You must notify the Engineer 48 hours before the start of functional test.

### 86-1.08 (BLANK)

## 86-2 MATERIALS AND INSTALLATION

### 86-2.01 EXCAVATING AND BACKFILLING

Dispose of surplus excavated material under Section 7-1.13, "Disposal of Materials Outside the Highway Right of Way."

Backfill as specified in Section 19-3, "Structure Excavation and Backfill." Compact backfill in conduit trenches outside the hinge point of slopes and not under pavement to a minimum relative compaction of 90 percent. Compact backfill within hinge points and in areas where pavement is to be constructed to a minimum relative compaction of 95 percent.

Backfill trenches and restore sidewalk, pavement, and landscaping at one intersection before starting excavation at another intersection.

If excavating on a street or highway, restrict closure to 1 lane at a time.

### 86-2.02 REMOVING AND REPLACING IMPROVEMENTS

Replace or reconstruct sidewalk, curb, gutter, concrete pavement, asphalt concrete pavement, underlying material, lawn, plant, and other facilities damaged by your activities. Replacement material must be of equal or better quality than the material replaced. Work must be in a serviceable condition.

If a part of a square or slab of concrete sidewalk, curb, gutter, or driveway is broken or damaged, the entire square or slab must be removed and reconstructed.

Cut outline of PCC sidewalk or driveway to be removed:

1. Using a power-driven saw
2. On a neat line
3. To a 0.17-foot minimum depth

## 86-2.03 FOUNDATIONS

Except for concrete for cast-in-drilled-hole concrete pile foundation, PCC must comply with Section 90-10, "Minor Concrete."

Construct concrete foundation on firm ground.

After each post, standard, and pedestal is properly positioned, place mortar under the base plate. Finish exposed portion to present a neat appearance. Mortar must comply with Section 51-1.135, "Mortar," except mortar must have:

1. 1 part by volume of cementitious material
2. 3 parts by volume of clean sand

Reinforced cast-in-drilled-hole concrete pile foundation must comply with Section 49, "Piling," except:

1. Material resulting from drilling holes must be disposed of as specified in Section 86-2.01, "Excavating and Backfilling"
2. Concrete for cast-in-drilled-hole concrete pile will not be considered as designated by compressive strength

Form exposed portion of the foundation to present a neat appearance and true to line and grade. The top of a foundation for post and standard must be finished to curb or sidewalk grade. Forms must be rigid and securely braced in place. Conduit ends and anchor bolts must be placed at proper height and position. Anchor bolts must be installed a maximum of 1:40 from vertical and held in place by rigid top and bottom templates. Use a steel bottom template at least 1/2 inch thick that provides proper spacing and alignment of anchor bolts near the embedded bottom end. Install bottom template before placing footing concrete.

Provide new foundation and anchor bolts of the proper type and size for relocated standards.

Steel parts must be galvanized as specified in Section 75-1.05, "Galvanizing."

Provide 2 nuts and washers for the upper threaded part of each anchor bolt. Provide 3 nuts and washers for each anchor bar or stud.

Do not weld high-strength steel used for anchor bolt, anchor bar, or stud.

Before placing concrete, moisten forms and ground. Keep forms in place until the concrete sets for at least 24 hours and is strong enough to prevent damage to surface.

Except if located on a structure, construct foundation for post, standard, and pedestal monolithically.

Apply ordinary surface finish as specified in Section 51-1.18A, "Ordinary Surface Finish."

If a foundation must be extended for additional depth, the extension work will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

Do not erect post, pole, standard, pedestal, or cabinet until the foundation is set for a minimum of 7 days.

The Engineer will choose the plumbing or raking technique for posts, standards, and pedestals. Plumb or rake by adjusting the leveling nuts before tightening nuts. Do not use shims or similar devices. After final adjustments of both top nuts and leveling nuts on anchorage assemblies have been made, and each post, standard, and pedestal on structure is properly positioned, tighten nuts as follows:

1. Tighten leveling nuts and top nuts, following a crisscross pattern, until bearing surfaces of all nuts, washers, and base plates are in firm contact.
2. Use an indelible marker to mark the top nuts and base plate with lines showing relative alignment of the nut to the base plate.
3. Tighten top nuts, following a crisscross pattern, an additional 1/6th of a turn.

In unpaved areas, construct a raised PCC pad in front of each controller cabinet.

Completely remove foundations not to be reused or abandoned.

If abandoning a foundation, remove the top of foundation, anchor bolts, and conduits to a minimum depth of 0.5 foot below sidewalk surface or original ground. Backfill the resulting hole with material equivalent to the surrounding material.

## 86-2.04 STANDARDS, STEEL PEDESTALS AND POSTS

Bolts, including anchor bolts, nuts, and washers for signal and lighting support structures must comply with Section 55-2, "Materials." Except for bearing-type connection or slip-base, high-strength bolted connection must comply with Section 55-3.14, "Bolted Connections." Welding, nondestructive testing of welds, and acceptance and repair criteria for steel member nondestructive testing must comply with American Welding Society (AWS) D1.1.

Using stainless steel rivets, attach rectangular corrosion-resistant metal identification tag on all standards and poles, except Type 1:

1. Above the hand hole, near the base of standards and poles
2. On the underside of mast arms near the arm plate

The lettering on each identification tag must be depressed or raised, 1/4 inch tall, legible, and include the following information:

1. Name of the manufacturer
2. Date of manufacture
3. Identification number
4. Contract number
5. Unique identification code that is:

    5.1. Assigned by the manufacturer

5.2. Traceable to a particular contract and the welds on that component
5.3. Readable after the support structure is coated and installed

Type 1 standard and steel pedestal for controller cabinet must be manufactured of one of the following:

1. 0.12-inch or thicker galvanized steel
2. 4-inch standard weight galvanized steel pipe as specified in ASTM A 53
3. 4-inch Type 1 conduit with the top designed for post-top slip-fitter

Ferrous metal parts of a standard that has a shaft length of 15 feet or longer must comply with the provisions in Section 55-2, "Materials," and the following:

1. Standard must be manufactured from sheet steel of weldable grade having a minimum yield strength of 40,000 psi after manufacturing.
2. Certified test report verifying compliance with minimum yield strength requirements must be submitted. Test report may be the mill test report for the as-received steel or if the as-received steel has a lower yield strength than required you must provide test data assuring that your method of cold forming will consistently increase the tensile properties of the steel to meet the specified minimum yield strength. Test data must include tensile properties of the steel after cold forming for specific heats and thicknesses.
3. If a single-ply 5/16-inch thick pole is specified, a 2-ply pole with equivalent section modulus may be substituted.
4. Standard may be manufactured of full-length sheets or shorter sections. Each section must be manufactured from 1 or 2 pieces of sheet steel. If 2 pieces are used, the longitudinal welded seams must be directly opposite from one another. If the sections are butt-welded together, the longitudinal welded seams of adjacent sections must be placed to form continuous straight seams from base to top of standard.
5. Butt-welded circumferential joints of tubular sections requiring CJP groove welds must be made using a metal sleeve backing ring inside each joint. The sleeve must be 1/8 inch nominal thickness, or thicker, and manufactured from steel having the same chemical composition as the steel in the tubular sections to be joined. If the sections to be joined have different specified minimum yield strengths, the steel in the sleeve must have the same chemical composition as the tubular section having the higher minimum yield strength. The width of the metal sleeve must be consistent with the type of nondestructive testing selected and must be a minimum width of 1 inch. At fitting time, the sleeve must be centered at the joint and in contact with the tubular section at the point of the weld.
6. Welds must be continuous.
7. Weld metal at the transverse joint must extend to the sleeve, making the sleeve an integral part of the joint.
8. During manufacturing, longitudinal seams on vertical tubular members of cantilevered support structures must be centered on and along the side of the pole that the pole plate is located. Longitudinal seams on horizontal tubular members, including signal and luminaire arms, must be within ±45 degrees of the bottom of the arm.

9. Longitudinal seam weld in steel tubular section may be made by the electric resistance welding process.
10. Longitudinal seam weld must have 60 percent minimum penetration, except:

    10.1. Within 6 inches of circumferential weld, longitudinal seam weld must be CJP groove weld.
    10.2. Longitudinal seam weld on lighting support structure having telescopic pole segment splice must be CJP groove weld on the female end for a length on each end equal to the designated slip-fit splice length plus 6 inches.

11. Exposed circumferential weld, except fillet and fatigue-resistant weld, must be ground flush with the base metal before galvanizing or painting. Ground flush is specified as -0, +0.08-inch.
12. Circumferential weld and base plate-to-pole weld may be repaired only one time.
13. Exposed edges of the plates that make up the base assembly must be finished smooth and exposed corners of the plates must be broken. Provide shafts with slip-fitter shaft caps.
14. Surface flatness requirements of ASTM A 6 apply to plates:

    14.1. In contact with concrete, grout, or washers and leveling nuts
    14.2. In high-strength bolted connections
    14.3. In joints, where cap screws are used to secure luminaire and signal arms
    14.4. Used for breakaway slip-base assemblies

15. Standard must be straight with a maximum variation of:

    15.1. 1 inch measured at the midpoint of a 30-foot to 35-foot standard
    15.2. 3/4 inch measured at the midpoint of a 17-foot to 20-foot standard
    15.3. 1 inch measured 15 feet above the base plate for Type 35 and Type 36 standards

16. Zinc-coated nuts used on fastener assemblies having a specified preload obtained by specifying a prescribed tension, torque value, or degree of turn must be provided with a colored lubricant, clean and dry to the touch. The lubricant color must contrast the zinc coating color on the nut so the presence of the lubricant is visually obvious. Lubricant must be insoluble in water or the fastener components must be shipped to the job site in a sealed container.
17. Do not make additional holes in structural members.
18. Standard with an outside diameter of 12 inches or less must be round. Standard with an outside diameter greater than 12 inches must be round or multisided. Multisided standard must be convex with a minimum of 12 sides and have a minimum bend radius of 4 inches.
19. Manufacture mast arm from material specified for standard.
20. Manufacture cast steel option for slip base from material of Grade 70-40, as specified in ASTM A 27/A 27M. Other comparable material may be used if approved by the Engineer. The casting tolerances must comply with the Steel Founders' Society of America's recommendations for green sand molding.

21. One casting from each lot of a maximum of 50 castings must be radiographed as specified in ASTM E 94. Casting must comply with the acceptance criteria for severity level 3 or better for the types and categories of discontinuities in ASTM E 186 and E 446. If the casting fails the inspection, 2 additional castings must be radiographed. If the 2 additional castings fail the inspection, the entire lot will be rejected.
22. Material certification, consisting of physical and chemical properties, and radiographic film of the casting must be filed at the manufacturer's office. Certification and film must be available for inspection.
23. High-strength bolts, nuts, and flat washers used to connect slip-base plate must comply with ASTM A 325 or A 325M and be galvanized as specified in Section 75-1.05, "Galvanizing."
24. Plate washers must be manufactured by saw cutting and drilling steel plate. Steel plate must comply with AISI 1018 and be galvanized as specified in Section 75-1.05, "Galvanizing." Before galvanizing, remove burrs and sharp edges and chamfer both sides of holes to allow the bolt head to make full contact with the washer without tension.
25. High-strength cap screws for attaching arms to standards must comply with ASTM A 325, A 325M, or A 449, and the mechanical requirements in ASTM A 325 or A 325M after galvanizing. Cap screws must be galvanized as specified in Section 75-1.05, "Galvanizing." Coat threads of cap screws with a colored lubricant, clean and dry to the touch. Lubricant color must contrast the zinc-coating color on the cap screw so the presence of the lubricant is visually obvious. Lubricant must be insoluble in water or the fastener components must be shipped to the job site in a sealed container.
26. Bolted connection attaching signal or luminaire arm to pole must be considered slip critical. Galvanized faying surfaces of plates on luminaire, signal arm, and pole must be roughened by hand using a wire brush before assembly and must comply with requirements for Class C surface conditions for slip-critical connections in "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts," a specification approved by the Research Council on Structural Connections (RCSC). Paint for faying surfaces must be as specified in the RCSC specification for Class B coating.
27. The Engineer will randomly take samples of fastener components from each production lot and submit to the Transportation Laboratory with test reports as specified in ASTM fastener specifications for QA testing and evaluation. The Engineer will determine sample sizes for each fastener component.

Change in mast arm configuration is allowed as long as the mounting height and stability are maintained.

Before manufacturing, details must be adjusted to ensure that cap screw heads can be turned using conventional installation tools. During manufacturing process, to avoid interference with the cap screw heads, the position of the luminaire arm on the arm plate must be properly located.

Configure mast arm as a smooth curving arm.

Push button post, pedestrian barricade, and guard post must comply with ASTM A 53.

Assemble and tighten slip base when pole is on the ground. Threads of heavy hex nuts for each slip-base bolt must be coated with additional lubricant that is clean and dry to the touch. Tighten high strength slip-base bolts to within ±10 foot-pounds of the following:

**Slip-Base Bolt-Tightening Requirements**

| Standard Type | Torque (foot-pounds) |
|---|---|
| 15-SB | 150 |
| 30 | 150 |
| 31 | 200 |
| 36-20A | 165 |

Hole in shaft of existing standard, due to removal of equipment or mast arms, must be sealed by fastening a galvanized steel disk to cover the hole. Fasten using a single central galvanized steel fastener. Seal edges of disk and hole with polysulfide or polyurethane sealing compound of Type S, Grade NS, Class 25, and Use O, as specified in ASTM C 920.

If existing standard is ordered to be relocated or reused, remove large dents, straighten shafts, and replace parts that are in poor condition. You must furnish anchor bolts or bars and nuts required for relocating or reusing standard. Repair and replacement work will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

New nuts, bolts, cap screws, and washers must be provided if:

1. Standard or mast arm is relocated
2. Used standard or mast arm is State furnished

If the standard has a slip base, a new keeper plate must be provided.

## 86-2.05 CONDUIT

Run conductors in conduit except for overhead and where conductors are run inside poles.

You may use a larger size conduit than specified as long as you use it for the entire length between outlets. Do not use reducing coupling.

New conduit must not pass through existing foundations for standards.

### 86-2.05A Material

Conduit and conduit fitting must be UL or ETL listed and comply with the following:

**Conduit and Conduit Fitting Requirements**

| | |
|---|---|
| Type 1 | Hot-dip galvanized rigid steel conduit and conduit couplings must comply with UL 6 and ANSI C80.1. Zinc coating testing must comply with copper sulfate test requirements in UL 6. Conduit couplings for rigid steel conduit must be electrogalvanized. |
| Type 2 | Hot-dip galvanized rigid steel conduit must comply with requirements for Type 1conduit and be coated with polyvinyl chloride (PVC) or polyethylene. Exterior thermoplastic coating must have a minimum thickness of 35 mils. Internal coating must have a minimum thickness of 2 mils. Coated conduit must comply with UL 6; NEMA RN 1; or ETL PVC-001. |
| Type 3 | Rigid non-metallic conduit must comply with UL 651, UL 651A or UL 651B. Install at underground locations only. |
| Type 4 | Waterproof flexible metal conduit must consist of conduit with a waterproof non-metallic sunlight-resistant jacket over an inner flexible metal core. Type4 conduit must be UL listed for use as the grounding conductor. |
| Type 5 | Intermediate steel conduit and conduit couplings must comply with UL 1242 and ANSI C80.6. Zinc coating testing must comply with copper sulfate test requirements in UL 1242. Conduit couplings for intermediate rigid steel conduit must be electrogalvanized. Type 5 conduit must only be used if specified. |

Bonding bushings to be installed on metal conduit must be insulated and either galvanized or zinc alloy type.

Fittings for steel conduit and for watertight flexible metal conduit must be UL listed at UL 514B.

### 86-2.05B Use

Install Type 1 conduit on all exposed surfaces and at the following locations:

1. In concrete structures
2. Between a structure and nearest pull box

Exposed conduit installed on painted structure must be painted the same color as the structure.

Change or extend existing conduit runs using the same material. Install pull box if an underground conduit changes from the metallic type to Type 3.

Minimum trade size of conduit must be:

1. 1-1/2 inches from electrolier to adjacent pull box
2. 1 inch from pedestrian push button post to adjacent pull box
3. 2 inches from signal standard to adjacent pull box
4. 3 inches from controller cabinet to adjacent pull box
5. 2 inches from overhead sign to adjacent pull box
6. 1-1/2 inches if unspecified

Two conduits must be installed between controller cabinet and adjacent pull box.

### 86-2.05C Installation

Whether shop or field cut, ream ends of conduit to remove burrs and rough edges. Make cuts square and true. Slip joints and running threads are not allowed for coupling conduit. If a standard coupling cannot be used for coupling metal type conduit, use a threaded union coupling that is UL or ETL listed. Tighten couplings for metal conduit to maintain a good electrical connection through conduit run.

Cut Type 3 conduit with tools that will not deform the conduit. Use solvent weld for connections.

Cut Type 2 conduit with pipe cutters; do not use hacksaws. Coated conduit must be threaded with standard conduit-threading dies. Tighten conduit into couplings or fittings using strap wrenches or approved groove-joint pliers.

Protect shop-cut threads from corrosion as follows:

**Shop-Cut Thread Protection**

| | |
|---|---|
| Steel conduit and conduit couplings | ANSI C80.1 |
| Intermediate metal conduit and conduit couplings | ANSI C80.6 |

Paint conduits as specified in Section 91, "Paint." Apply 2 coats of approved unthinned zinc-rich primer of organic vehicle type. Do not use aerosol cans. Paint the following parts of conduits:

1. All exposed threads
2. Field-cut threads before installing conduit couplings to steel conduit
3. Damaged surfaces on metal conduit

Do not remove shop-installed conduit couplings.

Damaged Type 2 conduit or conduit coupling must be wrapped with at least 1 layer of 2 inch wide, 20 mil minimum thickness PVC tape, as specified in ASTM D 1000, with a minimum tape overlap of 1/2 inch. Before applying the tape, conduit or fitting must be cleaned and painted with 1 coat of rubber-resin based adhesive as recommended by the tape manufacturer. You may repair damaged spots in the thermoplastic coating by painting over with a brushing type compound supplied by the conduit manufacturer instead of the tape wrap.

The ends of Types 1, 2, or 5 conduit must be threaded and capped with standard pipe caps until wiring is started. The ends of Types 3 and 4 conduit must be capped until wiring is started. If caps are removed, replace with conduit bushings. Fit insulated bonding bushings on the end of metal conduit ending in pull box or foundation. Bell or end bushings for Type 3 conduit must be non-metallic type.

Conduit bends, except factory bends, must have a radius of not less than 6 times the inside diameter of the conduit. If factory bends are not used, bend the conduit without crimping or flattening using the longest radius practicable. Bend conduits as follows:

**Conduit-Bending Requirements**

| | |
|---|---|
| Type 1 | By methods recommended by the conduit manufacturer and with equipment approved for the purpose. |
| Type 2 | Use standard bending tool designed for use on thermoplastic coated conduit. Conduit must be free of burrs and pits. |
| Type 3 | By methods recommended by the conduit manufacturer and with equipment approved for the purpose. Do not expose conduit to direct flame. |
| Type 4 | -- |
| Type 5 | By methods recommended by the conduit manufacturer and with equipment approved for the purpose. |

Install pull tape in conduit that is to receive future conductors. The pull tape must be a flat woven lubricated soft-fiber polyester tape with a minimum tensile strength of 1,800 pounds and have printed sequential measurement markings every 3 feet. At least 2 feet of pull tape must be doubled back into the conduit at each end.

Existing underground conduit to be incorporated into a new system must be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air.

Install conduit to a depth of not less than 30 inches below finished grade, except in sidewalk and curbed paved median areas, where it must be at least 18 inches below grade. You may lay conduit on existing pavement within new curbed median.

Conduit coupling must be a minimum of 6 inches from face of foundation.

Place a minimum of 2 inches of sand bedding in the trench before installing Type 2 or Type 3 conduit. Place a minimum of 4 inches of same material over conduit before placing additional backfill material.

Obtain approval from the Engineer before disturbing pavement. If obstruction is encountered, obtain approval from Engineer to cut small holes in the pavement to locate or remove obstruction If jacking or drilling method is used, keep jacking or drilling pit 2 feet away from edge of pavement. Pavement must not be weakened or subgrade softened from excess water use.

Conduit used for drilling or jacking must be removed; install new conduit for completed work. If a hole larger than the conduit is pre-drilled and you install conduit by hand or by method recommended by the conduit manufacturer with equipment approved for purpose, you may install Type 2 or Type 3 conduit under pavement.

If trenching in pavement method is specified, conduit installation under pavement that is not a freeway lane or freeway to freeway connector ramp, must comply with the following:

1. Use Type 3 conduit. Place conduit under pavement in a trench approximately 2 inches wider than the outside diameter of conduit, but not exceeding 6 inches in width. Trench depth must not exceed the greater of 12 inches or conduit trade size plus 10 inches, except that at pull boxes the trench may be hand dug to required depth. The top of the installed conduit must be a minimum of 9 inches below finished grade.
2. Trenching installation must be completed before placing final pavement layer.
3. Cut pavement to be removed with a rock cutting excavator. Minimize shatter outside the removal area.
4. Place conduit in bottom of trench and backfill with minor concrete as specified in Section 90-10, "Minor Concrete.". Minor concrete must contain a minimum of 590 pounds of

cementitious material per cubic yard. If the trench is in asphalt concrete pavement and pavement overlay is not placed, backfill the top 1-3/4-inch of trench with minor HMA.

5. Before spreading HMA, apply tack coat as specified in Section 39, "Hot Mix Asphalt."
6. Backfill trenches, except for the top 0.10 foot, by the end of each day. The top 0.10 foot must be filled within 3 days after trenching.

Conduit installed beneath railroad tracks must be:

1. Type 1 or 2
2. 1-1/2-inch minimum diameter
3. Placed a minimum depth of 3 feet below bottom of tie

If jacking or drilling method is used, construct jacking pit to a minimum of 13 feet from the centerline of track at the near side of jacking pit. Cover jacking pit with substantial planking if left overnight.

Conduit ending in standard or pedestal must not extend more than 3 inches vertically above the foundation and must be sloped toward the handhole opening. Conduit entering through the side of non-metallic pull box must end inside the box within 2 inches of the wall and 2 inches above the bottom and be sloped toward the top of box to facilitate pulling of conductors. Conduit entering through the bottom of a pull box must end 2 inches above the bottom and be located near the end walls to leave the major portion of the box clear. At outlet, conduit must enter from the direction of the run.

Underground conduit runs, including under sidewalks, that are adjacent to gasoline service stations or other underground gasoline or diesel storage, piping, or pumps and that lead to a controller cabinet, circuit breaker panel, service, or enclosure where an arc may occur during normal operations must be sealed if the conduit is within the limits specified in the NEC for Class 1, Division 1. Use Type 1 or Type 2 conduit for these runs.

Conduit for future use in structures must be threaded and capped. Conduit leading to soffit, wall, or other lights or fixtures below pull box grade must be sealed and made watertight, except where conduit ends in a No. 9 or No. 9A pull box.

Support for conduit in or on wall or bridge superstructure must comply with the following:

1. Steel hangers, steel brackets, and other fittings must comply with Section 75-1.03, "Miscellaneous Bridge Metal."
2. Construct precast concrete conduit cradles using minor concrete and commercial quality welded wire fabric. Minor concrete must comply with Section 90-10, "Minor Concrete," and contain a minimum of 590 pounds of cementitious material per cubic yard.. The cradles must be moist cured for a minimum of 3 days. Bond precast concrete cradles to structure with epoxy adhesives specified in one of the following:

    2.1. Section 95-2.03, "Epoxy Resin Adhesive for Bonding New Concrete to Old Concrete"
    2.2. Section 95-2.04, "Rapid Set Epoxy Adhesive for Pavement Markers"
    2.3. Section 95-2.05, "Standard Set Epoxy Adhesive for Pavement Markers"

3. Use pipe sleeve or form opening for conduit through bridge superstructure concrete. Sleeve or opening through either prestressed member or conventionally reinforced precast member must be:

   3.1. Transverse to the member
   3.2. Through the web
   3.3. Not more than 3 inches maximum gross opening in concrete

4. Where conduits pass through the abutment concrete, wrap conduit with 2 layers of asphalt-felt building paper securely taped or wired in place. Fill space around conduit that runs through bridge abutment wall with mortar as specified in Section 51-1.135, "Mortar," except the proportion of cementitious material to sand must be 1 to 3. Fill the space around conduits that run through abutments after prestressing is completed.
5. Run surface-mounted conduit straight and true, horizontal or vertical on the wall, and parallel to wall on ceiling or other similar surfaces. Support conduit at a maximum of 5-foot intervals or closer where necessary to prevent vibration or unsightly deflection. The supports must include galvanized malleable iron conduit clamps and clamp backs secured with expansion anchorage devices as specified for concrete anchorage devices in Section 75-1.03, "Miscellaneous Bridge Metal." Threaded studs must be galvanized and be of the largest diameter that will pass through the mounting hole in conduit clamp.
6. Where pull boxes are placed in conduit runs, conduit must be fitted with threaded bushings and bonded.
7. Mark location of conduit end in structure, curb, or wall with a "Y" that is a minimum of 3 inches tall, directly above conduit.

### 86-2.05D Expansion Fittings

Install expansion fitting where the conduit crosses an expansion joint in structure. Each expansion fitting for metal conduit must include a copper bonding jumper having the ampacity specified in NEC.

Each expansion-deflection fitting for expansion joints of 1-1/2-inch movement rating must be watertight and include a molded neoprene sleeve, a bonding jumper, and 2 silicon bronze or zinc-plated iron hubs. Each fitting must allow a minimum of 3/4-inch expansion, contraction, and lateral deflection.

## 86-2.06 PULL BOXES

You may use a larger standard size pull box than that shown on the plans or specified. Pull box, cover, and extensions must be of the same material.

### 86-2.06A Materials

Pull box, cover, and extension for installation in ground or sidewalk area must be precast reinforced PCC or non-PCC material. Non-PCC material must:

1. Be fire resistant with a burn rate no greater than 0.3-inch per minute per 0.1 inch of thickness when tested as specified in ASTM D 635

2. Show no significant change in physical properties with exposure to weather
3. Be dense, free of voids or porosity, and gray or brown in color

Non-PCC pull box must comply with the following:

1. Top dimensions must not exceed the bottom dimensions by more than 1 inch.
2. Extension must be attached to pull box to maintain the minimum combined depths.
3. Cover must not fail and must not deflect more than 1/4 inch when a vertical force of 1,500 pounds is applied through a 1/2" x 3" x 6" steel plate to a non-PCC cover on a pull box. Center the steel plate on cover with its longitudinal axis coinciding with longitudinal axis of cover.

Non-PCC pull boxes must be of sufficient rigidity that when a designated concentrated force is applied perpendicularly to the midpoint of one of the long sides at the top while the opposite long side is supported by a rigid surface, it must be possible to remove the cover without the use of tools. The designated concentrated force must be 150 pounds for a No. 3-1/2 pull box and must be 100 pounds for a No. 5 or No. 6 pull box.

If a transformer or other device must be placed in a non-metallic pull box, include recesses for hanger.

Secure cover, except ceiling pull box cover, with 3/8-inch hold down bolts, cap screws, or studs, washers, and brass stainless steel or other non-corroding-metal nut. Stainless steel hardware must have an 18 percent or greater chromium content and an 8 percent or greater nickel content.

Galvanize ferrous metal parts as specified in Section 75-1.05, "Galvanizing."

Traffic pull box must be provided with steel cover and special concrete footing. Steel cover must have a embossed non-skid pattern.

Traffic pull box and cover must have a vertical proof-load strength of 25,000 pounds. Comply with Federal Specification RR-F-621 and distribute the 25,000 pound load through a 9" x 9" x 2" steel plate. You must be able to place the load anywhere on box and cover for 1 minute without causing cracks or permanent deformations.

No. 3-1/2(T) and No. 5(T) traffic pull box must be reinforced with a galvanized Z bar welded frame and cover similar to that shown on the plans for No. 6(T) pull box. Frame must be anchored to box with 1/4" x 2-1/4" concrete anchors. Four concrete anchors must be included for No. 3-1/2(T) pull box; one placed in each corner. Six concrete anchors for must be included for No. 5(T) and No. 6(T) pull boxes; one placed in each corner and one near the middle of each of the longer sides.

Hold down screws must be 3/8 inch hex flange cap screws of Type 316 stainless steel. Nut must be zinc plated carbon steel, vibration resistant, and have a wedge ramp at the root of the thread. Nut must be spot welded to the underside or manufactured with galvanized Z bar pull box frame.

Steel cover must be countersunk approximately 1/4 inch to accommodate bolt head. When tightened, bolt head must not exceed more than 1/8 inch above the top of cover. A 1/4 inch tapped hole and brass bonding screw must be included.

Concrete placed around and under traffic pull box must be minor concrete as specified in Section 90-10, "Minor Concrete."

### 86-2.06B Cover Marking

Marking must be clearly defined, uniform in depth, and parallel to either the long or short sides of cover.

Marking letters must be between 1 inch to 3 inch high.

Before galvanizing steel or cast iron cover, apply marking by one of the following methods:

1. Use cast iron strip at least 1/4-inch thick with letters raised a minimum of 1/16 inch. Fasten strip to cover with 1/4 inch flathead stainless steel machine bolts and nuts. Peen bolts after tightening.
2. Use sheet steel strip at least 0.027-inch thick with letters raised a minimum of 1/16 inch. Fasten strip to cover by spot welding, tack welding, or brazing, with 1/4 inch stainless steel rivets or 1/4 inch roundhead stainless steel machine bolts and nuts. Peen bolts after tightening.
3. Bead weld the letters on cover so that letters are raised a minimum of 3/32 inch.

### 86-2.06C Installation and Use

Space pull boxes no more than 200 feet apart. You may install additional pull boxes to facilitate the work.

Pull box in ground or sidewalk area must be installed as follows:

1. Embed bottom of pull box in crushed rock.
2. Place a layer of roofing paper on crushed rock.
3. Place mortar over layer of roofing paper. Mortar must be 0.50 inch to 1 inch thick and be sloped toward the drain hole.
4. Make a 1-inch drain hole in center of pull box through mortar and roofing paper.
5. Place mortar between pull box and pull box extension, and around conduits.

Reconstruct sump of existing pull box if disturbed by your operations. Remove old grout and replace with new if the sump was grouted.

After installation of traffic pull box, install steel cover and keep bolted down when your activities are not in progress at the pull box. When steel cover is placed for final time, cover and Z bar frame must be cleaned of debris and securely tightened.

## 86-2.07 (BLANK)

## 86-2.08 CONDUCTORS AND CABLES

Conductor must be copper wire that complies with ASTM B 3 and B 8.

Wire size must comply with the following:

**Wire Size Requirements**

| Conductor usage | Requirement |
|---|---|
| In loop detector lead-in cable | ASTM B 286 |
| Everywhere except in loop detector lead-in cable | American Wire Gage (AWG)[a] |

[a]Except conductor diameter must not be less than 98 percent of specified AWG diameter.

Single conductor and cable, except detector lead-in cable, must have clear, distinctive, and permanent markings on the outer surface throughout its length. The markings must include the manufacturer's name or trademark, insulation type letter designation, conductor size, voltage, and temperature rating, and for cables, it must also include number of conductors.

### 86-2.08A Conductor Identification

Conductor insulation must be a solid color with a permanent stripe as specified below. The solid color must be homogeneous through the full depth of insulation. Identification stripe must be continuous throughout the length of conductor. For conductor sizes No. 2 and larger, the insulation may be black and the ends of the conductors must be taped for a minimum length of 20 inches with electrical insulating tape of the required color.

**Conductor Identification**

| Circuit | Signal Phase or Function | Identification | | | Size |
|---|---|---|---|---|---|
| | | Insulation Color[j] | | | |
| | | Base | Stripe[a] | Band Symbols[f] | |
| Vehicle Signals[a,b,d] | 2,6 | Red, Yel, Brn | Blk | 2,6 | 14 |
| | 4,8 | Red, Yel, Brn | Ora | 4,8 | 14 |
| | 1,5 | Red, Yel, Brn | None | 1,5 | 14 |
| | 3,7 | Red, Yel, Brn | Pur | 3,7 | 14 |
| | Ramp Meter 1 | Red, Yel, Brn | None | NBR | 14 |
| | Ramp Meter 2 | Red, Yel, Brn | Blk | NBR | 14 |
| Pedestrian Signals[d] | 2p,6p | Red, Brn | Blk | 2p,6p | 14 |
| | 4p,8p | Red, Brn | Ora | 4p,8p | 14 |
| | 1p,5p | Red, Brn | None | 1p,5p | 14 |
| | 3p,7p | Red, Brn | Pur | 3p,7p | 14 |
| Pedestrian Push Buttons[d] | 2p,6p | Blu | Blk | P-2,P-6 | 14 |
| | 4p,8p | Blu | Ora | P-4,P-8 | 14 |
| | 1p,5p | Blu | None | P-1,P-5 | 14 |
| | 3p,7p | Blu | Pur | P-3,P-7 | 14 |
| Traffic Signal Controller Cabinet | Ungrounded Circuit Conductor | Blk | None | CON-1 | 6 |
| | Grounded Circuit Conductor | Wht | None | CON-2 | 6 |
| Highway Lighting Pull Box to Luminaire | Ungrounded-Line 1 | Blk | None | NBR | 14 |
| | Ungrounded-Line 2 | Red | None | NBR | 14 |
| | Grounded | Wht | None | NBR | 14 |
| Multiple Highway Lighting | Ungrounded-Line 1 | Blk | None | ML1 | 10 |
| | Ungrounded-Line 2 | Red | None | ML2 | 10 |
| Lighting Control | Ungrounded to PEU | Blk | None | C1 | 14 |
| | Switching leg from PEU unit or SM transformer | Red | None | C2 | 14 |
| Multiple Service | Ungrounded-Line 1 (Signals) | Blk | None | NBR[e] | 6 |
| | Ungrounded-Line 2 (Lighting) | Red[i] | None | NBR[e] | 8 |
| Sign Lighting[h] | Ungrounded-Line 1 | Blk | None | SL-1 | 10 |
| | Ungrounded-Line 2 | Red | None | SL-2 | 10 |
| Flashing Beacons[g] | Ungrounded between Flasher and Beacons | Red or Yel | None | F-Loc.[c] | 14 |
| Grounded and Common | Pedestrian Push Buttons | Wht | Blk | NBR | 14 |
| | Signals and Multiple Lighting | Wht | None | NBR | 10 |
| | Flashing Beacons and Sign Lighting | Wht | None | NBR | 12 |
| | Lighting Control | Wht | None | C-3 | 14 |
| | Multiple Service | Wht | None | NBR | 14 |
| Railroad Preemption | | Blk | None | R | 14 |
| Spares | | Blk | None | NBR | 14 |

NBR = No Band Required PEU=Photoelectric unit
[a]On overlaps, insulation is striped for 1st phase in designation. e.g., phase (2+3) conductor is striped as for phase 2.
[b]Band for overlap and special phases as required.
[c]Flashing beacons having separate service do not require banding.
[d]These requirements do not apply to signal cable.
[e]"S" if circuit is switched on line side of service equipment by utility.
[f]Band conductors in each pull box and near ends of termination points. On signal light circuits, a single band may be placed around 2 or 3 ungrounded conductors comprising a phase.
[g]Ungrounded conductors between service switch and flasher mechanism must be black and banded.
[h]Conductors between ballasts and sign lighting lamps must be No. 16 and color must correspond to the ballast leads.
[i]Black acceptable for size No. 2 and larger. Tape ends for 20 inches with indicated color.
[j]Color Code: Yel-Yellow, Brn-Brown, Blu-Blue, Blk-Black, Wht-White, Ora-Orange, Pur-Purple.

### 86-2.08B Multiple Circuit Conductors

Conductor for multiple circuit must be UL or ETL listed and rated for 600 V(ac) operation. Insulation for No. 14 to No. 4 conductors must be one of the following:

1. Type TW PVC as specified in ASTM D 2219
2. Type THW PVC
3. Type USE, RHH, or RHW cross-linked polyethylene

Minimum insulation thickness must comply with the following:

**Insulation Thickness**

| Insulation Type | Conductor Size | Insulation Thickness (mils) |
|---|---|---|
| USE, RHH, or RHW | No. 14 to No. 10 | 39 |
| | No. 8 to No. 2 | 51 |
| THW or TW | No. 14 to No. 10 | 27 |
| | No. 8 | 40 |
| | No. 6 to No. 2 | 54 |

Insulation for No. 2 and larger conductor must be one of the types listed above or Type THWN.

Conductor for wiring wall and soffit luminaire must be stranded copper with insulation rated for use at temperatures up to 125 °C.

### 86-2.08C Signal Cable

Signal cable, except for the 28-conductor type, must:

1. Not be spliced
2. Be marked in each pull box with the signal standard information it is connecting to

Signal cable must comply with the following:

1. Cable jacket must be:

   1.1. Black polyethylene with an inner polyester binder sheath
   1.2. Rated for 600 V(ac) and 75 °C

2. Filler material, if used, must be polyethylene material.
3. Conductor must be solid copper with Type THWN insulation as specified in Section 86-2.08, "Conductors and Cables," and ASTM B 286. The minimum thickness of Type THWN insulation must be 12 mils for conductor sizes No. 14 to No. 12 and 16 mils for conductor size No. 10. The minimum thickness of nylon jacket must be 4 mils.

**Conductor Signal Cable Requirements**

| Cable Type[a] | Conductor Quantity and Type | Cable Jacket Thickness (mils) | | Maximum Nominal Outside Diameter (inch) | Conductor Color Code | Remarks |
|---|---|---|---|---|---|---|
| | | Average | Minimum | | | |
| 3CSC | 3 - No. 14 | 44 | 36 | 0.40 | blue/black, blue/orange, white/black stripe | Use for pedestrian push buttons and spare |
| 5CSC | 5 - No. 14 | 44 | 36 | 0.50 | red, yellow, brown, black, white | |
| 9CSC | 8 - No. 14<br>1 - No. 12 | 60 | 48 | 0.65 | No. 12 - white<br>No. 14 - red, yellow, brown, black, and red/black, yellow/black, brown/black, white/black stripe | |
| 12CSC | 11 - No. 14<br>1 - No. 12 | 60 | 48 | 0.80 | No. 12 - white<br>No. 14 - see "12CSC Color Code and Functional Connection" table | Use for vehicle signals, pedestrian signals, spares, and signal common |
| 28CSC | 27 - No. 14<br>1 - No. 10 | 80 | 64 | 0.90 | No. 10 - white<br>No. 14 - see "28CSC Color Code and Functional Connection" table | Keep signal commons in each cable separate except at the signal controller. Label each cable as "C1" or "C2" in pull box. Use "C1" for signal phases 1, 2, 3, and 4. Use "C2" for phases 5, 6, 7, and 8. |

[a]Conductor signal cable description starts with the number of conductors, followed by "CSC".
(e.g., a signal cable with 3 conductors is labeled "3CSC.")

**12CSC Color Code and Functional Connection**

| Color Code | Termination | Phase |
|---|---|---|
| Red | Vehicle signal red | 2, 4, 6, or 8 |
| Yellow | Vehicle signal yellow | 2, 4, 6, or 8 |
| Brown | Vehicle signal green | 2, 4, 6, or 8 |
| Red/black stripe | Vehicle signal red | 1, 3, 5, or 7 |
| Yellow/black stripe | Vehicle signal yellow | 1, 3, 5, or 7 |
| Brown/black stripe | Vehicle signal green | 1, 3, 5, or 7 |
| Black/red stripe | Spare, or use as required for red or DONT WALK | |
| Black/white stripe | Spare, or use as required for yellow | |
| Black | Spare, or use as required for green or WALK | |
| Red/white stripe | Ped signal DONT WALK | |
| Brown/white stripe | Ped signal WALK | |

**28CSC Color Code and Functional Connection**

| Color Code | Termination | Phase |
|---|---|---|
| Red/black stripe | Vehicle signal red | 2 or 6 |
| Yellow/black stripe | Vehicle signal yellow | 2 or 6 |
| Brown/black stripe | Vehicle signal green | 2 or 6 |
| Red/orange stripe | Vehicle signal red | 4 or 8 |
| Yellow/orange stripe | Vehicle signal yellow | 4 or 8 |
| Brown/orange stripe | Vehicle signal green | 4 or 8 |
| Red/silver stripe | Vehicle signal red | 1 or 5 |
| Yellow/silver stripe | Vehicle signal yellow | 1 or 5 |
| Brown/silver stripe | Vehicle signal green | 1 or 5 |
| Red/purple stripe | Vehicle signal red | 3 or 7 |
| Yellow/purple stripe | Vehicle signal yellow | 3 or 7 |
| Brown/purple stripe | Vehicle signal green | 3 or 7 |
| Red/2 black stripes | Ped signal DONT WALK | 2 or 6 |
| Brown/2 black stripes | Ped signal WALK | 2 or 6 |
| Red/2 orange stripes | Ped signal DONT WALK | 4 or 8 |
| Brown/2 orange stripes | Ped signal WALK | 4 or 8 |
| Red/2 silver stripes | Overlap A, C red | OLA, OLC |
| Brown/2 silver stripes | Overlap A, C green | OLA, OLC |
| Red/2 purple stripes | Overlap B, D red | OLB, OLD |
| Brown/2 purple stripes | Overlap B, D green | OLB, OLD |
| Blue/black stripe | Ped push button | 2 or 6 |
| Blue/orange stripe | Ped push button | 4 or 8 |
| Blue/silver stripe | Overlap A, C yellow | OLA(y), OLC(y) |
| Blue/purple stripe | Overlap B, D yellow | OLB(y), OLD(y) |
| White/black stripe | Ped push button common | |
| Black/red stripe | Railroad preemption | |
| Black | Spare | |

## 86-2.08D Signal Interconnect Cable (SIC)

Signal interconnect cable must be a 3-pair or 6-pair type with stranded tinned copper No. 20 conductors. Each conductor insulation must be 13 mils minimum nominal thickness, color-coded, polypropylene material. Conductors must be in twisted pairs. Color coding distinguishes each pair. Each pair must be wrapped with an aluminum polyester shield and must have a No. 22 or larger stranded tinned copper drain wire inside the shielded pair.

Cable jacket must be black, high density polyethylene, rated for a minimum of 300 V(ac) and 60 °C, and must have a minimum nominal wall thickness of 40 mils. Cable jacket or moisture-resistant tape directly under the outer jacket must be marked as specified in Section 86-2.08.

You must have a minimum of 6 feet of slack at each controller cabinet. Splicing is allowed only if shown on the plans.

Insulate conductor splice with heat-shrink tubing and overlap at least 0.6 inch. Cover overall cable splice with heat-shrink tubing and overlap the cable jacket at least 1-1/2 inch.

## 86-2.09 WIRING

Run conductors in conduit, except for overhead and temporary installations and where conductors are run inside poles.

Solder by hot iron, pouring, or dipping method, connectors and terminal lugs for conductor sizes No. 8 and smaller. Do not perform open-flame soldering.

### 86-2.09A Circuitry

Do not run traffic signal indication conductors to a terminal block on a standard unless connected to a mounted signal head.

Use only 1 conductor to connect to each terminal of a pedestrian push button.

The common for pedestrian push button circuit must be separate from traffic signal circuit grounded conductor.

### 86-2.09B Installation

Use a UL- or ETL-listed inert lubricant for placing conductors in conduit.

Pull conductors into conduit by hand using pull tape specified in Section 86-2.05C, "Installation." Do not use winches or other power-actuated pulling equipment.

If adding new conductors or removing existing conductors, remove all conductors, clean conduit as specified in Section 86-2.05C, "Installation," and pull all conductors in conduit as 1 unit.

If traffic signal conductors are run in lighting standard containing street lighting conductors from a different service point, you must encase the traffic signal conductors or the lighting conductors with a flexible or rigid metal conduit for a length until the 2 types of conductors are no longer in the same raceway.

If less than 10 feet above grade, enclose temporary conductors in flexible or rigid metal conduit.

Leave slack for each conductor as follows:

**Conductor Slack Requirements**

| Location | Slack (feet) |
|---|---|
| Signal standard | 1 |
| Lighting standard | 1 |
| Signal and lighting standard | 1 |
| Pull box | 3 |
| Splice | 3 |
| Standards with slip base | 0 |

After conductors are installed, seal ends of conduits with an approved sealing compound.

To form a watertight seal, tape ends of spare conductors and conductors ending in pull boxes.

Conductors and cables inside fixture or cabinet must be neatly arranged and tied together by function with self-clinching nylon cable ties or enclosed in plastic tubing or raceway.

Identify conductors for:

1. Signal overlap phase as specified for vehicle signals in the table titled "Conductor Identification."
2. Metered and unmetered conductors occupying the same pull box. Identify unmetered circuit conductors with "UNMETERED-STREET LTG," or "UNMETERED-COUNT STATION."

Permanently identify conductors by function. Place identification on each conductor, or each group of conductors forming a signal phase, at each pull box and near the end of conductors.

Label, tag, or band conductors by mechanical methods. Identification must not move along the conductors.

### 86-2.09C Connectors and Terminals

Connectors and terminals must be UL- or ETL-listed crimp type. Use manufacturer-recommended tool for connectors and terminals to join conductors. Comply with MIL-T-7928.

Terminate stranded conductors smaller than No. 14 in crimp style terminal lugs.

### 86-2.09D Splicing and Terminations

Splices are allowed for:

1. Grounded conductors in pull box.
2. Pedestrian push button conductors in pull box.
3. Conductors in pull box adjacent to each electrolier or luminaire.
4. Ungrounded traffic signal conductors in pull box, if traffic signals are modified.
5. Ungrounded traffic signal conductors to a terminal compartment or signal head on a standard with conductors of the same phase in the pull box adjacent to the standard.

6. Ungrounded lighting circuit conductors in pull box, if lighting circuits are modified.

### 86-2.09E Splice Insulation

Splice must function under continuous submersion in water.

Multi-conductor cable must be spliced and insulated to form a watertight joint and to prevent moisture absorption by the cable.

Low-voltage tape must be:

1. UL or ETL listed
2. Self-fusing, oil and flame-resistant, synthetic rubber
3. PVC, pressure-sensitive adhesive of 6 mils minimum thickness

Insulating pad must be a combination of an 80-mils thick electrical grade PVC laminate and a 120-mils thick butyl splicing compound with removable liner.

Heat-shrink tubing must comply with the following:

1. Be medium or heavy wall thickness, irradiated polyolefin tubing with an adhesive mastic inner wall.
2. Before contraction, minimum wall thickness must be 40 mils.
3. Heating must be as recommended by the manufacturer. Do not perform open-flame heating.
4. When heated, the inner wall must melt and fill crevices and interstices of the covered object and the outer wall must shrink to form a waterproof insulation.
5. After contraction, each end of the heat-shrink tubing or the open end of end cap of heat-shrink tubing must overlap the conductor insulation at least 1-1/2 inches. Coat ends and seams with electrical insulation coating.
6. Comply with requirements for extruded insulated tubing at 600 V(ac) in UL Standard 468D and ANSI C119.1, and the following requirements:

**Heat-Shrink Tubing Requirements**

| | |
|---|---|
| Shrinkage Ratio | 33 percent, maximum, of supplied diameter when heated to 125 °C and allowed to cool to 25 °C |
| Dielectric Strength | 350 kV per inch, minimum |
| Resistivity | $25^{13}$ Ω per inch, minimum |
| Tensile Strength | 2,000 psi, minimum |
| Operating Temperature | -40 °C to 90 °C (135 °C in emergency) |
| Water Absorption | 0.5 percent, maximum |

7. If 3 or more conductors are to be enclosed in 1 splice, place mastic around each conductor before placing inside tubing. Use mastic type recommended by heat-shrink tubing manufacturer.

You may use "Method B" as an alternative method for splice insulation. Use at least 2 thicknesses of electrical insulating pad. Apply pad to splice as recommended by manufacturer.

## 86-2.095 FUSED SPLICE CONNECTORS

Install a fused disconnect splice connector in each ungrounded conductor, between the line and the ballast, in the pull box adjacent to each luminaire. Connector must be accessible in the pull box.

For 240 and 480 V(ac) circuits, each connector must simultaneously disconnect both ungrounded conductors. Connector must not have exposed metal parts, except for the head of stainless steel assembly screw. Recess head of stainless steel assembly screw a minimum of 1/32 inch below top of plastic boss that surrounds the head.

Splice connector must protect fuse from water or weather damage. Contact between fuse and fuseholder must be spring loaded. Splice connector terminals must be:

1. Rigidly crimped, using a tool recommended by manufacturer of fused splice connector, onto ungrounded conductors
2. Insulated
3. Watertight

Fuses must be standard midget ferrule type, with "Non-Time-Delay" feature, and 13/32" x 1-1/2".

## 86-2.10 BONDING AND GROUNDING

Secure all metallic components, mechanically and electrically, to form a continuous system that is effectively grounded.

Bonding jumper must be copper wire or copper braid of the same cross sectional area as a No. 8 or larger to match the load. Equipment grounding conductors must be color coded as specified in NEC or be bare.

Attach bonding jumper to standard as follows:

**Bonding Jumper Attachment**

| Standard type | Requirements |
|---|---|
| Standard with handhole and traffic pull box lid cover | Use UL-listed lug and 3/16-inch diameter or larger brass or bronze bolt. Run jumper to conduit or bonding wire in adjacent pull box. Grounding jumper must be visible after the standard is installed and mortar pad is placed on foundation. |
| Standard without handhole | Use UL-listed ground clamp on each anchor bolt. |
| Slip-base standard | Use UL-listed ground clamp on each anchor bolt or attach UL-listed lug to bottom slip-base plate with 3/16-inch diameter or larger brass or bronze bolt. |

Ground one side of secondary circuit of step-down transformer.

Ground metal conduit, service equipment, and grounded conductor at service point as specified by NEC and service utility, except grounding electrode conductor must be No. 6 or larger.

Equipment bonding and grounding conductors are required in conduit. Run a No. 8 minimum bare copper wire continuously in conduit system. The bonding wire must be sized as specified in the NEC.

Ground electrode must be:

1. 1 piece
2. 10-foot minimum length of one of the following:

    2.1. Galvanized steel rod or pipe not less than 3/4 inch in diameter
    2.2. Copper clad steel rod not less than 5/8 inch in diameter

3. Installed as specified in NEC
4. Bonded to service equipment using one of the following:

    4.1. Ground clamp
    4.2. Exothermic weld
    4.3. No. 6 or larger copper conductor

On wood pole, metallic equipment mounted less than 8 feet above ground surface must be grounded.

Bond metallic conduit in non-metallic pull box using bonding bushing or bonding jumper.

Bond metallic conduit in metal pull box using bonding bushings and bonding jumpers connected to bonding wire running in the conduit system.

## 86-2.11 SERVICE

Electrical service installation and materials must comply with service utility requirements.

If service equipment is to be installed on utility-owned pole, you must furnish and install conduit, conductors, and other necessary material to complete service installation. Service utility will decide riser and equipment position.

Install service equipment early on to allow service utility to schedule its work before project completion.

Furnish each service with a circuit breaker that simultaneously disconnects all ungrounded service entrance conductors.

Circuit breakers must:

1. Be quick-break on either automatic or manual operation.
2. Have operating mechanism that is enclosed and trip-free from operating handle on overload.
3. Be trip indicating.
4. Have frame size plainly marked.
5. Have trip rating clearly marked on operating handle.
6. Have overload tripping of breakers not influenced by ambient temperature range of -18 °C to 50 °C.
7. Be internal trip type.

8. Be UL or ETL listed and comply with UL 489 or equal.
9. Have minimum interrupting capacity of 10,000 A, rms, if used as service disconnect.

Service equipment enclosure must be a NEMA 3R enclosure with dead-front panel and a hasp with a 7/16-inch hole for a padlock. Enclosure must be field marked as specified in the NEC to warn qualified persons of potential electric arc flash hazards.

Service equipment enclosure, except Types II and III, must be galvanized or have a factory-applied rust-resistant prime coat and finish coat.

Types II and III service equipment enclosures must be manufactured from one of the following:

1. Galvanized sheet steel
2. Sheet steel plated with zinc or cadmium after manufacturing
3. Aluminum

Manufacture service equipment enclosure as specified in Section 86-3.04A, "Cabinet Construction." Overlapping exterior seams and doors must comply with requirements for NEMA 3R enclosures in the NEMA Enclosure Standards.

If an alternative design is proposed for Type II or III service equipment enclosure, submit plans and shop drawings to the Engineer for approval before manufacturing.

Except for falsework lighting and power for your activities, when you submit a written request, the Engineer will arrange:

1. With the service utility to complete service connections for permanent installations and the Department will pay all costs and fees required by the service utility. Submit request at least 15 days before service connections are required.
2. For furnishing electrical energy. Energy used before contract completion will be charged to you, except cost of energy used for public benefit as ordered by the Engineer will be paid by the Department or local authorities.

Full compensation for furnishing and installing State-owned or permanent service poles, service equipment, conduit, conductors, and pull boxes, including equipment, conduit, and conductors placed on utility-owned poles, is included in the contract item of electrical work involved and no additional compensation will be allowed therefor.

If the service point is indeterminate and is shown on the plans as "approximate location" or "service point not yet established," the labor and materials required for making the connection between the service point, when established, and the nearest pull box shown on the plans will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

## 86-2.12 WOOD POLES

Wood poles must comply with the following:

1. Class 5 or larger as specified in ANSI O 5.1

2. Less than 180-degree twist in grain over the full length
3. 4-inch or less sweep
4. Beveled top
5. Placed in ground at least 6 feet
6. Length must be:

    6.1. 25 feet for service pole
    6.2. 35 feet for other

After each pole is set in ground, backfill space around pole with selected earth or sand, free of rocks and other deleterious material, placed in 4-inch thick layers. Moisten each layer and thoroughly compact.

Manufacture mast arm from standard pipe, free from burrs. Each mast arm must have an insulated wire inlet and wood pole mounting brackets for mast arm and tie-rod cross arm. Manufacture tie rod from structural steel and pipe.

Mount mast arm for luminaire to provide a 34-foot mounting height for a 200 W high pressure sodium luminaire and 40-foot mounting height for 310 W high pressure sodium luminaire. Traffic signals and flashing beacons on mast arm must provide a minimum vertical clearance of 17 feet from bottom of equipment to pavement.

After manufacturing, pressure-treat pole as specified in Section 58, "Preservative Treatment of Lumber, Timber and Piling," and AWPA Use Category System: UC4B, Commodity Specification D.

If specified, treat pole with waterborne wood preservative.

## 86-2.13 LIGHTING AND SIGN ILLUMINATION CONTROL

Enclosure for the circuit breaker for lighting and sign illumination control must:

1. Be NEMA 3R
2. Be galvanized, cadmium plated, or powder-coated
3. Include dead front panel and a hasp with a 7/16 inch diameter hole for padlock

## 86-2.14 TESTING

### 86-2.14A Materials Testing

Deliver material and equipment to be tested to either the Transportation Laboratory or a testing location ordered by the Engineer.

Allow 30 days for acceptance testing from the time material or equipment is delivered to test site. You must pay for all shipping, handling, and related transportation costs associated with testing. If equipment is rejected, you must allow 30 days for retesting. Retesting period starts when corrected equipment is delivered to test site. You must pay for all retesting costs. Delays resulting from submittal of non-compliant materials do not relieve you from executing the contract within the allotted time.

If equipment submitted for testing does not comply with specifications, remove the equipment within 5 business days after notification that the equipment is rejected. If equipment is not removed within that period, it may be shipped to you at your expense.

When testing is complete, you will be notified. You must pick up the equipment at the test site and deliver it to the job site.

Testing and quality control procedures for all other traffic signal controller assemblies must comply with NEMA TS Standards for Traffic Control Systems.

### 86-2.14B Field Testing

Before starting functional testing, perform the following tests in the presence of the Engineer:

#### 86-2.14B(1) Continuity

Test each circuit for continuity.

#### 86-2.14B(2) Ground

Test each circuit for grounds.

#### 86-2.14B(3) Insulation Resistance

Perform insulation resistance test at 500 V(dc) on each circuit between the circuit and a ground. Insulation resistance must be 10 MΩ minimum on all circuits, except for inductive loop detector circuits that must have an insulation resistance value at least 100 MΩ.

### 86-2.14C Functional Testing

Test periods must comply with Section 86-1.07, "Scheduling of Work."

Acceptance of new or modified traffic signal will be made only after all traffic signal circuits have been thoroughly tested.

Perform functional test to show that each part of the system functions as specified.

Functional test for each new or modified system must include at least 5 business days of continuous, satisfactory operation. If unsatisfactory performance of the system occurs, the condition must be corrected and the system retested until the 5 business days of continuous, satisfactory operation is obtained.

Except for new or modified parts of existing lighting circuit and sign illumination system, the State or local agency will maintain the system during test period and pay the electrical energy cost. Except for electrical energy, you must pay the cost of necessary maintenance performed by the State or local agency on new circuits or on the portions of existing circuits modified under the contract.

Shutdown of electrical system caused by traffic from a power interruption or from unsatisfactory performance of State-furnished materials does not constitute discontinuity of the functional test.

## 86-2.15 GALVANIZING

Galvanize as specified in Section 75-1.05, "Galvanizing." Cabinet material may be galvanized before manufacturing as specified in ASTM A 653/653M, Coating Designation G 90.

Steel pipe standard and pipe mast arm must be hot-dip galvanized after manufacturing and must comply with Section 75-1.05, "Galvanizing." . Remove spikes from galvanized surfaces.

A minimum of 10 inches of upper end of anchor bolts, anchor bars or studs, and nuts and washers must be galvanized as specified in Section 75-1.05, "Galvanizing."

After galvanizing, bolt threads must accept galvanized standard nuts without requiring tools or causing removal of protective coatings.

Galvanizing existing materials in an electrical installation will not be required.

## 86-2.16 PAINTING

Paint electrical equipment and material as specified in Section 59, "Painting," and the following:

1. Use paint material specified in Section 91, "Paint."
2. Factory or shop cleaning methods for metals are acceptable if equal to the methods specified.
3. Instead of temperature and seasonal restrictions for painting as specified in Section 59, "Painting," paint may be applied to equipment and materials for electrical installations if ordered by the Engineer.
4. Ungalvanized ferrous surface to be painted must be cleaned before applying prime coat. Blast cleaning is not required.
5. If an approved prime coat is applied by manufacturer, and in good condition, the 1st primer application is not required.
6. Existing equipment to be painted in the field, including State-furnished equipment, must be washed with a stiff bristle brush using a solution of water containing 2 tablespoons of heavy duty detergent powder per gallon. After rinsing, surface must be wire-brushed with a coarse, cup-shaped, power-driven brush to remove badly bonded paint, rust, scale, corrosion, grease, or dirt. Dust or residue remaining after wire brushing must be removed before priming.
7. Do not paint galvanized metal guard post, galvanized equipment, State-furnished controller cabinet, and wood poles for traffic signal or flashing beacon.
8. New galvanized metal surface to be painted in the field must be cleaned as specified for existing equipment before applying the prime coat. Do not wire brush new galvanized surface.
9. After erection, examine exterior surface for damaged primer, clean, and spot coat with primer.
10. Paint Types II and III steel service equipment enclosures with a polymeric or an enamel coating system matching Color No. 14672, light green, of Federal Standard 595B. Coating must be commercially smooth and free of flow lines, paint washout, streaks, blisters, and other defects that would impair serviceability or detract from general appearance. Coating must comply with the following:

    10.1. Coating hardness - Finish must have pencil lead hardness of HB, minimum, using an Eagle Turquoise pencil.

10.2. Salt spray resistance - Undercutting coating system's film must not exceed 1/8-inch average, from lines scored diagonally and deep enough to expose the base metal, after 336 hours of exposure in a salt spray cabinet complying with ASTM B 117.
10.3. Adherence - Must not have coating loss when tested as specified in California Test 645. Perform testing by applying coating to 4" x 8" x 0.024" test specimens of the same material as the cabinet, using the same application method.

11. Finish interior of metal signal visor, louver, and front face of back plates with 2 applications of lusterless black exterior grade latex paint formulated for application to properly prepared metal surface. Good condition factory finish will be acceptable.
12. Finish metal signal section, signal head mounting, brackets and fittings, outside of visor, pedestrian push button housing, pedestrian signal section and visor, and back face of back plate with 2 applications of lusterless black or dark olive green exterior grade latex paint formulated for application to properly prepared metal surface. Match dark olive green color to Color Chip No. 68 filed at the Transportation Laboratory.
13. Prepare and finish conduit and conduit fitting above ground the same as adjacent standard or post.
14. Relocated, reset or modified equipment previously finished as specified in this section, except for previously-finished galvanized standard with traffic signal yellow enamel, must be given a spot finishing application on newly primed areas and 1 finishing application over the entire surface. If signal face or mounting brackets are required to be painted under this section, all signal faces and mounting brackets on the same mounting must be repainted.
15. Small rusted or repaired areas of relocated or reset galvanized equipment must be cleaned and painted as specified in Section 75-1.05, "Galvanizing," for repairing damaged galvanized surfaces.
16. Stencil equipment number neatly on the standard or adjacent structure. Obtain number from the Engineer.
17. Perform painting neatly. The Engineer reserves the right to require use of brushes if the work performed by paint spraying machine is unsatisfactory.

## 86-3 CONTROLLER ASSEMBLIES

### 86-3.01 CONTROLLER ASSEMBLIES

A controller assembly houses a complete mechanism for controlling the operation of traffic signals or other systems.

Model 170 and Model 2070, specified as a Model 170/2070 controller assembly, includes a Model 170, 170E or 2070 controller unit, a wired cabinet, and all auxiliary equipment required to control the system.

### 86-3.02 (BLANK)

### 86-3.03 (BLANK)

## 86-3.04 CONTROLLER CABINETS

Controller cabinets for controller assemblies other than Model 170/2070 must comply with the following:

### 86-3.04A Cabinet Construction

Cabinet must be rainproof and the top crowned 1/2 inch or slanted toward the back to prevent standing water.

Cabinet and door must be manufactured from one of the following:

1. 0.073-inch minimum thickness cold-rolled steel with continuously-welded exterior seams
2. 0.073-inch minimum thickness stainless steel with overlapping exterior seams complying with Type 4 enclosures of the NEMA Enclosure Standards
3. 0.125-inch minimum thickness aluminum with continuously-welded exterior seams

Exterior welds must be ground smooth and edges filed to a radius of at least 0.03 inch.

Cabinet manufactured from cold-rolled steel must comply with Section 86-2.16, "Painting," and the following:

1. Cabinet manufactured from cold-rolled steel must be finished with a polymeric or an enamel coating system conforming to Color No. 14672 of Federal Standard 595B.
2. Cabinet must not have coating loss when 2 test specimens, 4" x 8", of the same material and coating as the cabinet are tested. Two 9-inch-diagonal scratches exposing bare metal will be made on a specimen. Soak specimen in demineralized water for 192 hours. Tightly affix a 1-inch wide strip of masking tape to the surface and remove with one quick motion. Specimen showing evidence of blistering, softening, or peeling of paint or coating from the base metal will be rejected. Testing must comply with California Test 645, except passing 180 Degree Bend Test is not required.
3. Metal must be prepared by the 3-step, iron phosphate conversion coating bonderizing technique.
4. Inside walls, doors, and ceiling of the housing must be the same as the outside finish.

Cabinet manufactured from stainless steel must comply with the following:

1. Use annealed or quarter-hard stainless steel that complies with ASTM A 666 for Type 304, Grades A or B.
2. Use gas tungsten arc welding (GTAW) process with bare stainless steel welding electrodes. Electrodes must comply with AWS A5.9 for ER308 chromium-nickel bare arc welding electrodes.
3. Procedures, welder, and welding operator must comply with requirements and practices recommended in AWS C5.5.
4. Ground or brush exposed, exterior surfaces of stainless steel cabinet to a 25 to 50-microinch finish using iron-free abrasives or stainless steel brushes.

5. After grinding or brushing, cabinet must not show rust discoloration when:

    5.1. Exposed for 48 hours in a salt spray cabinet as specified in ASTM B 117
    5.2. Exposed 24 hours in a tap water spray cabinet with the water temperature between 38 °C and 45 °C

6. After the test, cabinet showing rust discoloration anywhere on its surface will be rejected. Rejected cabinets may be cleaned, passivated, and resubmitted for testing.

Cabinet manufactured from aluminum sheet must comply with ASTM B 209 or B 209M for 5052-H32 aluminum sheet, and the following:

1. Use gas metal arc welding (GMAW) process with bare aluminum welding electrodes. Electrodes must comply with AWS A5.10 for ER5356 aluminum alloy bare welding electrodes.
2. Procedures, welder, and welding operator for welding must comply with requirements in AWS B3.0, "Welding Procedure and Performance Qualification," and to practices recommended in AWS C5.6.
3. Surface finish of each aluminum cabinet must comply with MIL-A-8625 for a Type II, Class I coating, except anodic coating must have a minimum thickness of 0.0007 inch and a minimum coating weight of 0.001 ounce per square inch. The anodic coating must be sealed in a 5 percent aqueous solution of nickel acetate, pH 5.0 to 6.5, for 15 minutes at 97 °C. Before applying anodic coating, clean and etch cabinets using the steps below:

    3.1. Clean by immersing into inhibited alkaline cleaner, Oakite 61A, Diversey 909, or equal, 6 to 8 ounces per gallon at 71 °C for 5 minutes.
    3.2. Rinse in cold water.
    3.3. Etch in solution of 1-1/2 ounce of sodium fluoride and 4 to 6 ounces of sodium hydroxide per gallon of distilled water at 60 °C to 65 °C for 5 minutes.
    3.4. Rinse in cold water.
    3.5. Immerse in 50 percent by volume nitric acid solution at room temperature for 2 minutes.
    3.6. Rinse in cold water.

Cabinet must have:

1. Single front door with:

    1.1. 44-inch maximum door width.
    1.2. Lock, when closed and latched, that is locked.
    1.3. Police panel mounted on door, equipped with a keyed lock and 2 police keys. Each police key must have a shaft at least 1-3/4 inch in length.

2. Dust-tight gasketing on all door openings, permanently bonded to the metal. Mating surface of the gasketing must be covered with silicone lubricant to prevent sticking.
3. Handle that:

    3.1. Allows padlocking in closed position
    3.2. Has a minimum length of 7 inches
    3.3. Has a 5/8-inch, minimum, steel shank
    3.4. Is manufactured of cast aluminum, or zinc-plated or cadmium-plated steel

4. Cabinet door frame with:

    4.1. Latching mechanism that:

        4.1.1. Holds tension on and forms a firm seal between door gasketing and frame.
        4.1.2. Is a 3-point cabinet latch with nylon rollers that have a minimum diameter of 3/4 inch and equipped with ball bearings.
        4.1.3. Has a center catch and a pushrod made of zinc-plated or cadmium-plated steel. Pushrod must be at least 1/4" x 3/4" and turned edgewise at outer supports. Cadmium plating must comply with MIL-QQ-416. Zinc plating must comply with MIL-QQ-325.

    4.2. Hinging that:

        4.2.1. Has 3-bolt butt hinges, each having a stainless steel fixed pin. Hinges must be stainless steel or may be aluminum for aluminum cabinet.
        4.2.2. Is bolted or welded to the cabinet. Hinge pins and bolts must not be accessible when door is closed.
        4.2.3. Has a catch to hold the door open at 90 degrees and 180 degrees, ± 10 degrees, if a door is larger than 22 inches in width or 6 square feet in area. Catch must be at least 3/8-inch diameter, stainless steel plated rod capable of holding door open at 90 degrees in a 60 mph wind at an angle perpendicular to the plane of the door.

5. Lock that:

    5.1. Is solid brass, 6-pin tumbler, rim type
    5.2. Has rectangular, spring-loaded bolts
    5.3. Is left hand and rigidly mounted with stainless steel machine screws approximately 2 inches apart
    5.4. Extends 1/8 to 3/8 inch beyond the outside surface of door

6. 2 keys that are removable in the locked and unlocked positions.

Submit alternative design details for review and approval before manufacturing cabinet.

Use metal shelves or brackets that will support controller unit and auxiliary equipment.

Machine screws and bolts must not protrude outside the cabinet wall.

### 86-3.04B Cabinet Ventilation

Each controller cabinet must have:

1. 8 screened, 1/2-inch diameter or larger, raintight vent holes, in lower side or bottom of cabinet. You may use louvered vents with a permanent metal mesh or 4-ply woven polypropylene air filter held firmly in place, instead.
2. Electric fan with ball or roller bearings and capacity of at least 100 cubic feet per minute. Fan must be thermostatically controlled and manually adjustable to turn on between 32 °C and 65 °C with a differential of not more than 6 °C between automatic turn on and turn off. Fan circuit must be fused at 125 percent of ampacity of installed fan motor.

Fan and cabinet vent holes must be positioned to direct bulk of airflow over controller unit or through ventilating holes of controller unit.

### 86-3.04C Cabinet Wiring

Conductors used in controller cabinet wiring must:

1. Be neatly arranged and laced, or enclosed in plastic tubing or raceway.
2. End with properly sized captive or spring-spade terminal or be soldered to a through-panel solder lug on the back side of the terminal block. Apply crimp-style connector with proper tool to prevent opening of handle until crimp is completed.

Controller cabinet must have an equipment grounding conductor bus that is grounded to the cabinet and connected to metal conduit system or other approved ground with a No. 8, or larger, grounding conductor.

With all cabinet equipment in place and connected, resistance between grounded conductor terminal bus and equipment grounding conductor bus must be 50 MΩ, minimum, when measured with an applied voltage of 150 V(dc).

If direct current is to be grounded, connect to equipment ground only.

Use two or more terminal blocks for field connection. Install field terminal within 22 inches from front of cabinet and orient for screwdriver operation. Terminal must be a minimum of 5 inches above foundation.

No more than 3 conductors per terminal are allowed. Two flat metal jumpers, straight or U shaped, may be placed under terminal screw. At least 2 full threads of terminal screws must be fully engaged when screw is tightened. Live parts must not extend beyond the barrier.

## 86-3.05 CABINET ACCESSORIES

### 86-3.05A Labels

Include permanently printed, engraved, or silk-screened label for equipment and removable items of equipment.

Labeling must match cabinet wiring diagram. Label for shelf-mounted equipment must be on shelf face below item. Label for wall-mounted equipment must be below item.

### 86-3.05B Convenience Receptacle

Mount convenience receptacle in a readily accessible location inside the cabinet.

Convenience receptacle must be a duplex, 3-prong, NEMA 5-15R grounding type outlet that complies with UL Standard 943.

### 86-3.05C Surge Arrestor

Surge arrestor must reduce effects of power line voltage transients and have ratings as follows:

**Surge Arrestor Requirements**

| | |
|---|---|
| Recurrent peak voltage | 184 V(ac) |
| Energy rating, maximum | 20 J |
| Power dissipation, average | 0.85 W |
| Peak current for pulses less than 7 µs | 1,250 A |

Standby current must be 1 mA or less for 120 V(ac), 60 Hz sinusoidal input.

### 86-3.05D Terminal Blocks

Terminal block must be rated 600 V(ac), minimum, and have nickel-, silver-, or cadmium-plated brass binder head screw terminal.

Heavy duty terminal block must be rated at 20 A and have 12 position with No. 10 x 5/16-inch nickel-plated brass binder head screws and nickel-plated brass inserts. Each position must have 2 screw-type terminals. Terminal block must be barrier type with shorting bars in each of the 12 positions, and must have integral type marking strips.

Light duty terminal block must be rated at 5 A and have 12 positions with No. 6 x 1/8 inch binder head screws. Each position must have 1 screw-type terminal.

## 86-3.06 COMPONENTS

### 86-3.06A Toggle Switches

Toggle switch must

1. Have poles as required
2. Be rated at 200 percent of circuit current for circuits of 10 A or less and 125 percent of circuit current for circuits over 10 A

### 86-3.06B Cartridge Fuses

Install cartridge fuse in panel-mounted fuseholder. Fuse type and rating must be as recommended by the fuse manufacturer for protecting the load.

### 86-3.06C Circuit Breakers

Circuit breaker must comply with Section 86-2.11, "Service," except breaker must have a minimum interrupting capacity of 5,000 A, rms.

### 86-3.06D Connectors

Use connector designed to interconnect various parts of circuit together and constructed for the application involved. Design connector for positive connection of circuit and easy insertion and removal of mating contacts. Connector must be permanently keyed to prevent improper connection of circuit.

Connector, or device plugging into connector, must have positive connection to prevent a circuit from breaking due to vibration, a pull on connecting cable, or similar disruptive force.

## 86-3.07 ACCESSORIES

Accessories must comply with the following:

### 86-3.07A Telephone Bridge

Telephone bridge must comply with the following:

#### 86-3.07A(1) General Description

Dual 5-way active data bridge must include:

1. 4-wire transmission interconnection between a dedicated common port and 4 multiple ports. Ports must be characterized by a balanced 600 Ω terminating impedance. The module's active circuit must allow unused multiple ports to be left unterminated without affecting the transmission response of ports in use.
2. Splitter channel and combiner channel. Connect multiple inputs to a common output in combiner channel. Connect common input to multiple outputs in splitter channel. Splitter and combiner must be separate and independent, allowing operation in full-duplex data transmission applications. Input, output, and line monitor jacks on front panel of bridge must allow isolated-module, isolated-facility, and cross-bridge measurement of transmission parameters in both, splitter and combiner channels.
3. Front-panel-accessible potentiometers with continuous adjustment of cross-bridge loss or gain within -30 to -10 dB and -10 to +10 dB ranges. Select either range for each channel. Adjusted level must be same for all cross-bridge port combinations so if the splitter-channel potentiometer is set for +3 dB gain, all common-to-multiple-port paths in the splitter channel must receive a +3 dB level increase.
4. Input voltage of -22 to -56 V(dc) at a maximum current of 60 mA.

Individually package each dual 5-way active bridge unit in housing. Circuitry must be solid state, constructed on removable industry standard circuit boards with plug in edge connectors. Test jack, edge connector, and external plug connector must be made of material suitable for use in above stated environment without deterioration of electrical connection for useful life of equipment. Physical size of case must not exceed 225 cubic inches and must be suitable for mounting to frame of field cabinet. Use mounting holes to attach unit to one side of frame of relay rack.

Include input and output ports for 5 full duplex telephone circuits with input and output ports labeled as to function. Level control, or switches and level adjustment potentiometers, and input and output level test jacks must provide external adjustments without removal of the housing.

### 86-3.07A(2) Application

Use dual 5-way active data bridge to interconnect 4-wire data modems to a common data channel or link. At the distant end, terminate common data link into a computer that may time sequentially poll outlying or remote data terminals. Use bridge for central transmission arrangement, or "hubbing" network, to extend data transmission to outlying terminals.

To expand number of multiple ports of a 4-wire data hubbing network in a tandem bridge arrangement, directly connect 1 multiple port in each channel of 1st bridge to common port of the same channel of 2nd bridge to get a 4-wire data bridge with 1 common and 7 multiple ports.

### 86-3.07A(3) Circuit Description

Combiner channel of dual 5-way active data bridge must have a variable-gain-integrated-circuit operational amplifier with an input summing circuit. Summing circuit must add transmission energy from all multiple input ports at low-impedance summing point for input port isolation. Connect amplifier output to transformer for balanced connection to facility.

Splitter channel must include a transformer-input, variable-gain, integrated-circuit operational amplifier and power amplifier. Power transformer output must be very low impedance and drive eight 300 Ω resistors to derive proper impedance at multiple output circuits and provide isolation between output circuits.

Multiple ports in bridge splitter and combiner channels must be isolated, and balanced by output transformer and matched precision resistors in each channel.

### 86-3.07A(4) Electrical Requirements

Comply with following electrical requirements:

**Electrical Requirements**

| Specification | Requirement |
|---|---|
| Splitter channel loss or gain | -30 to +10 dB usable range |
| Combiner channel loss or gain | -30 to +10 dB usable range |
| Maximum output level (overload point) | Splitter: +5 dBm<br>Combiner: +12 dBm |
| Level change with loading | 1 dB max, 1 port to all ports loaded |
| Input port impedance | Splitter (multiple ports): 600 Ω balanced<br>Combiner (common port): 600 Ω balanced |
| Output port impedance | Splitter (multiple ports): 600 Ω balanced<br>Combiner (common port): 600 Ω balanced |
| Harmonic distortion | Splitter: less than 1percent at +3 dBm<br>Combiner: less than 1 percent at +8 dBm |
| Noise | 20 dBm max |
| Frequency response | ±1 dB re 1,000 Hz level, 300 to 5,000 Hz |
| Delay distortion | Less than 75 µs, 400 to 3,000 Hz |
| Cross-port coupling loss (crosstalk) | Greater than 55 dB |
| Input power | -22 to -56 V(dc), 60 mA max |
| Operating environment | -7 °C to 54 °C, humidity to 95% (no condensation) |
| Mounting | 1 position |

### 86-3.07A(5) Testing and Troubleshooting

You must have complete testing and troubleshooting instructions, circuit diagrams and pictorial component location, and identification guides for each unit.

## 86-4 TRAFFIC SIGNAL FACES AND FITTINGS

## 86-4.01 VEHICLE SIGNAL FACES

Each vehicle signal face must:

1. Be adjustable and allow for 360-degree rotation about vertical axis
2. Comply with ITE publication ST-017B, "Vehicle Traffic Control Signal Heads"
3. Comply with California Test 604, except for arrow and "X" faces
4. Have 3 sections arranged vertically: red at top, yellow at center, and green at bottom
5. Be of the same manufacturer and material, if more than 1 is installed at an intersection, except for programmed visibility type
6. Be sealed with neoprene gasket at top opening
7. Be LED modules

### 86-4.01A Signal Sections

Each signal section must comply with the following:

1. Maximum height must be 10-1/4 inches for an 8-inch section and 14-3/4 inches for a 12-inch section.
2. Housing must:

    2.1. Be either die-cast or permanent mold-cast aluminum, or if specified, be structural plastic.
    2.2. Comply with ITE publication ST-017B if die-cast or permanent mold-cast aluminum is used.
    2.3. Have a 1-piece, hinged, square-shaped door designed to allow access for relamping without the use of tools. Door must be secured to hold the door closed during loading tests. Module or lens must be watertight and mounted in the door.

3. Hinge pins, door latching devices, and other exposed hardware must be Type 304 or 305 stainless steel. Interior screws and fittings must be stainless steel, or steel with a corrosion resistant plating or coating.
4. Opening must be placed on top and bottom to receive 1-1/2-inch pipe. The 8-inch and 12-inch sections of an individual manufacturer must be capable of joining to form a signal face in any combination. This interchangeability is not required between metal and plastic sections.
5. Gaskets must be made of a material that is not affected if installed in a section with metal or plastic housing that is continuously operated for 336 hours.

Structural failure is described as follows:

**Signal Section Structural Failure**

| Signal Section Type | Requirements | Description of Structural Failure |
|---|---|---|
| Metal | California Test 666 | Fracture within housing assembly or deflection of more than half the lens diameter of signal section during wind load test |
| Plastic | California Test 605 | Fracture within housing assembly or deflection of more than 10 degrees in either the vertical or horizontal plane after wind load has been removed from front of signal face, or deflection of more than 6 degrees in either the vertical or horizontal plane after wind load has been removed from back of signal face |

### 86-4.01A(1) Metal Signal Sections

Each metal signal section must have a metal visor. Metal signal faces requiring backplates must have metal backplates.

### 86-4.01A(2) Plastic Signal Sections

Housing must be molded in 1 piece, or fabricated from 2 or more pieces and joined into a single piece. Plastic must have ultraviolet stability, be unaffected by lamp heat, and be self-extinguishing. Housing and door must be colored throughout and be black, matching Color No. 17038, 27038, or 37038 of Federal Standard 595B.

Each face section must be joined to adjacent section by one of the following:

1. Minimum of 3 machine screws for 8-inch sections and 4 machine screws for 12-inch sections, installed through holes near front and back of housing. Each screw must be a No. 10 and have a nut, flat washer, and lock washer.
2. Two machine screws, each with a nut, flat washer, and lock washer, installed through holes near the front of the housing, and a fastening through the 1-1/2-inch pipe opening. Fastening must have 2 large flat washers to distribute the load around the pipe opening and 3 carriage bolts, each with a nut and lock washer. Minimum screw size must be No. 10. Minimum carriage bolt size must be 1/4 inch.

Supporting section of each signal face supported only at top or bottom must have reinforcement.

Reinforcement plate must be either sheet aluminum, galvanized steel, or cast aluminum. Each plate must be a minimum of 0.11-inch thick and have a hole concentric with 1-1/2-inch pipe-mounting hole in the housing. Place reinforcement plate as follows:

**Reinforcement Plate Placement**

| Type of Reinforcement Plate | Placement |
|---|---|
| Sheet aluminum | Inside and outside of housing |
| Galvanized steel | Inside of housing |
| Cast aluminum | Outside of housing |

Reinforcement plates placed outside of the housing must be finished to match signal housing color and be designed to allow proper serrated coupling between signal face and mounting hardware. Minimum of 3 No. 10 machine screws must be installed through holes in each plate and matching holes in the housing. Each screw must have a round or binder head, a nut, and lock washer.

If signal face is supported by a Type MAS side attachment slip-fitter inserted between 2 sections, place spacers between the 2 sections. Vertical dimension of spacers must allow proper seating of serrations between the slip-fitter and the 2 sections. In addition to the fastening through the large openings in housing, the 2 sections must join with at least 2 machine screws through holes near the front of housing and the spacers, and through matching holes in a reinforcing plate installed in housing. Machine screws must be No. 10 minimum size. Spacers must be made of same material as signal housing.

If reinforcing webs are used to connect back of housing to top, bottom, and sides, reinforcing plates are not required.

Holes for machine screws must be either cast or drilled during signal section manufacturing. Surround each hole with a 1/8-inch minimum width boss to allow contact between signal sections about axis of hole.

Each plastic signal section must have a plastic or metal visor. Plastic signal faces requiring backplates must have plastic backplates.

Serrated nylon washer must be inserted between each plastic signal section and metal mounting assembly. Each washer must be between 3/16- and 1/4-inch thick. Serrations must match those on signal section and mounting assembly.

### 86-4.01B Visors

Include removable visor with each signal section. Comply with ITE publication ST-017B. Visors are classified by lens enclosure as full circle, tunnel or cap. Bottom opens for tunnel type and both, bottom and lower sides open for cap type. Visors must be tunnel type.

Visor must have a downward tilt between 3 and 7 degrees with a length of:

1. 9-1/2-inch minimum for nominal 12-inch round lenses
2. 7 inch for nominal 8-inch round lenses

Metal visor must be formed from 0.050-inch, minimum thickness, aluminum alloy sheet.

Plastic visor must be either formed from sheet plastic or assembled from one or more injection, rotational, or blow-molded plastic sections. Material must be of a black homogeneous color with lusterless finish. Sections must be joined using thermal, chemical, or ultrasonic bonding, or with aluminum rivets and washers permanently colored to match visor.

Secure each visor to its door and prevent removal or permanent deformation when wind load specified in California Test 605 for plastic visors or 666 for metal visors is applied to its side for 24 hours.

If directional louvers are used, fit louvers snuggly into full-circular signal visors. Outside cylinder must be constructed of 0.030-inch nominal thickness, or thicker, sheet steel and vanes must be constructed of 0.016-inch nominal thickness, or thicker, sheet steel, or the cylinder and vanes must be constructed of 5052-H32 aluminum alloy of equal thickness.

## 86-4.02 (BLANK)

## 86-4.03 (BLANK)

## 86-4.04 BACKPLATES

Background light must not be visible between backplate and signal face or between sections.

Plastic backplates must be either formed from sheet plastic or assembled from extruded, molded, or cast sections. Sections must be factory joined using one of the following:

1. Appropriate solvent cement
2. Aluminum rivets and washers painted or permanently colored to match backplate
3. No. 10 machine screws with washers, lock washers, and nuts, painted to match backplate

Backplate material must be of black homogeneous color with a lusterless finish. Secure each plastic backplate to the plastic signal face in a manner that prevents its removal or permanent deformation when the wind-load test is applied to either the front or back of signal face. Permanent deformation of any portion of backplate must not exceed 5 degrees forward or backward after wind loading is applied for 24 hours.

If plastic backplate requires field assembly, join with at least 4 No. 10 machine screws at each field-assembled joint. Each machine screw must have an integral or captive flat washer, a hexagonal head

slotted for a standard screwdriver, and either a locking nut or a nut and lockwasher. Machine screws, nuts, and washers must be stainless steel or steel with a zinc or black-oxide finish.

If a metal backplate has 2 or more sections, fasten sections with rivets or aluminum bolts peened after assembly to avoid loosening.

Instead of the screws shown on the plans, you may use self-threading No. 10 steel screws to fasten plastic backplates to plastic signal face. Each screw must have an integral or captive flat washer, a hexagonal head slotted for a standard screwdriver, and is stainless steel or steel with a zinc or black-oxide finish.

## 86-4.05 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES

Programmed visibility signal face and its installation must comply with Section 86-4.01, "Vehicle Signal Faces," Section 86-4.04, "Backplates," and Section 86-4.08, "Signal Mounting Assemblies."

Each programmed visibility signal section must:

1. Have a nominal 12-inch diameter circular or arrow indication
2. Comply with ITE publication ST-017B for color and arrow configuration
3. Have a cap visor
4. Have an adjustable connection that provides incremental tilting from 0 to 10 degrees above or below horizontal while maintaining a common vertical axis through couplers and mountings

Terminal connection must allow external adjustment about the mounting axis in 5-degree increments.

Signal must be mountable with ordinary tools and capable of servicing without tools. Preset adjustment at 4 degrees below horizontal.

Visibility of each programmed visibility signal face must be capable of adjustment or programming, within the face. When programmed, each signal face's indication must be visible only in those areas or lanes to be controlled, except that during dusk and darkness a faint glow to each side is allowed.

You must program the head as recommended by the manufacturer.

## 86-4.06 PEDESTRIAN SIGNAL FACES

Message symbols for pedestrian signal faces must be white "WALKING PERSON" and Portland orange "UPRAISED HAND." Comply with ITE Standards: "Pedestrian Traffic Control Signal Indications" and California MUTCD. Each symbol's height must be at least 10 inches and width must be at least 6-1/2 inches.

Luminance of "UPRAISED HAND" symbol must be 1,100 foot-lamberts, minimum, and luminance of "WALKING PERSON" symbol must be 1,550 foot-lamberts, minimum, when tested as specified in California Test 606.

Uniformity ratio of an illuminated symbol must not exceed 4 to 1 between the highest luminance area and the lowest luminance area.

Luminance difference between a nonilluminated symbol and the background around the symbol must be less than 30 percent when viewed with the visor and front screen in place and at a low sun angle.

Each housing, including front screen, must have maximum overall dimensions of 18-1/2-inch width, 19-inch height, and 11-1/2-inch depth.

All new pedestrian signal faces installed at an intersection must be the same make and type.

### 86-4.06A Type A

Each Type A pedestrian signal face must include a housing, 1 LED pedestrian signal combo module and a front screen.

### 86-4.06B Front Screen

Front screen installation for each Type A signal must comply with one of the following:

1. Install, tilting downward, at an angle of 15±2 degrees out from the top, an aluminum honeycomb screen with 0.2-inch cells, 3/8-inch thick, or a plastic screen of 3/8-inch squares, 1/2-inch thick with wall thickness of 1/16-inch. Completely cover message plate. Include a clear front cover of 1/8-inch minimum thickness acrylic plastic sheet or 1/16-inch minimum thickness polycarbonate plastic. Hold screen and cover firmly in place with stainless steel or aluminum clips or stainless steel metal screws.
2. Install a 1-1/2-inch deep eggcrate or Z crate type screen of 1/32-inch nominal thickness polycarbonate. Mount screening in a frame constructed of 0.040-inch minimum thickness aluminum alloy or polycarbonate. Install screen parallel to face of message plate and hold in place with stainless steel screws. Visor as specified in Section 86-4.06D, "Visors," is not required.

The Department will test screens in a horizontal position with its edges supported. When a 3-inch diameter, 4-pound steel ball is dropped on the screen from a height of 4 feet above, the front screen must not fracture, separate at the welds, or compress more than 1/8-inch. When pedestrian housing is used to support front screen during test, remove message plate from pedestrian signal housing, so there is no back support for the screen.

Screen and frame must be one of the following:

1. Manufactured from aluminum anodized flat black
2. Finished with lusterless black exterior grade latex paint formulated for application to properly prepared metal surfaces
3. Manufactured from flat black plastic

### 86-4.06C Housing

Pedestrian signal housing must comply with Section 86-4.01A, "Signal Sections."

### 86-4.06D Visors

Use material similar to housing. Extend top of visor a minimum length of 6 inches at top and 5 inches at bottom when measured from front surface of line. Front must be normal to top.

### 86-4.06E Finish

Paint exterior of each housing and visor, and interior of visor as specified in Section 86-2.16, "Painting."

### 86-4.06F Control

Pedestrian signals must be controllable by solid-state switching devices specified for traffic signal controller assemblies.

### 86-4.06G Terminal Blocks

Include light duty terminal block, as specified in Section 86-4.01B, "Electrical Components," with each pedestrian signal face.

## 86-4.07 (BLANK)

## 86-4.08 SIGNAL MOUNTING ASSEMBLIES

Signal mounting assembly must include:

1. 1-1/2-inch standard steel pipe or galvanized conduit
2. Pipe fitting made of ductile iron, galvanized steel, aluminum alloy Type AC-84B No. 380, or bronze
3. Mast arm and post top slip-fitters, and terminal compartments made of cast bronze or hot-dip galvanized ductile iron

After installation, clean and paint exposed threads of galvanized conduit brackets and bracket areas damaged by wrench or vise jaws. Use wire brush to clean and apply 2 coats of approved unthinned zinc-rich primer, organic vehicle type, as specified in Section 91, "Paint." Do not use aerosol can.

Fit each terminal compartment with a terminal block having a minimum of 12 positions, each with 2 screw-type terminals. Each terminal must accommodate at least five No. 14 conductors. Include a cover on compartment for ready access to terminal block. Terminal compartment used to bracket mount signals must be bolted securely to pole or standard.

Horizontal dimension of mounting assembly members between vertical centerline of terminal compartment or slip-fitter, and the vertical centerline of each signal face must not exceed 11 inches, except where required for proper signal face alignment or to allow programming of programmed visibility signal faces.

Mounting assembly members must be plumb or level, symmetrically arranged, and securely assembled.

Mounting assembly must be watertight, and free of sharp edges or protrusions that might damage conductor insulation. Include positive locking serrated fittings that, if mated with similar fittings on signal faces, will prevent faces from rotating.

Orient each mounting assembly to allow maximum horizontal clearance to adjacent roadway.

Use slip-fitter for post-top mounting of signals. Fit slip-fitter over a 4-1/2-inch outside diameter pipe or tapered standard end. Include cadmium-plated steel set screws. Include an integral terminal compartment for each slip-fitter used to post-top mount signals with brackets.

Do not install signal faces at an intersection until all other signal equipment, including complete controller assembly, is in place and ready for operation. You may mount signal faces if covered or not directed toward traffic.

## 86-4.09 FLASHING BEACONS

Flashing beacon must include:

1. Single section traffic signal face with yellow or red LED module indications
2. Backplate
3. Tunnel visor
4. Flashing beacon control assembly

Beacon flasher unit must be independent of intersection flasher unit.

### 86-4.09A Flashing Beacon Control Assembly

#### 86-4.09A(1) Enclosure

Enclosure must be:

1. NEMA 3R with a dead front panel and a hasp with a 7/16-inch hole for a padlock
2. Powder coated, hot-dip galvanized, or factory-applied rust resistant prime coat and finish coat

#### 86-4.09A(2) Circuit Breakers and Switches

Circuit breakers must comply with Section 86-2.11, "Service."

Switch for manually operating sign lighting circuit must be a single-hole-mounting toggle type with a single pole and throw and rated at 12 A, 120 V(ac). Furnish switch with an indicating nameplate reading "Auto-Test."

#### 86-4.09A(3) Flasher

Comply with Section 8, "Solid-State Flashers," of NEMA Standards publication No. TS 1.

Flasher must be a solid-state device with no contact points or moving parts.

Include 2 output circuits to allow alternate flashing of signal faces. Flasher must be able to carry a minimum of 10 A per circuit at 120 V(ac).

#### 86-4.09A(4) Wiring

Conductors and wiring in the enclosure must comply with Section 86-2.09B(1), "Cabinet and Enclosure Installation."

**86-4.09A(5) Terminal Blocks**
Terminal blocks must be:

1. Rated 25 A, 600 V(ac)
2. Molded phenolic or nylon material
3. Barrier type with plated brass screw terminals and integral marking strips

## 86-5 DETECTORS

## 86-5.01 VEHICLE DETECTORS

Sensor unit and isolator must comply with TEES.

### 86-5.01A Inductive Loop Detectors

**86-5.01A(1) General**
Inductive loop detector includes a completely installed loop or group of loops, in the roadway, lead-in cable, and a sensor unit, with power supply installed in a controller cabinet.

**86-5.01A(2) Sensor Unit Construction**
Card type sensor unit must comply with TEES, issued by the Department. Shelf-mounted sensor unit must comply with Section 11 of the NEMA Standards Publication No. TS 1.

**86-5.01A(3) Construction Materials**
Conductor for each inductive loop detector must be continuous, unspliced, and one of the following:

**Conductor Options for Inductive Loop Detector**

| Option | Specifications |
|---|---|
| Type 1 loop wire | Type RHW-USE neoprene-jacketed or Type USE cross-linked polyethylene insulated, No. 12, stranded copper wire with a 40 mils minimum thickness at any point. |
| Type 2 loop wire | Type THWN or Type XHHW, No. 14, stranded copper wire in a plastic tubing. Plastic tubing must be polyethylene or vinyl, rated for use at 105 °C, and resistant to oil and gasoline. Outside diameter of tubing must be 0.27 inch maximum with a wall thickness of 0.028 inch minimum. |

Conductor for loop detector lead-in cable must be two No. 16, 19 x 29, stranded, tinned copper wires, comply with the calculated cross sectional area of ASTM B 286, Table 1, and be one of the following:

**Conductor Options for Loop Detector Lead-In Cable**

| Option | Specifications |
|---|---|
| Type B lead-in cable | Insulated with 20 mils of high-density polyethylene. Conductors must be twisted together with at least 2 turns per foot and the twisted pair must be protected with a copper or aluminum polyester shield. A No. 20, minimum, copper drain wire must be connected to equipment ground within cabinet. Cable must have a high-density polyethylene or high-density polypropylene outer jacket with a nominal thickness of 32 mils. Include an amorphous interior moisture penetration barrier of nonhydroscopic polyethylene or polypropylene fillers. |
| Type C lead-in cable | Comply with International Municipal Signal Association (IMSA) Specification No. 50-2. A No. 20, minimum, copper drain wire must be connected to equipment ground within cabinet. |

### 86-5.01A(4) Installation Details

Install loop conductors without splices and end in nearest pull box. Seal open end of cable jacket or tubing similar to splicing requirements to prevent water from entering. Do not make final splices between loops and lead-in cable until loop operations under actual traffic conditions is approved.

Splice all loop conductors for each direction of travel for same phase of a traffic signal system, in same pull box, to a detector lead-in cable that runs from pull box adjacent to loop detector to a sensor unit mounted in controller cabinet.

End all loop conductors in a pull box or terminal strip in the cabinet.

Identify and band conductors for inductive loop installations. Band, in pairs, by lane, in the pull box adjacent to the loops and near the end of conductors in the cabinet. Bands must comply with Section 86-2.09, "Wiring."

If HMA surfacing is to be placed, install loop conductors before placing uppermost layer of HMA. Install conductors in compacted layer of HMA immediately below the uppermost layer. Install conductors as shown on the plans, except fill slot with sealant flush to the surface.

When cutting loops:

1. Residue from slot cutting activities must not be allowed to flow across shoulders or lanes occupied by public traffic and must be removed from the pavement surface before residue flows off. Dispose of residue from slot cutting activities under Section 7-1.13, "Disposal of Materials Outside the Highway Right of Way."
2. Surplus sealant must be removed from adjacent road surface without using solvents before setting.

Sealant for filling slots must comply with one of the following:

<u>Elastomeric Sealant</u>

Polyurethane material that will, within stated shelf life, cure only in the presence of moisture. Sealant must be suitable for use in both HMA and PCC.

The cured sealant must have the following performance characteristics:

**Performance Characteristics of Cured Sealant**

| Specification | ASTM | Requirement |
|---|---|---|
| Hardness (indentation) at 25 °C and 50% relative humidity. (Type A, Model 1700 only) | D 2240 Rex. | 65-85 |
| Tensile Strength: Pulled at 508 mm per minute | D 412 Die C | 3.45 MPa, min. |
| Elongation: Pulled at 508 mm per minute | D 412 Die C | 400%, min. |
| Flex at -40 °C: 0.6-mm free film bend (180°) over 13-mm mandrel | -- | No cracks |
| Weathering Resistance: Weatherometer 350 h, cured 7 days at 25 °C @ 50% relative humidity | D 822 | Slight chalking |
| Salt Spray Resistance: 28 days at 38 °C with 5% NaCl, Die C & pulled at 508 mm per minute | B 117 | 3.45 MPa, min. tensile 400%, min. elongation |
| Dielectric Constant over a temperature range of -30 °C to 50 °C | D 150 | Less than 25% change |

Asphaltic Emulsion Sealant

Comply with State Specification 8040-41A-15. Use for filling slots in HMA pavement that are a maximum of 5/8 inch in width. Do not use where the slope causes the material to run from the slot. Material must not be thinned beyond manufacturer's recommendations. Place material when air temperature is at least 7 °C.

Hot-Melt Rubberized Asphalt Sealant

Hot-melt rubberized asphalt must be:

1. In solid form at room temperature and fluid at application temperature of 190 °C to 205 °C. Fumes must be non-toxic.
2. Suitable for use in both HMA and PCC.
3. Melted in a jacketed, double-boiler type melting unit. Temperature of heat transfer medium must not exceed 245 °C.
4. Applied with a pressure feed applicator or pour pot, when the pavement surface temperature is greater than 4 °C.
5. Packaged in containers clearly marked "Detector Loop Sealant" and specifying manufacturer's batch and lot number.

The cured sealant must have the following performance characteristics:

**Performance Characteristics of Cured Sealant**

| Specification | ASTM | Requirement |
|---|---|---|
| Cone Penetration, 25 °C, 150 g, 5 s | D 5329, Sec. 6 | 3.5 mm, max |
| Flow, 60 °C | D 5329, Sec. 8 | 5 mm, max |
| Resilience, 25 °C | D 5329, Sec. 12 | 25%, min |
| Softening Point | D 36 | 82 °C, min |
| Ductility, 25 °C, 50 mm/min | D 113 | 300 mm, min |
| Flash Point, COC, °C | D 92 | 288 °C, min |
| Viscosity, Brookfield Thermosel, No. 27 Spindle, 20 rpm, 190 °C | D 150 | Less than 25% change |

### 86-5.01B Magnetic Detectors

Cable from pull box, adjacent to magnetic detector sensing element, to the field terminals in the controller cabinet must be the type specified for inductive loop detectors.

## 86-5.02 PEDESTRIAN PUSH BUTTON ASSEMBLIES

Housing must be either die-cast or permanent mold-cast aluminum, or ultraviolet stabilized, self-extinguishing structural plastic, if specified. Plastic housing must be black matching Color No. 17038, 27038 or 37038 of Federal Standard 595B, and colored throughout. Assembly must be rainproof and shockproof in any weather condition.

Switch must be a single-pole, double-throw, switching unit, with screw type terminals, rated 15 A at 125 V(ac), and must have:

1. Plunger actuator and a U frame to allow recessed mounting in push button housing
2. Operating force of 3.5 pounds
3. 1/64-inch maximum pretravel
4. 7/32-inch minimum overtravel
5. 0.0004- to 0.002-inch differential travel
6. 2-inch minimum diameter actuator

Where pedestrian push button is attached to a pole, shape housing to fit the pole curvature and secure. Include saddles to make a neat fit if needed.

Where a pedestrian push button is mounted on top of a 2-1/2-inch diameter post, fit housing with a slip-fitter and use screws for securing rigidly to post.

Pedestrian push button signs must be porcelain enameled metal or structural plastic.

Install push button and sign on crosswalk side of pole.

Point arrows on push button signs in the same direction as the corresponding crosswalk.

Attach sign on Type B push button assembly.

For Type C pedestrian push button assembly, mount instruction sign on the same standard as the push button assembly, using 2 straps and saddle brackets. Straps and saddle brackets must be corrosion-resisting chromium nickel steel and comply with ASTM A 167, Type 302B. Theft-proof bolts must be stainless steel with a chromium content of at least 17 percent and a nickel content of at least 8 percent.

# 86-6 LIGHTING

## 86-6.01 HIGH PRESSURE SODIUM LUMINAIRES

High pressure sodium luminaires must be the enclosed cutoff type.

Housing must be manufactured from aluminum. Painted or powder-coated housing must withstand a 1,000-hour salt spray test as specified in ASTM B 117.

Other metal parts must be corrosion resistant.

Each housing must include a slip-fitter that can be mounted on a 2-inch pipe tenon and can be adjusted 5 degrees from the axis of the tenon. Clamping brackets of slip-fitter must not bottom out on housing bosses when adjusted within the ±5 degree range.

The slip-fitter mounting bracket must not permanently set in excess of 0.020-inch when the 3/8-inch diameter cap screw used for mounting is tightened to 10 foot-pounds.

Luminaire to be mounted horizontally on mast arm, when tested as specified in California Test 611, must be capable of withstanding cyclic loading for a minimum of 2 million cycles without failure of any luminaire parts as follows:

**Cyclic Loading**

| Plane | Internal Ballast | Minimum Peak Acceleration Level[a] |
|---|---|---|
| Vertical | Removed | 3.0 G peak-to-peak sinusoidal loading (same as 1.5 G peak) |
| Horizontal[b] | Installed | 1.5 G peak-to-peak sinusoidal loading (same as 0.75 G peak) |
| Vertical | Installed | 1.0 G peak-to-peak sinusoidal loading (same as 0.5 G peak) |

[a]G = Acceleration of gravity
[b]Perpendicular to direction of mast arm

If a photoelectric unit receptacle is included, a raintight shorting cap must be installed. If luminaire housing has a hole for the receptacle, hole must be permanently closed, covered, and sealed with weatherproof material.

Optical system must be in a sealed chamber and include:

1. Reflector shaped so that a minimum of light is reflected through the arc tube of the lamp. Reflector surface must be specular and protected by either an anodized finish or a silicate film on it's specular surface.
2. Refractor or lens mounted in a door frame that is hinged to the housing and secured with a spring-loaded latch. Refractor must be made of glass or polycarbonate plastic. Lens must be made of heat- and impact-resistant glass.
3. Lamp socket that is a porcelain enclosed mogul-multiple type. Shell must include integral lamp grips to assure electrical contact under conditions of normal vibration. Socket must be mounted in the luminaire to allow presetting a variety of specified light distribution patterns. Socket must be rated for 1,500 W and 600 V(ac), and a 4 kV pulse.
4. Lamp.

Sealing must be provided by a gasket between the reflector and:

1. Refractor or lens
2. Lamp socket

Chamber must allow for filtered flow of air in and out of the chamber from lamp heat. Filtering must be accomplished by either a separate filter or a filtering gasket.

If components are mounted on a down-opening door, door must be hinged and secured to luminaire housing separately from refractor or flat lens frame. Door must be easily removable and replaceable, and secured to housing to prevent accidental opening when refractor or flat lens frame is opened.

Field wires connected to luminaire must terminate on a barrier-type terminal block secured to the housing. Terminal screws must be captive and equipped with wire grips for conductors up to No. 6. Each terminal positions must be clearly identified.

Minimum light distribution for each luminaire must meet the isolux diagrams.

Maximum brightness of each cutoff luminaire, with the lamp indicated, must be as follows:

**Cutoff Type**

| Lamp ANSI Code No. | Lamp Wattage | Maximum Brightness foot-lamberts |
|---|---|---|
| S55 | 150 | 40 |
| S66 | 200 | 40 |
| S50 | 250 | 50 |
| S67 | 310 | 60 |
| S51 | 400 | 75 |

Brightness readings will be taken using a brightness meter with an acceptance angle of 1.5 degrees. When measured on the 90-degree and 270-degree lateral angle line, maximum brightness must not exceed above specified brightness when meter is located at a horizontal distance of 120 feet and a vertical distance of 7.5 feet between luminaire and meter, or at an angle of 3 degrees 35 minutes from the horizontal to the line between luminaire and meter. Measurements must be made from 90-degree line and 270-degree line, and averaged. Lamp used for each test must operate at wattage necessary to produce the following light output:

**Light Output**

| Lamp Wattage | Lumens |
|---|---|
| 150 | 16,000 |
| 200 | 22,000 |
| 250 | 27,000 |
| 310 | 37,000 |
| 400 | 50,000 |

### 86-6.01A High Pressure Sodium Lamp Ballasts

Each ballast must:

1. Operate the lamp for its rated characteristics and wattage

2. Continuously operate at ambient air temperatures from -20 °C to 25 °C without reduction in ballast life
3. Operate for at least 180 cycles of 12 hours on and 12 hours off, with the lamp circuit in an open or short-circuited condition and without measurable reduction in operating requirements
4. Have a design life of not less than 60,000 hours
5. Provide proper starting and operating waveforms, voltage, and current
6. Provide reliable lamp starting and operation at ambient temperature down to -20 °C for the rated life of lamp

Ballast must be tested as specified in ANSI C82.6-1980, "Methods of Measurement of High-Intensity-Discharge Lamp Ballasts."

Starting aids for ballast of a given lamp wattage must be interchangeable between ballasts of same wattage and manufacturer, without adjustment.

Each integral ballast must consist of separate components that can be easily replaced. An encapsulated starting aid will be counted as a single component. Each component must include screw terminals, NEMA tab connectors, or a single multi-circuit connector. Conductors and terminals must be identified.

Mount heat-generating component so as to use the portion of the luminaire it is mounted to as a heat sink. Place capacitor a maximum practicable distance from heat-generating components or thermally shield to limit the case temperature to 75 °C.

Transformer and inductor must be resin-impregnated for protection against moisture. Capacitors, except those in starting aids, must be metal cased and hermetically sealed.

The Department will test high-pressure sodium lamp ballast. High-pressure sodium lamp ballast must have a characteristic curve that will intersect both of the lamp-voltage limit lines between the wattage limit lines and remain between the wattage limit lines throughout the full range of lamp voltage. This requirement must be met at the rated input voltage of the ballast and at the lowest and highest rated input voltage of the ballast.

Throughout the lifetime of the lamp, ballast curve must fall within the specified limits of the lamp voltage and wattage.

Ballast for luminaires must be located in the luminaire housing.

**86-6.01A(1) Regulator Type Ballasts**

Regulator type ballast must comply with the following:

1. For nominal input voltage and lamp voltage, ballast design center must not vary more than 7.5 percent from rated lamp wattage.
2. Ballast must be designed for a capacitance variance of ±6 percent that will not cause more than ±8 percent variation in lamp wattage regulation during rated lamp life.
3. Lamp current crest factor must not exceed 1.8 for input voltage variation of ±10 percent at any lamp voltage during lamp life.

Regulator-type ballast must be one of the following:

**Regulator-Type Ballast**

| Ballast Type | Power Factor | Lamp Regulation |
|---|---|---|
| Lag-type[a] | Not less than 90 percent throughout the life of lamp when ballast is operated at nominal line voltage with a nominally-rated reference lamp | Lamp wattage regulation spread does not vary by more than 18 percent for ±10 percent input voltage variation from nominal through life |
| Lead-type[b] | Not less than 90 percent throughout the life of lamp when ballast is operated at nominal line voltage with a nominally-rated reference lamp | Lamp wattage regulation spread does not vary by more than 30 percent for ±10 percent input voltage variation from nominal through life |

[a]Primary and secondary windings must be electrically isolated
[b]Constant wattage autoregulator (CWA)

### 86-6.01A(2) Nonregulator Type Ballasts

Each nonregulator type ballast must comply with the following:

1. For nominal input voltage and lamp voltage, ballast design center must not vary more than 7.5 percent from rated lamp wattage.
2. Lamp current crest factor must not exceed 1.8 for input voltage variation of ±5 percent at any lamp voltage during lamp life.

**Nonregulator-Type Ballast**

| Ballast Type | Power Factor | Lamp Regulation |
|---|---|---|
| Autotransformer or High-Reactance | Not less than 90 percent throughout the life of lamp when ballast is operated at nominal line voltage with a nominally-rated reference lamp | Lamp wattage regulation spread does not vary by more than 25 percent for ±5 percent input voltage variation from nominal through life |

### 86-6.01B High Pressure Sodium Lamps

High pressure sodium lamps must comply with ANSI C 78.42, "High Pressure Sodium Lamps," when tested as specified in ANSI C 78.389, "American National Standard for Electric Lamps - High Intensity Discharge-Methods of Measuring Characteristics." High pressure sodium lamps must have a minimum average rated life of 24,000 hours.

## 86-6.02 LOW PRESSURE SODIUM LUMINAIRES

Each low pressure sodium luminaire must be completely assembled with a lamp and ballast, and must:

1. Be the enclosed type, either semi-cutoff or cutoff type.
2. Include housing, reflector, refractor or lens, lamp socket, integral ballast, removable ballast tray, lamp support, terminal strip, capacitor, and slip fitter. Reflector may be an integral part of the housing.

Luminaire housing must be minimum 1/16-inch thick, corrosion resistant die cast aluminum sheet and plate with concealed continuous welds, or minimum nominal wall thickness of 3/32-thick acrylonitrile-butadiene-styrene sheet material, on a cast aluminum frame that provides mounting for all electrical components and slip fitter. Housing must be divided into optical and power compartments that are individually accessible for service and maintenance. Position and clamp luminaire to pipe tenon by tightening mounting bolts.

Painted exterior surface of luminaire must be finished with a fused coating of electrostatically applied polyester powder paint or other ultraviolet inhibiting film. Color must be aluminum gray.

High temperature neoprene, or equal, sealing ring must be installed in pipe tenon opening to prevent entry of water and insects into power and optical compartments.

Access to power unit assembly must be through a weathertight hinged cover, secured with spring type latches or captive screws, to luminaire housing.

Hardware must be stainless steel or cadmium plated. Use machine screws or bolts to secure removable components. Do not use sheet metal screws.

Semi-cutoff luminaires and molded refractor style cutoff luminaires must include a refractor. Other cutoff luminaires must include a flat lens.

Refractor must be 1-piece injection molded polycarbonate of 3/32 inch minimum thickness, or 1-piece injection molded acrylic of 1/8 inch minimum thickness. Flat lens must be 1-piece polycarbonate of 3/32 inch minimum thickness, mounted to metal frame. Refractor assembly and flat lens assembly must be constructed to rigidly maintain its shape, and hinged and secured with spring type latches to luminaire housing. Alternate methods of manufacturing refractor may be approved provided minimum specified thicknesses are maintained.

Lamp socket must be high temperature, flame retardant thermoset material with self-wiping contacts or equivalent. Socket must be rated for 660 W and 1,000 V(ac). Position of socket and support must maintain the lamp in correct relationship with reflector and refractor for designed distribution pattern.

Isofootcandle distribution must be ANSI Type III, short or Type IV, medium distribution, for cutoff or semi-cutoff luminaires.

With a 40-foot mounting height, each type of luminaire must maintain a minimum of 0.2 footcandle at least 60 feet each side, along the longitudinal roadway line below the luminaire, and a minimum of 0.35 footcandle at a transverse roadway distance from luminaire location equal to 1.5 times the luminaire mounting height.

Certified luminaire performance data must be provided. This data must include complete photometric test data in isofootcandle charts at a scale of 1 inch equals 20 feet, for the luminaire and lamp sizes shown on the plans.

Alternate data may be in horizontal footcandle values recorded on a 15' x 15' area extending 90 feet longitudinally each side of the light source, and 15 feet behind and 90 feet in front of the light source, for luminaire and lamp sizes, and mounting height shown on the plans. Horizontal footcandle levels in data submitted must equal or exceed levels specified. Failure to meet referenced values will be justification for rejection of the luminaires.

Photometric testing must be performed and certified by an independent and recognized testing laboratory.

Low pressure sodium lamps must:

1. Be 180 W, single-ended, bayonet base, tubular gas discharge lamp
2. Maintain a minimum of 93 percent of initial lumens during rated life and must comply with the following minimum performance requirements:

**Performance Requirements**

| Lamp Designation | ANSI L74-RF-180 |
|---|---|
| Initial Lumens | 33,000 lumens |
| Rated Ave. Life (@ 10 hrs/Start) | 18,000 hours |
| Operating Position | Horizontal ±20 degrees |

3. Reach 80 percent of light output within 10 minutes and must restrike within 1 minute after an outage due to power interruption or voltage drop at the lamp socket
4. Identify the month and year of installation.
5. Have an autotransformer or high-reactance type ballast. The ballast must comply with the following:

   5.1. Lamp current crest factor must not exceed 1.8 at nominal line voltage
   5.2. Ballast loss must not exceed 24 percent for 180 W ballast at nominal line voltage

**Autotransformer or High-Reactance Type Ballast**

| Ballast Type | Power Factor | Lamp Operation |
|---|---|---|
| Autotransformer or High-Reactance | Not less than 90 percent when ballast is operated at nominal line voltage with a nominally-rated reference lamp | Lamp wattage regulation spread does not vary by more than ±6 percent for ±10 percent input voltage variation from nominal through life |

A multi-circuit connector must be included for quick disconnection of ballast tray.

## 86-6.03 SOFFIT AND WALL LUMINAIRES

Soffit and wall luminaire must be weatherproof and corrosion resistant.

Each flush-mounted soffit luminaire must consist of:

1. Metal body with two 1-inch minimum conduit hubs and provisions for anchoring into concrete
2. Prismatic refractor made of heat-resistant polycarbonate mounted in a door frame and clearly identified as to street side
3. Specular anodized aluminum reflector
4. Ballast located either within housing or in a ceiling pull box as shown on the plans
5. Lamp socket

The door frame assembly must be hinged, gasketed, and secured to body by at least 3 machine screws.

Each pendant soffit luminaire must be enclosed and gasketed, have an aluminum finish, and include:

1. Reflector with a specular anodized aluminum finish
2. Refractor made of heat-resistant polycarbonate
3. Optical assembly hinged and latched for lamp access and a device to prevent dropping
4. Ballast designed for operation in a raintight enclosure
5. Galvanized metal box with a gasketed cover, 2 captive screws, and 2 chains to prevent dropping and for luminaire mounting

Each wall-mounted luminaire must consist of:

1. Cast metal body
2. Prismatic refractor, made of glass, mounted in a door frame
3. Aluminum reflector with a specular anodized finish
4. Integral ballast
5. Lamp socket
6. Gasket between refractor and body
7. At least two 5/16-inch minimum diameter mounting bolts

Cast-aluminum bodies to be cast into or mounted against concrete must have a thick application of alkali-resistant bituminous paint on all surfaces to be in contact with concrete.

Each soffit luminaire and wall luminaire must include a 70 W high-pressure sodium lamp with a minimum average rated life of 24,000 hours. Each lamp socket must be positioned to locate the light center of the lamp within 1/2 inch of light center location of the luminaire design.

Ballast must comply with Section 86-6.01A, "High Pressure Sodium Lamp Ballasts." Wall luminaire ballast must be located in luminaire housing or, if shown on the plans, in a pull box adjacent to luminaire.

## 86-6.04 PEDESTRIAN CROSSING FIXTURES

Before starting fixture manufacturing, submit fixture design for approval. If requested, submit 1 complete prototype fixture for approval at least 30 days before manufacturing the fixtures. The prototype fixture will be returned to you, and if permitted, the fixture may be installed in the work.

Lens unit in door section must be formed of 1-1/2-inch methyl methacrylate rod cut and fire-glazed for a clear finish or a cast unit with equivalent tolerances and finish.

Lens must be secured to door section with an extruded lens retainer of 6063-T5 aluminum alloy that fits the lens shape. Lens retainer must fit the full length of lens on both sides. Continuous lens retainer for the full length of 3 lenses is allowed. Z bars of 5052-H32 or 5005-H14 aluminum alloy, 1/16 inch minimum thickness may be substituted for extruded lens retainer.

A captive positive-keyed screw-type latching device requiring a special socket wrench must be installed at upper edge to secure door in the closed position as shown on the plans. Furnish 2 special wrenches to the Engineer.

Each fixture must include a F48T12/CW rapid start fluorescent lamp with recessed, double contact base installed on back side of door directly behind lens.

Each lampholder must be UL listed for outdoor use without an enclosure and with 1,500 mA rapid start fluorescent lamp. Lampholder must be spring-loaded type.

For each lamp, the distance from face of lampholder to the lamp must be designed to provide a compression of at least 0.10-inch on the spring-type lampholder when lamp is in place. Lamp must have positive mechanical and electrical contact when lamp is in place. Socket on spring-type lampholder must have enough travel to allow lamp installation. Spring must not be a part of current-carrying circuit.

Ballast must be high-power-factor type with weatherproof leads for operation of one 48-inch rapid-start lamp. Ballast must be UL listed for outdoor operation on 110 to 125 V(ac) 60 Hz circuit and rated at 1,500 mA.

Conductors from ballast leads to lampholder must be minimum size of No. 16, stranded, and UL-listed copper AWM. Splicing of lampholder conductors to ballast leads must be performed by using mechanically secure connectors.

Conductors in fixture except ballast leads and entrance line conductors, must be UL-listed AWM.

Provide sufficient slack in the conductors to allow the fixture door to fully open.

Circuit conductors entering the fixture must be terminated on molded phenolic barrier-type terminal blocks rated at 15 A and 600 V(ac) and must have integral-type white waterproof-marking strips. Current-carrying parts of terminal blocks must be insulated from fixture with integral plugs or strips to provide protection from line-to-ground flashover voltage. Terminal blocks must be attached to wireway cover in top section. If you use sectionalized terminal blocks, each section must include an integral barrier on each side and be capable of rigid mounting and alignment.

Exposed surfaces of fixture must be uniform in appearance and free from significant defects, including improper fit, dents, deep scratches and abrasions, burrs, roughness, off-square ends, holes off-center or jagged, and surface irregularities. Screws for attaching components to fixture door, including Z bars, ballasts, and terminal block, must be tapped into door from the inside only. Screwheads, nuts, or other fasteners must not be removable from the outside.

### 86-6.04A Pedestrian Undercrossing Fixtures

Fixture shell must be cast aluminum alloy, industrial type or Federal Class 18 aluminum of 1/4 inch minimum thickness.

Door must be 1 piece of 6061-T6 aluminum alloy of 1/8 inch minimum thickness.

Continuous piano hinge must be Type 1100 aluminum alloy. The piano hinge must be welded or riveted to door section with 1/8 inch aluminum rivets. Matching holes must be drilled in the hinge and lower edge of fixture. After shell is in place, door assembly must be attached by minimum 3/8-inch No. 8 stainless steel self-tapping screws.

A neoprene gasket must be attached to frame to provide a cushion between the shell and the door.

Chain or other device must be included to prevent the door, when fully opened, from coming in contact with the undercrossing wall.

Fixture must be held in place by three 3/8" x 8" anchor bolts with 2 nuts each.

Fixture surfaces in contact with concrete, and with anchor bolts and nuts must be painted with a thick application of alkali-resistant bituminous paint. Paint must comply with MIL-P-6883.

Circuit conductor entering the fixture must be terminated on 2-position terminal blocks.

Both ends of fixture must have holes for 1-inch conduit. Unused holes must be plugged with pressed metal closures.

### 86-6.04B Pedestrian Overcrossing Fixtures

Fixture shell must consist of:

1. Top section and a door section of extruded 6063-T5 aluminum alloy, each with a nominal 1/8 inch wall thickness
2. 2 cast-end sections of 319 aluminum alloy
3. Internal wireway cover of 505-H32 aluminum alloy

Top section and door section must be joined together on one side by a continuous hinge formed as part of the 2 extrusions and must overlay to allow locking on the other side. Hinge must be treated with a silicone grease that will prevent the entrance of water by capillary action.

Wireway cover with 3/16 inch hemmed ends up and terminal blocks and circuit conductors must be inserted before welding end sections and must provide clearance at both ends for conductors. Cover must be fastened by at least two 1/4 inch No. 4 self-threading sheet metal screws with binding head and blunt point. You may substitute blind rivets of equivalent strength.

One or more bronze sash chains or other device must be included to prevent door from opening to an extent that will damage the hinge.

Lampholder must include heat-resistant circular cross section neoprene sealing gasket, silver-coated contacts, and waterproofed lead entrance for use with a 1,500 mA rapid start fluorescent lamp.

Ballast must be at most 13-1/4 inches long.

Circuit conductors entering the fixture must be terminated on 3-position terminal blocks.

Electrical system of pedestrian overcrossing must be grounded by a No. 8 copper wire installed in conduit from fixture to fixture, from end fixture to conduit fitting on end post and from conduit fitting on end post to grounding bushing in nearest pull box.

Ground wire must be secured to inside of telescoping sleeve end casting where conductors are carried and to the inside of Type LB conduit fitting on end post by a connecting lug and a No. 8 self-threading pan screw.

Lamp, lampholder, ballast, and fixture wire, must be attached to door section. Terminal blocks must be attached to top section or wireway cover.

Three No. 10, solid copper circuit conductors must be installed between terminal blocks as part of each completed fixture.

Before shipment to job site, fixture must be completely manufactured and assembled in the shop.

## 86-6.05 INDUCTION SIGN LIGHTING FIXTURES

Each induction sign lighting fixture must include housing with door, reflector, refractor or lens, lamp, power coupler, high frequency generator, socket assembly, fuse block, and fuses.

Each induction sign lighting fixture must:

1. Be designed for mounting near the bottom of sign panel on an overhead sign structure.

2. Be an enclosed design and be raintight and corrosion resistant.
3. Have a minimum average rating of 60,000 hours.
4. Be for a wattage of 87 W, 120/240 V(ac).
5. Have a power factor greater than 90 percent and total harmonic distortion less than 10 percent.
6. Be UL approved for wet locations and be FCC Class A-listed.
7. Not exceed 44 pounds in weight.
8. Include the manufacturer's brand name, trademark, model number, serial number, and date of manufacture on packaged assembly. Same information must be permanently marked on the outside and inside of housing.
9. Comply with minimum horizontal footcandle requirement shown on the plans.
10. Be a maximum height of 12 inches above the top of the mounting rails.

If fixture is located so that the light center of the lamp is 55 inches in front of, 1 foot below, and centered on a 10-foot high by 20-foot wide sign panel, the ratio of maximum to minimum illuminance level on the panel must not exceed 12 to 1 in 95 percent of the points measured. Illuminance gradient must not exceed 2 to 1 and is defined as the ratio of minimum illuminance on a 1-foot square of panel to that on an adjacent 1-foot square of panel.

Each fixture must have a mounting assembly that will allow fixture to be mounted on continuous slot channels. Mounting assembly must be either cast aluminum, hot-dip galvanized steel plate, or steel plate that has been galvanized and finished with a polymeric coating system or same finish that is used for housing.

Housing must have a door designed to hold a refractor or lens, and to open without the use of special tools. Housing and door must be manufactured of sheet or cast aluminum, and have a powder coat or polyester paint finish of a gray color resembling unfinished manufacturing. Sheet aluminum must comply with ASTM B 209 or B 209M for 5052-H32 aluminum sheet. External bolts, screws, hinges, hinge pins, and door closure devices must be corrosion resistant.

Housing must include weep holes.

Door must be hinged to housing on side of fixture away from the sign panel and include 2 captive latch bolts or other latching device. Door must be designed to lock in the open position, 50 degrees minimum from the plane of the door opening, with an 85-mph 3-second-wind-gust load striking the door from either side.

Door and housing must be gasketed to be raintight and dusttight. Thickness of gasket must be 1/4 inch, minimum.

Fixture height must be less than 12 inches above the top of mounting rails.

Reflector must be 1 piece, made from specularly finished aluminum protected with an electrochemically applied anodized finish or a chemically applied silicate film, and designed so deposited water due to condensation will drain away. Reflector must be secured to housing with a minimum of 2 screws and removable without removing any fixture parts. Do not attach reflectors to outside of housing.

Refractor or lens must have a smooth exterior and must be manufactured from the material as follows:

**Refractor and Lens Material Requirements**

| Component | Manufactured From |
|---|---|
| Flat lens | Heat-resistant glass |
| Convex lens | Heat resistant, high-impact resistant tempered glass |
| Refractor | Borosilicate heat resistant glass |

Refractor and convex lens must be designed or shielded so no fixture luminance is visible if fixture is approached directly from the rear and viewing level is the bottom of the fixture. If a shield is used, it must be an integral part of the door casting.

Each fixture must include an 85 W induction lamp with an interior wall that is fluorescent phosphor-coated. Light output must be at least 70 percent at 60,000 hours. Lamp must have a minimum color-rendering index of 80, be rated at a color temperature of 4,000K and be removable without the use of tools.

Lamp socket must be a porcelain enclosed mogul type with a shell that contains integral lamp grips to assure electrical contact under normal vibration conditions. Center contact must be spring-loaded. Shell and center contact must be nickel-plated brass. Socket must be rated for 1,500 W and 600 V(ac).

Power coupler must include a construction base with antenna, heat sink, and electrical connection cable, and be designed so it can be removed with common hand tools.

High frequency generator must:

1. Start and operate lamps at an ambient temperature of -25 °C or greater for the rated life of the lamp
2. Operate continuously at ambient air temperatures from -25 °C to 25 °C without reduction in generator life
3. Have a design life of at least 100,000 hours at 55 °C
4. Have an output frequency of 2.65 MHz ± 10 percent
5. Have radio frequency interference that complies with FCC Title 47, Part 18, regulations regarding harmful interference
6. Be replaceable with common hand tools
7. Mounted so the fixture can be used as a heat sink

Conductor terminal must be identified by the component terminal the conductor connects to.

Submit a copy of the high frequency generator test methods and results from the manufacturer with each lot of fixtures.

Each fixture must include a barrier-type fuse block for terminating field connections. Fuse block must:

1. Be secured to housing and be accessible without removal of any fixture parts
2. Be mounted to leave a minimum of 1/2 inch air space from sidewalls of housing
3. Be designed for easy removal of fuses with a fuse puller, be rated at 600 V(ac), and have box terminals.

Fuses must be 13/32-inch diameter, 1-1/2 inch long ferrule type and UL or ETL listed. For 120 V(ac) input fixture, only the ungrounded conductor must be fused and there must be a solid link between the neutral and the high frequency generator.

If shown on the plans, include a wire guard to prevent damage to the refractor or lens. Guard must be constructed of 1/4-inch minimum diameter galvanized steel wire, and either hot-dip galvanized or electroplated-zinc coated as specified in ASTM B 633, Service Condition SC4 with a clear chromate dip treatment. Guard elements must be spaced to prevent rocks larger than 1-1/2-inch diameter from passing through.

## 86-6.06 SIGN LIGHTING FIXTURES FOR FLASHING BEACON

Sign lighting fixture must:

1. Be UL or ETL listed for outdoor installation
2. Include a hood with side outlet tapped for conduit, a symmetrical 10-inch steel reflector with a white porcelain-enamel finish, and a medium base socket
3. Be rated at 150 W minimum

## 86-6.07 INTERNALLY ILLUMINATED STREET NAME SIGNS

Sign fixture must be:

1. Designed and constructed to prevent deformation or failure when subjected to an 85 mph 3-second-wind-gust load as specified in AASHTO publication, "Standard Specifications for Structural Supports of Highway Signs, Luminaires and Traffic Signals," and its interim revisions
2. Manufactured from all new material and all ferrous parts must be galvanized or cadmium-plated
3. Type A or B signs

Top and bottom must be formed or extruded aluminum and must be attached to formed or cast aluminum end fittings. Housing must be designed for continuous sealing between top and bottom assemblies, and end fittings, and be constructed to resist torsional twist and warp. Opening or removing 1 panel must allow access to the interior of the sign for lamp, ballast, and fuse replacement.

Photoelectric unit sockets are not allowed.

For Type A sign, both sides must be hinged at the top to allow installation or removal of sign panel, and to allow access to interior of sign.

For Type B sign, sign panel must be slide-mounted into housing.

Reflectors may be used to obtain required sign brightness. Reflectors must be formed aluminum with acrylic baked white enamel surface having a minimum reflectance of 0.85.

Sign panel must be slide-mounted or rigid-mounted in a frame, with white legend, symbols, arrows, and border on each face. Background must be green.

Sign panels surface must be evenly illuminated. Average of brightness readings for letters must be 150 foot-lamberts, minimum. Light transmission factor of sign panel must provide a letter to background brightness ratio between 10 to 1 and 20 to 1. Background luminance must not vary by more than 40 percent from the average background brightness reading. Luminance of letters, symbols, and arrows must not vary by more than 20 percent from their average brightness readings.

Sign panels must be translucent, high impact, resistant plastic panels of one of the following:

1. Glass fiber reinforced acrylated resin
2. Polycarbonate resin
3. Cellulose acetate butyrate plastic

Paint on the outside of plastic must be protected by a plastic film that seals the front surface of panel and filters out ultraviolet radiation. Paint must be acrylic plastic type.

Surface must be free of blemishes in the plastic or coating that may impair the serviceability or detract from the general appearance and color matching of sign.

White or green color must not fade or darken when sign is exposed to an accelerated test of ultraviolet light equivalent to 2 years of outdoor exposure. Green color of sign, when not illuminated, must match Color No. 14109 of Federal Standard 595B.

Sign panel must not crack or shatter when a 1-inch diameter, steel ball with a weight of 2.4 ounces is dropped from a height of 8.5 feet above the sign panel to any point of sign panel. For this test, sign panel must be lying in a horizontal position and supported within its frame.

For Type A sign, gasket must be installed between sign panel frame and fixture housing to prevent water entry between frame and fixture housing. Gasket must be uniform and even-textured, and be the closed-cell, sponge-neoprene type, designed for use at temperatures between -20 °C and +74 °C.

Gasket must be neatly applied to thoroughly degreased, clean surface with a suitable heat-resistant adhesive that will not allow the gasket to slip at temperatures between -20 °C and +74 °C.

Ballast must be high power factor type and capable of starting the lamp at -20 °C and above.

Ballast for Type A sign must be rated at 200 mA. Ballasts for Type B sign must be rated at 430 mA. Ballast must be UL or ETL listed for operation on 110 to 125 V(ac), 60 Hz circuits, and comply with ANSI C 82.1 and ANSI C 82.2.

Lampholder must be UL or ETL listed for outdoor use and of the spring-loaded type. Lampholder must have silver-coated contacts and waterproofed entrance leads for use with a rapid-start fluorescent lamp. Removal of lamp from socket must de-energize the primary of ballast. Each lampholder must include heat-resistant, circular cross section, partially-recessed neoprene ring to seal against lamp ends and protect electrical contacts from moisture, dirt or other injurious elements.

Distance between face of lampholders must be designed to provide compression of at least 0.10 inch on the spring-type lampholder when lamp is in place. Lamp must have positive mechanical and electrical contact when lamp is in place. Socket on spring-type lampholder must have sufficient travel to allow lamp installation. Spring must not be a part of current carrying circuit. Lampholder must match lamp requirements and must not increase cathode filament circuit resistance by more than 0.10 Ω.

Lamp must comply with ANSI C 78.

Wiring connections in fixture must be terminated on molded, phenolic, barrier-type, terminal blocks rated at 15 A, 1,000 V(ac), and must have integral-type white waterproof-marking strips. Current carrying

parts of terminal blocks must be insulated from fixture with integral plugs or strips to provide protection from line-to-ground flashover voltage. If you choose to use sectionalized terminal blocks, each section must include an integral barrier on each side and be capable of rigid mounting and alignment. Terminal screws must be No. 10, minimum.

Fuses must be Type 3AG, miniature, slow-blowing type with appropriate current and voltage ratings.

Fuseholder must be a panel-mounting type with threaded or bayonet-type knob that grips the fuse tightly for extraction. Use a separate fuse for each ballast.

Screened weep holes must be constructed at strategic locations in members subject to moisture collection.

Fasteners, screws, and hardware must be passive stainless steel, Type 302 or 304, or aluminum Type 6060-T6.

Top of fixture housing must have 2 free-swinging mounting brackets. Each bracket must be adjustable vertically for leveling the sign to either a straight or curved mast arm. Bracket assembly must allow fixture to swing perpendicular to the sign panel.

Hinge pins for the free-swinging brackets must have a minimum diameter of 1/4 inch.

Message, as shown on the plans, must be displayed on both sign panels.

If not shown on the plans, the message and the size of symbols or arrows will be given by the Engineer at your request. Letters must be 8-inch upper case and 6-inch lower case, Series E.

Fixture conductors must be UL- or ETL-listed AWM stranded copper wire with 28 mils, minimum, thermoplastic insulation, rated at 1,000 V(ac) and rated for use at 90 °C. Conductors must be No. 16 minimum and must match color coding of ballast leads.

Conductors within the fixture must be secured with easily removable spring cross straps, not clamped, in the chassis or fixture. Straps must be installed 12 inches apart or less.

Stranded copper conductors connected to screw-type terminals must terminate in approved crimp-type ring connectors.

Splices are not allowed within fixture.

Submit shop drawings showing the message for each sign, including size of letters, symbols or arrows, as shown on the plans. If requested, you must supply, without cost to the State, sufficient samples of materials to be used in the manufacturing of the sign or a complete sign assembly, to allow adequate testing and evaluation of compliance to specified requirements.

## 86-6.08 PHOTOELECTRIC CONTROLS

Photoelectric controls must be capable of directly switching multiple lighting systems.

### 86-6.08A Types

Photoelectric control type must comply with the following:

**Photoelectric Control Types**

| | |
|---|---|
| Type I | Includes a remote photoelectric unit and a test switch housed in an enclosure. |
| Type II | Includes a remote photoelectric unit, a separate contactor located in a service equipment enclosure, and a test switch located in service equipment enclosure. |
| Type III | Includes a remote photoelectric unit, a separate contactor, and a test switch housed in an enclosure. |
| Type IV | Includes a photoelectric unit that plugs into an EEI-NEMA twist-lock receptacle integral with the luminaire. |
| Type V | Includes a photoelectric unit, contactor, and test switch located in service equipment enclosure. |

A switch to allow manual operation of lighting circuit must be included for each Type I, Type II, Type III, and Type V photoelectric control. Switches must be single-hole mounting toggle type, single-pole, single-throw, rated at 12 A with a voltage rating that matches the circuit. Switches must have an indicating nameplate reading "Auto-Test" and be connected in parallel with the load contacts of the photoelectric unit. Test switches must not have an "OFF" position.

Photoelectric unit for Types I, II, and III photoelectric controls, must be pole-top mounted.

## 86-6.08B Equipment Details

### 86-6.08B(1) Photoelectric Unit

Photoelectric unit must:

1. Have an output in response to changing light levels. Response level must remain stable throughout life of control unit.
2. Have a "turn-on" between 1 and 5 footcandles, and a "turn-off" between 1.5 and 5 times "turn-on." Measurements must be made by procedures in EEI-NEMA standards for physical and electrical interchangeability of light-sensitive control devices used in the control of roadway lighting.
3. Have a EEI-NEMA type receptacle. Mounting brackets must be used where pole-top mounting is not possible. Photoelectric controls must be installed at locations show on the plans and oriented.
4. Be screened to prevent artificial light from causing cycling.
5. Have a supply voltage rating of 60 Hz, 105-130 V(ac), 210-240 V(ac), or 105-240 V(ac), as specified.
6. Have a load rating of 800 W minimum, incandescent, high intensity discharge, or fluorescent.
7. Operate at a temperature range of -20 °C to 55 °C.
8. Have a power consumption less than 10 W.
9. Be housed in a weatherproof enclosure.
10. Have a base with a 3-prong, EEI-NEMA standard, twist-lock plug mounting.
11. Have a "fail-on" feature.

Unit components must not require periodic replacement.

Photoelectric controls, except Type IV and Type V, must include a 4-inch minimum inside diameter, pole-top mounting adaptor containing a terminal block, and cable supports or clamps to support pole wires.

For switching 480 V(ac), 60 Hz circuits, a 100 VA, minimum, 480/120 V(ac) transformer must be installed in the contactor enclosure to allow 120 V(ac) for the photoelectric control unit. If more than 1 photoelectric unit is to be installed at a location, a single transformer with a volt-ampere rating capable of handling the total controlled load, may be used.

#### 86-6.08B(2) Contactor

Contactor must:

1. Have contacts rated to switch the specified lighting load
2. Be normally open
3. Be the mechanical armature type with contacts of fine silver, silver alloy, or superior alternative material

#### 86-6.08B(3) Enclosure

Enclosure for Type I and Type III photoelectric controls must be NEMA 3R. Enclosure must be supplied with a factory-applied rust-resistant prime coat and finish coat. Two applications of paint to match the color of the standard must be applied as specified in Section 86-2.16, "Painting." Enclosure may be hot-dip galvanized instead of painting. A minimum of 2-1/2 inches must be provided between contactor terminals and end of enclosure for wiring connections. Enclosure must be mounted on the same standard as the photoelectric unit at a height of about 6 feet above finished grade.

#### 86-6.08B(4) Terminal Blocks

Terminal blocks must be rated at 25 A, 600 V(ac), molded from phenolic or nylon material, and of the barrier type with plated-brass screw terminals and integral-type marking strips.

## 86-6.09 TRANSFORMERS

Multiple-to-multiple transformers must be single-phase dry type designed for operation on a 60 Hz supply.

### 86-6.09A Electrical Requirements

Transformers must have a decal showing a connection diagram. Diagram must show either color-coding or wire-tagging with primary (H1, H2) or secondary (X1, X2) markers, and the primary and secondary voltage and volt-ampere rating. Transformers must comply with the following:

**Transformer Electrical Requirements**

| Transformer Characteristic | Multiple-to-Multiple Unit |
|---|---|
| Rating | 120/480 V(ac), 240/480 V(ac), or 480/120 V(ac) |
| Efficiency | Exceed 95 percent |
| Secondary Voltage Regulation and Tolerance | ±3 percent from half load to full load |

Secondary 480 V(ac) windings must be center-tapped.

### 86-6.09B Physical Requirements

External leads for multiple-to-multiple secondary connections must be Type USE, No. 10, rated 600 V(ac).

Transformer leads must extend a minimum of 12 inches from the case.

Transformer insulation must be NEMA 185 C or better.

Multiple-to-multiple transformers must withstand the application of 2,200 V(ac) from core to coils and from coil to coil for a 1-minute period.

The above tests must be made immediately after operation of transformer at full load for 24 hours.

Non-submersible transformers must include metal half-shell coil protection, have moisture resistant synthetic varnish impregnated windings, and be suitable for outdoor operation in a raintight enclosure.

Each transformer to be installed in a pull box must be the submersible type and include a handle and a hanger.

### 86-6.09C Submersible Type Transformers

Submersible type transformers must be securely encased in a rugged corrosion resistant, watertight case and must withstand a 5-day test submerged in 2 feet of salt water, 2 percent salt by weight, with 12-hour on and off periods. The operating periods must be at full load.

Leads of submersible transformers must be brought out through one or more sealed hubs and secured to withstand a 100 pound static pull without loosening or leaking.

## 86-6.10 (BLANK)

## 86-6.11 FALSEWORK LIGHTING

### 86-6.11A General

Falsework lighting must include lighting to illuminate the pavement, portals, and pedestrian walkways at or under openings in the falsework required for traffic.

Lighting for pedestrian walkway illumination must be installed at all pedestrian openings through or under falsework.

Before starting falsework opening construction, you must submit a plan of proposed lighting installations for review and obtain approval. Approval will be made as specified in Section 5-1.02, "Plans and Working Drawings."

You must design falsework lighting so that required maintenance can be performed with a minimum of inconvenience to public traffic. Closing of traffic lanes for routine maintenance will not be permitted on roadways with posted speed limits greater than 25 mph.

Pavement under falsework with portals less than 150 feet apart and falsework portals must be illuminated only during the hours of darkness as defined in Division 1, Section 280, of the California Vehicle Code. Photoelectric switches must be used to control falsework lighting systems. Pavement under falsework with portals 150 feet or more apart and all pedestrian openings through falsework must be illuminated 24 hours per day.

Lighting fixtures must be aimed to avoid glare to oncoming motorists.

Type NMC cable with No. 12 minimum conductors, with ground wire, must be used. Fasten cable to supporting structure at sufficient intervals to adequately support cable and within 12 inches from every box or fitting. Conductors within 8 feet of ground must be enclosed in a 1/2 inch or larger metal conduit.

Each illumination system must be on a minimum of 1 separate branch circuit at each bridge location. Each branch circuit must be fused, not to exceed 20 A.

For falsework lighting, you must arrange with the serving utility to complete service connections. You must pay for energy, line extension, service, and service hookup costs.

At completion of project or when ordered by the Engineer, falsework lighting equipment will become your property and you must remove it from the job site.

You may propose a lighting plan that fulfills light intensity requirements to the systems specified herein. You must supply sufficient data to allow evaluation of alternative methods.

### 86-6.11B Pavement Illumination

Illumination of pavement at vehicular openings through falsework must comply with the following:

1. Fixture must include R/FL commercial type floodlamp holder with protective covers.
2. Fixture must be fully adjustable with brackets and locking screws, and allow mounting directly to a standard metal junction box.
3. Lamp must be medium-base 120 V(ac), 120 W, minimum, PAR-38 quartz-halogen floodlamp.
4. A continuous row of fixture types required must be installed at locations and spacing specified. Fixtures must be installed beneath falsework structure, with the end fixtures not further than 10 feet inside portal faces. Fixtures must be installed and energized immediately after the members supporting them have been erected.
5. Fixtures along the sides of the opening must be placed not more than 4 feet behind or 2 feet in front of the roadway face of the temporary railing. Mounting heights of fixtures must be between 12 and 16 feet above the roadway surface and must present an unobstructed light pattern on the pavement.

### 86-6.11C Portal Illumination

Illumination of falsework portals must comply with the following:

1. On each side of each entrance portal, plywood sheet clearance guides, 4 feet wide by 8 feet high, must be fastened vertically, facing traffic, with the bottom of the panel 3 feet to 4 feet above the roadway. The center of the panel must be located approximately 3 feet horizontally behind the roadway face of the railing. Panels must be freshly painted for each installation with not less than 2 applications of flat white paint. Paint testing will not be required.
2. If ordered by the Engineer, in order to improve the general appearance of the painted surfaces, you must repaint designated areas and that painting will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."
3. Falsework portals must be illuminated on the side facing traffic with 150 W, minimum, PAR reflector floodlamps mounted on the structure directly over each vertical support adjacent to the traveled way, as needed to uniformly illuminate the exterior falsework beam, the clearance guides, and the overhead clearance sign. Each lamp must be supported approximately 16 feet above the pavement and approximately 6 feet in front of the portal face.
4. Portal lighting and clearance guides must be installed on the day that vertical members are erected.

### 86-6.11D Pedestrian Walkway Illumination

Illumination of pedestrian openings through or under falsework must comply with the following:

1. Fixtures must be flush-mounted in the overhead protection shield and equipped with a damage-resistant clear polycarbonate diffuser lens. Lamps must be standard incandescent 100 W, 120 V(ac).
2. Fixtures must be centered over the passageway at intervals of not more than 15 feet with the end fixtures not more than 7 feet inside the end of the pedestrian openings.
3. Pedestrian passageway light systems must be installed immediately after the overhead protection shield is erected.

## 86-7 REMOVING, REINSTALLING OR SALVAGING ELECTRICAL EQUIPMENT

### 86-7.01 REMOVING ELECTRICAL EQUIPMENT

Existing electrical equipment, pull boxes, and conduits, to be removed and not reused or salvaged, become your property and you must dispose of it under Section 7-1.13, "Disposal of Materials Outside the Highway Right of Way." Unused underground conduit may be abandoned in place after all conductors have been removed, except that conduit terminations from conduit to be abandoned must be removed from pull boxes to remain.

Exercise care in salvaging equipment so that it will not be damaged or destroyed. Mast arms must be removed from standards. Luminaires, signal heads, and signal mounting assemblies must be removed from standards and mast arms.

Holes resulting from removing pull boxes must be filled with material equivalent to the surrounding material.

### 86-7.02 REINSTALLING REMOVED ELECTRICAL EQUIPMENT

If removed electrical equipment is to be reinstalled, you must supply all necessary materials and equipment, including signal mounting assemblies, anchor bolts, nuts, washers, and concrete as required to complete the new installation.

Luminaires to be reinstalled must be cleaned and relamped.

Existing materials required to be reused and found to be unsatisfactory by the Engineer must be replaced with new material and the replacement cost will be paid for as extra work as specified in Section 4-1.03D, "Extra Work."

## 86-8 PAYMENT

### 86-8.01 PAYMENT

The contract lump sum price or prices paid for signal, ramp metering, flashing beacon, lighting, sign illumination, traffic monitoring station, highway advisory radio systems, closed circuit television systems, or combinations thereof; for modifying or removing those systems; for temporary systems; or the lump sum or unit prices paid for various units of those systems; or the lump sum or per foot price paid for conduit of the various sizes, types, and installation methods listed in the Engineer's Estimate include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in furnishing and installing, modifying, or removing the systems, combinations or units thereof, including any necessary pull boxes (except if the type required is shown as a separate contract item); excavation and backfill; concrete foundations (except if shown as a separate contract item); pedestrian barricades; furnishing and installing illuminated street name signs; installing sign panels on pedestrian barricades, on flashing beacon standards, and on traffic signal mast arms; restoring sidewalk, pavement and appurtenances damaged or destroyed during construction; salvaging existing materials; and making all required tests, as shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

If poles for electrical systems are manufactured from a source located more than 300 air-line miles from Sacramento and Los Angeles, the Department will deduct $5,000 for inspection costs for each inspection site. If poles for electrical systems are manufactured from a source located more than 3,000 air-line miles from Sacramento and Los Angeles, the Department will deduct $8,000 for inspection costs for each inspection site.

Full compensation for all additional materials and labor, not shown on the plans or specified, that are necessary to complete the installation of the various systems, is included in the prices paid for the systems, or units thereof, except as provided in Section 86-1.06, "Maintaining Existing and Temporary Electrical Systems," and no additional compensation will be allowed therefor.

If shown as a contract item, the contract price paid per foot for cast-in-drilled-hole concrete pile (signal foundation) includes full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing reinforced concrete pile foundations of the size shown on the Engineer's Estimate, including drilling holes, disposing of the material resulting from drilling holes, furnishing and placing anchor bolt assemblies and reinforcing steel, complete in place, as shown on the plans, and as specified in these specifications and the special provisions, and as directed by the Engineer.

If shown as a contract item, non-reinforced PCC foundations will be measured and paid for by the cubic yard for foundation concrete in the same manner as specified for minor concrete (minor structure) in Section 51, "Concrete Structures."

If shown as a separate contract item by the lump sum or per foot, interconnection conduit and cable includes all interconnection conductors, and conduit and pull boxes containing interconnection cable and no other conductors. The quantity of interconnection conduit and cable to be paid for by the foot is the length of that conduit. Compensation for conduit containing interconnection cable and other conductors is included in the contract price paid for the item requiring the other conductors.

Full compensation for furnishing, installing, maintaining, and removing falsework lighting equipment is included in the contract prices paid for the items of work involved in the structure that requires the falsework lighting and no additional compensation will be allowed therefor.

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## SECTION 88 ENGINEERING FABRICS
## (Issued 06-05-09)

## Replace Section 88 with:
## SECTION 88 GEOSYNTHETICS

### 88-1.01 GENERAL

#### 88-1.01A Summary

Section 88 includes specifications for geosynthetics. Geosynthetics are used for:

1. Filtration
2. Drainage
3. Reinforcement
4. Water pollution control
5. Channel and shore protection
6. Pavement interlayer
7. Separation and stabilization

#### 88-1.01B Submittals

Submit:

1. Certificate of Compliance under Section 6-1.07, "Certificates of Compliance"
2. Samples representing each lot
3. Minimum average roll values (MARV)

Label submittals with the manufacturer's name and product information.

### 88-1.01C Quality Control and Assurance

Treat geosynthetics to resist degradation from exposure to sunlight. Using covers, protect geosynthetics from moisture, sunlight, and shipping and storage damage.

## 88-1.02 FILTRATION

### 88-1.02A Filter Fabric

Geosynthetics used for filter fabric must be permeable and nonwoven. Filter fabric must consist of 1 of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Filter fabric must comply with:

**Filter Fabric**

| Property | ASTM | Specification | | |
|---|---|---|---|---|
| | | Class A | Class B | Class C |
| Grab breaking load, 1-inch grip, lb minimum in each direction | D 4632 | 157 | | |
| Apparent elongation, percent minimum in each direction | D 4632 | 50 | | |
| Hydraulic bursting strength, psi minimum | D 3786 | 210 | | |
| Ultraviolet resistance, percent minimum retained grab breaking load, 500 hr | D 4355 | 70 | | |
| Permittivity, $sec^{-1}$ minimum | D 4491 | 0.5 | 0.2 | 0.1 |
| Apparent opening size, average roll value, U.S. Standard sieve size maximum | D 4751 | 40 | 60 | 70 |

## 88-1.03 DRAINAGE

### 88-1.03A Geocomposite Wall Drain

Geocomposite wall drain must consist of a polymeric core with filter fabric integrally bonded to 1 or both sides of the core creating a stable drainage void.

Filter fabric must comply with Section 88-1.02, "Filtration."

Geocomposite wall drain must comply with:

**Geocomposite Wall Drain**

| Property | ASTM | Specification |
|---|---|---|
| Thickness with fabric, inches maximum | -- | 2 |
| Transmissivity, gradient = 1.0, normal stress = 5,000 psf, gal/min/ft | D 4716 | 4 |

## 88-1.04 REINFORCEMENT

### 88-1.04A Geotechnical Subsurface Reinforcement

**General**

Geosynthetic used for geotechnical subsurface reinforcement must be either of the following:

1. Geotextile
2. Geogrid

Geotextile permittivity must be at least 0.05 $sec^{-1}$ determined under ASTM D 4491.

Geogrid must have a regular and defined open area. The open area must be from 50 to 90 percent of the total grid area.

**Long Term Design Strength**

Long Term Design Strength (LTDS) of geosynthetic reinforcement is the ultimate tensile strength in the primary strength direction divided by reduction factors. Calculate the LTDS from the guidelines in Geosynthetic Research Institute (GRI) Standard Practice GG4a, GRI GG4b, or GRI GT7.

The product of the appropriate reduction factors must be at least 1.30. Determine the reduction factor for creep using a 75-year design life for permanent applications and a 5-year design life for temporary applications. Determine the installation damage reduction factor based on the characteristics of the backfill materials used.

If test data is not available, use default values of reduction factors in the GRI Standard Practice to calculate LTDS.

Submit the LTDS and its supporting calculations at least 15 days before placing geosynthetic reinforcement. Do not install before the Engineer's approval. The LTDS must be signed by an engineer who is registered as a civil engineer in the State.

## 88-1.05 WATER POLLUTION CONTROL

Geosynthetics used for water pollution control must comply with:

**Water Pollution Control Geosynthetics**

| Property | ASTM | Application | | | | |
|---|---|---|---|---|---|---|
| | | Silt Fence | | Sediment Filter Bag | Gravel-Filled Bags | Temporary Cover |
| | | Woven | Non-woven | | | |
| Grab breaking load, 1-inch grip, lb minimum in each direction | D 4632 | 120 | 120 | 255 | 205 | 200 |
| Apparent elongation, percent minimum, in each direction | D 4632 | 15 | 50 | -- | -- | 50 |
| Water flow rate, gallons per minute/square foot minimum and maximum average roll value | D 4491 | 10 - 100 | 100 - 150 | 80 - 200 | 80 - 150 | 75 - 120 |
| Permittivity, $sec^{-1}$ minimum | D 4491 | 0.1 | 1.1 | 1.0 | 0.2 | 1.0 |
| Apparent opening size, inches maximum average roll value | D 4751 | 0.023 | 0.023 | 0.033 | 0.016 | 0.007 |
| Ultraviolet resistance, percent minimum retained grab breaking load, 500 hr. | D 4355 | 70 | 70 | 70 | 70 | 70 |

## 88-1.06 CHANNEL AND SHORE PROTECTION

### 88-1.06A Rock Slope Protection

Rock slope protection (RSP) fabric must be a permeable, nonwoven, needle-punched geotextile. RSP fabric consists of 1 of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Polymers must be either virgin compounds or clean reworked material. Do not subject virgin compounds to use or processing other than required for initial manufacture. Clean reworked material must be previously processed material from the processor's own production that has been reground, pelletized, or solvated. RSP fabric must not consist of more than 20 percent by weight of clean reworked material. Do not use recycled materials from either post-consumer or post-industrial sources.

Class 8 or Class 10 RSP fabric must comply with:

**Rock Slope Protection Fabric**

| Property | ASTM | Specification | |
|---|---|---|---|
| | | Class 8 | Class 10 |
| Weight, oz/yd$^2$ minimum | D 5261 | 7.5 | 9.5 |
| Grab breaking load, lb 1-inch grip, min. in each direction | D 4632 | 200 | 250 |
| Apparent elongation, percent min., in each direction | D 4632 | 50 | 50 |
| Permittivity, sec$^{-1}$, minimum | D 4491 | 1.0 | 0.70 |
| Apparent opening size, U.S. Standard sieve size minimum and maximum | D 4751 | 70 - 100 | 70 - 100 |
| Ultraviolet resistance, percent minimum retained grab breaking load, 500 hr. | D4355 | 70 | 70 |

## 88-1.07 PAVEMENT INTERLAYER

### 88-1.07A Paving Fabric

Geosynthetics used for paving fabric must be nonwoven. Paving fabric must comply with:

**Geosynthetic Paving Fabric**

| Property | ASTM | Specification |
|---|---|---|
| Mass per unit area, oz/yd$^2$ minimum | D 5261 | 4.1 |
| Grab breaking load, lb 1-inch grip, minimum, in each direction | D 4632 | 100 |
| Apparent elongation, percent minimum in each direction | D 4632 | 50 |
| Hydraulic bursting strength, psi minimum | D 3786 | 200 |
| Melting point, °F minimum | D 276 | 325 |
| Asphalt retention, gal/yd$^2$ minimum | D 6140 | 0.2 |

### 88-1.07B Paving Mat

Geosynthetics used for paving mat must be a nonwoven fiberglass and polyester hybrid material. Paving mat must comply with:

**Geosynthetic Paving Mat**

| Property | ASTM | Specification |
|---|---|---|
| Breaking force, lb/2 inches minimum | D 5035 | 45 |
| Ultimate elongation, percent maximum | D 5035 | 5 |
| Mass per unit area, oz/ sq yd minimum | D 5261 | 3.7 |
| Melting point, °F minimum | D 276 | 400 |
| Asphalt retention, gal/yd$^2$ minimum | D 6140 | 0.10 |

## 88-1.07C Paving Grid

Geosynthetics used for paving grid must be a geopolymer material formed into a grid of integrally connected elements with openings. Paving grid must comply with:

**Geosynthetic Paving Grid**

| Property | Test | Specification | | |
|---|---|---|---|---|
| | | Class I | Class II | Class III |
| Tensile strength at ultimate, lb/in [a] minimum | ASTM D 6637 | 560 x 1,120 | 560 | 280 |
| Aperture size, inch minimum | Calipered | 0.5 | 0.5 | 0.5 |
| Elongation, % maximum | ASTM D 6637 | 12 | 12 | 12 |
| Mass per area, oz / sqyd minimum | ASTM D 5261 | 16 | 10 | 5.5 |
| Melting point, °F minimum | ASTM D 276 | 325 | 325 | 325 |

Note:
[a] For Class I, machine direction x cross direction. For Class II and Class III, both directions.

## 88-1.07D Paving Geocomposite Grid

Paving geocomposite grid consists of paving grid specified under Section 88-1.07C, "Paving Grid," bonded or integrated with paving fabric specified under Section 88-1.07A, "Paving Fabric."

Paving geocomposite grid must have a peel strength of at least 10 pounds per foot determined under ASTM D 413.

## 88-1.07E Geocomposite Strip Membrane

Geocomposite strip membrane must consist of various widths of strips manufactured from of asphaltic rubber and geosynthetics. Geocomposite strip membrane must comply with:

**Geocomposite Strip Membrane**

| Property | ASTM | Specification |
|---|---|---|
| Strip tensile strength, lbs/inch minimum | D 882 | 50 |
| Elongation at break, % minimum | D 882 | 50 |
| Resistance to puncture, lbs. minimum | E 154 | 200 |
| Permeance, perms maximum | E 96/E 96M | 0.10 |
| Pliability, 1/4 inch mandrel with sample conditioned at 25 °F | D 146 | No cracks in fabric or bitumen |
| Melting point, °F | D 276 | 325 |

## 88-1.08 SEPARATION AND STABILIZATION

### 88-1.08A Subgrade Enhancement Geotextile

Subgrade enhancement geotextile must consist of either of the following:

1. Polyester
2. Polypropylene

Subgrade enhancement geotextile must comply with:

**Subgrade Enhancement Geotextile**

| Property | ASTM | Specification [a] | | | | |
|---|---|---|---|---|---|---|
| | | Class A1 | Class A2 | Class B1 | Class B2 | Class B3 |
| Elongation at break, % | D 4632 | <50 | ≥50 | <50 | <50 | ≥50 |
| Grab tensile strength, lb minimum | D4632 | 250 | 160 | -- | 320 | 200 |
| Wide width tensile strength at 5% strain, lb/ft minimum | D 4595 | -- | -- | 2,000 | -- | -- |
| Wide width tensile strength at ultimate strength, lb/ft minimum | D 4595 | -- | -- | 4,800 | -- | -- |
| Tear strength, lb minimum | D 4533 | 90 | 60 | -- | 120 | 80 |
| Puncture strength, lb minimum | D 6241 | 500 | 310 | 620 | 620 | 430 |
| Permittivity, $sec^{-1}$ minimum | D 4491 | 0.05 | 0.05 | 0.20 | 0.20 | 0.20 |
| Apparent opening size, inches maximum | D 4751 | 0.012 | 0.012 | 0.024 | 0.012 | 0.012 |
| Ultraviolet stability (retained strength after 500 hrs exposure), % minimum | D 4355 | 70 | 70 | 70 | 70 | 70 |

Notes:
[a] Specifications are based on minimum average roll value in the weaker principle direction except apparent opening size is based on maximum average roll value.

## 88-1.09 PAYMENT

The Department measures and pays for geosynthetics under the specifications requiring their use.

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# SECTION 90 PORTLAND CEMENT CONCRETE
# (Issued 11-30-10)

## Replace Section 90 with:

# SECTION 90 PORTLAND CEMENT CONCRETE

# 90-1 GENERAL

## 90-1.01 DESCRIPTION

Portland cement concrete shall be composed of cementitious material, fine aggregate, coarse aggregate, admixtures if used, and water, proportioned and mixed as specified in these specifications.

The Contractor shall determine the mix proportions for concrete in conformance with these specifications.

Minor concrete shall contain not less than 505 pounds of cementitious material per cubic yard unless otherwise specified in these specifications or the special provisions.

Unless otherwise designated on the plans or specified in these specifications or the special provisions, the amount of cementitious material used per cubic yard of concrete in structures or portions of structures shall conform to the following:

| Use | Cementitious Material Content (Pounds/CY) |
|---|---|
| Concrete designated by compressive strength: | |
| Deck slabs and slab spans of bridges | 675 min., 800 max. |
| Roof sections of exposed top box culverts | 675 min., 800 max. |
| Other portions of structures | 590 min., 800 max. |
| Concrete not designated by compressive strength: | |
| Deck slabs and slab spans of bridges | 675 min. |
| Roof sections of exposed top box culverts | 675 min. |
| Prestressed members | 675 min. |
| Seal courses | 675 min. |
| Other portions of structures | 590 min. |
| Concrete for precast members | 590 min., 925 max. |

Except for minor structures, the minimum required compressive strength for concrete in structures or portions of structures shall be the strength specified, or 3600 pounds per square inch at 28 days, whichever is greater.

Except for when a modulus of rupture is specified, the minimum required compressive strength for concrete shall be the strength specified, or 2,500 pounds per square inch, whichever is greater. Concrete shall be proportioned such that the concrete will attain the minimum required compressive strength.

If the specified 28-day compressive strength is 3,600 pounds per square inch or greater, the concrete is designated by compressive strength. For concrete with a 28-day compressive strength greater than 3,600 pounds per square inch, 42 days will be allowed to obtain the specified strength.

For concrete not designated by compressive strength, the Engineer may test the concrete for compressive strength. The concrete will be accepted if the compressive strength at 28 days attains 85 percent or more of the minimum required compressive strength.

Concrete shall be proportioned to conform to the following shrinkage limitations when tested in conformance with the requirements of AASHTO Designation: T 160, modified as follows:

| Condition | Maximum Shrinkage of Laboratory Cast Specimens at 28 days Drying (average of 3, %) |
|---|---|
| Paving and approach slab concrete | 0.050 |
| Bridge deck concrete | 0.045 |

Note: Shrinkage requirement is waived for concrete that is used for precast elements.

Shrinkage tests shall be either:

A. Performed by a laboratory accredited to perform AASHTO Designation: T 160, or
B. Performed by a laboratory that maintains a current rating of 3 or better for the Cement and Concrete Reference Laboratory (CCRL) concrete proficiency sample program.

Laboratory cast specimens shall have a 4" x 4" cross section. Specimens shall be removed from the molds 23 ± 1 hours after mixing the concrete and placed in lime water at 73 ± 3 °F to 7 days age. A comparator reading shall be taken at 7 days age and recorded as the initial reading. Specimens then shall be stored in a humidity controlled room maintained at 73 ± 3 °F and 50 ± 4 percent relative humidity for the remainder of the test. Subsequent readings shall be taken at 7, 14, 21, and 28 days drying.

Test data verifying conformance to the shrinkage limitations shall be submitted with the mix design. Shrinkage testing data accepted by the Engineer no more than 3 years prior to the first working day of this contract will be acceptable for this entire contract, provided the data was for concrete with similar proportions and the same materials and material sources to be used on this contract. Concrete shall be considered to have similar proportions if, when compared to concrete to be used on this project, no more than 2 mix design elements are varied. Varied mix design elements shall fall within the tolerances in the following table:

| Mix Design Element | Tolerance (±) |
|---|---|
| Water to cementitious material ratio | 0.03 |
| Total water content | 5 % |
| Coarse aggregate (weight per cubic yard) | 10 % |
| Fine aggregate (weight per cubic yard) | 10 % |
| Supplementary cementitious material content | 5 % |
| Admixture (as originally dosed) | 25 % |

Note: Admixtures must be of the same brand.

Before using concrete or in advance of revising the mix proportions, the Contractor shall submit in writing to the Engineer a copy of the mix design.

Compliance with cementitious material content requirements will be verified in conformance with procedures described in California Test 518 for cement content. For testing purposes, supplementary cementitious material (SCM) shall be considered to be cement. Batch proportions shall be adjusted as necessary to produce concrete having the specified cementitious material content.

If any concrete has a cementitious material, portland cement, or SCM content that is less than the minimum required, the concrete shall be removed. However, if the Engineer determines that the concrete is structurally adequate, the concrete may remain in place and the Contractor shall pay to the State $0.25 for each pound of cementitious material, portland cement, or SCM that is less than the minimum required. The Department may deduct the amount from any moneys due, or that may become due, the Contractor under the contract. The deductions will not be made unless the difference between the contents required

and those actually provided exceeds the batching tolerances permitted by Section 90-5, "Proportioning." No deductions will be made based on the results of California Test 518.

The requirements of the preceding paragraph shall not apply to minor concrete.

# 90-2 MATERIALS

## 90-2.01 CEMENTITIOUS MATERIALS

Unless otherwise specified, cementitious material shall be either a combination of Type II or Type V portland cement and SCM, or a blended cement. No cementitious material shall be used in the work unless it is on the Department's Pre-Qualified Products List at the time of mix design submittal. Information regarding cementitious material qualification and placement on the Department's approved list can be obtained at the Transportation Laboratory.

Cementitious materials used in cast-in-place concrete for exposed surfaces of like elements of a structure shall be from the same sources and of the same proportions.

Cementitious materials shall be protected from moisture until used. Sacked cementitious materials shall be piled to permit access for tallying, inspecting, and identifying each shipment.

Facilities shall be provided to ensure that the various cementitious materials meeting this Section 90-2.01 are kept separate from each other and from other cementitious materials. A storage silo containing a cementitous material shall be emptied before using that silo for a different cementitious material. Blended cements with a percentage of SCM differing by more than 2 percentage points are considered different cementitious materials. Sampling cementitious materials shall be in conformance with California Test 125.

The Contractor shall furnish a Certificate of Compliance for cementitious materials in conformance with the provisions in Section 6-1.07, "Certificates of Compliance." The Certificate of Compliance shall indicate the source by name and location (including country, state, and city). If cementitious material is delivered directly to the job site, the Certificate of Compliance shall be signed by the cementitious material supplier. If the cementitious material is used in ready-mixed concrete or in precast concrete products purchased as such by the Contractor, the Certificate of Compliance shall be signed by the manufacturer of the concrete or product. If blended cement is used, the Certificate of Compliance shall include a statement signed by the blended cement supplier that indicates the actual percentage, by weight, of SCM in the blend. Weight of SCM shall be by weighing device conforming to Section 9-1.01, "Measurement of Quantities," or as determined by chemical analysis.

### 90-2.01A Cement

Portland cement shall conform to the requirements in ASTM Designation: C 150 except the $C_3S$ content of Type II cement shall not exceed 65 percent.

Blended cement shall conform to the requirements for Portland Blast-Furnace Slag Cement, Type IS (MS) or Portland-Pozzolan Cement, Type IP (MS) in AASHTO Designation: M 240, except that the maximum limits on the pozzolan content shall not apply. Blended cement shall be comprised of Type II or Type V cement and SCM produced either by intergrinding portland cement clinker and SCM, by blending portland cement and either finely ground granulated blast furnace slag or finely divided pozzolan, or a combination of intergrinding and blending.

In addition, Type II portland cement and Type V portland cement shall conform to the following requirements:

A. The cement shall not contain more than 0.60-percent by mass of alkalies, calculated as the percentage of $Na_2O$ plus 0.658 times the percentage of $K_2O$, when determined by methods as required in AASHTO Designation: T 105; and
B. The autoclave expansion shall not exceed 0.50-percent

Type III portland cement shall be used only as specified or with the approval of the Engineer. Type III portland cement shall conform to the additional requirements listed above for Type II portland cement. The Contractor may use Type III portland cement in the manufacturing of precast concrete.

### 90-2.01B Supplementary Cementitious Materials

Each supplementary cementitious material shall conform to one of the following:

A. Fly ash conforming to the requirements in AASHTO Designation: M 295, Class F, and these specifications. The available alkali, as sodium oxide equivalent, shall not exceed 1.5 percent when determined in conformance with the requirements in ASTM Designation: C 311 or the total alkali, as sodium oxide equivalent, shall not exceed 5.0 percent when determined in conformance with the requirements in AASHTO Designation: T 105.
B. Ultra fine fly ash (UFFA) conforming to the requirements in AASHTO Designation: M 295, Class F, and the following chemical and physical requirements:

| Chemical Requirements | Percent |
|---|---|
| Sulfur Trioxide ($SO_3$) | 1.5 max. |
| Loss on ignition | 1.2 max. |
| Available Alkalies (as $Na_2O$) equivalent | 1.5 max. |

| Physical Requirements | Percent |
|---|---|
| Particle size distribution | |
| Less than 3.5 microns | 50 |
| Less than 9.0 microns | 90 |
| Strength Activity Index with portland cement | |
| 7 days | 95 (minimum % of control) |
| 28 days | 110 (minimum % of control) |
| Expansion at 16 days when testing job materials in conformance with ASTM C 1567* | 0.10 max. |

* In the test mix, Type II or Type V portland cement shall be replaced with at least 12% UFFA by weight.

C. Raw or calcined natural pozzolans conforming to the requirements in AASHTO Designation: M 295, Class N. and the following requirements and these specifications. The available alkali, as sodium oxide equivalent, shall not exceed 1.5 percent when determined in conformance with the requirements in ASTM Designation: C 311 or the total alkali, as sodium oxide equivalent, shall not exceed 5.0 percent when determined in conformance with the requirements in AASHTO Designation: T 105.

D. Metakaolin conforming to the requirements in AASHTO Designation: M 295, Class N, and the following chemical and physical requirements:

| Chemical Requirements | Percent |
|---|---|
| Silicon Dioxide ($SiO_2$) + Aluminum Oxide ($Al_2O_3$) | 92.0 min. |
| Calcium Oxide (CaO) | 1.0 max |
| Sulfur Trioxide ($SO_3$) | 1.0 max. |
| Loss on ignition | 1.2 max. |
| Available Alkalies (as $Na_2O$) equivalent | 1.0 max. |

| Physical Requirements | Percent |
|---|---|
| Particle size distribution<br>Less than 45 microns | 95 |
| Strength Activity Index with portland cement<br>7 days<br>28 days | <br>100 (minimum % of control)<br>100 (minimum % of control) |

E. Ground Granulated Blast Furnace Slag (GGBFS) conforming to the requirements in AASHTO Designation: M 302, Grade 100 or Grade 120.
F. Silica Fume conforming to the requirements of AASHTO Designation: M 307, with reduction in mortar expansion of 80 percent, minimum, using the cement from the proposed mix design.

Commingling of fly ash from different sources at uncontrolled ratios is permissible only if the following criteria are satisfied:

A. Sources of fly ash to be commingled shall each produce fly ash that conforms to the requirements in AASHTO Designation: M 295, Class F.
B. Testing of the commingled product is the responsibility of the fly ash supplier.
C. Each fly ash's running average of relative density shall not differ from any other by more than 0.25 pound per cubic inch at the time of commingling.
D. Each fly ash's running average of loss on ignition shall not differ from any other by more than one percent at the time of commingling.
E. The final product of commingled fly ash shall conform to the requirements in AASHTO Designation: M 295, Class F.

### 90-2.01C Required Use Of Supplementary Cementitious Materials

**General**

The amount of portland cement and SCM used in portland cement concrete shall conform to the minimum cementitious material content provisions in Section 90-1.01, "Description," or Section 90-4.05, "Optional Use of Chemical Admixtures," and these specifications.

The SCM content in portland cement concrete shall conform to one of the following:

A. Any combination of portland cement and at least one SCM, satisfying Equations (1) and (2):

Equation (1)

$$\frac{(25 \times UF) + (12 \times FA) + (10 \times FB) + (6 \times SL)}{MC} \geq X$$

Where:

UF = Silica fume, metakaolin, or UFFA, including the amount in blended cement, pounds per cubic yard.
FA = Fly ash or natural pozzolan conforming to the requirements in AASHTO Designation: M 295, Class F or N with a CaO content up to 10 percent, including the amount in blended cement, pounds per cubic yard.
FB = Fly ash or natural pozzolan conforming to the requirements in AASHTO Designation: M 295, Class F or N with a CaO content up to 15 percent, including the amount in blended cement, pounds per cubic yard.
SL = GGBFS, including the amount in blended cement, pounds per cubic yard.
MC = Minimum amount of cementitious material specified, pounds per cubic yard.
X = 1.8 for innocuous aggregate, 3.0 for all other aggregate.

Equation (2)

$$MC - MSCM - PC \geq 0$$

Where:

MC = Minimum amount of cementitious material specified, pounds per cubic yard.
MSCM = The minimum sum of SCMs that satisfies Equation (1) above, pounds per cubic yard.
PC = The amount of portland cement, including the amount in blended cement, pounds per cubic yard.

B. 15 percent of Class F fly ash with at least 48 ounces of $LiNO_3$ solution added per 100 pounds of portland cement. CaO content of the fly ash shall not exceed 15 percent.

**Precast Concrete**

The SCM content in precast portland cement concrete shall conform to one of the following:

A. Any combination of portland cement and SCM, satisfying the following equation:

Equation (3)

$$\frac{(25 \times UF) + (12 \times FA) + (10 \times FB) + (6 \times SL)}{TC} \geq X$$

Where:

UF = Silica fume, metakaolin, or UFFA, including the amount in blended cement, pounds per cubic yard.
FA = Fly ash or natural pozzolan conforming to the requirements in AASHTO Designation: M 295, Class F or N with a CaO content up to 10 percent, including the amount in blended cement, pounds per cubic yard.
FB = Fly ash or natural pozzolan conforming to the requirements in AASHTO Designation: M 295, Class F or N with a CaO content up to 15 percent, including the amount in blended cement, pounds per cubic yard.
SL = GGBFS, including the amount in blended cement, pounds per cubic yard.
TC = Total amount of cementitious material used in the mix, pounds per cubic yard.
X = 0.0 if precast members are constructed with portland cement concrete using aggregate that is "innocuous" in conformance with the provisions in Section 90-2.02, "Aggregates."
X = 3.0 for all other aggregate.

B. 15 percent of Class F fly ash with at least 48 ounces of $LiNO_3$ solution added per 100 pounds of portland cement. CaO content of the fly ash shall not exceed 15 percent.
C. Any combination of supplementary cementitious material and portland cement may be used if the expansion of cementitious material and aggregate does not exceed 0.10 percent when tested in conformance with the requirements in ASTM C 1567. Test data shall be submitted with each mix design. Test data accepted by the Engineer no more than 3 years prior to the first working day of this contract will be acceptable for this entire contract, provided the data was for the same concrete mix and the same materials and material sources to be used on this contract.

## 90-2.02 AGGREGATES

To be considered innocuous, aggregate must be on the Department's approved list, "Innocuous Aggregates for use in Concrete." Information regarding aggregate qualification and placement on the Department's approved list can be obtained at the Transportation Laboratory.

Both coarse and fine aggregate must be on the approved list for the aggregate used in concrete to be considered innocuous.

Aggregates shall be free from deleterious coatings, clay balls, roots, bark, sticks, rags, and other extraneous material.

The Contractor shall provide safe and suitable facilities, including necessary splitting devices for obtaining samples of aggregates, in conformance with California Test 125.

Aggregates shall be of such character that it will be possible to produce workable concrete within the limits of water content provided in Section 90-6.06, "Amount of Water and Penetration."

Aggregates shall have not more than 10 percent loss when tested for soundness in conformance with the requirements in California Test 214. The soundness requirement for fine aggregate will be waived, provided that the durability index, $D_f$, of the fine aggregate is 60 or greater when tested for durability in conformance with California Test 229.

If the results of any one or more of the Cleanness Value, Sand Equivalent, or aggregate grading tests do not meet the requirements specified for "Operating Range" but all meet the "Contract Compliance" requirements, the placement of concrete shall be suspended at the completion of the current pour until tests or other information indicate that the next material to be used in the work will comply with the requirements specified for "Operating Range."

If the results of either or both the Cleanness Value and coarse aggregate grading tests do not meet the requirements specified for "Contract Compliance," the concrete that is represented by the tests shall be removed. However, if the Engineer determines that the concrete is structurally adequate, the concrete may remain in place, and the Contractor shall pay to the State $3.50 per cubic yard for paving concrete and $5.50 per cubic yard for all other concrete for the concrete represented by these tests and left in place. The Department may deduct the amount from any moneys due, or that may become due, the Contractor under the contract.

If the results of either or both the Sand Equivalent and fine aggregate grading tests do not meet the requirements specified for "Contract Compliance," the concrete which is represented by the tests shall be removed. However, if the Engineer determines that the concrete is structurally adequate, the concrete may remain in place, and the Contractor shall pay to the State $3.50 per cubic yard for paving concrete and $5.50 per cubic yard for all other concrete for the concrete represented by these tests and left in place. The Department may deduct the amount from any moneys due, or that may become due, the Contractor under the contract.

The 2 preceding paragraphs apply individually to the "Contract Compliance" requirements for coarse aggregate and fine aggregate. When both coarse aggregate and fine aggregate do not conform to the "Contract Compliance" requirements, both paragraphs shall apply. The payments specified in those paragraphs are in addition to any payments made in conformance with the provisions in Section 90-1.01, "Description."

No single Cleanness Value, Sand Equivalent, or aggregate grading test shall represent more than 300 cubic yards of concrete or one day's pour, whichever is smaller.

When the source of an aggregate is changed, the Contractor shall adjust the mix proportions and submit in writing to the Engineer a copy of the mix design before using the aggregates.

### 90-2.02A Coarse Aggregate

Coarse aggregate shall consist of gravel, crushed gravel, crushed rock, reclaimed aggregate, crushed air-cooled iron blast furnace slag or combinations thereof. Crushed air-cooled blast furnace slag shall not be used in reinforced or prestressed concrete.

Reclaimed aggregate is aggregate that has been recovered from plastic concrete by washing away the cementitious material. Reclaimed aggregate shall conform to all aggregate requirements.

Coarse aggregate shall conform to the following quality requirements:

| Tests | California Test | Requirements |
|---|---|---|
| Loss in Los Angeles Rattler (after 500 revolutions) | 211 | 45% max. |
| Cleanness Value | | |
| Operating Range | 227 | 75 min. |
| Contract Compliance | 227 | 71 min. |

In lieu of the above Cleanness Value requirements, a Cleanness Value "Operating Range" limit of 71, minimum, and a Cleanness Value "Contract Compliance" limit of 68, minimum, will be used to determine the acceptability of the coarse aggregate if the Contractor furnishes a Certificate of Compliance, as provided in Section 6-1.07, "Certificates of Compliance," certifying that:

A. Coarse aggregate sampled at the completion of processing at the aggregate production plant had a Cleanness Value of not less than 82 when tested in conformance with the requirements in California Test 227; and
B. Prequalification tests performed in conformance with the requirements in California Test 549 indicated that the aggregate would develop a relative strength of not less than 95 percent and would have a relative shrinkage not greater than 105 percent, based on concrete.

### 90-2.02B Fine Aggregate

Fine aggregate shall consist of natural sand, manufactured sand produced from larger aggregate or a combination thereof. Manufactured sand shall be well graded.

Fine aggregate shall conform to the following quality requirements:

| Test | California Test | Requirements |
|---|---|---|
| Organic Impurities | 213 | Satisfactory[a] |
| Sand Equivalent: | | |
| Operating Range | 217 | 75, min. |
| Contract Compliance | 217 | 71, min. |

[a] Fine aggregate developing a color darker than the reference standard color may be accepted if 95% relative mortar strength is achieved when tested in conformance with ASTM C87.

In lieu of the above Sand Equivalent requirements, a Sand Equivalent "Operating Range" limit of 71, minimum, and a Sand Equivalent "Contract Compliance" limit of 68, minimum, will be used to determine the acceptability of the fine aggregate if the Contractor furnishes a Certificate of Compliance, as provided in Section 6-1.07, "Certificates of Compliance," certifying that:

A. Fine aggregate sampled at the completion of processing at the aggregate production plant had a Sand Equivalent value of not less than 82 when tested by California Test 217; and

B. Prequalification tests performed in conformance with California Test 549 indicated that the aggregate would develop a relative strength of not less than 95 percent and would have a relative shrinkage not greater than 105 percent, based on concrete.

## 90-2.03 WATER

In conventionally reinforced concrete work, the water for curing, for washing aggregates, and for mixing shall be free from oil and shall not contain more than 1,000 parts per million of chlorides as Cl, when tested in conformance with California Test 422, nor more than 1,300 parts per million of sulfates as $SO_4$, when tested in conformance with California Test 417. In prestressed concrete work, the water for curing, for washing aggregates, and for mixing shall be free from oil and shall not contain more than 650 parts per million of chlorides as Cl, when tested in conformance with California Test 422, nor more than 1,300 parts per million of sulfates as $SO_4$, when tested in conformance with California Test 417. In no case shall the water contain an amount of impurities that will cause either: 1) a change in the setting time of cement of more than 25 percent when tested in conformance with the requirements in ASTM Designation: C 191 or ASTM Designation: C 266 or 2) a reduction in the compressive strength of mortar at 14 days of more than 5 percent, when tested in conformance with the requirements in ASTM Designation: C 109, when compared to the results obtained with distilled water or deionized water, tested in conformance with the requirements in ASTM Designation: C 109.

In nonreinforced concrete work, the water for curing, for washing aggregates and for mixing shall be free from oil and shall not contain more than 2,000 parts per million of chlorides as Cl, when tested in conformance with California Test 422, or more than 1,500 parts per million of sulfates as $SO_4$, when tested in conformance with California Test 417.

In addition to the above provisions, water for curing concrete shall not contain impurities in a sufficient amount to cause discoloration of the concrete or produce etching of the surface.

Water reclaimed from mixer wash-out operations may be used in mixing concrete. The water shall not contain coloring agents or more than 300 parts per million of alkalis ($Na_2O$ + 0.658 $K_2O$) as determined on the filtrate. The specific gravity of the water shall not exceed 1.03 and shall not vary more than ±0.010 during a day's operations.

## 90-2.04 Admixture Materials

Admixture materials shall be stored and dispersed in liquid form and conform to the following requirements:

A. Chemical Admixtures—ASTM Designation: C 494.
B. Air-entraining Admixtures—ASTM Designation: C 260.
C. Lithium Nitrate shall be in an aqueous solution conforming to the following:

1. Lithium Nitrate ($LiNO_3$) must be 30 percent +/- 0.5 percent by weight
2. Sulfate ($SO_4$) must be less than 1000 ppm
3. Chloride (Cl) must be less than 1000 ppm
4. Alkalis ($Na_2O$ + 0.658 $K_2O$) must be less than 1000 ppm

# 90-3 AGGREGATE GRADINGS

## 90-3.01 GENERAL

Before beginning concrete work, the Contractor shall submit in writing to the Engineer the gradation of the primary aggregate nominal sizes that the Contractor proposes to furnish. If a primary coarse aggregate or the fine aggregate is separated into 2 or more sizes, the proposed gradation shall consist of the gradation for each individual size, and the proposed proportions of each individual size, combined mathematically to indicate one proposed gradation. The proposed gradation shall meet the grading requirements shown in the table in this section, and shall show the percentage passing each of the sieve sizes used in determining the end result.

The Engineer may waive, in writing, the gradation requirements in this Section 90-3.01 and in Sections 90-3.02, "Coarse Aggregate Grading," 90-3.03, "Fine Aggregate Grading," and 90-3.04, "Combined Aggregate Gradings," if, in the Engineer's opinion, furnishing the gradation is not necessary for the type or amount of concrete work to be constructed.

Gradations proposed by the Contractor shall be within the following percentage passing limits:

| Primary Aggregate Nominal Size | Sieve Size | Limits of Proposed Gradation |
|---|---|---|
| 1-1/2" x 3/4" | 1" | 19 - 41 |
| 1" x No. 4 | 3/4" | 52 - 85 |
| 1" x No. 4 | 3/8" | 15 - 38 |
| 1/2" x No. 4 | 3/8" | 40 - 78 |
| 3/8" x No. 8 | 3/8" | 50 - 85 |
| Fine Aggregate | No. 16 | 55 - 75 |
| Fine Aggregate | No. 30 | 34 - 46 |
| Fine Aggregate | No. 50 | 16 - 29 |

Should the Contractor change the source of supply, the Contractor shall submit in writing to the Engineer the new gradations before their intended use.

## 90-3.02 COARSE AGGREGATE GRADING

The grading requirements for coarse aggregates are shown in the following table for each size of coarse aggregate:

| | Percentage Passing Primary Aggregate Nominal Sizes | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-1/2" x 3/4" | | 1" x No. 4 | | 1/2" x No. 4 | | 3/8" x No. 8 | |
| Sieve Sizes | Operating Range | Contract Compliance | Operating Range | Contract Compliance | Operating Range | Contract Compliance | Operating Range | Contract Compliance |
| 2" | 100 | 100 | — | — | — | — | — | — |
| 1-1/2" | 88 - 100 | 85 - 100 | 100 | 100 | — | — | — | — |
| 1" | X ±18 | X ±25 | 88 - 100 | 86 - 100 | — | — | — | — |
| 3/4" | 0 - 17 | 0 - 20 | X ±15 | X ±22 | 100 | 100 | — | — |
| 1/2" | — | — | — | — | 82 - 100 | 80 - 100 | 100 | 100 |
| 3/8" | 0 - 7 | 0 - 9 | X ±15 | X ±22 | X ±15 | X ±22 | X ±15 | X ±20 |
| No. 4 | — | — | 0 - 16 | 0 - 18 | 0 - 15 | 0 - 18 | 0 - 25 | 0 - 28 |
| No. 8 | — | — | 0 - 6 | 0 - 7 | 0 - 6 | 0 - 7 | 0 - 6 | 0 - 7 |

In the above table, the symbol X is the gradation that the Contractor proposes to furnish for the specific sieve size as provided in Section 90-3.01, "General."

Coarse aggregate for the 1-1/2 inch, maximum, combined aggregate grading as provided in Section 90-3.04, "Combined Aggregate Gradings," shall be furnished in 2 or more primary aggregate nominal sizes. Each primary aggregate nominal size may be separated into 2 sizes and stored separately, provided that the combined material conforms to the grading requirements for that particular primary aggregate nominal size.

When the one inch, maximum, combined aggregate grading as provided in Section 90-3.04, "Combined Aggregate Gradings," is to be used, the coarse aggregate may be separated into 2 sizes and stored separately, provided that the combined material shall conform to the grading requirements for the 1" x No. 4 primary aggregate nominal size.

## 90-3.03 FINE AGGREGATE GRADING

Fine aggregate shall be graded within the following limits:

| Sieve Sizes | Percentage Passing | |
|---|---|---|
| | Operating Range | Contract Compliance |
| 3/8" | 100 | 100 |
| No. 4 | 95 - 100 | 93 - 100 |
| No. 8 | 65 - 95 | 61 - 99 |
| No. 16 | X ±10 | X ±13 |
| No. 30 | X ±9 | X ±12 |
| No. 50 | X ±6 | X ±9 |
| No. 100 | 2 - 12 | 1 - 15 |
| No. 200 | 0 - 8 | 0 - 10 |

In the above table, the symbol X is the gradation that the Contractor proposes to furnish for the specific sieve size as provided in Section 90-3.01, "General."

In addition to the above required grading analysis, the distribution of the fine aggregate sizes shall be such that the difference between the total percentage passing the No. 16 sieve and the total percentage passing the No. 30 sieve shall be between 10 and 40, and the difference between the percentage passing the No. 30 and No. 50 sieves shall be between 10 and 40.

Fine aggregate may be separated into 2 or more sizes and stored separately, provided that the combined material conforms to the grading requirements specified in this Section 90-3.03.

## 90-3.04 COMBINED AGGREGATE GRADINGS

Combined aggregate grading limits shall be used only for the design of concrete mixes. Concrete mixes shall be designed so that aggregates are combined in proportions that shall produce a mixture within the grading limits for combined aggregates as specified herein.

The combined aggregate grading, except when otherwise specified in these specifications or the special provisions, shall be either the 1-1/2 inch, maximum grading, or the 1 inch, maximum grading, at the option of the Contractor.

Grading Limits of Combined Aggregates

| | Percentage Passing | | | |
|---|---|---|---|---|
| Sieve Sizes | 1-1/2" Max. | 1" Max. | 1/2" Max. | 3/8" Max. |
| 2" | 100 | — | — | — |
| 1-1/2" | 90 - 100 | 100 | — | — |
| 1" | 50 - 86 | 90 - 100 | — | — |
| 3/4" | 45 - 75 | 55 - 100 | 100 | — |
| 1/2" | — | — | 90 - 100 | 100 |
| 3/8" | 38 - 55 | 45 - 75 | 55 - 86 | 50 - 100 |
| No. 4 | 30 - 45 | 35 - 60 | 45 - 63 | 45 - 63 |
| No. 8 | 23 - 38 | 27 - 45 | 35 - 49 | 35 - 49 |
| No. 16 | 17 - 33 | 20 - 35 | 25 - 37 | 25 - 37 |
| No. 30 | 10 - 22 | 12 - 25 | 15 - 25 | 15 - 25 |
| No. 50 | 4 - 10 | 5 - 15 | 5 - 15 | 5 - 15 |
| No. 100 | 1 - 6 | 1 - 8 | 1 - 8 | 1 - 8 |
| No. 200 | 0 - 3 | 0 - 4 | 0 - 4 | 0 - 4 |

Changes from one grading to another shall not be made during the progress of the work unless permitted by the Engineer.

## 90-4 ADMIXTURES

### 90-4.01 GENERAL

Admixtures used in portland cement concrete shall conform to and be used in conformance with the provisions in this Section 90-4 and the special provisions. Admixtures shall be used when specified or ordered by the Engineer and may be used at the Contractor's option as provided herein.

Chemical admixtures and air-entraining admixtures containing chlorides as Cl in excess of one percent by weight of admixture, as determined by California Test 415, shall not be used.

Admixtures shall be uniform in properties throughout their use in the work. Should it be found that an admixture as furnished is not uniform in properties, its use shall be discontinued.

If more than one admixture is used, the admixtures shall be compatible with each other so that the desirable effects of all admixtures used will be realized.

Chemical admixtures shall be used in conformance with the manufacturer's written recommendations. The manufacturer's written recommendations shall include a statement that the admixtures are compatible with the types and amounts of SCMs used.

### 90-4.02 MATERIALS

Admixture materials shall conform to the provisions in Section 90-2.04, "Admixture Materials."

### 90-4.03 ADMIXTURE APPROVAL

No admixture brand shall be used in the work unless it is on the Department's current list of approved brands for the type of admixture involved. Information regarding admixture qualification and placement on the Department's list can be obtained at the Transportation Laboratory.

If the Contractor proposes to use an admixture of a brand and type on the current list of approved admixture brands, the Contractor shall furnish a Certificate of Compliance from the manufacturer, as provided in Section 6-1.07, "Certificates of Compliance," certifying that the admixture furnished is the same as that previously approved. If a previously approved admixture is not accompanied by a Certificate of Compliance, the admixture shall not be used in the work until the Engineer has had sufficient time to make the appropriate tests and has approved the admixture for use. The Engineer may take samples for testing at any time, whether or not the admixture has been accompanied by a Certificate of Compliance.

## 90-4.04 REQUIRED USE OF CHEMICAL ADMIXTURES

If the use of a chemical admixture is specified, the admixture shall be used at the dosage specified, except that if no dosage is specified, the admixture shall be used at the dosage normally recommended by the manufacturer of the admixture.

## 90-4.05 OPTIONAL USE OF CHEMICAL ADMIXTURES

The Contractor may use Type A or F, water-reducing; Type B, retarding; or Type D or G, water-reducing and retarding admixtures as described in ASTM Designation: C 494 to conserve cementitious material or to facilitate any concrete construction application subject to the following conditions:

A. If a water-reducing admixture or a water-reducing and retarding admixture is used, the cementitious material content specified or ordered may be reduced by a maximum of 5 percent by weight, except that the resultant cementitious material content shall be not less than 505 pounds per cubic yard; and
B. When a reduction in cementitious material content is made, the dosage of admixture used shall be no less than the dosage used in determining approval of the admixture.

The Contractor may use Type S admixtures conforming to the requirements in ASTM Designation: C 494.

Unless otherwise specified, a Type C accelerating chemical admixture conforming to the requirements in ASTM Designation: C 494, may be used in portland cement concrete. Inclusion in the mix design submitted for approval will not be required provided that the admixture is added to counteract changing conditions that contribute to delayed setting of the portland cement concrete, and the use or change in dosage of the admixture is approved in writing by the Engineer.

## 90-4.06 REQUIRED USE OF AIR-ENTRAINING ADMIXTURES

When air-entrainment is specified or ordered by the Engineer, the air-entraining admixture shall be used in amounts to produce a concrete having the specified air content as determined by California Test 504.

## 90-4.07 OPTIONAL USE OF AIR-ENTRAINING ADMIXTURES

When air-entrainment has not been specified or ordered by the Engineer, the Contractor will be permitted to use an air-entraining admixture to facilitate the use of any construction procedure or equipment provided that the average air content, as determined by California Test 504, of 3 successive tests does not

exceed 4 percent, and no single test value exceeds 5.5 percent. If the Contractor elects to use an air-entraining admixture in concrete for pavement, the Contractor shall so indicate at the time the Contractor designates the source of aggregate.

## 90-4.08 BLANK

## 90-4.09 BLANK

## 90-4.10 PROPORTIONING AND DISPENSING LIQUID ADMIXTURES

Chemical admixtures and air-entraining admixtures shall be dispensed in liquid form. Dispensers for liquid admixtures shall have sufficient capacity to measure at one time the prescribed quantity required for each batch of concrete. Each dispenser shall include a graduated measuring unit into which liquid admixtures are measured to within ±5 percent of the prescribed quantity for each batch. Dispensers shall be located and maintained so that the graduations can be accurately read from the point at which proportioning operations are controlled to permit a visual check of batching accuracy prior to discharge. Each measuring unit shall be clearly marked for the type and quantity of admixture.

Each liquid admixture dispensing system shall be equipped with a sampling device consisting of a valve located in a safe and readily accessible position such that a sample of the admixture may be withdrawn slowly by the Engineer.

If more than one liquid admixture is used in the concrete mix, each liquid admixture shall have a separate measuring unit and shall be dispensed by injecting equipment located in such a manner that the admixtures are not mixed at high concentrations and do not interfere with the effectiveness of each other. When air-entraining admixtures are used in conjunction with other liquid admixtures, the air-entraining admixture shall be the first to be incorporated into the mix, unless it is demonstrated that a different sequence improves performance.

When automatic proportioning devices are required for concrete pavement, dispensers for liquid admixtures shall operate automatically with the batching control equipment. The dispensers shall be equipped with an automatic warning system in good operating condition that will provide a visible or audible signal at the point at which proportioning operations are controlled when the quantity of admixture measured for each batch of concrete varies from the preselected dosage by more than 5 percent, or when the entire contents of the measuring unit are not emptied from the dispenser into each batch of concrete.

Unless liquid admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow into the stream of water so that the admixtures are well dispersed throughout the batch, except that air-entraining admixtures may be dispensed directly into moist sand in the batching bins provided that adequate control of the air content of the concrete can be maintained.

Liquid admixtures requiring dosages greater than one-half gallon per cubic yard shall be considered to be water when determining the total amount of free water as specified in Section 90-6.06, "Amount of Water and Penetration."

## 90-4.11 BLANK

# 90-5 PROPORTIONING

## 90-5.01 STORAGE OF AGGREGATES

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size shall be avoided and the various sizes shall not become intermixed before proportioning.

Aggregates shall be stored or stockpiled and handled in a manner that prevent contamination by foreign materials. In addition, storage of aggregates at batching or mixing facilities that are erected subsequent to the award of the contract and that furnish concrete to the project shall conform to the following:

A. Intermingling of the different sizes of aggregates shall be positively prevented. The Contractor shall take the necessary measures to prevent intermingling. The preventive measures may include, but are not necessarily limited to, physical separation of stockpiles or construction of bulkheads of adequate length and height; and
B. Contamination of aggregates by contact with the ground shall be positively prevented. The Contractor shall take the necessary measures to prevent contamination. The preventive measures shall include, but are not necessarily limited to, placing aggregates on wooden platforms or on hardened surfaces consisting of portland cement concrete, asphalt concrete, or cement treated material.

In placing aggregates in storage or in moving the aggregates from storage to the weigh hopper of the batching plant, any method that may cause segregation, degradation, or the combining of materials of different gradings that will result in any size of aggregate at the weigh hopper failing to meet the grading requirements, shall be discontinued. Any method of handling aggregates that results in excessive breakage of particles shall be discontinued. The use of suitable devices to reduce impact of falling aggregates may be required by the Engineer.

## 90-5.02 PROPORTIONING DEVICES

Weighing, measuring, or metering devices used for proportioning materials shall conform to the requirements in Section 9-1.01, "Measurement of Quantities," and this Section 90-5.02. In addition, automatic weighing systems shall comply with the requirements for automatic proportioning devices in Section 90-5.03A, "Proportioning for Pavement." Automatic devices shall be automatic to the extent that the only manual operation required for proportioning the aggregates, cement, and SCM for one batch of concrete is a single operation of a switch or starter.

Proportioning devices shall be tested as frequently as the Engineer may deem necessary to ensure their accuracy.

Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the plant is in operation, the weight of each batch of material shall not vary from the weight designated by the Engineer by more than the tolerances specified herein.

Equipment for cumulative weighing of aggregate shall have a zero tolerance of ±0.5 percent of the designated total batch weight of the aggregate. For systems with individual weigh hoppers for the various sizes of aggregate, the zero tolerance shall be ±0.5 percent of the individual batch weight designated for each size of aggregate. Equipment for cumulative weighing of cement and SCM shall have a zero tolerance of ±0.5 percent of the designated total batch weight of the cement and SCM. Equipment for weighing cement or SCM separately shall have a zero tolerance of ±0.5 percent of their designated

individual batch weights. Equipment for measuring water shall have a zero tolerance of ±0.5 percent of its designated weight or volume.

The weight indicated for any batch of material shall not vary from the preselected scale setting by more than the following:

A. Aggregate weighed cumulatively shall be within 1.0 percent of the designated total batch weight of the aggregate. Aggregates weighed individually shall be within 1.5 percent of their respective designated batch weights; and
B. Cement shall be 99 to 102 percent of its designated batch weight. When weighed individually, SCM shall be 99 to 102 percent of its designated batch weight. When SCM and cement are permitted to be weighed cumulatively, cement shall be weighed first to 99 to 102 percent of its designated batch weight, and the total for cement and SCM shall be 99 to 102 percent of the sum of their designated batch weights When a blended cement is used, the percentages of cement and SCM used for calculating batch weights shall be based on the percentage of SCM indicated in the Certificate of Compliance from the blended cement supplier; and
C. Water shall be within 1.5 percent of its designated weight or volume.

Each scale graduation shall be approximately 0.001 of the total capacity of the scale. The capacity of scales for weighing cement, SCM, or cement plus SCM and aggregates shall not exceed that of commercially available scales having single graduations indicating a weight not exceeding the maximum permissible weight variation above, except that no scale shall be required having a capacity of less than 1,000 pounds, with one pound graduations.

## 90-5.03 PROPORTIONING

Proportioning shall consist of dividing the aggregates into the specified sizes, each stored in a separate bin, and combining them with cementitious material and water as provided in these specifications. Aggregates shall be proportioned by weight.

At the time of batching, aggregates shall have been dried or drained sufficiently to result in a stable moisture content such that no visible separation of water from aggregate will take place during transportation from the proportioning plant to the point of mixing. In no event shall the free moisture content of the fine aggregate at the time of batching exceed 8 percent of its saturated, surface-dry weight.

Should separate supplies of aggregate material of the same size group, but of different moisture content or specific gravity or surface characteristics affecting workability, be available at the proportioning plant, withdrawals shall be made from one supply exclusively and the materials therein completely exhausted before starting upon another.

Bulk Type IP (MS) or Type IS (MS) cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the ingredients are released for discharge into the mixer.

Bulk cement and SCM may be weighed in separate, individual weigh hoppers or may be weighed in the same weigh hopper and shall be kept separate from the aggregates until the ingredients are released for discharge into the mixer. If the cement and SCM are weighed cumulatively, the cement shall be weighed first.

If cement and SCM are weighed in separate weigh hoppers, the weigh systems for the proportioning of the aggregate, the cement, and the SCM shall be individual and distinct from all other weigh systems. Each weigh system shall be equipped with a hopper, a lever system, and an indicator to constitute an individual and independent material-weighing device. The cement and the SCM shall be discharged into the mixer simultaneously with the aggregate.

The scales and weigh hoppers for bulk weighing cement, SCM, or cement plus SCM shall be separate and distinct from the aggregate weighing equipment.

For batches of one cubic yard or more, the batching equipment shall conform to one of the following combinations:

A. Separate boxes and separate scale and indicator for weighing each size of aggregate.
B. Single box and scale indicator for all aggregates.
C. Single box or separate boxes and automatic weighing mechanism for all aggregates.

In order to check the accuracy of batch weights, the gross weight and tare weight of batch trucks, truck mixers, truck agitators, and non-agitating hauling equipment shall be determined when ordered by the Engineer. The equipment shall be weighed on scales designated by the Engineer.

### 90-5.03A Proportioning For Pavement

Aggregates and bulk SCM for use in pavement shall be proportioned by weight by means of automatic proportioning devices of approved type conforming to these specifications.

The Contractor shall install and maintain in operating condition an electronically actuated moisture meter that will indicate, on a readily visible scale, changes in the moisture content of the fine aggregate as it is batched within a sensitivity of 0.5 percent by weight of the fine aggregate.

The batching of cement, SCM, or cement plus SCM and aggregate shall be interlocked so that a new batch cannot be started until all weigh hoppers are empty, the proportioning devices are within zero tolerance, and the discharge gates are closed. The interlock shall permit no part of the batch to be discharged until all aggregate hoppers and the cement and SCM hoppers or the cement plus SCM hopper are charged with weights that are within the tolerances specified in Section 90-5.02, "Proportioning Devices."

If interlocks are required for cement and SCM charging mechanisms and cement and SCM are weighed cumulatively, their charging mechanisms shall be interlocked to prevent the introduction of SCM until the weight of cement in the cement weigh hopper is within the tolerances specified in Section 90-5.02, "Proportioning Devices."

If concrete is completely mixed in stationary paving mixers, the SCMs shall be weighed in a separate weigh hopper and the SCM and cement shall be introduced simultaneously into the mixer proportionately with the aggregate. If the Contractor provides certification that the stationary mixer is capable of mixing the cement, SCM, aggregates, and water uniformly before discharge, weighing the SCM cumulatively with the cement is permitted. Certification shall contain the following:

A. Test results for 2 compressive strength test cylinders of concrete taken within the first one-third and 2 compressive strength test cylinders of concrete taken within the last one-third of the concrete discharged from a single batch from the stationary paving mixer.

Strength tests and cylinder preparation will be in conformance with the provisions of Section 90-9, "Compressive Strength";

B. Calculations demonstrating that the difference in the averages of 2 compressive strengths taken in the first one-third is no greater than 7.5 percent different than the averages of 2 compressive strengths taken in the last one-third of the concrete discharged from a single batch from the stationary paving mixer. Strength tests and cylinder preparation will be in conformance with the provisions of Section 90-9, "Compressive Strength;" and

C. The mixer rotation speed and time of mixing before discharge that are required to produce a mix that meets the requirements above.

The discharge gate on the cement and SCM hoppers or the cement plus SCM hopper shall be designed to permit regulating the flow of cement, SCM, or cement plus SCM into the aggregate as directed by the Engineer.

If separate weigh boxes are used for each size of aggregate, the discharge gates shall permit regulating the flow of each size of aggregate as directed by the Engineer.

Material discharged from the several bins shall be controlled by gates or by mechanical conveyors. The means of withdrawal from the several bins, and of discharge from the weigh box, shall be interlocked so that not more than one bin can discharge at a time, and so that the weigh box cannot be tripped until the required quantity from each of the several bins has been deposited therein. Should a separate weigh box be used for each size of aggregate, all may be operated and discharged simultaneously.

If the discharge from the several bins is controlled by gates, each gate shall be actuated automatically so that the required mass is discharged into the weigh box, after which the gate shall automatically close and lock.

The automatic weighing system shall be designed so that all proportions required may be set on the weighing controller at the same time.

## 90-6 MIXING AND TRANSPORTING

### 90-6.01 GENERAL

Concrete shall be mixed in mechanically operated mixers, except that when permitted by the Engineer, batches not exceeding 1/3 cubic yard may be mixed by hand methods in conformance with the provisions in Section 90-6.05, "Hand-Mixing."

Equipment having components made of aluminum or magnesium alloys that would have contact with plastic concrete during mixing, transporting, or pumping of portland cement concrete shall not be used.

Concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cementitious material.

Uniformity of concrete mixtures will be determined by differences in penetration as determined by California Test 533, or slump as determined by ASTM Designation: C 143, and by variations in the proportion of coarse aggregate as determined by California Test 529.

When the mix design specifies a penetration value, the difference in penetration, determined by comparing penetration tests on 2 samples of mixed concrete from the same batch or truck mixer load, shall not exceed 1/2 inch. When the mix design specifies a slump value, the difference in slump, determined by comparing slump tests on 2 samples of mixed concrete from the same batch or truck mixer load, shall not exceed the values given in the table below. Variation in the proportion of coarse aggregate

will be determined by comparing the results of tests of 2 samples of mixed concrete from the same batch or truck mixer load and the difference between the 2 results shall not exceed 170 pounds per cubic yard of concrete.

| Average Slump | Maximum Permissible Difference |
|---|---|
| Less than 4" | 1" |
| 4" to 6" | 1-1/2" |
| Greater than 6" to 9" | 2" |

The Contractor shall furnish samples of the freshly mixed concrete and provide satisfactory facilities for obtaining the samples.

## 90-6.02 MACHINE MIXING

Concrete mixers may be of the revolving drum or the revolving blade type, and the mixing drum or blades shall be operated uniformly at the mixing speed recommended by the manufacturer. Mixers and agitators that have an accumulation of hard concrete or mortar shall not be used.

The temperature of mixed concrete, immediately before placing, shall be not less than 50 °F or more than 90 °F. Aggregates and water shall be heated or cooled as necessary to produce concrete within these temperature limits. Neither aggregates nor mixing water shall be heated to exceed 150 °F. If ice is used to cool the concrete, discharge of the mixer will not be permitted until all ice is melted.

The batch shall be so charged into the mixer that some water will enter in advance of cementitious materials and aggregates. All water shall be in the drum by the end of the first one-fourth of the specified mixing time. When concrete is delivered in a truck mixer, a portion of the mixing water may be withheld and may be added at the point of delivery as specified under Section 90-6.03, "Transporting Mixed Concrete."

Cementitious materials shall be batched and charged into the mixer by means that will not result either in loss of cementitious materials due to the effect of wind, in accumulation of cementitious materials on surfaces of conveyors or hoppers, or in other conditions that reduce or vary the required quantity of cementitious material in the concrete mixture.

Paving and stationary mixers shall be operated with an automatic timing device. The timing device and discharge mechanism shall be interlocked so that during normal operation no part of the batch will be discharged until the specified mixing time has elapsed.

The total elapsed time between the intermingling of damp aggregates and all cementitious materials and the start of mixing shall not exceed 30 minutes.

The size of batch shall not exceed the manufacturer's guaranteed capacity.

When producing concrete for pavement or base, suitable batch counters shall be installed and maintained in good operating condition at job site batching plants and stationary mixers. The batch counters shall indicate the exact number of batches proportioned and mixed.

Concrete shall be mixed and delivered to the job site by means of one of the following combinations of operations:

A. Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in truck agitators or in nonagitating hauling equipment (central-mixed concrete).
B. Mixed partially in a stationary mixer, and the mixing completed in a truck mixer (shrink-mixed concrete).
C. Mixed completely in a truck mixer (transit-mixed concrete).
D. Mixed completely in a paving mixer.

Agitators may be truck mixers operating at agitating speed or truck agitators. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the manufacturer's guaranteed capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades.

Truck mixers shall be equipped with electrically or mechanically actuated revolution counters by which the number of revolutions of the drum or blades may readily be verified.

When shrink-mixed concrete is furnished, concrete that has been partially mixed at a central plant shall be transferred to a truck mixer and all requirements for transit-mixed concrete shall apply. No credit in the number of revolutions at mixing speed will be allowed for partial mixing in a central plant.

## 90-6.03 TRANSPORTING MIXED CONCRETE

Mixed concrete may be transported to the delivery point in truck agitators or truck mixers operating at the speed designated by the manufacturer of the equipment as agitating speed, or in non-agitating hauling equipment, provided the consistency and workability of the mixed concrete upon discharge at the delivery point is suitable for adequate placement and consolidation in place, and provided the mixed concrete after hauling to the delivery point conforms to the provisions in Section 90-6.01, "General."

Truck agitators shall be loaded not to exceed the manufacturer's guaranteed capacity and shall maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

Bodies of nonagitating hauling equipment shall be constructed so that leakage of the concrete mix, or any part thereof, will not occur at any time.

Concrete hauled in open-top vehicles shall be protected during hauling against rain or against exposure to the sun for more than 20 minutes when the ambient temperature exceeds 75 °F.

No water in excess of that in the approved mix design shall be incorporated into the concrete. If approved by the Engineer, water withheld during batching may be added to the concrete at the delivery point in one operation before the discharge of more than 1/4 cubic yard. Equipment for supplying the water shall conform to Section 90-6.06, "Amount of Water and Penetration." When water is added at the point of delivery, the drum shall be revolved not less than 30 revolutions at mixing speed after the water is added and before discharged is commenced.

The rate of discharge of mixed concrete from truck mixer-agitators shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

If a truck mixer or agitator is used for transporting concrete to the delivery point, discharge shall be completed within 1.5 hours or before 250 revolutions of the drum or blades, whichever occurs first, after the introduction of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or if the temperature of the concrete is 85 °F or above, the time allowed may be less than 1.5 hours. If an admixture is used to retard the set time, the temperature of the concrete shall not exceed 85 °F, the time limit shall be 2 hours, and the revolution limitation shall be 300.

If nonagitating hauling equipment is used for transporting concrete to the delivery point, discharge shall be completed within one hour after the addition of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 °F or above, the time between the introduction of cement to the aggregates and discharge shall not exceed 45 minutes.

Each load of concrete delivered at the job site shall be accompanied by a weighmaster certificate showing the mix identification number, nonrepeating load number, date and time at which the materials were batched, the total amount of water added to the load, and for transit-mixed concrete, the reading of the revolution counter at the time the truck mixer is charged with cement. This weighmaster certificate shall also show the actual scale weights (pounds) for the ingredients batched. Theoretical or target batch weights shall not be used as a substitute for actual scale weights.

Weighmaster certificates shall be provided in printed form, or if approved by the Engineer, the data may be submitted in electronic media. Electronic media shall be presented in a tab-delimited format on a CD or DVD. Captured data, for the ingredients represented by each batch shall be "line feed, carriage return" (LFCR) and "one line, separate record" with allowances for sufficient fields to satisfy the amount of data required by these specifications.

The Contractor may furnish a weighmaster certificate accompanied by a separate certificate that lists the actual batch weights or measurements for a load of concrete provided that both certificates are imprinted with the same nonrepeating load number that is unique to the contract and delivered to the jobsite with the load.

Weighmaster certificates furnished by the Contractor shall conform to the provisions in Section 9-1.01, "Measurement of Quantities."

## 90-6.04 TIME OR AMOUNT OF MIXING

Mixing of concrete in paving or stationary mixers shall continue for the required mixing time after all ingredients, except water and admixture, if added with the water, are in the mixing compartment of the mixer before any part of the batch is released. Transfer time in multiple drum mixers shall not be counted as part of the required mixing time.

The required mixing time, in paving or stationary mixers, of concrete used for concrete structures, except minor structures, shall be not less than 90 seconds or more than 5 minutes, except that when directed by the Engineer in writing, the requirements of the following paragraph shall apply.

The required mixing time, in paving or stationary mixers, except as provided in the preceding paragraph, shall be not less than 50 seconds or more than 5 minutes.

The minimum required revolutions at the mixing speed for transit-mixed concrete shall not be less than that recommended by the mixer manufacturer, but in no case shall the number of revolutions be less than that required to consistently produce concrete conforming to the provisions for uniformity in Section 90-6.01, "General."

When a high range water-reducing admixture is added to the concrete at the job site, the total number of revolutions shall not exceed 300.

## 90-6.05 HAND-MIXING

Hand-mixed concrete shall be made in batches of not more than 1/3 cubic yard and shall be mixed on a watertight, level platform. The proper amount of coarse aggregate shall be measured in measuring boxes and spread on the platform and the fine aggregate shall be spread on this layer, the 2 layers being not

more than one foot in total depth. On this mixture shall be spread the dry cementitious materials and the whole mass turned no fewer than 2 times dry; then sufficient clean water shall be added, evenly distributed, and the whole mass again turned no fewer than 3 times, not including placing in the carriers or forms.

## 90-6.06 AMOUNT OF WATER AND PENETRATION

The amount of water used in concrete mixes shall be regulated so that the penetration of the concrete as determined by California Test 533 or the slump of the concrete as determined by ASTM Designation: C 143 is within the nominal values shown in the following table. When the penetration or slump of the concrete is found to exceed the nominal values listed, the mixture of subsequent batches shall be adjusted to reduce the penetration or slump to a value within the nominal range shown. Batches of concrete with a penetration or slump exceeding the maximum values listed shall not be used in the work. If Type F or Type G chemical admixtures are added to the mix, the penetration requirements shall not apply and the slump shall not exceed 9 inches after the chemical admixtures are added.

| Type of Work | Nominal | | Maximum | |
|---|---|---|---|---|
| | Penetration (inches) | Slump (inches) | Penetration (inches) | Slump (inches) |
| Concrete Pavement | 0 - 1 | — | 1-1/2 | — |
| Non-reinforced concrete facilities | 0 – 1-1/2 | — | 2 | — |
| Reinforced concrete structures | | | | |
| Sections over 12 inches thick | 0 – 1-1/2 | — | 2-1/2 | — |
| Sections 12 inches thick or less | 0 - 2 | — | 3 | — |
| Concrete placed under water | — | 6 - 8 | — | 9 |
| Cast-in-place concrete piles | 2-1/2 – 3-1/2 | 5 - 7 | 4 | 8 |

The amount of free water used in concrete shall not exceed 310 pounds per cubic yard, plus 20 pounds for each required 100 pounds of cementitious material in excess of 550 pounds per cubic yard.

The term free water is defined as the total water in the mixture minus the water absorbed by the aggregates in reaching a saturated surface-dry condition.

If there are adverse or difficult conditions that affect the placing of concrete, the above specified penetration and free water content limitations may be exceeded providing the Contractor is granted permission by the Engineer in writing to increase the cementitious material content per cubic yard of concrete. The increase in water and cementitious material shall be at a ratio not to exceed 30 pounds of water per added 100 pounds of cementitious material per cubic yard. Full compensation for additional cementitious material and water added under these conditions shall be considered as included in the contract price paid for the concrete work involved and no additional compensation will be allowed therefor.

The equipment for supplying water to the mixer shall be constructed and arranged so that the amount of water added can be measured accurately. Any method of discharging water into the mixer for a batch shall be accurate within 1.5 percent of the quantity of water required to be added to the mix for any position of the mixer. Tanks used to measure water shall be designed so that water cannot enter while water is being discharged into the mixer and discharge into the mixer shall be made rapidly in one operation without dribbling. All equipment shall be arranged so as to permit checking the amount of water delivered by discharging into measured containers.

# 90-7 CURING CONCRETE

## 90-7.01 METHODS OF CURING

Newly placed concrete shall be cured by the methods specified in this Section 90-7.01 and the special provisions.

### 90-7.01A Water Method

The concrete shall be kept continuously wet by the application of water for a minimum curing period of 7 days after the concrete has been placed.

Cotton mats, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period.

If a curing medium consisting of cotton mats, rugs, carpets, polyethylene sheeting, polyethylene sheeting on burlap, or earth or sand blankets is to be used to retain the moisture, the entire surface of the concrete shall be kept damp by applying water with a nozzle that so atomizes the flow that a mist and not a spray is formed, until the surface of the concrete is covered with the curing medium. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface. At the expiration of the curing period, the concrete surfaces shall be cleared of all curing media.

At the option of the Contractor, a curing medium consisting of white opaque polyethylene sheeting extruded onto burlap may be used to cure concrete structures. The polyethylene sheeting shall have a minimum thickness of 4-mil, and shall be extruded onto 10-ounce burlap.

At the option of the Contractor, a curing medium consisting of polyethylene sheeting may be used to cure concrete columns. The polyethylene sheeting shall have a minimum thickness of 10-mil achieved in a single layer of material.

If the Contractor chooses to use polyethylene sheeting or polyethylene sheeting on burlap as a curing medium, these media and any joints therein shall be secured as necessary to provide moisture retention and shall be within 3 inches of the concrete at all points along the surface being cured. When these media are used, the temperature of the concrete shall be monitored during curing. If the temperature of the concrete cannot be maintained below 140° F, use of these curing media shall be disallowed.

When concrete bridge decks and flat slabs are to be cured without the use of a curing medium, the entire surface of the bridge deck or slab shall be kept damp by the application of water with an atomizing nozzle as specified above, until the concrete has set, after which the entire surface of the concrete shall be sprinkled continuously with water for a period of not less than 7 days.

### 90-7.01B Curing Compound Method

Surfaces of the concrete that are exposed to the air shall be sprayed uniformly with a curing compound.

Curing compounds to be used shall be as follows:

1. Pigmented curing compound conforming to the requirements in ASTM Designation: C 309, Type 2, Class B, except the resin type shall be poly-alpha-methylstyrene.

2. Pigmented curing compound conforming to the requirements in ASTM Designation: C 309, Type 2, Class B.
3. Pigmented curing compound conforming to the requirements in ASTM Designation: C 309, Type 2, Class A.
4. Nonpigmented curing compound conforming to the requirements in ASTM Designation: C 309, Type 1, Class B.
5. Nonpigmented curing compound conforming to the requirements in ASTM Designation: C 309, Type 1, Class A.
6. Nonpigmented curing compound with fugitive dye conforming to the requirements in ASTM Designation: C 309, Type 1-D, Class A.

The infrared scan for the dried vehicle from curing compound (1) shall match the infrared scan on file at the Transportation Laboratory.

The loss of water for each type of curing compound, when tested in conformance with the requirements in California Test 534, shall not be more than 0.28 pounds per square yard in 24 hours.

The curing compound to be used will be specified elsewhere in these specifications or in the special provisions.

If the use of curing compound is required or permitted elsewhere in these specifications or in the special provisions and no specific kind is specified, any of the curing compounds listed above may be used.

Curing compound shall be applied at a nominal rate of one gallon per 150 square feet, unless otherwise specified.

At any point, the application rate shall be within ±50 square feet per gallon of the nominal rate specified, and the average application rate shall be within ±25 square feet per gallon of the nominal rate specified when tested in conformance with the requirements in California Test 535. Runs, sags, thin areas, skips, or holidays in the applied curing compound shall be evidence that the application is not satisfactory.

Curing compounds shall be applied using power operated spray equipment. The power operated spraying equipment shall be equipped with an operational pressure gage and a means of controlling the pressure. Hand spraying of small and irregular areas that are not reasonably accessible to mechanical spraying equipment, in the opinion of the Engineer, may be permitted.

The curing compound shall be applied to the concrete following the surface finishing operation, immediately before the moisture sheen disappears from the surface, but before any drying shrinkage or craze cracks begin to appear. In the event of any drying or cracking of the surface, application of water with an atomizing nozzle as specified in Section 90-7.01A, "Water Method," shall be started immediately and shall be continued until application of the compound is resumed or started; however, the compound shall not be applied over any resulting freestanding water. Should the film of compound be damaged from any cause before the expiration of 7 days after the concrete is placed in the case of structures and 72 hours in the case of pavement, the damaged portion shall be repaired immediately with additional compound.

At the time of use, compounds containing pigments shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. A paddle shall be used to loosen all settled pigment from the bottom of the container, and a power driven agitator shall be used to disperse the pigment uniformly throughout the vehicle.

Agitation shall not introduce air or other foreign substance into the curing compound.

The manufacturer shall include in the curing compound the necessary additives for control of sagging, pigment settling, leveling, de-emulsification, or other requisite qualities of a satisfactory working material. Pigmented curing compounds shall be manufactured so that the pigment does not settle badly, does not cake or thicken in the container, and does not become granular or curdled. Settlement of pigment shall be a thoroughly wetted, soft, mushy mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sideways manual motion of the paddle across the bottom of the container, to form a smooth uniform product of the proper consistency.

Curing compounds shall remain sprayable at temperatures above 40 °F and shall not be diluted or altered after manufacture.

The curing compound shall be packaged in clean 274-gallon totes, 55-gallon barrels or 5-gallon pails shall be supplied from a suitable storage tank located at the jobsite. The containers shall comply with "Title 49, Code of Federal Regulations, Hazardous Materials Regulations." The 274-gallon totes and the 55-gallon barrels shall have removable lids and airtight fasteners. The 5-gallon pails shall be round and have standard full open head and bail. Lids with bungholes will not be permitted. Settling or separation of solids in containers, except tanks, must be completely redispersed with low speed mixing prior to use, in conformance with these specifications and the manufacturer's recommendations. Mixing shall be accomplished either manually by use of a paddle or by use of a mixing blade driven by a drill motor, at low speed. Mixing blades shall be the type used for mixing paint. On-site storage tanks shall be kept clean and free of contaminants. Each tank shall have a permanent system designed to completely redisperse settled material without introducing air or other foreign substances.

Steel containers and lids shall be lined with a coating that will prevent destructive action by the compound or chemical agents in the air space above the compound. The coating shall not come off the container or lid as skins. Containers shall be filled in a manner that will prevent skinning. Plastic containers shall not react with the compound.

Each container shall be labeled with the manufacturer's name, kind of curing compound, batch number, volume, date of manufacture, and volatile organic compound (VOC) content. The label shall also warn that the curing compound containing pigment shall be well stirred before use. Precautions concerning the handling and the application of curing compound shall be shown on the label of the curing compound containers in conformance with the Construction Safety Orders and General Industry Safety Orders of the State.

Containers of curing compound shall be labeled to indicate that the contents fully comply with the rules and regulations concerning air pollution control in the State.

When the curing compound is shipped in tanks or tank trucks, a shipping invoice shall accompany each load. The invoice shall contain the same information as that required herein for container labels.

Curing compound will be sampled by the Engineer at the source of supply, at the job site, or at both locations.

Curing compound shall be formulated so as to maintain the specified properties for a minimum of one year. The Engineer may require additional testing before use to determine compliance with these specifications if the compound has not been used within one year or whenever the Engineer has reason to believe the compound is no longer satisfactory.

Tests will be conducted in conformance with the latest ASTM test methods and methods in use by the Transportation Laboratory.

### 90-7.01C Waterproof Membrane Method

The exposed finished surfaces of concrete shall be sprayed with water, using a nozzle that so atomizes the flow that a mist and not a spray is formed, until the concrete has set, after which the curing membrane, shall be placed. The curing membrane shall remain in place for a period of not less than 72 hours.

Sheeting material for curing concrete shall conform to the requirements in AASHTO Designation: M 171 for white reflective materials.

The sheeting material shall be fabricated into sheets of such width as to provide a complete cover for the entire concrete surface. Joints in the sheets shall be securely cemented together in such a manner as to provide a waterproof joint. The joint seams shall have a minimum lap of 0.33 foot.

The sheets shall be securely weighted down by placing a bank of earth on the edges of the sheets or by other means satisfactory to the Engineer.

Should any portion of the sheets be broken or damaged before the expiration of 72 hours after being placed, the broken or damaged portions shall be immediately repaired with new sheets properly cemented into place.

Sections of membrane that have lost their waterproof qualities or have been damaged to such an extent as to render them unfit for curing the concrete shall not be used.

### 90-7.01D Forms-In-Place Method

Formed surfaces of concrete may be cured by retaining the forms in place. The forms shall remain in place for a minimum period of 7 days after the concrete has been placed, except that for members over 20 inches in least dimension the forms shall remain in place for a minimum period of 5 days.

Joints in the forms and the joints between the end of forms and concrete shall be kept moisture tight during the curing period. Cracks in the forms and cracks between the forms and the concrete shall be resealed by methods subject to the approval of the Engineer.

## 90-7.02 BLANK

## 90-7.03 CURING STRUCTURES

Newly placed concrete for cast-in-place structures, other than highway bridge decks, shall be cured by the water method, the forms-in-place method, or, as permitted herein, by the curing compound method, in conformance with the provisions in Section 90-7.01, "Methods of Curing."

The curing compound method using a pigmented curing compound may be used on concrete surfaces of construction joints, surfaces that are to be buried underground, and surfaces where only ordinary surface finish is to be applied and on which a uniform color is not required and that will not be visible from a public traveled way. If the Contractor elects to use the curing compound method on the bottom slab of box girder spans, the curing compound shall be curing compound (1).

The top surface of highway bridge decks shall be cured by both the curing compound method and the water method. The curing compound shall be curing compound (1).

Concrete surfaces of minor structures, as defined in Section 51-1.02, "Minor Structures," shall be cured by the water method, the forms-in-place method or the curing compound method.

When deemed necessary by the Engineer during periods of hot weather, water shall be applied to concrete surfaces being cured by the curing compound method or by the forms-in-place method, until the Engineer determines that a cooling effect is no longer required. Application of water for this purpose will be paid for as extra work as provided in Section 4-1.03D, "Extra Work."

## 90-7.04 CURING PRECAST CONCRETE MEMBERS

Precast concrete members shall be cured in conformance with any of the methods specified in Section 90-7.01, "Methods of Curing." Curing shall be provided for the minimum time specified for each method or until the concrete reaches its design strength, whichever is less. Steam curing may also be used for precast members and shall conform to the following provisions:

A. After placement of the concrete, members shall be held for a minimum 4-hour presteaming period. If the ambient air temperature is below 50 °F, steam shall be applied during the presteaming period to hold the air surrounding the member at a temperature between 50 °F and 90 °F.
B. To prevent moisture loss on exposed surfaces during the presteaming period, members shall be covered as soon as possible after casting or the exposed surfaces shall be kept wet by fog spray or wet blankets.
C. Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good repair and secured in such a manner as to prevent the loss of steam and moisture.
D. Steam at the jets shall be at low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders, or forms. During application of the steam, the temperature rise within the enclosure shall not exceed 40 °F per hour. The curing temperature throughout the enclosure shall not exceed 150 °F and shall be maintained at a constant level for a sufficient time necessary to develop the required transfer strength. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.
E. Temperature recording devices that will provide an accurate, continuous, permanent record of the curing temperature shall be provided. A minimum of one temperature recording device per 200 feet of continuous bed length will be required for checking temperature.
F. Members in pretension beds shall be detensioned immediately after the termination of steam curing while the concrete and forms are still warm, or the temperature under the enclosure shall be maintained above 60 °F until the stress is transferred to the concrete.
G. Curing of precast concrete will be considered completed after termination of the steam curing cycle.

## 90-7.05 CURING PRECAST PRESTRESSED CONCRETE PILES

Newly placed concrete for precast prestressed concrete piles shall be cured in conformance with the provisions in Section 90-7.04, "Curing Precast Concrete Members," except that piles in a corrosive environment shall be cured as follows:

A. Piles shall be either steam cured or water cured. If water curing is used, the piles shall be kept continuously wet by the application of water in conformance with the provisions in Section 90-7.01A, "Water Method."
B. If steam curing is used, the steam curing provisions in Section 90-7.04, "Curing Precast Concrete Members," shall apply except that the piles shall be kept continuously wet for their entire length for a period of not less than 3 days, including the holding and steam curing periods.

### 90-7.06 CURING SLOPE PROTECTION

Concrete slope protection shall be cured in conformance with any of the methods specified in Section 90-7.01, "Methods of Curing."

Concreted-rock slope protection shall be cured in conformance with any of the methods specified in Section 90-7.01, "Methods of Curing," with a blanket of earth kept wet for 72 hours, or by sprinkling with a fine spray of water every 2 hours during the daytime for a period of 3 days.

### 90-7.07 CURING MISCELLANEOUS CONCRETE WORK

Exposed surfaces of curbs shall be cured by pigmented curing compounds as specified in Section 90-7.01B, "Curing Compound Method."

Concrete sidewalks, gutter depressions, island paving, curb ramps, driveways, and other miscellaneous concrete areas shall be cured in conformance with any of the methods specified in Section 90-7.01, "Methods of Curing."

Shotcrete shall be cured for at least 72 hours by spraying with water, by a moist earth blanket, or by any of the methods provided in Section 90-7.01, "Methods of Curing."

Mortar and grout shall be cured by keeping the surface damp for 3 days.

After placing, the exposed surfaces of sign structure foundations, including pedestal portions, if constructed, shall be cured for at least 72 hours by spraying with water, by a moist earth blanket, or by any of the methods provided in Section 90-7.01, "Methods of Curing."

## 90-8 PROTECTING CONCRETE

### 90-8.01 GENERAL

In addition to the provisions in Section 7-1.16, "Contractor's Responsibility for the Work and Materials," the Contractor shall protect concrete as provided in this Section 90-8. If required by the Engineer, the Contractor shall submit a written outline of the proposed methods for protecting the concrete.

The Contractor shall protect concrete from damage from any cause, which shall include, but not be limited to: rain, heat, cold, wind, Contractor's actions, and actions of others.

Concrete shall not be placed on frozen or ice-coated ground or subgrade nor on ice-coated forms, reinforcing steel, structural steel, conduits, precast members, or construction joints.

Under rainy conditions, placing of concrete shall be stopped before the quantity of surface water is sufficient to damage surface mortar or cause a flow or wash of the concrete surface, unless the Contractor provides adequate protection against damage.

Concrete that has been frozen or damaged by other causes, as determined by the Engineer, shall be removed and replaced by the Contractor at the Contractor's expense.

### 90-8.02 PROTECTING CONCRETE STRUCTURES

Structure concrete and shotcrete used as structure concrete shall be maintained at a temperature of not less than 45 °F for 72 hours after placing and at not less than 40 °F for an additional 4 days.

## 90-9 COMPRESSIVE STRENGTH

### 90-9.01 GENERAL

Concrete compressive strength requirements consist of a minimum strength that shall be attained before various loads or stresses are applied to the concrete and, for concrete designated by compressive strength, a minimum strength at the age of 28 days or at the age otherwise allowed in Section 90-1.01, "Description." The various strengths required are specified in these specifications or the special provisions or are shown on the plans.

The compressive strength of concrete will be determined from test cylinders that have been fabricated from concrete sampled in conformance with the requirements of California Test 539. Test cylinders will be molded and initially field cured in conformance with California Test 540. Test cylinders will be cured and tested after receipt at the testing laboratory in conformance with the requirements of California Test 521. A strength test shall consist of the average strength of 2 cylinders fabricated from material taken from a single load of concrete, except that, if any cylinder should show evidence of improper sampling, molding, or testing, that cylinder shall be discarded and the strength test shall consist of the strength of the remaining cylinder.

When concrete compressive strength is specified as a prerequisite to applying loads or stresses to a concrete structure or member, test cylinders for other than steam cured concrete will be cured in conformance with Method 1 of California Test 540. The compressive strength of concrete determined for these purposes will be evaluated on the basis of individual tests.

When concrete is designated by compressive strength rather than by cementitious material content, the concrete strength to be used as a basis for acceptance of other than steam cured concrete will be determined from cylinders cured in conformance with Method 1 of California Test 540. If the result of a single compressive strength test at the maximum age specified or allowed is below the specified strength but is 95 percent or more of the specified strength, the Contractor shall make corrective changes, subject to approval of the Engineer, in the mix proportions or in the concrete fabrication procedures, before placing additional concrete, and shall pay to the State $10 for each in-place cubic yard of concrete represented by the deficient test. If the result of a single compressive strength test at the maximum age specified or allowed is below 95 percent of the specified strength, but is 85 percent or more of the specified strength, the Contractor shall make the corrective changes specified above, and shall pay to the State $15 for each in-place cubic yard of concrete represented by the deficient test. In addition, such corrective changes shall be made when the compressive strength of concrete tested at 7 days indicates, in the judgment of the Engineer, that the concrete will not attain the required compressive strength at the maximum age specified or allowed. Concrete represented by a single test that indicates a compressive strength of less than 85 percent of the specified 28-day compressive strength will be rejected in conformance with the provisions in Section 6-1.04, "Defective Materials."

If the test result indicates that the compressive strength at the maximum age specified or allowed is below the specified strength, but is 85 percent or more of the specified strength, payments to the State as required above shall be made, unless the Contractor, at the Contractor's expense, obtains and submits

evidence acceptable to the Engineer that the strength of the concrete placed in the work meets or exceeds the specified 28-day compressive strength. If the test result indicates a compressive strength at the maximum age specified or allowed below 85 percent, the concrete represented by that test will be rejected, unless the Contractor, at the Contractor's expense, obtains and submits evidence acceptable to the Engineer that the strength and quality of the concrete placed in the work are acceptable. If the evidence consists of tests made on cores taken from the work, the cores shall be obtained and tested in conformance with the requirements in ASTM Designation: C 42.

No single compressive strength test shall represent more than 320 cubic yards.

If a precast concrete member is steam cured, the compressive strength of the concrete will be determined from test cylinders that have been handled and stored in conformance with Method 3 of California Test 540. The compressive strength of steam cured concrete will be evaluated on the basis of individual tests representing specific portions of production. If the concrete is designated by 28-day compressive strength rather than by cementitious material content, the concrete shall be considered to be acceptable whenever its compressive strength reaches the specified 28-day compressive strength provided that strength is reached in not more than the maximum number of days specified or allowed after the member is cast.

When concrete has a specified 28-day compressive strength greater than 3,600 pounds per square inch, prequalification of materials, mix proportions, mixing equipment, and procedures proposed for use will be required prior to placement of the concrete. Prequalification shall be accomplished by the submission of acceptable certified test data or trial batch reports by the Contractor. Prequalification data shall be based on the use of materials, mix proportions, mixing equipment, procedures, and size of batch proposed for use in the work.

Certified test data, in order to be acceptable, shall indicate that not less than 90 percent of at least 20 consecutive tests exceed the specified strength at the maximum number of days specified or allowed, and none of those tests are less than 95 percent of specified strength. Strength tests included in the data shall be the most recent tests made on concrete of the proposed mix design and all shall have been made within one year of the proposed use of the concrete.

Trial batch test reports, in order to be acceptable, shall indicate that the average compressive strength of 5 consecutive concrete cylinders, taken from a single batch, at not more than 28 days (or the maximum age allowed) after molding shall be at least 580 pounds per square inch greater than the specified 28-day compressive strength, and no individual cylinder shall have a strength less than the specified strength at the maximum age specified or allowed. Data contained in the report shall be from trial batches that were produced within one year of the proposed use of specified strength concrete in the project. Whenever air-entrainment is required, the air content of trial batches shall be equal to or greater than the air content specified for the concrete without reduction due to tolerances.

Tests shall be performed in conformance with either the appropriate California Test methods or the comparable ASTM test methods. Equipment employed in testing shall be in good condition and shall be properly calibrated. If the tests are performed during the life of the contract, the Engineer shall be notified sufficiently in advance of performing the tests in order to witness the test procedures.

The certified test data and trial batch test reports shall include the following information:

A. Date of mixing.
B. Mixing equipment and procedures used.
C. The size of batch in cubic yards and the weight, type, and source of all ingredients used.

D. Penetration or slump (if the concrete will be placed under water or placed in cast-in-place concrete piles) of the concrete.
E. The air content of the concrete if an air-entraining admixture is used.
F. The age at time of testing and strength of all concrete cylinders tested.

Certified test data and trial batch test reports shall be signed by an official of the firm that performed the tests.

When approved by the Engineer, concrete from trial batches may be used in the work at locations where concrete of a lower quality is required and the concrete will be paid for as the type of concrete required at that location.

After materials, mix proportions, mixing equipment, and procedures for concrete have been prequalified for use, additional prequalification by testing of trial batches will be required prior to making changes that, in the judgment of the Engineer, could result in a strength of concrete below that specified.

The Contractor's attention is directed to the time required to test trial batches and the Contractor shall be responsible for production of trial batches at a sufficiently early date so that the progress of the work is not delayed.

When precast concrete members are manufactured at the plant of an established manufacturer of precast concrete members, the mix proportions of the concrete shall be determined by the Contractor, and a trial batch and prequalification of the materials, mix proportions, mixing equipment, and procedures will not be required.

## 90-10 MINOR CONCRETE

### 90-10.01 GENERAL

Concrete for minor structures, slope paving, curbs, sidewalks and other concrete work, when designated as minor concrete on the plans, in the specifications, or in the contract item, shall conform to the provisions specified herein.

The Engineer, at the Engineer's discretion, will inspect and test the facilities, materials and methods for producing the concrete to ensure that minor concrete of the quality suitable for use in the work is obtained.

Before using minor concrete or in advance of revising the mix proportions, the Contractor shall submit in writing to the Engineer a copy of the mix design. When required by the following table, the Contractor shall include compressive strength test results verifying the minimum specified compressive strength:

| SCM | Test Submittal Required |
|---|---|
| Fly Ash used alone | When portland cement content<350 lbs/cy |
| GGBFS used alone | When portland cement content <250 lbs/cy |
| Natural Pozzolan used alone | When portland cement content <350 lbs/cy |
| More than 1 SCM | Always |

Tests shall be performed by an ACI certified technician.

## 90-10.02 MATERIALS

Minor concrete shall conform to the following requirements:

### 90-10.02A Cementitious Material

Cementitious material shall conform to the provisions in Section 90-1.01, "Description," and 90-2, "Materials."

### 90-10.02B Aggregate

Aggregate shall be clean and free from deleterious coatings, clay balls, roots, and other extraneous materials.

Use of crushed concrete or reclaimed aggregate is acceptable only if the aggregate satisfies all aggregate requirements.

The Contractor shall submit to the Engineer for approval, a grading of the combined aggregate proposed for use in the minor concrete. After acceptance of the grading, aggregate furnished for minor concrete shall conform to that grading, unless a change is authorized in writing by the Engineer.

The Engineer may require the Contractor to furnish periodic test reports of the aggregate grading furnished. The maximum size of aggregate used shall be at the option of the Contractor, but in no case shall the maximum size be larger than 1-1/2-inch or smaller than 3/4 inch.

The Engineer may waive, in writing, the gradation requirements in this Section 90-10.02B, if, in the Engineer's opinion, the furnishing of the gradation is not necessary for the type or amount of concrete work to be constructed.

### 90-10.02C Water

Water used for washing, mixing, and curing shall be free from oil, salts, and other impurities that would discolor or etch the surface or have an adverse affect on the quality of the concrete.

### 90-10.02D Admixtures

The use of admixtures shall conform to the provisions in Section 90-4, "Admixtures."

## 90-10.03 PRODUCTION

Cementitious material, water, aggregate, and admixtures shall be stored, proportioned, mixed, transported, and discharged in conformance with recognized standards of good practice that will result in concrete that is thoroughly and uniformly mixed, that is suitable for the use intended, and that conforms to requirements specified herein. Recognized standards of good practice are outlined in various industry publications such as are issued by American Concrete Institute, AASHTO, or the Department.

The cementitious material content of minor concrete shall conform to the provisions in Section 90-1.01, "Description."

The amount of water used shall result in a consistency of concrete conforming to the provisions in Section 90-6.06, "Amount of Water and Penetration." Additional mixing water shall not be incorporated into the concrete during hauling or after arrival at the delivery point, unless authorized by the Engineer.

Discharge of ready-mixed concrete from the transporting vehicle shall be made while the concrete is still plastic and before stiffening occurs. An elapsed time of 1.5 hours (one hour in non-agitating hauling equipment), or more than 250 revolutions of the drum or blades, after the introduction of the cementitious material to the aggregates, or a temperature of concrete of more than 90 °F will be considered conditions contributing to the quick stiffening of concrete. The Contractor shall take whatever action is necessary to eliminate quick stiffening, except that the addition of water will not be permitted.

The required mixing time in stationary mixers shall be not less than 50 seconds or more than 5 minutes.

The minimum required revolutions at mixing speed for transit-mixed concrete shall be not less than that recommended by the mixer manufacturer, and shall be increased, if necessary, to produce thoroughly and uniformly mixed concrete.

When a high range water-reducing admixture is added to the concrete at the job site, the total number of revolutions shall not exceed 300.

Each load of ready-mixed concrete shall be accompanied by a weighmaster certificate that shall be delivered to the Engineer at the discharge location of the concrete, unless otherwise directed by the Engineer. The weighmaster certificate shall be clearly marked with the date and time of day when the load left the batching plant and, if hauled in truck mixers or agitators, the time the mixing cycle started.

A Certificate of Compliance conforming to the provisions in Section 6-1.07, "Certificates of Compliance," shall be furnished to the Engineer, prior to placing minor concrete from a source not previously used on the contract, stating that minor concrete to be furnished meets contract requirements, including minimum cementitious material content specified.

### 90-10.04 CURING MINOR CONCRETE

Curing minor concrete shall conform to the provisions in Section 90-7, "Curing Concrete."

### 90-10.05 PROTECTING MINOR CONCRETE

Protecting minor concrete shall conform to the provisions in Section 90-8, "Protecting Concrete," except the concrete shall be maintained at a temperature of not less than 40 °F for 72 hours after placing.

### 90-10.06 MEASUREMENT AND PAYMENT

Minor concrete will be measured and paid for in conformance with the provisions specified in the various sections of these specifications covering concrete construction when minor concrete is specified in the specifications, shown on the plans, or indicated by contract item in the Engineer's Estimate.

## 90-11 MEASUREMENT AND PAYMENT

### 90-11.01 MEASUREMENT

Portland cement concrete will be measured in conformance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

For concrete measured at the mixer, the volume in cubic feet shall be computed as the total weight of the batch in pounds divided by the density of the concrete in pounds per cubic foot. The total weight of the batch shall be calculated as the sum of all materials, including water, entering the batch. The density of the concrete will be determined in conformance with the requirements in California Test 518.

## 90-11.02 PAYMENT

Portland cement concrete will be paid for in conformance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

Full compensation for furnishing and incorporating admixtures required by these specifications or the special provisions will be considered as included in the contract prices paid for the concrete involved and no additional compensation will be allowed therefor.

Should the Engineer order the Contractor to incorporate any admixtures in the concrete when their use is not required by these specifications or the special provisions, furnishing the admixtures and adding them to the concrete will be paid for as extra work as provided in Section 4-1.03D, "Extra Work."

Should the Contractor use admixtures in conformance with the provisions in Section 90-4.05, "Optional Use of Chemical Admixtures," or Section 90-4.07, "Optional Use of Air-entraining Admixtures," or should the Contractor request and obtain permission to use other admixtures for the Contractor's benefit, the Contractor shall furnish those admixtures and incorporate them into the concrete at the Contractor's expense and no additional compensation will be allowed therefor.

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# SECTION 91 PAINT
**(Issued 05-1-06)**

**Replace Section 91-3 with:**

## 91-3 PAINTS FOR TIMBER

### 91-3.01 WOOD PRIMER, LATEX-BASE

**Classification:**

This specification covers a ready-mixed priming paint for use on unpainted wood or exterior woodwork. It shall conform with the requirements in the Detailed Performance Standards of the Master Painters Institute (MPI) for exterior wood primers, and be listed on the Exterior Latex Wood Primer MPI List Number 6.

### 91-3.02 PAINT; LATEX-BASE FOR EXTERIOR WOOD, WHITE AND TINTS

**Classification:**

This specification covers a ready-mixed paint for use on wood surfaces subject to outside exposures. This paint shall conform to the requirements in the Detailed Performance Standards of the Master Painters Institute (MPI) for Paint, Latex, Exterior, and shall be listed on the following MPI Approved Products List:

A. Exterior Latex, Flat MPI Gloss Level 1, MPI List Number 10.
B. Exterior Latex, Semi-Gloss, MPI Gloss Level 5, MPI List Number 11.
C. Exterior Latex, Gloss, MPI Gloss Level 6, MPI List Number 119.

Unpainted wood shall first be primed with wood primer conforming to the provisions in Section 91-3.01, "Wood Primer, Latex-Base."

**Replace Section 91-4 with:**

## 91-4 MISCELLANEOUS PAINTS

### 91-4.01 THROUGH 91-4.04 (BLANK)

### 91-4.05 PAINT; ACRYLIC EMULSION, EXTERIOR WHITE AND LIGHT AND MEDIUM TINTS

**Classification:**

This specification covers an acrylic emulsion paint designed for use on exterior masonry. This paint shall conform to the requirements in the Detailed Performance Standards of the Master Painters Institute (MPI) for Paint, Latex, Exterior, and shall be listed on the following MPI Approved Products Lists:

A. Exterior Latex, Flat MPI Gloss Level 1, MPI List Number 10.
B. Exterior Latex, Semi-Gloss, MPI Gloss Level 5, MPI List Number 11.
C. Exterior Latex, Gloss, MPI Gloss Level 6, MPI List Number 119.

This paint may be tinted by using "universal" or "all purpose" concentrates.

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## SECTION 92 ASPHALTS
**(Issued 03-21-08)**

**Replace Section 92 with:**

## SECTION 92 ASPHALTS

## 92-1.01 DESCRIPTION

Asphalt is refined petroleum or a mixture of refined liquid asphalt and refined solid asphalt that are prepared from crude petroleum. Asphalt is:

1. Free from residues caused by the artificial distillation of coal, coal tar, or paraffin
2. Free from water
3. Homogeneous

## 92-1.02 MATERIALS

### GENERAL

Furnish asphalt under the Department's "Certification Program for Suppliers of Asphalt." The Department maintains the program requirements, procedures, and a list of approved suppliers at:

http://www.dot.ca.gov/hq/esc/Translab/fpm/fpmcoc.htm

Transport, store, use, and dispose of asphalt safely.

Prevent the formation of carbonized particles caused by overheating asphalt during manufacturing or construction.

### GRADES

Performance graded (PG) asphalt binder is:

Performance Graded Asphalt Binder

| Property | AASHTO Test Method | Specification Grade | | | | |
|---|---|---|---|---|---|---|
| | | PG 58-22 [a] | PG 64-10 | PG 64-16 | PG 64-28 | PG 70-10 |
| Original Binder | | | | | | |
| Flash Point, Minimum °C | T 48 | 230 | 230 | 230 | 230 | 230 |
| Solubility, Minimum % [b] | T 44 | 99 | 99 | 99 | 99 | 99 |
| Viscosity at 135°C, [c] Maximum, Pa·s | T 316 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Dynamic Shear, Test Temp. at 10 rad/s, °C | T 315 | 58 | 64 | 64 | 64 | 70 |
| Minimum G*/sin(delta), kPa | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| RTFO Test, [e] Mass Loss, Maximum, % | T 240 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| RTFO Test Aged Binder | | | | | | |
| Dynamic Shear, Test Temp. at 10 rad/s, °C | T 315 | 58 | 64 | 64 | 64 | 70 |
| Minimum G*/sin(delta), kPa | | 2.20 | 2.20 | 2.20 | 2.20 | 2.20 |
| Ductility at 25°C Minimum, cm | T 51 | 75 | 75 | 75 | 75 | 75 |
| PAV [f] Aging, Temperature, °C | R 28 | 100 | 100 | 100 | 100 | 110 |
| RTFO Test and PAV Aged Binder | | | | | | |
| Dynamic Shear, Test Temp. at 10 rad/s, °C | T 315 | 22 [d] | 31 [d] | 28 [d] | 22 [d] | 34 [d] |
| Maximum G*sin(delta), kPa | | 5000 | 5000 | 5000 | 5000 | 5000 |
| Creep Stiffness, Test Temperature, °C | T 313 | -12 | 0 | -6 | -18 | 0 |
| Maximum S-value, Mpa | | 300 | 300 | 300 | 300 | 300 |
| Minimum M-value | | 0.300 | 0.300 | 0.300 | 0.300 | 0.300 |

Notes:

a. Use as asphalt rubber base stock for high mountain and high desert area.

b. The Engineer waives this specification if the supplier is a Quality Supplier as defined by the Department's "Certification Program for Suppliers of Asphalt."

c. The Engineer waives this specification if the supplier certifies the asphalt binder can be adequately pumped and mixed at temperatures meeting applicable safety standards.

d. Test the sample at 3°C higher if it fails at the specified test temperature. G*sin(delta) remains 5000 kPa maximum.

e. "RTFO Test" means the asphaltic residue obtained using the Rolling Thin Film Oven Test, AASHTO Test Method T 240 or ASTM Designation: D 2872. The residue from mass change determination may be used for other tests.

f. "PAV" means Pressurized Aging Vessel.

Performance graded polymer modified asphalt binder (PG Polymer Modified) is:

Performance Graded Polymer Modified Asphalt Binder [a]

| Property | AASHTO Test Method | Specification Grade | | |
|---|---|---|---|---|
| | | PG 58-34 PM | PG 64-28 PM | PG 76-22 PM |
| Original Binder | | | | |
| Flash Point, Minimum °C | T 48 | 230 | 230 | 230 |
| Solubility, Minimum % [b] | T 44[c] | 98.5 | 98.5 | 98.5 |
| Viscosity at 135°C, [d]<br>Maximum, Pa·s | T 316 | <br>3.0 | <br>3.0 | <br>3.0 |
| Dynamic Shear,<br>Test Temp. at 10 rad/s, °C<br>Minimum G*/sin(delta), kPa | T 315 | <br>58<br>1.00 | <br>64<br>1.00 | <br>76<br>1.00 |
| RTFO Test ,<br>Mass Loss, Maximum, % | T 240 | <br>1.00 | <br>1.00 | <br>1.00 |
| RTFO Test Aged Binder | | | | |
| Dynamic Shear,<br>Test Temp. at 10 rad/s, °C<br>Minimum G*/sin(delta), kPa | T 315 | <br>58<br>2.20 | <br>64<br>2.20 | <br>76<br>2.20 |
| Dynamic Shear,<br>Test Temp. at 10 rad/s, °C<br>Maximum (delta), % | T 315 | <br>Note e<br>80 | <br>Note e<br>80 | <br>Note e<br>80 |
| Elastic Recovery[f],<br>Test Temp., °C<br>Minimum recovery, % | T 301 | <br>25<br>75 | <br>25<br>75 | <br>25<br>65 |
| PAV[g] Aging,<br>Temperature, °C | R 28 | <br>100 | <br>100 | <br>110 |
| RTFO Test and PAV Aged Binder | | | | |
| Dynamic Shear,<br>Test Temp. at 10 rad/s, °C<br>Maximum G*sin(delta), kPa | T 315 | <br>16<br>5000 | <br>22<br>5000 | <br>31<br>5000 |
| Creep Stiffness,<br>Test Temperature, °C<br>Maximum S-value, MPa<br>Minimum M-value | T 313 | <br>-24<br>300<br>0.300 | <br>-18<br>300<br>0.300 | <br>-12<br>300<br>0.300 |

Notes:

a. Do not modify PG Polymer Modified using acid modification.

b. The Engineer waives this specification if the supplier is a Quality Supplier as defined by the Department's "Certification Program for Suppliers of Asphalt."

c. The Department allows ASTM D 5546 instead of AASHTO T 44

d. The Engineer waives this specification if the supplier certifies the asphalt binder can be adequately pumped and mixed at temperatures meeting applicable safety standards.

e. Test temperature is the temperature at which G*/sin(delta) is 2.2 kPa. A graph of log G*/sin(delta) plotted against temperature may be used to determine the test temperature when G*/sin(delta) is 2.2 kPa. A graph of (delta) versus temperature may be used to determine delta at the temperature when G*/sin(delta) is 2.2 kPa. The Engineer also accepts direct measurement of (delta) at the temperature when G*/sin(delta) is 2.2 kPa.

f. Tests without a force ductility clamp may be performed.

g. "PAV" means Pressurized Aging Vessel.

### SAMPLING

Provide a sampling device in the asphalt feed line connecting the plant storage tanks to the asphalt weighing system or spray bar. Make the sampling device accessible between 24 and 30 inches above the platform. Provide a receptacle for flushing the sampling device.

Include with the sampling device a valve:

1. Between 1/2 and 3/4 inch in diameter
2. Manufactured in a manner that a one-quart sample may be taken slowly at any time during plant operations
3. Maintained in good condition

Replace failed valves.

In the Engineer's presence, take 2 one-quart samples per operating day. Provide round, friction top, one-quart containers for storing samples.

## 92-1.03 EXECUTION

If asphalt is applied, you must comply with the heating and application specifications for liquid asphalt in Section 93, "Liquid Asphalts."

## 92-1.04 MEASUREMENT

If the contract work item for asphalt is paid by weight, the Department measures asphalt tons by complying with the specifications for weight determination of liquid asphalt in Section 93, "Liquid Asphalts."

The Engineer determines the asphalt weight from volumetric measurements if you:

1. Use a partial asphalt load
2. Use asphalt at a location other than a mixing plant and no scales within 20 miles are available and suitable
3. Deliver asphalt in either of the following:

    3.1. A calibrated truck with each tank accompanied by its measuring stick and calibration card
    3.2. A truck equipped with a calibrated thermometer that determines the asphalt temperature at the delivery time and with a vehicle tank meter complying with the specifications for weighing, measuring, and metering devices in Section 9-1.01, "Measurement of Quantities"

If you furnish hot mix asphalt from a mixing plant producing material for only one project, the Engineer determines the asphalt quantity by measuring the volume in the tank at the project's start and end provided the tank is calibrated and equipped with its measuring stick and calibration card.

The Engineer determines pay quantities from volumetric measurements as follows:

1. Before converting the volume to weight, the Engineer reduces the measured volume to that which the asphalt would occupy at 60 °F.
2. The Engineer uses 235 gallons per ton and 8.51 pounds per gallon for the average weight and volume for PG and PG Polymer Modified asphalt grades at 60 °F.
3. The Engineer uses the Conversion Table in Section 93, "Liquid Asphalts."

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## SECTION 93 LIQUID ASPHALTS
**(Issued 11-03-06)**

**In Section 93-1.04 replace the 9th paragraph with:**

The following Legend and Conversion Table is to be used for converting volumes of liquid asphalt products, Grades 70 to 3000, inclusive, and paving asphalt Grades PG 58-22, PG 64-10, PG 64-16, PG 64-28, and PG 70-10, and Grades PG 58-34 PM, PG 64-28 PM, and PG 76-22 PM.

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## SECTION 95 EPOXY
**(Issued 06-05-09)**

**Replace the table in Section 95-2.11 with:**

**Characteristics of Adhesive:**

| Test[a] | California Test | Requirement |
|---|---|---|
| Brookfield Viscosity, No. 3 Spindle at 20 rpm, Poise at 77°F | 434, Part 4 | 0.9 max. |
| Gel time, minutes | 434, Part 1 | 2 to 15 |
| Slant Shear Strength on Dry Concrete, psi, after 4 days of cure in air at 77° F ±2° F | 434, Part 5[b] | 3,000 min. |
| Slant Shear Strength on Wet Concrete, psi, after 4 days of cure in air at 77° F ±2° F | 434, Part 5[b] | 1,700 min. |
| Tensile Strength, psi | 434, Part 7, except test after 4 days of cure at 77° F ±2° F | 4,500 min. |
| Elongation, % | 434, Part 7, except test after 4 days of cure at 77° F ±2° F | 10 max. |

[a] The mixing ratio used will be that recommended by the manufacturer.
[b] For slant shear strength on concrete, delete Sections B-1 and B-5 of California Test 434, Part 5. For dry concrete, use Step "2" below only. For wet concrete, use both Steps "1" & "2":

1. Soak blocks in water for 24 hours at 77° F ±2° F. Remove and wipe off excess water.
2. Mix epoxy as described in California Test 434, Part 1, and apply a coat approximately 0.010-inch thick to each diagonal surface. Place four 0.125-inch square pieces of shim stock 0.012-inch thick on one block to control final film thickness. Before pressing the coated surfaces together, leave the blocks so that the coated surfaces are horizontal until the epoxy reacts slightly to prevent excessive flow.

# 5 MODIFICATIONS TO SPECIAL PROVISIONS

The following District Standard Special Provisions can be used without any additional Owner Approval unless there are edits requested:

1. Rock Blanket
2. Hot Mix Asphalt
3. Hot Mix Asphalt Aggregate Lime Treatment – Slurry Method
4. Hot Mix Asphalt Aggregate Lime Treatment – Dry Lime Method
5. Architectural Surface (Textural Concrete)
6. Microwave Vehicle Detection System – Side Fire
7. Vehicle Classification Station
8. NEMA 3R Enclosure
9. Closed Circuit Television System
10. Extinguishable Message Sign (LED)
11. Fiber Optic System

# 1. Rock Blanket 20-080_E_A09-21-07

# 10-1.__ ROCK BLANKET

Rock blanket shall be placed at gore areas, as shown on the plans and in conformance with these special provisions.

## MATERIALS

Rock for the rock blanket shall be clean, smooth rock obtained from a single source.

Rock shall conform to the following grading:

| Screen Size (Inches) | Percentage Passing |
|---|---|
| 8 | 100 |
| 6 | 50-85 |
| 4 | 0-50 |

A sample of the rock shall be submitted to the Engineer for approval prior to delivery of the rock to the project site.

Rock shall be secured in place with Class 2 concrete conforming to the provisions in Section 90, "Portland Cement Concrete," of the Standard Specifications and these special provisions. Concrete aggregate size shall be 3/4 inch maximum.

## SITE PREPARATION

Prior to beginning rock blanket work, areas to receive the rock blanket shall be cleared in conformance with the provisions in "Roadside Clearing" of these special provisions.

After clearing, the areas shall be excavated to the depth shown on the plans, graded to a smooth uniform surface and compacted to a minimum relative compaction of 90 percent.

Reset utility concrete boxes within gore areas, to be flush with new grades, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

## PLACEMENT

Rock shall be placed while concrete is still plastic, and spaced a maximum of 1/2 inch apart. The Contractor shall remove concrete adhering to the exposed surfaces of the rock. Loose rocks, or rock with a gap greater than 3/8 inch, measured from the edge of the rock to the surrounding concrete bedding shall be reset at the Contractor's expense by methods determined by the Engineer.

## 2. Hot Mix Asphalt
## 39-056_E_D06-05-08

# 10-1.__ HOT MIX ASPHALT

## GENERAL

**Summary**

This work includes producing and placing hot mix asphalt (HMA) Type ____ using the _____ process.

Comply with Section 39, "Hot Mix Asphalt," of the Standard Specifications.

**Submittals**

Quality Control / Quality Assurance Projects

With the job mix formula (JMF) submittal, submit:

1. California Test 204 plasticity index results
2. California Test 371 tensile strength ratio results for untreated HMA
3. California Test 371 tensile strength ratio results for treated HMA if untreated HMA tensile strength ratio is below 70

At project start-up and once during production, submit samples split from your HMA production sample for California Test 371 to the Engineer and the Transportation Laboratory, Attention: Moisture Test.

With the JMF submittal, at project start-up, and each 5,000 tons, submit the California Test 371 test results for mix design and production to the Engineer and electronically to:

Moisture_Tests@dot.ca.gov

Data Cores

Three business days before starting coring, submit proposed methods and materials for backfilling data core holes.

Submit to the Engineer and electronically to Coring@dot.ca.gov:

1. A summary of data cores taken
2. A photograph of each data core

For each data core, the summary must include:

1. Project identification number
2. Date cored
3. Core identification number
4. Type of materials recovered
5. Type and approximate thickness of unstabilized material not recovered
6. Total core thickness

7. Thickness of each individual material to within:

    7.1 For recovered material, 1/2 inch
    7.2 For unstabilized material, 1.0 inch

8. Location including:

    8.1. County
    8.2. Route
    8.3. Post mile
    8.4. Lane number
    8.5. Lane direction
    8.6. Station

Each data core digital photograph must include a ruler laid next to the data core. Each photograph must include:

1. The core
2. Project identification number
3. Core identification number
4. Date cored
5. County
6. Route
7. Post mile
8. Lane number
9. Lane direction

After data core summary and photograph submittal, dispose of cores under Section 7-1.13, "Disposal of Material Outside the Highway Right of Way," of the Standard Specifications.

## Quality Control and Assurance

Quality Control / Quality Assurance Projects

For the mix design, determine the plasticity index of the aggregate blend under California Test 204. Choose an antistrip treatment and use the corresponding laboratory procedure for the mix design in compliance with:

**Antistrip Treatment Lab Procedures for Mix Design**

| Antistrip Treatment | Lab Procedure |
|---|---|
| Plasticity index from 4 to 10 [a] | |
| Dry hydrated lime with marination | LP-6 |
| Lime slurry with marination | LP-7 |
| Plasticity index less than 4 | |
| Liquid | LP-5 |
| Dry hydrated lime without marination | LP-6 |
| Dry hydrated lime with marination | LP-6 |
| Lime slurry with marination | LP-7 |

Notes:
[a] If the plasticity index is greater than 10, do not use that aggregate blend.

For the mix design, determine tensile strength ratio under California Test 371 on untreated HMA. If the tensile strength ratio is less than 70:

1. Choose from the antistrip treatments specified based on plasticity index.
2. Test treated HMA under California Test 371.
3. Treat to a minimum tensile strength ratio of 70.

On the first production day and at least every 5,000 tons, sample HMA and test under California Test 371.

The Department does not use California Test 371 test results for JMF verification and production to determine specification compliance.

Perform sampling and testing at the specified frequency and location for the following additional quality characteristics:

**Minimum Quality Control**

| Quality Characteristic | Test Method | Minimum Sampling and Testing Frequency | Requirement | Location of Sampling | Minimum Reporting Time Allowance |
|---|---|---|---|---|---|
| Coarse durability index ($D_c$) (min) | CT 229 | 1 per 3,000 tons during production but not less than 1 per paving day | 65 | Stockpile [a] | 48 hours |
| Fine durability index ($D_f$) (min) | CT 229 | | 50 | | |

Note:
[a] Before lime treatment.

The Engineer samples aggregate for acceptance testing and tests for the following additional quality characteristics:

**HMA Acceptance**

| Quality Characteristic | Test Method | Specification | Sampling Location |
|---|---|---|---|
| Coarse durability index ($D_c$) (min) | CT 229 | 65 | Stockpile [a] |
| Fine durability index ($D_f$) (min) | CT 229 | 50 | |

Note:
[a] Before lime treatment.

## MATERIALS

### Asphalt Binder

The grade of asphalt binder mixed with aggregate for HMA Type ____ must be PG _____.

### Aggregate

Before the addition of asphalt binder and lime treatment, aggregate must comply with the following additional quality characteristics:

| Quality Characteristic | Test Method | Requirement |
|---|---|---|
| Coarse Durability Index, $D_c$ (min.) | CT 229 | 65 |
| Fine Durability Index, $D_f$ (min.) | CT 229 | 50 |

| | |
|---|---|
| | |
| | |
| | |

The aggregate for HMA Type ____ must comply with the _____ grading.

### Antistrip Treatment

Treat aggregate with lime slurry or with dry lime. Treat aggregate with lime slurry under "Hot Mix Asphalt Aggregate Lime Treatment – Slurry Method" and use Lab Procedure LP-7 for the mix design. Treat aggregate with dry lime under "Hot Mix Asphalt Aggregate Lime Treatment – Dry Lime Method" and use Lab Procedure LP-6 for the mix design.

## CONSTRUCTION

### Rumble Strips

Construct rumble strips in the top layer of new HMA surfacing.

**Vertical Joints**

If you perform half-width paving, at the end of each day's work the distance between the ends of adjacent surfaced lanes must not be greater than can be completed in the following day of normal paving.

Before opening the lane to public traffic, pave shoulders and median borders adjacent to a lane being paved.

Do not leave a vertical joint more than 0.15 foot high between adjacent lanes open to public traffic.

Place HMA on adjacent traveled way lanes so that at the end of each work shift, the distance between the ends of HMA layers on adjacent lanes is between 5 feet and 10 feet. Place additional HMA along the transverse edge at each lane's end and along the exposed longitudinal edges between adjacent lanes. Hand rake and compact the additional HMA to form temporary conforms. You may place Kraft paper or another approved bond breaker under the conform tapers to facilitate the taper removal when paving operations resume.

**Widening**

If widening existing pavement, construct new structural section on both sides of the existing pavement to match the elevation of the existing pavement's edge for the project's entire length before placing HMA over the existing pavement.

If widening existing pavement, construct new structural section on both sides of the existing pavement to match the elevation of the existing pavement's edge at each location before placing HMA over the existing pavement.

If widening existing pavement, construct new structural section on both sides of the existing pavement to match the elevation of the existing pavement's edge in increments of at least _____ feet before placing HMA over the existing pavement.

**Conform Tapers**

Place shoulder conform tapers concurrently with the adjacent lane's paving.

Place additional HMA along the pavement's edge to conform to road connections and private drives. Hand rake, if necessary, and compact the additional HMA to form a smooth conform taper.

**Data Cores**

Take data cores that include the completed HMA pavement, underlying base, and subbase material. Protect data cores and surrounding pavement from damage.

Take 4-inch or 6-inch diameter data cores:

1. At the beginning, end, and every 1/2 mile within the paving limits of each route on the project
2. After all paving is complete
3. From the center of the specified lane

On a 2-lane roadway, take data cores from either lane. On a 4-lane roadway, take data cores from each direction in the outermost lane. On a roadway with more than 4 lanes, take data cores from the median lane and the outermost lane in each direction.

Each core must include the stabilized materials encountered. You may choose not to recover unstabilized material but you must identify the material. Unstabilized material includes:

1. Granular material
2. Crumbled or cracked stabilized material
3. Sandy or clayey soil

# 3. Hot Mix Asphalt Aggregate Lime Treatment – Slurry Method 39-406_E_D06-05-09

# 10-1.__ HOT MIX ASPHALT AGGREGATE LIME TREATMENT - SLURRY METHOD

## GENERAL

### Summary

This work includes treating hot mix asphalt (HMA) aggregate with lime using the slurry method and placing it in stockpiles to marinate.

Treat aggregate for _____ with lime slurry.

### Submittals

Determine the exact lime proportions for fine and coarse virgin aggregate and submit them as part of the proposed job mix formula (JMF) under Section 39, "Hot Mix Asphalt," of the Standard Specifications.

Submit the averaged aggregate quality test results to the Engineer within 24 hours of sampling.

Submit a treatment data log from the slurry proportioning device in the following order:

1. Treatment date
2. Time of day the data is captured
3. Aggregate size being treated
4. Wet aggregate flow rate collected directly from the aggregate weigh belt
5. Moisture content of the aggregate just before treatment, expressed as a percent of the dry aggregate weight
6. Dry aggregate flow rate calculated from the wet aggregate flow rate
7. Lime slurry flow rate measured by the slurry meter
8. Dry lime flow rate calculated from the slurry meter output
9. Approved lime ratio for each aggregate size being treated
10. Actual lime ratio calculated from the aggregate weigh belt and the slurry meter output, expressed as a percent of the dry aggregate weight
11. Calculated difference between the approved lime ratio and the actual lime ratio
12. Dry lime and water proportions at the slurry treatment time

Every day during lime treatment, submit the treatment data log on electronic media in tab delimited format on a removable CD-ROM storage disk. Each continuous treatment data set must be a separate record using a line feed carriage return to present the specified data on one line. The reported data must include data titles at least once per report.

### Quality Control and Assurance

Your quality control plan (QCP) must include aggregate quality control sampling and testing during aggregate lime treatment. Perform sampling and testing in compliance with:

**Aggregate Quality Control During Lime Treatment**

| Quality Characteristic | Test Method | Minimum sampling and testing frequency |
|---|---|---|
| Sand Equivalent | CT 217 | Once per 1,000 tons of aggregate treated with lime |
| Percent of crushed particles | CT 205 | As necessary and as designated in the QCP |
| Los Angeles Rattler | CT 211 | |
| Fine aggregate angularity | AASHTO T 304, Method A | |
| Flat and elongated particles | ASTM D 4791 | |
| Coarse Durability Index | CT 229 | |
| Fine Durability Index | CT 229 | |

Note:
During lime treatment, sample coarse and fine aggregate from individual stockpiles. Combine aggregate in the JMF proportions. Run tests for aggregate quality in triplicate and report test results as the average of 3 tests.

The Engineer orders proportioning operations stopped for any of the following if you:

1. Do not submit the treatment data log.
2. Do not submit the aggregate quality control data.
3. Submit incomplete, untimely, or incorrectly formatted data.
4. Do not take corrective actions.
5. Take late or unsuccessful corrective actions.
6. Do not stop treatment when proportioning tolerances are exceeded.
7. Use malfunctioning or failed proportioning devices.

If you stop treatment, notify the Engineer of any corrective actions taken and conduct a successful 20-minute test run before resuming treatment.

For the aggregate to be treated, determine the moisture content at least once during each 2 hours of treatment. Calculate moisture content under California Test 226 or California Test 370 and report it as a percent of dry aggregate weight. Use the moisture content calculations as a set point for the proportioning process controller.

## MATERIALS

Lime must be high-calcium hydrated lime. Llime and water must comply with Section 24-1.02, "Materials," of the Standard Specifications.

Before virgin aggregate is treated, it must comply with the aggregate quality specifications. Do not test treated aggregate for quality control except for gradation. The Engineer does not test treated aggregate for acceptance except for gradation.

The Engineer determines the combined aggregate gradation during HMA production after you have treated aggregate. When reclaimed asphalt pavement (RAP) is used, the Engineer determines combined aggregate gradations containing RAP under Laboratory Procedure LP-9.

Treated aggregate must not have lime balls or clods.

## CONSTRUCTION

### General

Notify the Engineer at least 24 hours before the start of aggregate treatment.

Treat aggregate separate from HMA production.

Do not treat RAP.

Add lime to the aggregate as slurry consisting of mixed dry lime and water at a ratio of 1 part lime to between 2 parts and 3 parts water by weight. The slurry must completely coat the aggregate.

Lime treat and marinate coarse and fine aggregates separately.

Immediately before mixing lime slurry with aggregate, water must not visibly separate from aggregate.

Treat aggregate and stockpile for marination only once.

The lime ratio is the pounds of dry hydrated lime per 100 pounds of dry virgin aggregate expressed as a percent. Water content of slurry or untreated aggregate must not affect the lime ratio.

Lime ratio ranges are:

| Aggregate Gradation | Lime Ratio |
|---|---|
| Coarse | 0.4 to 1.0 |
| Fine | 1.5 to 2.0 |
| Combined virgin aggregate | 0.8 to 1.5 |

You may reduce the combined aggregate lime ratio for open graded friction course to between 0.5 and 1.0 percent.

The lime ratio for fine and coarse aggregate must be within ±0.2 percent of the lime ratio in the accepted JMF. The lime ratio must be within ±0.2 percent of the approved lime ratio when you combine the individual aggregate sizes in the JMF proportions. The lime ratio must be determined before the addition of RAP.

If 3 consecutive sets of recorded treatment data indicate deviation more than 0.2 percent above or below the lime ratio in the accepted JMF, stop treatment.

If a set of recorded treatment data indicates a deviation of more than 0.4 percent above or below the lime ratio in the accepted JMF, stop treatment and do not use the material represented by that set of data in HMA.

If 20 percent or more of the total daily treatment indicates deviation of more than 0.2 percent above or below the lime ratio in the accepted JMF, stop treatment and do not use the day's total treatment in HMA.

If you stop treatment for noncompliance, you must implement corrective action and successfully treat aggregate for a 20-minute period. Notify the Engineer before beginning the 20-minute treatment period.

### Lime Slurry Proportioning

Proportion lime and water with a continuous or batch operation.

The device controlling slurry proportioning must produce a treatment data log. The log consists of a series of data sets captured at 10-minute intervals throughout daily treatment. The data must be a treatment activity register and not a summation. The material represented by the data set is the amount

produced 5 minutes before and 5 minutes after the capture time. For the contract's duration, collected data must be stored by the controller.

**Proportioning and Mixing Lime Slurry Treated Aggregate**

Treat HMA aggregate by proportioning lime slurry and aggregate by weight in a continuous operation.

Marinate treated aggregate in stockpiles from 24 hours to 60 days before using in HMA. Do not use aggregate marinated longer than 60 days.

# 4. Hot Mix Asphalt Aggregate Lime Treatment – Dry Lime Method 39-456_E_D06-05-09

# 10-1.__ HOT MIX ASPHALT AGGREGATE LIME TREATMENT - DRY LIME METHOD

## GENERAL

### Summary

This work includes treating hot mix asphalt (HMA) aggregate with lime using the dry lime method either with marination or without.

Treat aggregate for _____ with dry lime.

Marinate aggregate if the plasticity index determined under California Test 204 is from 4 to 10.

### Submittals

Determine the exact lime proportions for fine and coarse virgin aggregate and submit them as part of the proposed job mix formula (JMF) under Section 39, "Hot Mix Asphalt," of the Standard Specifications.

If marination is required, submit in writing the averaged aggregate quality test results to the Engineer within 24 hours of sampling.

Submit in writing a treatment data log from the dry lime and aggregate proportioning device in the following order:

1. Treatment date
2. Time of day the data is captured
3. Aggregate size being treated
4. HMA type and mix aggregate size
5. Wet aggregate flow rate collected directly from the aggregate weigh belt
6. Aggregate moisture content, expressed as a percent of the dry aggregate weight
7. Flow rate of dry aggregate calculated from the flow rate of wet aggregate
8. Dry lime flow rate
9. Lime ratio from the accepted JMF for each aggregate size being treated
10. Lime ratio from the accepted JMF for the combined aggregate
11. Actual lime ratio calculated from the aggregate weigh belt output, the aggregate moisture input, and the dry lime meter output, expressed as a percent of the dry aggregate weight
12. Calculated difference between the approved lime ratio and the actual lime ratio

Every day during lime treatment, submit the treatment data log on electronic media in tab delimited format on a removable CD-ROM storage disk. Each continuous treatment data set must be a separate record using a line feed carriage return to present the specified data on one line. The reported data must include data titles at least once per report.

### Quality Control and Assurance

If marination is required, your quality control plan (QCP) must include aggregate quality control sampling and testing during lime treatment. Perform sampling and testing in compliance with:

| Quality Characteristic | Test Method | Minimum sampling and testing frequency |
|---|---|---|
| Sand Equivalent | CT 217 | Once per 1,000 tons of aggregate treated with lime |
| Percent of crushed particles | CT 205 | As necessary and as designated in the QCP |
| Los Angeles Rattler | CT 211 | |
| Fine aggregate angularity | AASHTO T 304, Method A | |
| Flat and elongated particles | ASTM D 4791 | |
| Coarse Durability Index | CT 229 | |
| Fine Durability Index | CT 229 | |

Note:
During lime treatment, sample coarse and fine aggregate from individual stockpiles. Combine aggregate in the JMF proportions. Run tests for aggregate quality in triplicate and report test results as the average of 3 tests.

The Engineer orders proportioning operations stopped for any of the following if you:

1. Do not submit the treatment data log
2. Do not submit the aggregate quality control data for marinated aggregate
3. Submit incomplete, untimely, or incorrectly formatted data
4. Do not take corrective actions
5. Take late or unsuccessful corrective actions
6. Do not stop treatment when proportioning tolerances are exceeded
7. Use malfunctioning or failed proportioning devices

If you stop treatment, notify the Engineer of any corrective actions taken and conduct a successful 20-minute test run before resuming treatment.

## MATERIALS

Lime must be high-calcium hydrated lime. Lime and water must comply with Section 24-1.02, "Materials," of the Standard Specifications.

Before virgin aggregate is treated, it must comply with the aggregate quality specifications. Do not test treated aggregate for quality control except for gradation. The Engineer does not test treated aggregate for acceptance except for gradation.

The Engineer determines the combined aggregate gradation during HMA production after you have treated aggregate. When reclaimed asphalt pavement (RAP) is used, the Engineer determines combined aggregate gradations containing RAP under Laboratory Procedure LP-9.

Treated aggregate must not have lime balls or clods.

## CONSTRUCTION

### General

Notify the Engineer in writing at least 24 hours before the start of aggregate treatment.

Do not treat RAP.

If marination is required:

1. Treat and marinate coarse and fine aggregates separately.
2. Treat aggregate and stockpile for marination only once.
3. Treat aggregate separate from HMA production.

The lime ratio is the pounds of dry hydrated lime per 100 pounds of dry virgin aggregate expressed as a percent. Water content of untreated aggregate must not affect the lime ratio.

Lime ratio ranges are:

| Aggregate Gradation | Lime Ratio |
|---|---|
| Coarse | 0.4 to 1.0 |
| Fine | 1.5 to 2.0 |
| Combined virgin aggregate | 0.8 to 1.5 |

You may reduce the combined aggregate lime ratio for open graded friction course to between 0.5 and 1.0 percent.

The lime ratio for fine and coarse aggregate must be within ±0.2 percent of the lime ratio in the accepted JMF. The lime ratio must be within ±0.2 percent of the approved lime ratio when you combine the individual aggregate sizes in the JMF proportions. The lime ratio must be determined before the addition of RAP.

Proportion dry lime by weight with a continuous operation.

The device controlling dry lime and aggregate proportioning must produce a treatment data log. The log consists of a series of data sets captured at 10-minute intervals throughout daily treatment. The data must be a treatment activity register and not a summation. The material represented by a data set is the amount produced 5 minutes before and 5 minutes after the capture time. For the duration of the contract, collected data must be stored by the controller.

If 3 consecutive sets of recorded treatment data indicate deviation more than 0.2 percent above or below the lime ratio in the accepted JMF, stop treatment of lime treated aggregates.

If a set of recorded treatment data indicates a deviation of more than 0.4 percent above or below the lime ratio in the accepted JMF, stop treatment of lime treated aggregates and do not use the material represented by that set of data in HMA.

If 20 percent or more of the total daily treatment indicates deviation of more than 0.2 percent above or below the lime ratio in the accepted JMF, stop treatment and do not use the day's treated aggregate in HMA.

If you stop treatment for noncompliance, you must implement corrective action and successfully treat aggregate for a 20-minute period. Notify the Engineer before beginning the 20-minute treatment period.

If you use a batch-type proportioning operation for HMA production, control proportioning in compliance with the specifications for continuous mixing plants. Use a separate dry lime aggregate treatment operation from HMA batching operations including:

1. Pugmill mixer
2. Controller
3. Weigh belt for the lime
4. Weigh belt for the aggregate

If using a continuous mixing operation for HMA without lime marinated aggregates, use a controller that measures the blended aggregate weight after any additional water is added to the mixture. The controller must determine the amount of lime added to the aggregate from the aggregate weigh belt input in connection with the manually input total aggregate moisture, the manually input target lime content, and the lime proportioning system output. Use a continuous aggregate weigh belt and pugmill mixer for the lime treatment operation in addition to the weigh belt for the aggregate proportioning to asphalt binder in the HMA plant. If you use a water meter for moisture control for lime treatment, the meter must comply with California Test 109.

At the time of mixing dry lime with aggregate, the aggregate moisture content must ensure complete lime coating. The aggregate moisture content must not cause aggregate to be lost between the point of weighing the combined aggregate continuous stream and the dryer. Add water for mixing and coating aggregate to the aggregate before dry lime addition. Immediately before mixing lime with aggregate, water must not visibly separate from aggregate.

The HMA plant must be equipped with a bag house dust system. Material collected in the dust system must be returned to the mix.

**Mixing Dry Lime and Aggregate**

Mix aggregate, water, and dry lime with a continuous pugmill mixer with twin shafts. Immediately before mixing lime with aggregate, water must not visibly separate from aggregate. Store dry lime in a uniform and free flowing condition. Introduce dry lime to the pugmill in a continuous operation. The introduction must occur after the aggregate cold feed and before the point of proportioning across a weigh belt and the aggregate dryer. Prevent loss of dry lime.

If marination is required, marinate treated aggregate in stockpiles between 24 hours and 60 days before using in HMA. Do not use aggregate marinated more than 60 days.

The pugmill must be equipped with paddles arranged to provide sufficient mixing action and mixture movement. The pugmill must produce a homogeneous mixture of uniformly coated aggregates at mixer discharge.

If the aggregate treatment operation is stopped longer than 1 hour, clean the equipment of partially treated aggregate and lime.

Aggregate must be completely treated before introduction into the mixing drum.

# 5. Architectural Surface (Textural Concrete) 51-TEXT_E_R05-02-06

## 10-1.__ ARCHITECTURAL SURFACE (TEXTURED CONCRETE)

Architectural textures for concrete surfaces shall conform to the details shown on the plans and the provisions in Section 51, "Concrete Structures," of the Standard Specifications and these special provisions.

Architectural textures listed below are required at concrete surfaces shown on the plans:

A. Ripped texture (reinforcing bar)

The ripped texture (reinforcing bar) shall be an architectural texture from which embedded reinforcing steel bars together with adhering concrete have been ripped from the concrete. Bar imprints in the concrete surface shall be from either No. 5 or No. 6 deformed reinforcing steel bars. Imprints shall be continuous with no apparent curves or discontinuities. The spacing of imprints shall be such that a fractured concrete texture is imparted to the entire surface between imprints, yet far enough apart to make the fractured concrete the predominate texture. Surfaces between imprints that do not exhibit the fractured concrete texture shall be textured with a suitable tool. The architectural texture shall have random shadow patterns. Broken concrete between imprints and between groups of imprints shall impart a random pattern to the concrete surface. The architectural texture shall not have secondary patterns imparted by shadows or repetitive fractured surfaces.

*TEST PANEL*

A test panel at least 4' x 4' in size shall be successfully completed at a location approved by the Engineer before beginning work on architectural textures. The test panel shall be constructed and finished with the materials, tools, equipment, and methods to be used in constructing the architectural texture. If ordered by the Engineer, additional test panels shall be constructed and finished until the specified finish, texture, and color are obtained, as determined by the Engineer.

The test panel approved by the Engineer shall be used as the standard of comparison in determining acceptability of architectural texture for concrete-surfaces.

*ABRASIVE BLASTING*

The architectural texture shall be abrasive blasted with fine abrasive to remove the sheen without exposing coarse aggregate.

*CURING*

Concrete surfaces with architectural texture shall be cured only by the forms-in-place or water methods. Seals and curing compounds shall not be used.

# 6. Microwave Vehicle Detection System – Side Fire 86-424_E_A01-19-07

# 10-3.__ MICROWAVE VEHICLE DETECTION SYSTEM - SIDE FIRE

This work consists of furnishing and installing a microwave vehicle detection system (MVDS).

## MATERIALS LIST AND DRAWINGS

A list of materials which the Contractor proposes to install for the MVDS together with the drawings and other data shall be submitted to the Engineer in conformance with Section 86-1.04, "Equipment List and Drawings," of the Standard Specifications. Additionally, the following shall be provided before the completion of the contract:

1. **Certificate of Compliance** - A Certificate of Compliance for MVDS shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications.
2. **Site Analysis Report** - Prior to MVDS installation the Contractor shall review each detection site and provide a written analysis recommending the optimum sensor placement for meeting the performance requirements of this special provision. The analysis shall be reviewed and approved by the MVDS manufacturer.
3. **Lane Configuration -** The documentation shall include a diagram that illustrates how the microwave beam is covering the traffic lanes as well as the corresponding MVDS connector pins or wire terminals that correspond to the respective lanes. The lanes shall be identified by direction (NB, SB, EB, WB), and in order, with lane one being the lane nearest to the center of the roadway.
4. **Mounting and Wiring Information** - The Contractor shall provide to the Engineer for approval one set of detailed diagrams showing wiring and service connections for each MVDS. The approved diagrams shall be covered separately on each side with clear self-adhesive plastic and placed in a heavy-duty plastic envelope. The envelope shall be attached securely to the inside of the cabinet door or at a location designated by the Engineer.
5. **Communication Protocol** - The MVDS communication protocol shall be open and shall be freely available for use in the public domain. The Contractor shall provide documentation that defines the complete MVDS communication protocol (e.g. message structure organization, data packet length, as well as all information necessary to make use of such messages).
6. **Remote Programming** - The Contractor shall provide all information and software necessary for operating the system from a remote Windows 2000/NT or newer based Personal Computer (PC). This information and software shall include at minimum the capability to calibrate, tune, align, and program the MVDS and shall be provided on a Windows 2000/NT or newer compatible compact disc (CD). The information shall be formatted so that the files can be matched with the equipment being calibrated or aligned. This documentation shall contain files that allow for replacement equipment to be loaded with the same configuration.
7. **MVDS Accuracy Analysis** - The Contractor shall be responsible for conducting MVDS Performance Testing and shall submit to the Engineer an MVDS accuracy analysis that conforms to requirements of these special provisions within 15 days of MVDS testing.

The original video recordings as well as digital versatile disc (DVD) or CD copies of the video images covering the analysis periods shall be included.

8. **Acceptance Testing Documentation -** The Contractor shall provide a test plan, containing time and period of the testing, to be approved by the Engineer. The test plan shall be organized so that the Engineer will be able to perform acceptance testing using the documentation without assistance from the Contractor. The Contractor shall collect and submit the data to be certified by the Engineer. If required by the Engineer, the data shall be collected in the presence of the Engineer.
9. **Acceptance Testing Schedule -** The Contractor shall submit a testing schedule to the Engineer for approval 15 days prior to acceptance testing of the MVDS. If the testing period extends beyond the normal working shift or if the Contractor fails to provide the necessary material for the testing within one hour of the scheduled testing start time, the Engineer may cancel testing for the day.
10. **Training -** The Contractor shall provide a copy of the training material to the Engineer for approval 30 days prior to the training. The content of the training shall include instruction on how to align, program, adjust, calibrate and maintain the MVDS.

## FUNCTIONAL REQUIREMENTS

MVDSs shall simultaneously provide vehicle detection data in the form of vehicle presence, volumes, counts, speed, classification, and occupancy for a minimum of 8 lanes of traffic with the performance requirements of these special provisions. MVDSs shall provide a separate zone per lane and detect vehicles as close as 7 feet and as far as 200 feet from the MVDS sensor. MVDSs shall monitor traffic lanes in the presence of barrier railings, guardrails and other obstacles. Each MVDS sensor shall be connected via a MVDS Cable (6-pair 18 gauge conductors) into a MVDS surge protection module. The MVDS Cable shall include both power and EIA 232 communication for the MVDS sensor.

MVDSs shall meet the following detection performance criteria when installed a minimum of 7 feet from the nearest lane and at a minimum height of 15 feet above the roadway detection zone:

1. Average 5 minute volumes for all lanes combined with better than 95 percent accuracy compared to vehicles observed in video images for the same period, for any 15 minute period selected by the Engineer.
2. Average 30 second volumes in every lane with better than 90 percent accuracy compared to vehicles observed in video images for the same period, for any 5 minute period selected by the Engineer.
3. Average 30 second speed in any lane with better than 95 percent accuracy, for any 5 minute period selected by the Engineer.
4. Average 5 minute occupancy for any lane with better than 85 percent accuracy, for any 15 minute period selected by the Engineer.
5. Count accuracy, when compared to vehicles observed in video images for the same period, shall be not less than 90 percent for any lane and not less than 95 percent for all lanes combined.
6. Average 15 minute classification according to user defined criteria with better than 90 percent accuracy compared to vehicles observed in video images for the same period.

Vehicle Classification (or Length Classification) shall be provided for categories (small car, average car, mid size car, long car, extra-long car) that are user definable as either by length parameters (minimum length to maximum length for the category) or by a multiple of length of the average car.

7. The Contractor shall provide the criteria for speed and volume acceptance test for approval by the Engineer. The Contractor shall also provide speed and volume data for verification by the Engineer.

MVDS shall consist of a sensor unit and include all required mounting hardware, power supplies, surge suppression, cables, connectors and wiring. The MVDS sensor shall include, as a minimum, a directional microwave transmitter, antenna, microwave receiver, a processor, memory and communication interface.

The MVDS shall have an EIA 232 and EIA 485 communication port that supports the National Transportation Communication for ITS Protocol (NTCIP). The MVDS communication protocol shall be non-proprietary and openly specified and available for use in the public domain. The MVDS shall be addressable and shall download count, speed, and occupancy data when polled by the traffic management center computer. Speed shall be configurable in English units. The MVDS shall support unit set-up from a serial console port on the MVDS unit. The console port protocol shall support sensor unit setup from a local Windows 2000/NT or newer compatible laptop or from a remote location with a desktop computer and standard phone modem.

MVDSs shall be user programmable in the field, via the MVDS unit console port, with a Windows 2000/NT or newer compatible laptop computer. The Contractor shall provide software, firmware and equipment to set-up, calibrate and operate the unit. MVDS software shall observes the vehicular traffic and automatically places detection lanes and set the sensor sensitivity. MVDSs shall be designed so that a trained State employee can configure and calibrate the MVDS in less than 15 minutes per lane once the MVDS sensor unit is installed.

## TECHNICAL REQUIREMENTS

MVDSs shall be FCC certified under Part 15 for low-power, unlicensed, continuous radio transmitter operation. The MVDS shall comply with FCC regulations under all specified operating conditions and over the expected life of the MVDS.

MVDS sensor unit shall not weigh more than 5 pounds. The MVDS shall operate over a temperature range from –40 °C to +74 °C, with up to 95 percent relative humidity. The MVDS sensor enclosure shall be weatherproof with a NEMA 3R rating, and the sensor mounted and directed perpendicular to the flow of traffic lanes at the locations shown on the plans.

All electronic assemblies shall conform to the requirements detailed in Chapters 1 and 5 of the Transportation Electrical Equipment Specifications (TEES).

MVDS sensors shall be wired with a connectorized cable harness. Cables shall run continuously (without splices) between the sensor and NEMA 3R enclosure and terminate in the MVDS surge protection module. The connector shall be a standard Mil Type and rated plug. The cable shall have the number of conductors specified by the MVDS manufacturer to support the number of detection zones depicted on the plans plus spares for two future zones with an overall shield and copper drain wire. Conductors shall be stranded copper equal to or exceeding the minimum strands and wire dimensions specified by the MVDS manufacturer for the wiring distance involved and covered with a minimum 12 mils polyvinyl chloride (PVC) insulation, rated for 300 V at 105 °C. The outer jacket shall be chrome PVC with minimum

thickness of 53 mils and the outside diameter of the cable shall not exceed 3/4 inch. A minimum of 3 feet slack of MVDS cable shall be coiled inside the NEMA 3R enclosure.

MVDS surge protection modules shall be mounted on a standard DIN rack rail using standard mounting hardware. The Contractor shall wire the MVDS power conductors to the DIN rail mounted surge protection module. The serial data communication output conductors shall be terminated at the surge protection module. The ends of unused and spare conductors shall be coiled and taped to prevent accidental contact to other circuits. Conductors inside the cabinet shall be labeled for the functions as shown on the approved detailed diagrams.

Field terminated circuits shall include transient protection that complies with IEEE Standard C62.41.2.

A MVDS surge protection module shall be installed at each MVDS location as shown on the plans. At the Contractor's option, the surge protection module may be internal to the MVDS sensor.

The MVDS surge protection module shall meet or exceed the following minimum requirements:

| | MVDS Surge Protection Module |
|---|---|
| Lines Protected | EIA 485, EIA 232 DTE with CTS / RTS<br>DC Power |
| Protection Types: | |
| EIA 485 Surge | Differential and Common Modes up to 4 kV minimum<br>Clamping Voltage to 8 V(dc) |
| EIA 232 Surge | Differential and Common Modes up to 4 kV minimum<br>Clamping Voltage to11 V(dc) |
| DC Power | Differential and Common Modes up to 4 kV minimum |
| Peak Surge Current | 10 kA (8 x 20 microseconds) minimum |
| Mounting | DIN rail |
| Operating Temperature | From –35° C to +74° C |
| Operating Humidity Range | From 5% to 95% |

Each wireless modem shall meet the requirements as shown on the plans and specified elsewhere in these special provisions.

The MVDS shall automatically restores normal operation following a power failure within 3 minutes and not require manual intervention. The MVDS shall maintain the configuration and calibration information in non-volatile memory and retain the information while powered off for at least 90 days.

The MVDS shall be configurable for 30 second to 24-hour polling cycles and store vehicle count, speed, classification, and occupancy data in 10 second to not less than 15 minute intervals.

The MVDS shall be tested and in standard production for a minimum of 3 months. The Contractor shall not install any MVDS that is older than 6 months from the scheduled start date of the MVDS installation as indicated by date codes or serial numbers of electronic circuit assemblies.

The MVDS system and all supporting equipment shall be designed to operate continuously in an outdoor traffic monitoring and control environment. The Contractor shall provide a manufacturer's warranty stating that the manufacturing quality and electronic components shall support a Mean Time Between Failures of 10 years in this environment.

## CONSTRUCTION

The Contractor shall assure that the MVDS will not cause harmful interference to radio communication in the area of the installation as required by FCC Part 15 requirements. The MVDS units shall be installed such that each unit operates independently and that MVDS units not interfere with other MVDS units or other equipment in the vicinity.

The Contractor is responsible for site visits and analysis of each proposed pole location to assure that the detector placement will comply with the manufacturer's published installation instructions, and the performance required in these special provisions. The Contractor shall confirm detector placement with the manufacturer before performing work at the MVDS location. When the manufacturer's analysis requires a change in the proposed pole location, the Contractor shall arrange a meeting with the manufacturer and the Engineer to select a new pole location.

The Contractor shall not proceed with any MVDS installation without the Engineer's written approval of the pole location.

The Contractor shall be responsible for the compatibility of components and for making necessary calibration adjustment to deliver the performance required in these special provisions. The Contractor shall provide equipment required to setup, calibrate, verify performance and maintain the MVDS.

The Contractor shall provide programming software needed to support the MVDS. The software shall be installed in the appropriate equipment and used for the acceptance testing.

## TESTING

Accuracy of the MVDS system shall be verified by comparing the MVDS vehicle counts to recorded video image counts for the same period. The video camera shall be located and oriented so that traffic is visible in all lanes. Video images shall be time stamped and analysis periods recorded to a DVD or CD media for viewing on a PC. The video field of view shall totally encompass the area in which vehicles are detected. The Contractor shall provide a means for synchronizing the test start and test ending times or provide software that displays time stamped MVDS data along with the video images of the moving vehicles. The Contractor shall provide the Engineer with the original recording medium and documentation that supports the accuracy analysis and make a copy of these materials for their own use.

The accuracy test shall take place during a complex traffic period as specified by the Engineer. The following video recording and analysis options that depend on the available traffic conditions are acceptable; however the heaviest expected traffic conditions should be used, if possible. The minimum recording period shall be 30 minutes when the recording includes congested traffic (vehicles traveling at less than 20 mph for five or more minutes in any lane). The minimum recording period shall be 45 minutes when the traffic flow exceeds 1500 vehicles per hour in any lane during the test period. The minimum recording period shall be 60 minutes when the flow is less than 1500 vehicles per hour in every lane. The analysis shall be based on a minimum of 100 detected vehicles in every lane and cover the same time period for all lanes. The time period within the selected video will be selected by the Engineer. The total vehicle count for every lane shall be used and include the first and last partial vehicles for each lane. Errors in the start and finish of the MVDS and manual counts are included in the performance criterion specified in these special provisions.

MVDS unit count shall be compared to vehicle counts under traffic conditions of the prior paragraph. Vehicles licensed for use on State roads shall be counted by the MVDS. The data accuracy shall be determined by the formula:

Accuracy (Absolute Value) = 100{1-(TC-MC)/TC)}
where TC = Traffic Count derived from the media recording, and
MC = MVDS reported count over the same period of time.

The accuracy of each MVDS unit shall be determined and documented so that each unit may be approved or rejected separately by the Engineer. Failure to submit the materials at the conclusion of testing invalidates the test. The recorded media serves as acceptance evidence and shall not be used for calibration. The calibration shall have been completed prior to testing and verification.

The Engineer will review the accuracy data findings and accept or reject the results within 15 days. Determination of vehicle anomalies or unusual occurrences will be decided by the Engineer. Data or counts that are not accepted by the Engineer shall be considered errors and count against the MVDS unit's calibration. If the Engineer finds that the MVDS does not meet performance requirements, the Contractor shall re-calibrate and re-test the unit and re-submit new test data within 10 days. Following three failed attempts, the Contractor shall replace the MVDS detector with a new unit.

In addition to the accuracy analysis performed by the Contractor, the Contractor shall provide equipment, software, documentation, support equipment, and any other materials, personnel and devices that may be required for acceptance testing by the Engineer. The Contractor shall notify the Engineer 15 days before the MVDS unit is ready for acceptance testing. Testing shall be scheduled to be accomplished before the end of the normal work shift.

## TRAINING

The Contractor shall provide a minimum of 8 hours of training by a certified manufacturer's representative for up to 6 students selected by the Engineer. The content of the training shall include instruction on how to align, program, adjust, calibrate and maintain the MVDS. The Contractor shall provide materials and equipment for the training. The Contractor shall give the Engineer 15 days notice prior to the training. The time and location of the training shall be agreed upon by the Engineer and the Contractor. If no agreement can be reached, the Engineer shall determine the time and location.

# 7. Vehicle Classification Station 86-451X_E_D07-13-10

## 10-3.__ VEHICLE CLASSIFICATION STATION

The work includes furnishing and installing a vehicle classification station (VCS) consisting of a Model 334 cabinet, automated traffic counter, inductive loop detectors, piezo axle sensors, screened transmission cables, and the required wiring and auxiliary equipment required for a fully functional system as shown on the plans and in conformance with these special provisions.

### *MATERIALS LIST AND DRAWINGS*

A list of materials which the Contractor proposes to install for the VCS together with the drawings and other data shall be submitted to the Engineer in conformance with Section 86-1.04, "Equipment List and Drawings," of the Standard Specifications. Additionally, the following shall be provided before the completion of the contract:

1. **Certificate of Compliance** - A Certificate of Compliance for Automated Traffic Counter (ATC) shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications.
2. **Site Analysis Report** - Prior to VCS installation the Contractor shall review each detection site and provide a written analysis recommending the optimum sensor placement for meeting the performance requirements of this special provision. The analysis shall be reviewed and approved by the ATC manufacturer.
3. **Lane Configuration -** The documentation shall include a diagram that illustrates how the loops and piezos are covering the traffic lanes as well as the corresponding ATC connector pins or wire terminals that correspond to the respective lanes. The lanes shall be identified by direction (NB, SB, EB, WB), and in order, with lane one being the lane nearest to the center of the roadway.
4. **Mounting and Wiring Information** - The Contractor shall provide to the Engineer for approval one set of detailed diagrams showing wiring and service connections for each ATC. The approved diagrams shall be covered separately on each side with clear self-adhesive plastic and placed in a heavy-duty plastic envelope. The envelope shall be attached securely to the inside of the cabinet door or at a location designated by the Engineer.
5. **Communication Protocol** - The ATC communication protocol shall be open and shall be freely available for use in the public domain. The Contractor shall provide documentation that defines the complete ATC communication protocol (e.g. message structure organization, data packet length, as well as all information necessary to make use of such messages).
6. **Remote Programming** - The Contractor shall provide all information and software necessary for operating the system from a remote Windows XP/7 or newer based Personal Computer (PC). This information and software shall include at minimum the capability to calibrate and program the ATC and shall be provided on a Windows XP/7 or newer compatible compact disc (CD). This documentation shall contain files that allow for replacement equipment to be loaded with the same configuration.
7. **ATC Accuracy Analysis** - The Contractor shall be responsible for conducting ATC Performance Testing and shall submit to the Engineer an ATC accuracy analysis that conforms to requirements of these special provisions within 15 days of VCS testing. The

original video recordings as well as digital versatile disc (DVD) or CD copies of the video images covering the analysis periods shall be included.

8. **Acceptance Testing Documentation -** The Contractor shall provide a test plan, containing time and period of the testing, to be approved by the Engineer. The test plan shall be organized so that the Engineer will be able to perform vacceptance testing using the documentation without assistance from the Contractor. The Contractor shall collect and submit the data to be certified by the Engineer. If required by the Engineer, the data shall be collected in the presence of the Engineer.
9. **Acceptance Testing Schedule -** The Contractor shall submit a testing schedule to the Engineer for approval 15 days prior to acceptance testing of the VCS. If the testing period extends beyond the normal working shift or if the Contractor fails to provide the necessary material for the testing within one hour of the scheduled testing start time, the Engineer may cancel testing for the day.
10. **Training** - The Contractor shall provide a copy of the training material to the Engineer for approval 30 days prior to the training.

### *MODEL 334 CABINET*

Model 334 cabinets shall conform to the provisions in "Controller Cabinets" of these special provisions.

### *AUTOMATED TRAFFIC COUNTER*

The automated traffic counter (ATC) must collect data for traffic volume, vehicle speed and vehicle classification from permanently installed sites. The ATC must be capable of storing data, generate reports and provide outputs in suitable format to Caltrans Transportation System Network (TSN) database.

**ATC Hardware Requirements**

ATC must meet the provisions for connecting the following inputs:

1. 8 inputs for piezoelectric axle sensors
2. 16 inputs for inductive loop detectors

**ATC Requirements**

The ATC shall meet the following specifications:

1. **Construction** - All traffic data collection equipment and accessories must be of solid state construction with no moving or wearing parts, exclusive of switches and keypads.
2. **Operating Temperature Range** - From –40 to +158 °F minimum.
3. **Noise** - Equipment must be resistant to electromagnetic noise, electrostatic discharges, and induced power supply fluctuations. The signal-to-noise level shall be equal to or greater than 10:1.
4. **Lane/Direction** - Equipment must be capable of sensing, collecting, and recording data by lane. Number and direction of lanes shall be user configurable.

5. **Internal Clock** - The equipment must have continuous date (corrected for leap years) and time (24 hour). The internal clock must continue to keep the correct time even when the primary battery is completely discharged or disconnected.
6. **Loop Separation** - The loop sensor separation (spacing - leading edge to leading edge) must be a user-programmable parameter by lane.
7. **Piezo Separation** - The piezo sensor separation must be a user-programmable parameter by lane.
8. **Memory Retention During Power Loss** - Data stored in memory must not be lost when the battery of the unit is completely discharged or disconnected.
9. **Data Overwrite** - The counter must provide RAM memory that utilizes first-in, first-out (FIFO), also known as wrap around, so that when memory is filled the most recent observations replace the oldest observations.
10. **Vehicle Density** - The maximum vehicle density measured by the ATC must be three vehicles per lane per second.
11. **Operating Speed Range** - The operating speed range of the unit must be from 5 to 95 miles per hour.
12. **Count Storage Capacity** - The unit must be able to detect, count, measure speed and classify at least 3,600 vehicles per lane per hour.
13. **Memory Capacity** - The internal RAM of the unit must be capable of storing a minimum of 45 days of data in hourly interval or bins, in a configuration that stores data for at least eight lanes.
14. **Time Intervals** - Time intervals must be user programmable with intervals of thirty seconds, one minute, five minute, ten minutes, fifteen minutes, sixty minutes and twenty four hours.
15. **Rack Mountable** - Shall have the option to mount in an EIA 19 inch rack.

Power

The ATC shall be powered with 120 V(ac) or a 12 V(dc) photovoltaic power supply with battery back up as shown on the plans.

Accuracy

The ATC equipment must meet the following accuracy standards:

1. Accuracy of Traffic Volumes Counts - ± 3 percent with 95 percent accuracy level.
2. Accuracy of Vehicle Classification - Within ± 4 %.
3. Number of Vehicle Classification Bins - Vehicles must be classified into a minimum of fifteen user-programmable bins.
4. User-Programmable Classification Parameters - Users must be able to program the algorithms for axle spacing for all classes.
5. Default Vehicle Classification Scheme - Shall be user programmable.

Accessories

Contractor must provide all accessories that are necessary for making the equipment fully functional and tested. At a minimum, the following equipment shall be furnished:

1. Laptop to ATC cable
2. An ATC to sensor port cable for each port on the ATC

**Software Requirements**

Data Retrieval

Contractor must provide all communication software, which must be compatible with all existing ATCs. Access to stored data in ATC in the field or in office must be available through personal computers, both laptop and desktop with Windows XP, Windows 7, or newer operating system via standard EIA-232 interface. Remote access shall be available through modem and telephone, either hard wired or wireless such as, satellite or cellular.

Communications

Communications, either in the field or from the office, via direct connection or wireless modem must support all programmable features and shall include the following applications:

1. Real Time View - The real time view application shall provide for on-line monitoring of traffic. The display on the traffic census host computer shall indicate the number of vehicles passing within the time interval and update each passage. If programmed for vehicle classification, the display on the traffic census host computer shall depict the axle type and speed of each vehicle passing through the site. The user shall have the option of displaying either all traffic or only vehicle classifications as well as the option of displaying a selected individual lane or all lanes.
2. System Data Programming - The system data programming application shall provide for on-line modification to the ATC.'s software parameters, such as speed, axle spacing factors, loop and piezo sensitivity settings. System shall be password protected.
3. Manual Downloading - The manual downloading application shall be capable of downloading selected daily data files from the storage medium of the ATC to the storage medium of the traffic census host computer. The program shall provide for a listing of the daily data files stored in the ATC and shall provide for user selection of the file or files to be downloaded. The program shall provide for the downloading of the current day's data stored as of the time of downloading.
4. Automatic Downloading - When required, the automatic downloading application shall provide for unattended downloading of daily data files stored in the ATC's storage medium to the traffic census host computer. The program shall provide the following:

   4.1 User's input for the date and time that unattended downloading is to begin.
   4.2 Downloading of all daily files not previously downloaded by the automatic down loading application.
   4.3 Program shall indicate when any interrupted or incomplete file download has occurred.

4.4 Discontinuation of telephone connection after downloading of files from the ATC (or after an abort) and returning the traffic census host computer to a standby mode. The polling feature in communications software must support a telephone directory with a minimum of 200 sites where the user can add, change, or delete any data in a directory record.

5. History file - The history file application shall create a daily file that chronologically records the events occurring during manual and automatic downloading sessions. Such events shall include, but not be limited to, modem result messages, and start and end time of each file being downloaded and any pertinent messages generated by the program. The programming shall provide either:

   5.1 The history file shall be in the form of an ASCII text file which can be viewed or sent to the printer or,
   5.2 A menu selection which shall provide for a listing of available history files and user selection of a file to be sent to the printer in the form of a report.

Retrieved data must include information to produce the data formats specified in Attachment 1, 2, and 3 "ASCII Speed and Classification Formats."

The communications portion of the system program shall meet the following functional requirements:

1. Baud Rate - The programming will provide for operation at a minimum baud rate of 9600.
2. Error Control - The program shall not in any way disable the modem's error-checking features, which prevent phone-line noise from corrupting data during file downloading.
3. File Downloading Monitoring - The program shall display a window that allows the user to monitor the progress of file downloading. The program shall also provide for the abort of a file download.

## *INDUCTIVE LOOP DETECTORS*

Inductive loop detectors for vehicle classification station and the installation thereof shall conform to the provisions in "Detectors" of these special provisions.

## *PIEZO AXLE SENSORS*

Piezo axle sensors shall be Class II and use for vehicle classification purposes. Piezo axle sensors shall consist of a piezo-electric copolymer surrounded by a 1/64" thick outer brass sheath. Each sensor shall be 1/4" wide x 1/16" thick x 6' long with a screened transmission cable (STC) attached. The Engineer will determine the exact location of the inductive loop detector/piezo axle sensors.

The piezo axle sensor shall be installed in a channel as shown on the plans, per manufacturer's specifications, and as directed by the Engineer. The channel shall be filled with epoxy grout. The epoxy grout shall consist of an acrylic resin and a benzoyl peroxide catalyst. The grout shall not exceed 76 °C while curing, and shall be adequately set before re-opening the lane to traffic.

All sawed pavement slots containing screened transmission cable shall be filled with elastomeric sealant. Elastomeric sealant shall conform to Section 86-5.01A(5), "Installation Details" of the Standard Specifications.

Piezo axle sensors shall meet or exceed the following requirements:

| Performance Requirements | |
|---|---|
| Output Uniformity | ±20% |
| Operating Temperature Range | -40° to +70°C |
| Typical Output Level | A wheel load of 400 pounds will produce a minimum output signal of 250 mV, at 21°C and 55 mph. |
| Signal-to-Noise Level | The signal-to-noise level shall be equal to or greater than 10:1 |
| Insulation Resistance | >500 Mohms |
| Product Life | Equivalent Single Axle Loadings (ESAL) |

### *SCREENED TRANSMISSION CABLE*

Screened transmission cable (STC) shall be RG-58C/U coaxial cable with a high density polyethylene outer jacket. STC shall be rated for direct burial. Sufficient STC to reach the cabinet shall be supplied with each axle sensor. The STC shall not be spliced. STC terminations shall be made using properly sized captive or spring spade type terminals, crimped and soldered.

### *ATC FUNCTIONAL ACCEPTANCE*

To be considered fully functional, an individual ATC unit must:

1. Collect data locally and remotely meeting the accuracy specifications for a minimum of 30 continuous days
2. Successfully process downloaded files for input in Caltrans TSN database

### *TESTING*

The Contractor must demonstrate that the vehicle classification station is available for use by the State by successfully completing the acceptance test for each lane of data collection.

The Contractor must provide the test equipment and documentation that the equipment meets performance specifications and accuracy requirements outlined above. The Contractor must provide the Engineer with documentation that supports the accuracy analysis.

The acceptance test shall consist of the following:

1. Loop detectors shall be tested according to the procedure in Section 86-2.14B, "Field Testing" of the Standard Specifications.
2. Piezo axle sensors shall be tested as follows:
   a) Capacitance shall be 20% of the sensor's data sheet as provided by the manufacturer.
   b) Dissipation factor shall be less than 0.04 when measured in the 20 nF range.

c) Resistance shall be greater than 20 Megohms.

3. A minimum of 100 per-vehicle records shall be collected for each lane. Collected data must meet the following accuracy standards:
   a) Total volume ±3% with 95% accuracy
   b) Vehicle classification 95% accurate classification by type.
4. Correct functioning of the communications link shall be verified by collecting data files from the on-site equipment with the traffic census host computer.
5. Continuous operation of the vehicle classification system on-site equipment be checked for 5 consecutive days. Failure of the system to record and store data meeting the requirements set forth in these special provisions for an accumulated time exceeding 3 hours during the 5-day period shall be cause for the acceptance test to be rejected and repeated.
6. Failure of the software to perform any application required in these special provisions shall be cause for the acceptance test to be rejected and repeated.

Accuracy of the VCS system shall be verified by comparing the ATC vehicle counts and classifications to recorded video images of traffic for the same period. The video camera shall be located and oriented so that traffic is visible in all lanes. Video images shall be time stamped and analysis periods recorded to a DVD or CD media for viewing on a PC. The video field of view shall totally encompass the area in which vehicles are detected. The Contractor shall provide a means for synchronizing the test start and test ending times or provide software that displays time stamped ATC data along with the video images of the moving vehicles. The Contractor shall provide the Engineer with the original recording medium and documentation that supports the accuracy analysis and make a copy of these materials for their own use.

The accuracy test shall take place during a complex traffic period as specified by the Engineer. The following video recording and analysis options that depend on the available traffic conditions are acceptable; however the heaviest expected traffic conditions should be used, if possible. The minimum recording period shall be three records of 100 vehicles per lane for all lanes. The analysis shall be based on a minimum of 100 detected vehicles in every lane and cover the same time period for all lanes. The time period within the selected video will be selected by the Engineer. The total vehicle count for every lane shall be used and include the first and last partial vehicles for each lane. Errors in the start and finish of the VCS and manual counts are included in the performance criterion specified in these special provisions.

ATC unit count shall be compared to vehicle counts under traffic conditions of the prior paragraph. Vehicles licensed for use on State roads shall be counted by the ATC. The data accuracy shall be determined by the formula:

Accuracy (Absolute Value) = 100{1-(TC-RC)/TC)}
where TC = Traffic Count derived from the media recording, and
RC = VCS reported count over the same period of time.

ATC classification shall be compared to vehicle types using the same data for counting vehicles of the prior paragraph. Vehicles licensed for use on State roads shall be classified by the ATC. The data accuracy shall be determined by comparing the video images of each type of vehicle to its corresponding vehicle classification as defined by Caltrans TSN and FHWA parameters.

The resulting manual classifications results from the video images shall be compared to the ATC classifications for the same time period.

The accuracy of each ATC unit shall be determined and documented so that each unit may be approved or rejected separately by the Engineer. Failure to submit the materials at the conclusion of testing invalidates the test. The recorded media serves as acceptance evidence and shall not be used for calibration. The calibration shall have been completed prior to testing and verification.

The Engineer will review the accuracy data findings and accept or reject the results within 15 days. Determination of vehicle anomalies or unusual occurrences will be decided by the Engineer. Data or counts that are not accepted by the Engineer shall be considered errors and count against the VCS acceptance. If the Engineer finds that the VCS does not meet performance requirements, the Contractor shall re-test all sensors and re-test the ATC unit and re-submit new test data within 10 days. Following three failed attempts, the Contractor shall replace the sensors and/or ATC.

In addition to the accuracy analysis performed by the Contractor, the Contractor shall provide equipment, software, documentation, support equipment, and any other materials, personnel and devices that may be required for acceptance testing by the Engineer. The Contractor shall notify the Engineer 15 days before the VCS is ready for acceptance testing. Testing shall be scheduled to be accomplished before the end of the normal work shift.

## *TRAINING*

The Contractor shall provide a minimum of 6 hours of training by a certified manufacturer's representative for up to 8 students selected by the Engineer. The content of the training shall include instruction on how to wire a sensor to the ATC, configure and program an ATC, download - locally and remotely- ATC data using a traffic census laptop or computer and maintain the VCS. The Contractor shall provide materials and equipment for the training. The Contractor shall give the Engineer 15 days notice prior to the training. The time and location of the training shall be agreed upon by the Engineer and the Contractor. If no agreement can be reached, the Engineer shall determine the time and location.

## *WARRANTY*

The Contractor must provide a written warranty of the manufacturer against defects in materials and workmanship of the equipments for a period of 12 months. The warranty for each unit will begin when the equipment is installed and commissioned in the field and is fully functional. A completed form will be returned to the Contractor for each unit certifying that the unit has been fully functional on the date specified.

The warranty will include repair or replacement of defective components including two-way shipping charges by the State's district office that owns the equipment. Repair or replacement of any traffic data collection device is expected to be accomplished within five working days of receipt at the manufacturer's repair facility of the defective equipment returned by the State.

## *MANUALS*

The Contractor must provide 10 copies of all user and operator manuals, technical briefs or other documentation for the units and accessories for equipment installation and commissioning; software installation and operation; and system and unit diagnostics and repair.

## *ATTACHMENTS*

Attachment 1

**ASCII SPEED FILE FORMAT**

| Field | Length (characters) | Starts in Column |
|---|---|---|
| Lane | 2 | 1 |
| Hour | 2 | 4 |
| Count, from 0 to 35 mph | 4 | 7 |
| Count, from 36 to 40 mph | 4 | 12 |
| Count, from 41 to 45 mph | 4 | 17 |
| Count, from 46 to 50 mph | 4 | 22 |
| Count, from 51 to 55 mph | 4 | 27 |
| Count, from 56 to 60 mph | 4 | 32 |
| Count, from 61 to 65 mph | 4 | 37 |
| Count, from 66 to 70 mph | 4 | 42 |
| Count, from 71 to 75 mph | 4 | 47 |
| Count, from 76 to 80 mph | 4 | 52 |
| Count, from 81 to 85 mph | 4 | 57 |
| Count, greater than 86 mph | 4 | 62 |

**ASCII CLASSIFICATION FILE FORMAT**

| Field | Length (characters) | Starts in Column |
|---|---|---|
| Lane | 2 | 1 |
| Hour | 2 | 4 |
| Count, Class 1 | 4 | 7 |
| Count, Class 2 | 4 | 12 |
| Count, Class 3 | 4 | 17 |
| Count, Class 4 | 4 | 22 |
| Count, Class 5 | 4 | 27 |
| Count, Class 6 | 4 | 32 |
| Count, Class 7 | 4 | 37 |
| Count, Class 8 | 4 | 42 |
| Count, Class 9 | 4 | 47 |
| Count, Class 10 | 4 | 52 |
| Count, Class 11 | 4 | 57 |
| Count, Class 12 | 4 | 62 |
| Count, Class 13 | 4 | 67 |
| Count, Class 14 | 4 | 72 |
| Count, Class 15 | 4 | 77 |

Attachment 2

**Caltrans Total Vehicle Load Format**

| Columns | Length (characters) | Char/Num | Name | Interface Notes |
|---|---|---|---|---|
| 1 | 1 | N | Record Type | Default - 3 |
| 2-3 | 2 | N | FIPS State Code | Default - 06 |
| 4-5 | 2 | N | Functional Class | Input from lookup table columns 54-55 |
| 6-10 | 5 | N | Site Identification | Input from lookup field "TSN," if columns 8-10=--go to column 141 of Load Format and write data from Lookup Table Fields: District, County, Route, Route Suffix, Postmile Prefix, Postmile, Highway Group, Leg. |
| 11 | 1 | N | | Not used |
| 12 | 1 | N | Direction of Travel | Input "Direction" from Lookup Table; N=1, S=5, E=3, W=7 |
| 13 | 1 | N | Lane of Travel | Channel from traffic counter file |
| 14-15 | 2 | N | Year of Data | |
| 16-17 | 2 | N | Month of Data | |
| 18-19 | 2 | N | Day of Data | |
| 20 | 1 | N | Day of Week | 1=Sun, 2=Mon, 3=Tues, 4=Wed, 5=Thurs, 6=Fri, 7=Sat |
| 21-25 | 5 | N | Traffic Counted for hour ending 01 (Midnight to 1 AM) | From traffic counter file; Null Fields for no counts |
| 26-140 | 5 | N | Columns 21-25 repeated (hour 2 to hour 24) | From traffic counter file; Null Fields for no counts |
| 141-142 | 2 | N | District | If columns 8-10= -- write"District" from Lookup Table |
| 143-145 | 3 | C | County | If columns 8-10= -- write"County" from Lookup Table |
| 146-148 | 3 | N | Route | If columns 8-10= -- write"Route" from Lookup Table |
| 149 | 1 | C | Route Suffix | If columns 8-10= -- write"Route Suffix" from Lookup Table |
| 150 | 1 | C | Postmile Prefix | If columns 8-10= -- write “Postmile Prefix” from Lookup Table |
| 151-156 | 6 | N | Postmile | If columns 8-10= -- write “Postmile” from Lookup Table |
| 157 | 1 | A | Highway Group | If columns 8-10= -- write “Highway Group” from Lookup Table |
| 158 | 1 | A | Leg | If columns 8-10= -- write “Leg” from Lookup Table |

Attachment 3

**MS Access TSN Location Load Lookup Table Definition**

| Columns | Length (characters) | Char/Num | Name | Interface Notes |
|---|---|---|---|---|
| 1 | 15 | C/N | Site Identification from Traffic Counter | |
| 16 | 38 | N | Channels from Traffic Counter | Channels separated by commas |
| 54 | 2 | N | Functional Class | Write to columns 4-5 of Total Vehicle Load Format |
| 56 | 5 | N | TSN Site Identification | Match with Site ID from counter and write to columns 6-10 of Total Vehicle Load Format or columns 4-8 of Vehicle Class Load |
| 61 | 16 | N | TSN Direction of Travel | Match with channels set in counter and write to column 12 of Total Vehicle Load Format or column 10 of Vehicle Class Load |
| 77 | 2 | N | District | Write to columns 141-142 of Total Vehicle Load or columns 100-101 of Vehicle Class Load |
| 79 | 3 | C | County | Write to columns 143-145 of Total Vehicle Load or columns 102-104 of Vehicle Class Load |
| 82 | 3 | N | Route | Write to columns 146-148 of Total Vehicle Load or columns 105-107 of Vehicle Class Load |
| 85 | 1 | C | Route Suffix | Write to column 149 of Total Vehicle Load or column 108 of Vehicle Class Load |
| 86 | 1 | C | Postmile Prefix | Write to column 150 of Total Vehicle Load or column 109 of Vehicle Class Load |
| 87 | 6 | N | Postmile | Write to columns 151-156 of Total Vehicle Load or columns 110-115 of Vehicle Class Load |
| 93 | 1 | A | Highway Group | Write to column 157 of Total Vehicle Load or column 116 of Vehicle Class Load |
| 94 | 1 | A | Leg | Write to column 158 of Total Vehicle Load or column 117 of Vehicle Class Load |
| 20-24 | 5 | N | Total Volume | |
| 25-29 | 5 | N | Count for Class 1 | From traffic counter file; Null Fields for no counts |
| 30-99 | 5 | N | Columns 25-29 repeated for Class 2 to Class 15 | From traffic counter file; Null Fields for no counts |
| 100-101 | 2 | N | District | If columns 6-8= -- write"District" from Lookup Table |
| 102-104 | 3 | C | County | If columns 6-8= -- write"County" from Lookup Table |
| 105-107 | 3 | N | Route | If columns 6-8= -- write"Route" from Lookup Table |
| 108 | 1 | C | Route Suffix | If columns 6-8= -- write"Route Suffix" from Lookup Table |
| 109 | 1 | C | Postmile Prefix | If columns 6-8= -- write"Postmile Prefix" from Lookup Table |
| 110-115 | 6 | N | Postmile | If columns 6-8= -- write"Postmile" from Lookup Table |
| 116 | 1 | A | Highway Group | If columns 6-8= -- write"Highway Group" from Lookup Table |

| | | | | |
|---|---|---|---|---|
| 117 | 1 | A | Leg | If columns 6-8= -- write"Leg" from Lookup Table |

# 8. NEMA 3R Enclosure 86-455X_E_D01-21-10

## 10-3.__ NEMA 3R ENCLOSURE

Each NEMA 3R enclosure shall be the size as shown on the plans. The NEMA 3R enclosure shall house the equipment as shown on the plans.

### *ENCLOSURE CONSTRUCTION*

Enclosure construction of the NEMA 3R enclosures shall be as specified in Section 86-3.04A, "Cabinet Construction," of the Standard Specifications and these special provisions.

The enclosure and doors shall be fabricated of 0.125-inch minimum thickness aluminum.

#### Door Latch

The door latch shall be either a quarter-turn latch handle with padlock hasp or a zinc-plated draw pull catch with padlock hasp.

### *ENCLOSURE VENTILATION*

Enclosure ventilation of the NEMA 3R enclosures shall be as specified in Section 86-3.04B, "Cabinet Ventilation," of the Standard Specifications.

Each enclosure shall be provided with louvered vents with a permanent metal mesh or 4ply woven polypropylene air filter held firmly in place.

### *ENCLOSURE WIRING*

Enclosure wiring within the NEMA 3R enclosures shall be as specified in Section 86-3.04C, "Cabinet Wiring," of the Standard Specifications.

# 9. Closed Circuit Television System 86-CCTV_D_09-16-10

# 10-3.__ CLOSED CIRCUIT TELEVISION SYSTEM

## *GENERAL*

The closed circuit television (CCTV) system shall conform to all rules and regulations of the Federal Communications Commissions and shall conform to the provisions in Section 86, "Signals, Lighting and Electrical Systems," of the Standard Specifications and these special provisions.

The existing CCTV system deployed in the district is the Pelco ES30C, Model #ES30CBW24-5N, with SMR1-DCWG7. The existing camera assembly is mounted on a pedestal mount. The existing pedestal mount deployed in the district is the Pelco PM2010-Pedestal Mount with SMR1-1A3JIS. The new system furnished by the Contractor shall be compatible with the existing CCTV system and these special provisions.

Each CCTV system shall consist of providing electrical service, furnishing and installing a camera assembly, video encoder, a camera pole, Model 334 cabinet, composite cable and wiring, and other required equipment as shown on the plans. Testing of all CCTV equipment shall be performed after installation as described elsewhere in these special provisions.

All components of the camera assembly shall have a minimum 2-year manufacturer's warranty for parts and labor. Warranty periods shall begin the day the contract is accepted.

The Contractor shall fill out and mail equipment warranties of all camera equipment under "CALTRANS District 06, 1352 West Olive Avenue, Fresno, California 93722." Copies of mailed warranties with serial numbers shall be submitted as part of the system documentation.

## *CAMERA ASSEMBLY*

The camera assembly shall consist of the camera and positioner components integrated into one unit.

The camera component shall meet or exceed the following requirements: an imager with a ¼" color charge-coupled device (CCD), NTSC horizontal resolution of 520 lines, optical zoom range of 24X, 4 mm to 88 mm and auto/manual focus, and camera shall be enclosed in a sealed housing.

The positioner component shall meet or exceed the following requirements: an angular travel of 360 degrees continuous pan and –83 to +33 degree tilt ranges.

## *VIDEO ENCODER*

The existing video encoder deployed in the district is the Axis 241S. The new video encoder furnished by the Contractor shall be compatible with the existing CCTV system and these special provisions.

## *COMPOSITE CABLE*

The existing composite cable deployed in the district is the Cohu CA290 series, Model #CA297H with a 4 foot Model # CA297G pigtail cable installed in the Model 334 cabinet. The new cable system furnished by the Contractor shall be compatible with the existing CCTV system and these special provisions.

The composite cable shall provide video, data, and power conductors in a single jacketed cable. The cable shall have a strain relief located towards the top of the CCTV pole and hung on the pole j-hook.

Wiring shall run continuous from source to destination. No splices shall be allowed.

The Contractor shall verify composite cable length prior to ordering of materials and shall use a vendor manufactured and tested cable.

## *CCTV POLE*

CCTV poles shall conform to the provisions in Section 86-2.04, "Standards, Steel Pedestals and Posts," of the Standard Specifications and these special provisions.

## *MODEL 334 CABINET*

Each Model 334 cabinet shall meet the requirements as shown on the plans and specified elsewhere in these special provisions and the following requirements.

### Surge Protector

The Contractor shall furnish and install a surge arrestor, which shall reduce the effect of power line transients and rated as follows:

| | |
|---|---|
| Recurrent Peak Voltage | 184 V |
| Energy Rating (Minimum) | 20 J |
| Power Dissipation, Average | 0.85 W |
| Peak Current for pulses less than 7 microseconds | 1250 A |
| Stand-by Current for 60 Hz Sinusoidal | 1 mA or less |

## *TESTING AND DOCUMENTATION*

Once the CCTV System is installed the Contractor shall conduct tests of the CCTV system in accordance with these special provisions.

Transportation Management Center personnel prior to acceptance of CCTV System shall be present for the testing of the CCTV System.

Each CCTV camera shall be tested after installed in place on the pole. In the Model 334 Cabinet the camera video output cable will be connected to a Contractor-furnished NTSC color monitor and the pan/tilt/zoom communications link will be connected to a State-furnished portable laptop computer configured to the Pelco D protocol. The tests performed are:

A. Video quality observed on the NTSC color monitor as the lens focal lengths and apertures of the lens are varied and verifying the correct operation of the auto focus.
B. Pan/tilt/zoom ranges as specified in these Special Provisions for the CCTV Camera.
C. Preset storage: two presets will be stored in the CCTV Camera memory and observed for accurate positioning for a minimum of five cycles of pan/tilt/zoom movement.

Documentation of all test results shall be provided to the Engineer for review and approval. System documentation shall incorporate the test results for ongoing maintenance and performance measurements.

The Contractor shall be responsible for all deliveries.

# 10.Extinguishable Message Sign (LED) 86-EMS_E_D02-25-08

# 10-3.__ EXTINGUISHABLE MESSAGE SIGN (LED)

Extinguishable message sign (EMS) must use Light Emitting Diodes (LED) in pixels, the pixels forming a module, and the module forming legends in nominal 10 inch size letters. The LED messages must automatically adjust its light output by means of photosensors installed in the EMS housing. Multiple EMS's may be controlled from the same photosensor. Light output must be proportional to the ambient light (more ambient light / more output and less ambient light / less output). There must be a minimum of three adjustable levels of luminance: 100 percent, 60 percent, and 30 percent luminance. The signs must have a 30 percent luminance manual control as shown on the plans.

## CONSTRUCTION

EMS's must be constructed so that an anti-glare polycarbonate or hardened acrylic front face panel with anti-glare film must be contained within an extruded aluminum frame.

The extruded aluminum frame must be hinged to allow access to the interior of the sign and have fully welded seams with a high gloss textured black finish powder coat paint meeting the color standards of Federal specifications 595b, 17038. Install a 1/2 inch nominal black anodized aluminum hex cell louver having 95 percent open area and providing 60 degree shielding between the LED pixels and the front face panel to enhance resistance to sun phantom. Secure louvers in front of the LED pixels with captive type retainers.

EMS's must be gasketed with a closed cell neoprene gasket making the sign rain tight. Stainless steel latches must provide for quick access to the interior of the sign. The sign must be provided with devices to retain the face panel in a fully open mode assisting the servicing of the sign. Exterior hardware must be of stainless steel or cadmium plated materials.

EMS's must be vented on the bottom and must have an interior temperature controlled ventilation fan to ensure the interior of the housing remains below 55°C without compromising the rain tight integrity. Install insect screen in the vents.

Use ultra bright type Aluminum Indium Gallium Phosphide (AlInGaP) LED's rated for 100 000 hours of continuous operation from –37°C to +74°C. LED pixels must be ultra violet stabilized. Individual LED's must be wired so that a failure of one LED will not result in the loss of more than one third of a pixel.

LED modules must consist of multiple pixels in a 5w x 7h configuration. Each pixel must consist of at least 12 high intensity LED's. Each pixel must be 590 nanometers nominal amber in color having an initial nominal luminous intensity of 9.5 candela (cd) on the maximum setting. Each LED pixel must consume no more than 750 mW of power. Each pixel must be removable or replaceable on the module with a screwdriver, and each module must be removable from the housing in the same manner.

LED's must be soldered in place, and the LED leads must not be shortened or removed. LED's must be from the same manufacturer and same color bin.

## OPERATION

LED messages must be steadily lit when activated. EMS's must have internal power supplies and dimming capability to fully operate the sign. The EMS power factor must be greater than 90 percent, and current total harmonic distortion must be less than 25 percent.

EMS's must operate at a frequency of 60Hz ± 3Hz AC line over a voltage ranging from 90 volts to 135 volts. The LED circuitry must prevent perceptible flicker over the voltage range specified. Line voltage fluctuations must have no visible effect on the luminous intensity of the EMS. The rated voltage for measurements must be 120 V(ac).

EMS's must include voltage surge protection to withstand high repetition noise transient as stated in section 2.1.6 of NEMA Standard TS-2, 1992.

EMS's must meet Federal Communications Commission (FCC) Title 47, SubPart B, Section 15 regulations concerning the emission of electronic noise.

## *PHOTOMETRIC REQUIREMENTS*

EMS pixels must meet at least 85 percent of the minimum intensity requirements while operating throughout the operating range of –37°C to +74°C.

The minimum initial luminous intensity values for LED pixels must be 60 cd/ft$^2$ at 25°C. Each EMS pixel must have a viewing angle of 30 degrees to the sign.

The measured chromatic coordinates of the EMS pixels must conform to the chromaticity requirements of section 5.3.2.1. and Figure C of the Equipment and Materials Standards of the Institute of Transportation Engineers ITE Publication No. ST-017A.

## *TERMINAL BLOCKS*

Terminal blocks must be installed in the interior bottom of the sign housing with sufficient number of terminals to accommodate the wiring. Wiring must be bundled, wrapped, and permanently labeled.

## *DOCUMENTATION*

Complete shop drawings for the EMS's must be submitted to the Engineer for testing, evaluation and approval, a minimum of 30 days before ordering or fabrication of equipment.

The following operating characteristics must be identified: rated voltage, power consumption, current and volt-amperes. EMS's must have the manufacturer's name and trademark permanently marked on the side of sign. Individual EMS's must be identified with a model, serial number and shipping date stamped on a tag attached to the sign for warranty purposes. The lettering must be a minimum of 1/4 inch high. The information may be either depressed or raised, and must be legible and durable.

## *WARRANTY*

The manufacturer must provide a Certificate of Compliance to this standard and must replace or repair any EMS that exhibits a failure due to workmanship or material defects within 60 months of delivering the sign to the State or the date of acceptance whichever is later. The manufacturer must replace or repair any sign that exhibits light degradation greater than 50 percent within the first 36 months of operation, or if more than 20 percent of the LED's fail during that same period.

# 11.Fiber Optic System
## 86-FOS_E_D10-07-10

## 10-3.__ FIBER OPTIC SYSTEM

The work includes furnishing and installing a fiber optic system consisting of fiber optic conduit, fiber optic cable, and auxiliary equipment required as shown on the plans and in conformance with these special provisions.

### *FIBER OPTIC CONDUIT*

Fiber optic conduit shall comply with UL 651B, unless otherwise specified. Fiber optic conduit shall be orange Schedule 40 high density polyethylene conduit and comply with NEMA TC-7.

High density polyehylene conduit shall be joined by heat fusion. Heat fusion (includes electrofusion) shall be by methods recommended by the conduit manufacturer, and with equipment approved for the purpose. Equipment shall not expose conduit to direct flame. Heat fusion shall be performed by conduit manufacturer certified or authorized personnel. A minimum of 2 test fusions, by each fusion operator, shall be demonstrated to the Engineer prior to performing fusion operations on any high density polyethylene conduit to be installed.

Fiber optic conduit in structures shall be Type 1 unless otherwise specified.

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### *WARNING TAPE*

Warning tape must be furnished, installed and placed in the trench over fiber optic conduit as shown on the plans.

The warning tape must have:

| DESCRIPTION | PARAMETERS |
|---|---|
| Thickness | not be less than (4 mil) thick |
| Width | 4 inch |
| Material | pigmented polyolefin film |
| Tensile strength | Minimum of 2800 PSI |
| Elongation | minimum of 500 percent elongation before breakage |
| Printed Text height | 1 inch |
| Message background color | bright orange color background |
| Message statement | CAUTION: BURIED FIBER OPTIC CABLE - CALTRANS |
| Message spacing intervals | approximately 30 inch |

The printed warning must not be removed by the normal handling and burial of the tape and must be rated to last the service life of the tape.

The construction of the warning tape must be such that it will not delaminate when it is wet. It must be resistant to insects, acid, alkaline and other corrosive elements in the soil.

### *TRACER WIRE*

Tracer wire must be provided and placed in fiber optic conduit as shown on the plans.

Tracer wire must be No. 12 minimum, stranded solid copper conductor with Type TW, THW, RHW, or USE insulation. A minimum of 3 feet of slack must be extended into each communication pull box and splice vault from each direction.

The tracer wire must form a mechanically and electrically continuous line throughout the length of the trench.

Tracer wire may be spliced at intervals of not less than 500 feet and in pull boxes. Splices must conform to Section 86-2.09, "Wiring," of the Standard Specifications.

## *COLOR SLURRY CEMENT BACKFILL*

The color slurry cement backfill for the installation of fiber optic conduit must be a medium to dark, red or orange color to clearly distinguish the concrete backfill from other concrete and soil. The concrete must be pigmented by the addition of commercial quality cement pigment to the concrete mix. The red or orange concrete pigment must be LM Scofield Company, Orange Chromix Colorant, Davis Colors, or equal.

For trenches in pavement areas, only the top 4 inches of concrete backfill must be pigmented concrete. At the option of the Contractor, the full depth may have the pigment.

## *CONDUIT SEALING PLUGS*

All fiber optic conduit must have their ends sealed with commercial pre formed plugs, which prevent the passage of gas, dust and water into these conduits. Sealing plugs must be installed at the ends of conduits terminating in splice vaults, communication pull boxes, and controller cabinets.

Sealing plugs must be removable and reusable. Plugs must be the split type that permits installation or removal without removing conductors or cables.

Sealing plug that seals an empty conduit must have an eye or other type of capturing device (on the side of the plug that enters the conduit) to attach to the polyester tape.

## *FIBER OPTIC CABLE*

Fiber optic cable shall conform to the details shown on the plans and these special provisions.

### Definitions Fiber Optics Glossary

The following definitions shall apply to these special provisions:

A. Active Component Link Loss Budget.—The active component link loss budget is the difference between the average transmitter launch power (in dBm) and the receiver maximum sensitivity (in dBm).
B. Backbone.—Fiber cable that provides connections between the TMC and hubs, as well as between equipment rooms or buildings, and between hubs. The term is used interchangeably with "trunk" cable.

C. Connector.—A mechanical device used to align and join two fibers together to provide a means for attaching to and decoupling from a transmitter, receiver, or another fiber (patch panel).
D. Connectorized.—The termination point of a fiber after connectors have been affixed.
E. Connector Module Housing (CMH) .—A patch panel used to terminate singlemode fibers with most common connector types. It may include a jumper storage shelf and a hinged door.
F. Couplers.—Devices which mate fiber optic connectors to facilitate the transition of optical light signals from one connector into another. They are normally located within FDUs, mounted in panels. They may also be used unmounted, to join two simplex fiber runs.
G. Distribution Cable.—Fiber cable that provides connections between hubs. Drop cables are typically spliced into a distribution cable.
H. Drop Cable.—Fiber cable that provides connections between a distribution cable to a field element. Typically these run from a splice vault to a splice tray within a field cabinet. Drop cables are usually short in length (less than 65 feet) and are of the same construction as outside plant cable. The term "breakout cable" is used interchangeably with drop cable.
I. End-to-End Loss.—The maximum permissible end-to-end system attenuation is the total loss in a given link. This loss could be the actual measured loss, or calculated using typical (or specified) values. A designer should use typical values to calculate the end-to-end loss for a proposed link. This number will determine the amount of optical power (in dB) needed to meet the System Performance Margin.
J. Fan Out Termination.—Permits the branching of fibers contained in an optical cable into individual cables and can be done at field locations; thus, allowing the cables to be connectorized or terminated per system requirements. A kit provides pull-out protection for individual bare fibers to support termination. It provides three layers of protection consisting of a Teflon inner tube, a dielectric strength member, and an outer protective PVC jacket. Fan out terminations shall not be used for more than 6 fibers. Using a patch panel would be appropriate.
K. Fiber Distribution Frame (FDF) .—A rack mounted system that is usually installed in hubs or the Transportation Management Center (TMC), that may consist of a standard equipment rack, fiber routing guides, horizontal jumper troughs and Fiber Distribution Units (FDU). The FDF serves as the termination and interconnection of passive fiber optic components from cable breakout, for connection by jumpers, to the equipment.
L. Fiber Distribution Unit (FDU) .—An enclosure or rack mountable unit containing both a patch panel with couplers and splice tray(s). The unit's patch panel and splice trays may be integrated or separated by a partition.
M. F/O.—Fiber optic.
N. FOIP.—Fiber optic inside plant cable.
O. FOOP.—Fiber optic outside plant cable.
P. FOTP.—Fiber optic test procedure(s) as defined by TIA/EIA standards.
Q. Jumper.—A short cable, typically one meter or less, with connectors on each end, used to join two CMH couplers or a CMH to active electronic components.

R. Light Source.—Portable fiber optic test equipment that, when coupled with a power meter, is used to perform end-to-end attenuation testing. It contains a stabilized light source operating at the wavelength of the system under test.

S. Link.—A passive section of the system, the ends of which are connectorized. A link may include splices and couplers. For example, a video link may be from a F/O transmitter to a video multiplexer (MUX).

T. Loose Tube Cable.—Type of cable construction in which fibers are placed in buffer tubes to isolate them from outside forces (stress). A flooding compound or material is applied to the interstitial cable core to prevent water migration and penetration. This type of cable is primarily for outdoor applications.

U. Mid-span Access Method.—Description of a procedure in which fibers from a single buffer tube are acessed and spliced to an adjoining cable without cutting the unused fibers in the buffer tube, or disturbing the remaining buffer tubes in the cable.

V. MMFO.—Multimode Fiber Optic Cable.

W. Optical Time Domain Reflectometer (OTDR) .—Fiber optic test equipment similar in appearance to an oscilloscope that is used to measure the total amount of power loss in a F/O cable between two points. It provides a visual and printed display of the losses associated with system components such as fiber, splices and connectors.

X. Optical Attenuator.—An optical element that reduces the intensity of a signal passing through it.

Y. Patchcord.—A term used interchangeably with "jumper".

Z. Patch Panel.—A precision drilled metal frame containing couplers used to mate two fiber optic connectors.

AA. Pigtail.—A short optical fiber permanently attached to a source, detector, or other fiber optic device.

AB. Power Meter.—Portable fiber optic test equipment that, when coupled with a light source, is used to perform end-to-end attenuation testing. It contains a detector that is sensitive to light at the designed wavelength of the system under test. Its display indicates the amount of optical power being received at the end of the link.

AC. Riser Cable.—NEC approved cable installed in a riser (a vertical shaft in a building connecting floors).

AD. Segment.—A section of F/O cable that is not connected to any active device and may or may not have splices per the design.

AE. SMFO.—Singlemode Fiber Optic Cable.

AF. Splice.—The permanent joining of two fiber ends using a fusion splicer.

AG. Splice Closure.—A environmentally sealed container used to organize and protect splice trays. The container allows splitting or routing of fiber cables from multiple locations. Normally installed in a splice vault.

AH. Splice Module Housing (SMH) .—A unit that stores splice trays as well as pigtails and short cable lengths. The unit allows splitting or routing of fiber cables to or from multiple locations.

AI. Splice Tray.—A container used to organize and protect spliced fibers.

AJ. Splice Vault.—An underground container used to house excess cable and/or splice closures.

AK. System Performance Margin.—A calculation of the overall "End to End" permissible attenuation from the fiber optic transmitter (source) to the fiber optic receiver

(detector). The system performance margin should be at least 6 dB. This includes the difference between the active component link loss budget, the passive cable attenuation (total fiber loss) and the total connector/splice loss.

AL. Tight Buffered, Non-Breakout Cable (Tight Buffer Cable).—Type of cable construction where each glass fiber is tightly buffered (directly coated) with a protective thermoplastic coating to 900 µm(compared to 250 µm for loose tube fibers).

**Fiber Optic Outside Plant Cable**

General

Each fiber optic outside plant cable (FOOP) for this project shall be all dielectric, gel filled or water-blocking material, duct type, with loose buffer tubes and shall conform to these special provisions. Cables with singlemode fibers shall contain 12 singlemode (SM) dual-window (1310 nm and 1550 nm) fibers. The optical fibers shall be contained within loose buffer tubes. The loose buffer tubes shall be stranded around an all dielectric central member. Aramid yarn and/or fiberglass shall be used as a primary strength member, and a polyethylene outside jacket shall provide for overall protection.

All fiber optic (F/O) cable on this project shall be from the same manufacturer, who is regularly engaged in the production of this material.

The cable shall be qualified as compliant with Rural Utilities Service Chapter XVII, Title 7, Section 1755.900 (RUS Federal Rule 7CFR1755.900).

| CABLE TYPE | DESCRIPTION |
|---|---|
| E | 12SMFO |

Fiber Characteristics

Each optical fiber shall be glass and consist of a doped silica core surrounded by concentric silica cladding. All fibers in the buffer tube shall be usable fibers, and shall be sufficiently free of surface imperfections and occlusions to meet the optical, mechanical, and environmental requirements of these specifications. The required fiber grade shall reflect the maximum individual fiber attenuation, to guarantee the required performance of each and every fiber in the cable.

The coating shall be a dual layered, UV cured acrylate. The coating shall be mechanically or chemically strippable without damaging the fiber.

The cable shall comply with the optical and mechanical requirements over an operating temperature range of -40°C to +70°C. The cable shall be tested in accordance with EIA-455-3A (FOTP-3), "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components." The change in attenuation at extreme operational temperatures (-40°C to +70°C) for singlemode fiber shall not be greater than 0.20 dB/km, with 80 percent of the measured values no greater than 0.10 dB/km. The singlemode fiber measurement is made at 1550 nm.

For all fibers the attenuation specification shall be a maximum attenuation for each fiber over the entire operating temperature range of the cable.

Singlemode fibers within the finished cable shall meet the requirements in the following table:

| Fiber Characteristics Table | |
|---|---|
| Parameters | Singlemode |
| Type | Step Index |
| Core diameter | 8.3 µm (nominal) |
| Cladding diameter | 125 µm ±1.0 µm |
| Core to Cladding Offset | ≤0.8 µm |
| Coating Diameter | 250 µm ±15 µm |
| Cladding Non-circularity defined as:<br>[1-(min. cladding dia ÷max. cladding dia.)]x100 | ≤1.0% |
| Proof/Tensile Test | 345 Mpa, min. |
| Attenuation: (-40°C to +70°C)<br>@1310 nm<br>@1550 nm | <br>≤0.4 dB/km<br>≤0.3 dB/km |
| Attenuation at the Water Peak | ≤2.1 dB/km @ 1383 ±3 nm |
| Chromatic Dispersion:<br>Zero Dispersion Wavelength<br>Zero Dispersion Slope | <br>1301.5 to 1321.5 nm<br>≤0.092 ps/(nm$^2$∗km) |
| Maximum Dispersion: | ≤3.3 ps/(nm∗km) for 1285 – 1330 nm<br><18 ps/(nm∗km) for 1550 nm |
| Cut-Off Wavelength | <1260 nm |
| Mode Field Diameter<br>(Petermann II) | 9.3 ±0.5 µm at 1300 nm<br>10.5 ±1.0 µm at 1550 nm |

## Color Coding

In buffer tubes containing multiple fibers, each fiber shall be distinguishable from others in the same tube by means of color coding according to the following:

1. Blue (BL)
2. Orange (OR)
3. Green (GR)
4. Brown (BR)
5. Slate (SL)
6. White (WT)
7. Red (RD)
8. Black (BK)
9. Yellow (YL)
10. Violet (VL)
11. Rose (RS)
12. Aqua (AQ)

Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors according to the same table listed above for fibers.

These colors shall be targeted in accordance with the Munsell color shades and shall meet EIA/TIA-598 "Color Coding of Fiber Optic Cables."

The color formulation shall be compatible with the fiber coating and the buffer tube filling compound, and be heat stable. It shall not fade or smear or be susceptible to migration and it shall not affect the transmission characteristics of the optical fibers and shall not cause fibers to stick together.

## Cable Construction

The fiber optic cable shall consist of, but not be limited to, the following components:

1. Buffer tubes
2. Central member
3. Filler rods
4. Stranding
5. Core and cable flooding
6. Tensile strength member
7. Ripcord
8. Outer jacket

### *Buffer Tubes*

Clearance shall be provided in the loose buffer tubes between the fibers and the inside of the tube to allow for expansion without constraining the fiber. The fibers shall be loose or suspended within the tubes. The fibers shall not adhere to the inside of the buffer tube. Each buffer tube shall contain a maximum of 12 fibers.

The loose buffer tubes shall be extruded from a material having a coefficient of friction sufficiently low to allow free movement of the fibers. The material shall be tough and abrasion resistant to provide mechanical and environmental protection of the fibers, yet designed to permit safe intentional "scoring" and breakout, without damaging or degrading the internal fibers.

Buffer tube filling compound shall be a homogeneous hydrocarbon-based gel with anti-oxidant additives and used to prevent water intrusion and migration. The filling compound shall be non-toxic and dermatologically safe to exposed skin. It shall be chemically and mechanically compatible with all cable components, non-nutritive to fungus, non-hygroscopic and electrically non-conductive. The filling compound shall be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

Buffer tubes shall be stranded around a central member by a method, such as the reverse oscillation stranding process, that will prevent stress on the fibers when the cable jacket is placed under strain.

### *Central Member*

The central member, which functions as an anti-buckling element shall be a glass reinforced plastic rod with similar expansion and contraction characteristics as the optical fibers and buffer tubes. To ensure the proper spacing between buffer tubes during stranding, a symmetrical linear overcoat of polyethylene may be applied to the central member to achieve the optimum diameter.

### *Filler Rods*

Fillers may be included in the cable to maintain the symmetry of the cable cross-section. Filler rods shall be solid medium or high density polyethylene. The diameter of filler rods shall be the same as the outer diameter of the buffer tubes.

### *Stranding*

Completed buffer tubes shall be stranded around the overcoated central member using stranding methods, lay lengths and positioning such that the cable shall meet mechanical, environmental and performance specifications. A polyester binding shall be applied over the stranded buffer tubes to hold them in place. Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

### *Core and Cable Flooding*

The cable core interstices shall contain a water blocking material, to prevent water ingress and migration. The water blocking material shall be either a polyolefin based compound which fills the cable core interstices, or an absorbent polymer, which fills voids and swells to block the ingress of water. The flooding compound or material shall be homogeneous, non-hygroscopic, electrically non-conductive, and non-nutritive to fungus. The compound or material shall also be nontoxic, dermatologically safe and compatible with all other cable components.

### *Tensile Strength Member*

Tensile strength shall be provided by high tensile strength aramid yarns and/or fiberglass which shall be helically stranded evenly around the cable core and shall not adhere to other cable components.

### *Ripcord*

The cable shall contain at least one ripcord under the jacket for easy sheath removal.

### *Outer Jacket*

The jacket shall be free of holes, splits, and blisters and shall be medium or high density polyethylene (PE), or medium density cross-linked polyethylene with minimum nominal jacket thickness of 39.4 mil ± 3 mil. Jacketing material shall be applied directly over the tensile strength members and water blocking material and shall not adhere to the aramid strength material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The jacket or sheath shall be marked with the manufacturer's name, the words "Optical Cable", the number of fibers, "SM", year of manufacture, and sequential measurement markings every meter. The actual length of the cable shall be within -0/+1 percent of the length marking. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be 98.4 mil ±8 mil.

General Cable Performance Specifications

The F/O cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one

hour. No water shall leak through the open cable end. Testing shall be done in accordance with EIA-455-82 (FOTP-82), "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable."

A representative sample of cable shall be tested in accordance with EIA/TIA-455-81 (FOTP-81), "Compound Flow (Drip) Test for Filled Fiber Optic Cable". No preconditioning period shall be conducted. The cable shall exhibit no flow (drip or leak) at 70°C as defined in the test method.

Crush resistance of the finished F/O cables shall be 220 N/mm applied uniformly over the length of the cable without showing evidence of cracking or splitting when tested in accordance with EIA-455-41 (FOTP-41), "Compressive Loading Resistance of Fiber Optic Cables". The average increase in attenuation for the fibers shall be ≤0.10 dB at 1550 nm (singlemode) for a cable subjected to this load. The cable shall not exhibit any measurable increase in attenuation after removal of load. Testing shall be in accordance with EIA-455-41 (FOTP-41), except that the load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for 10 minutes.

The cable shall withstand 25 cycles of mechanical flexing at a rate of 30 ±1 cycles/minute. The average increase in attenuation for the fibers shall be ≤0.20 dB at 1550 nm (singlemode) at the completion of the test. Outer cable jacket cracking or splitting observed under 10x magnification shall constitute failure. The test shall be conducted in accordance with EIA-455-104 (FOTP-104), "Fiber Optic Cable Cyclic Flexing Test," with the sheave diameter a maximum of 20 times the outside diameter of the cable. The cable shall be tested in accordance with Test Conditions I and II of (FOTP-104).

The cable shall withstand 20 impact cycles, with a total impact energy of 5.9 N•m. Impact testing shall be conducted in accordance with TIA/EIA-455-25B (FOTP-25) "Impact Testing of Fiber Optic Cables and Cable Assemblies." The average increase in attenuation for the fibers shall be <0.20 dB at 1550 nm for singlemode fiber. The cable shall not exhibit evidence of cracking or splitting.

The finished cable shall withstand a tensile load of 2700 N without exhibiting an average increase in attenuation of greater than 0.20 dB (singlemode). The test shall be conducted in accordance with EIA-455-33 (FOTP-33), "Fiber Optic Cable Tensile Loading and Bending Test." The load shall be applied for one-half hour in Test Condition II of the EIA-455-33 (FOTP-33) procedure.

Packaging and Shipping Requirements

Documentation of compliance to the required specifications shall be provided to the Engineer prior to ordering the material.

Attention is directed to "Fiber Optic Testing," elsewhere in these special provisions.

The completed cable shall be packaged for shipment on reels. The cable shall be wrapped in a weather and temperature resistant covering. Both ends of the cable shall be sealed to prevent the ingress of moisture.

Each end of the cable shall be securely fastened to the reel to prevent the cable from coming loose during transit. Four meters of cable length on each end of the cable shall be accessible for testing.

Each cable reel shall have a durable weatherproof label or tag showing the manufacturer's name, the cable type, the actual length of cable on the reel, the Contractor's name, the contract number, and the reel number. A shipping record shall also be included in a weatherproof envelope showing the above information and also include the date of manufacture, cable

characteristics (size, attenuation, bandwidth, etc.), factory test results, cable identification number and any other pertinent information.

The minimum hub diameter of the reel shall be at least thirty times the diameter of the cable. The F/O cable shall be in one continuous length per reel with no factory splices in the fiber. Each reel shall be marked to indicate the direction the reel should be rolled to prevent loosening of the cable.

Installation procedures and technical support information shall be furnished at the time of delivery.

## Labeling

General

The Contractor shall label all fiber optic cabling in a consistent manner. All tags shall be of a material designed for long term permanent labeling of fiber optic cables and shall be marked with permanent ink on non-metal types, or embossed lettering on metal tags. Metal tags shall be constructed of stainless steel. Non-metal label materials shall be approved by the Engineer. Labels shall be affixed to the cable per the manufacturer's recommendations and shall not be affixed in a manner which will cause damage to the fiber. Handwritten labels shall not be allowed.

Label Identification

### *Labeling of Cables*

Labeling of the backbone, distribution and drop fiber optic cables shall conform to the identification method provided by the Engineer.

### *Labeling of Jumpers and Pigtails*

Labeling of the jumpers and pigtails shall conform to the identification method provided by the Engineer.

Label Placement

### *Cables*

All cables shall be clearly labeled with the unique identification method provided by the Engineer, at all terminations, even if no connections or splices are made, and at all splice vault entrance and exit points.

### *Cable to Cable Splices*

All cable jackets entering the splice closure shall be labeled in accordance with the identification method provided by the Engineer.

### *Cable to Fiber Distribution Units*

The cable jackets shall be clearly labeled at entry to the FDU in accordance with the unique identification method provided by the Engineer. In addition, each fiber shall be labeled with the Fiber ID and pigtails shall be labeled at the connector with the Fiber ID. The FDU shall be clearly labeled with the Cable ID on the face of the FDU. If multiple cables are connected to the FDU, each block of connectors relating to each individual cable shall be clearly identified by a single label with the Cable ID. Individual connections shall be clearly marked on the face of the FDU in the designated area with the Fiber ID.

### *Fiber*

Fibers labels shall be placed next to the connectors of the individual fibers.

### *Patch Panels*

The cable jackets shall be clearly labeled at entry to the Patch Panel in accordance with the identification method provided by the Engineer. In addition, each fiber shall be labeled with the Fiber ID and pigtails shall be labeled at the connector with the Fiber ID. The Patch panel shall be clearly labeled with the Cable ID on the face of the Panel. If multiple cables are connected to the Patch Panel, each block of connectors relating to each individual cable shall be clearly identified by a single label with the Cable ID. Individual connections shall be clearly marked on the face of the Panel in the designated area with the Fiber ID.

### *Jumpers*

Equipment to FDU jumpers shall be labeled as to the equipment type connected and shall be labeled at both ends. FDU to FDU jumpers shall be labeled at each end in accordance with the identification method provided by the Engineer.

### *Pigtails*

Pigtails shall be labeled at the connector in accordance with the identification method provided by the Engineer.

### Cable Installation

Installation procedures shall be in conformance with the procedures specified by the cable manufacturer for the specific cable being installed. The contractor shall submit the manufacturer's recommended procedures for pulling fiber optic cable at least 10 working days prior to installing cable. Mechanical aids may be used provided that a tension measuring device, and a break away swivel are placed in tension to the end of the cable. The tension in the cable shall not exceed 2225 N or the manufacturer's recommended pulling tension, whichever is less.

During cable installation, the bend radius shall be maintained at a minimum of twenty times the outside diameter. The cable grips for installing the fiber optic cable shall have a ball bearing swivel to prevent the cable from twisting during installation.

F/O cable shall be installed using a cable pulling lubricant recommended by the F/O cable and/or the innerduct manufacturer, and a pull tape conforming to the provisions described under "conduit" elsewhere in these special provisions. Contractor's personnel shall be stationed at each splice vault and pullbox through which the cable is to be pulled to lubricate and prevent kinking or other damage.

F/O cable shall be installed without splices except where specifically allowed on the plans. If splice locations are not shown on the plans, splicing shall be limited to one cable splice every 3.5 miles. Any midspan access splice or FDU termination shall involve only those fibers being spliced as shown on the plans. Cable splices shall be located in splice closures, installed in splice vaults shown on the plans. A minimum of 65 feet of slack shall be provided for each F/O cable at each splice vault. Slack shall be divided equally on each side of the F/O splice closure.

Unless shown or provided otherwise, only F/O cable shall be installed in each innerduct. Pulling a separate F/O cable into a spare duct to replace damaged fiber will not be allowed.

At the Contractor's option, the fiber may be installed using the air blown method. If integral innerduct is used, the duct splice points or any temporary splices of innerduct used for installation must withstand a static air pressure of 110 pounds per square inch.

The fiber installation equipment must incorporate a mechanical drive unit or pusher, which feeds cable into the pressurized innerduct to provide a sufficient push force on the cable, which is coupled with the drag force created by the high-speed airflow. The unit must be equipped with controls to regulate the flow rate of compressed air entering the duct and any hydraulic or pneumatic pressure applied to the cable. It must accommodate longitudinally ribbed, or smooth wall ducts from nominal 0.63-inch to 2-inch inner diameter. Mid assist or cascading of equipment must be for the installation of long cable runs. The equipment must incorporate safety shutoff valves to disable the system in the event of sudden changes in pneumatic or hydraulic pressure.

The equipment must not require the use of a piston or any other air capturing device to impose a pulling force at the front end of the cable, which also significantly restricts the free flow of air through the inner duct. It must incorporate the use of a counting device to determine the speed of the cable during installation and the length of the cable installed.

**Splicing**

Field splices shall be done either in splice vaults or cabinets as shown on the plans. All splices in splice vaults shall be done in splice trays, housed in splice closures. All splices in cabinets shall be done in splice trays housed in FDU's.

Unless otherwise specified, fiber splices shall be the fusion type. The mean splice loss shall not exceed 0.07 dB per splice. The mean splice loss shall be obtained by measuring the loss through the splice in both directions and then averaging the resultant values.

All splices shall be protected with a metal reinforced thermal shrink sleeve.

The mid-span access method shall be used to access the individual fibers in a cable for splicing to another cable as shown on the plans. Cable manufacturers recommended procedures and approved tools shall be used when performing a mid-span access. Only the fibers to be spliced may be cut. All measures shall be taken to avoid damaging buffer tubes and individual fibers not being used in the mid-span access.

The individual fibers shall be looped one full turn within the splice tray to avoid micro bending. A 2-inch minimum bend radius shall be maintained during installation and after final assembly in

the optical fiber splice tray. Each bare fiber shall be individually restrained in a splice tray. The optical fibers in buffer tubes and the placement of the bare optical fibers in the splice tray shall be such that there is no discernable tensile force on the optical fiber.

The Contractor will be allowed to splice a total of 30 percent of all fibers to repair any damage done during mid-span access splicing without penalty. The Contractor will be assessed a fine of $300.00 for each additional and unplanned splice. Any single fiber may not have more than 3 unplanned splices. If any fiber requires more than 3 unplanned splices, the entire length of F/O cable must be replaced at the Contractor's expense.

**Splice Closures**

The F/O field splices shall be enclosed in splice closures which shall be complete with splice organizer trays, brackets, clips, cable ties, seals and sealant, as needed. The splice closure shall be suitable for a direct burial or pull box application. Manufacturer's installation instructions shall be supplied to the Engineer prior to the installation of any splice closures. Location of the splice closures shall be where a splice is required as shown on the plans, designated by the Engineer, or described in these special provisions.

The splice closure shall conform to the following specifications:

A. Non-filled thermoplastic case
B. Rodent proof, water proof, re-enterable and moisture proof
C. Expandable from 2 cables per end to 8 cables per end by using adapter plates
D. Cable entry ports shall accommodate 0.4-inch to 1-inch diameter cables
E. Multiple grounding straps
F. Accommodate up to 8 splice trays
G. Suitable for "butt" or "through" cable entry configurations
H. Place no stress on finished splices within the splice trays

The splice closure shall be bolted to the side wall of the splice vault. Each splice closure shall be filled to capacity with splice trays.

The Contractor shall verify the quality of each splice prior to sealing the splice closure. The splice closure shall not be sealed until link testing is performed and is approved by the Engineer.

**Splice Trays**

Splice trays must accommodate a minimum of 12 fusion splices and must allow for a minimum bend radius of 1.75 inches. Individual fibers must be looped one full turn within the splice tray to allow for future splicing. No stress is to be applied on the fiber when it is located in its final position. Buffer tubes must be secured near the entrance of the splice tray to reduce the chance that an inadvertent tug on the pigtail will damage the fiber. The splice tray cover may be transparent.

Splice trays in the splice closure shall conform to the following:

A. Accommodate up to 24 fusion splices

B. Place no stress on completed within the tray
C. Stackable with a snap-on hinge cover
D. Buffer tubes securable with channel straps
E. Must be able to accommodate a fusion splice with the addition of an alternative splice holder
F. Must be labeled after splicing is completed.

Only one single splice tray may be secured by a bolt through the center of the tray in the fiber termination unit. Multiple trays must be securely held in place as per the manufacturer's recommendation.

**Passive Cable Assemblies and Components**

The F/O cable assemblies and components shall be compatible components, designed for the purpose intended, and manufactured by a company regularly engaged in the production of material for the fiber optic industry. All components or assemblies shall be best quality, non-corroding, with a design life of at least 20 years.

The cable assemblies and components manufacturer shall be ISO9001 registered.

**Fiber Optic Cable Terminations**

General

Fiber optic outside plant (FOOP) cable shall continue within the conduit to the designated termination point for cable termination. All components shall be the size and type required for the specified fiber. Fiber optic cable terminations may take place in several locations such as TOS cabinets, camera sites, etc.

Cable Termination

At the FDU, the cable jacket of the outside plant cable shall be removed exposing the aramid yarn, filler rods, and buffer tubes. The exposed length of the buffer tubes shall be at least the length recommended by the FDU manufacturer which allows the tubes to be secured to the splice trays. Each buffer tube shall be secured to the splice tray in which it is to be spliced. The remainder of the tubes shall be removed to expose sufficient length of the fibers in order to properly install on the splice tray, as described in "Splicing," elsewhere in these special provisions

The cable shall then be spliced and secured with tie wraps and routed to its appropriate fiber distribution frame/unit (FDU) as shown on the plans.

When applicable, moisture blocking gel shall be removed from the exposed buffer tubes and fibers. The transition from the buffer tube to the bundle of jacketed fibers shall be treated by an accepted procedure for sleeve tubing, shrink tube and silicone blocking of the transition to prevent future gel leak. Manufacturer directions shall be followed to ensure that throughout the specified temperature range gel will not flow from the end of the buffer tube. The individual fibers shall be stripped and prepared for splicing.

Factory terminated pigtails shall then be spliced and placed in the splice tray.

All fibers inside a fiber optic cable entering an Fiber Distribution Unit (FDU) shall be terminated and labeled. Attention is directed to "Fiber Distribution Unit" elsewhere in these special provisions.

A transition shall then be made, with flexible tubing, to isolate each fiber to protect the individual coated fibers. The final transition from bundle to individual fiber tube shall be secured with an adhesive heat shrink sleeve. Refer to Fan Out Termination, elsewhere in these special provisions.

Distribution Interconnect Package

Distribution involves connecting the fibers to locations shown on the plans. The distribution interconnect package consists of FDUs with connector panels, couplers, splice trays, fiber optic pigtails and cable assemblies with connectors. The distribution interconnect package shall be assembled and tested by a company that is regularly engaged in the assembly of these packages. Attention is directed to "Fiber Optic Testing" elsewhere in these special provisions. All distribution components shall be products of the same manufacturers, who are regularly engaged in the production of these components, and the respective manufacturers shall have quality assurance programs.

Fiber Optic Cable Assemblies and Pigtails

***General***

Cable assemblies (jumpers and pigtails) shall be products of the same manufacturer. The cable used for cable assemblies shall be made of fiber meeting the performance requirements of these special provisions for the F/O cable being connected.

***Pigtails***

Pigtails shall be of simplex (one fiber) construction, in 900 μm tight buffer form, surrounded by aramid for strength, with a PVC jacket with manufacturer identification information, and a nominal outer jacket diameter of 3 mm. Singlemode simplex cable jackets shall be yellow in color. All pigtails shall be factory terminated and 3 feet in length.

***Jumpers***

Jumpers may be of simplex or duplex design. Duplex jumpers shall be of duplex round cable construction, and shall not have zipcord (siamese) construction. All jumpers shall be at least 6 feet in length, sufficient to avoid stress and allow orderly routing.

The outer jacket of duplex jumpers shall be colored according to the singlemode color (yellow) specified above. The two inner simplex jackets shall be contrasting colors to provide easy visual identification for polarity.

***Connectors***

Connectors shall be of the ceramic ferrule SC type for SM. Outdoor SC connector body housing shall be glass reinforced polymer.

The associated coupler shall be of the same material as the connector housing.

All F/O connectors shall be the 2.5 mm SC connector ferrule type with Zirconia Ceramic material with a PC (Physical Contact) pre-radiused tip.

The SC connector operating temperature range shall be -40°C to +70°C. Insertion loss shall not exceed 0.4 dB for singlemode, and the return reflection loss on singlemode connectors shall be at least -55 dB. Connection durability shall be less than a 0.2 dB change per 500 mating cycles per EIA-455-21A (FOTP-21). All terminations shall provide a minimum 222 N pull out strength. Factory test results shall be documented and submitted to the Engineer prior to installing any of the connectors. Singlemode connectors shall have a yellow color on the body and/or boot that renders them easily identifiable.

Field terminations shall be limited to splicing of adjoining cable ends and/or cables to SC pigtails.

Fiber Distribution Unit

The Contractor shall furnish and install all components to terminate the incoming fiber optic communication cables.

| FDU Type | Accomodates Termination of |
|---|---|
| B | 12 SMFO fibers |

The fiber distribution unit (FDU) shall include the following:

1. A patch panel to terminate the appropriate number of singlemode fibers with SC type connector feed through couplers.
2. Splice trays.
3. Storage for splice trays.
4. A slide out metal drawer for the storage of spare jumpers.

Strain relief shall be provided for the incoming fiber optic cable. Cable accesses shall have rubber grommets or similar material to prevent the cable from coming in contact with bear metal. All fibers shall be terminated and individually identified in the FDU and on the patch panel.

The patch panel shall be hinged or have coupler plates to provide easy access and maintenance. Brackets shall be provided to spool the incoming fiber a minimum of two turns, each turn shall not be less than 1 foot, before separating out individual fibers to the splice tray.

The FDU shall be 19-inch rack mountable.

The FDU shall not exceed 10 inches in height and 15 inches in depth.

**Fiber Optic Testing**

General

Testing shall include the tests on elements of the passive fiber optic components: (1) at the factory, (2) after delivery to the project site but prior to installation, (3) after installation but prior to connection to any other portion of the system. The Contractor shall provide all personnel, equipment, instrumentation and materials necessary to perform all testing. The Engineer shall be notified two working days prior to all field tests. The notification shall include the exact location or portion of the system to be tested.

Documentation of all test results shall be provided to the Engineer within 2 working days after the test involved.

A minimum of 10 working days prior to arrival of the cable at the site, the Contractor shall provide detailed test procedures for all field testing for the Engineer's review and approval. The procedures shall include the tests involved and how the tests are to be conducted. Included in the test procedures shall be the model, manufacturer, configuration, calibration and alignment procedures for all proposed test equipment.

Factory Testing

Documentation of compliance with the fiber specifications as listed in the Fiber Characteristics Table shall be supplied by the original equipment manufacturer. Before shipment, but while on the shipping reel, 100 percent of all fibers shall be tested for attenuation. Copies of the results shall be (1) maintained on file by the manufacturer with a file identification number for a minimum of seven years, (2) attached to the cable reel in a waterproof pouch, and (3) submitted to the Contractor and to the Engineer.

Arrival On Site

The cable and reel shall be physically inspected on delivery and 100 percent of the fibers shall be attenuation tested to confirm that the cable meets requirements. The failure of any single fiber in the cable to comply with these special provisions, is cause for rejection of the entire reel. Test results shall be recorded, dated, compared and filed with the copy accompanying the shipping reel in a weather proof envelope. Attenuation deviations from the shipping records of greater than five percent shall be brought to the attention of the Engineer. The cable shall not be installed until completion of this test sequence and the Engineer provides written approval. Copies of traces and test results shall be submitted to the Engineer. If the test results are unsatisfactory, the reel of F/O cable shall be considered unacceptable and all records corresponding to that reel of cable shall be marked accordingly. The unsatisfactory reels of cable shall be replaced with new reels of cable at the Contractor's expense. The new reels of cable shall then be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer.

After Cable Installation

Index matching gel shall not be allowed in connectors during testing. After the fiber optic cable has been pulled but before breakout and termination, 100 percent of all the fibers shall be tested with an OTDR for attenuation. Test results shall be recorded, dated, compared and filed with the previous copies of these tests. Copies of traces and test results shall be submitted to the

Engineer. If the OTDR test results are unsatisfactory, the F/O cable segment of cable shall be unacceptable. The unsatisfactory segment of cable shall be replaced with a new segment, without additional splices, at the Contractor's expense. The new segment of cable then shall be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer.

System Cable Verification At Completion

### *Power Meter and Light Source*

At the conclusion of the OTDR testing, 100 percent of the fiber links shall be tested end to end with a power meter and light source, in accordance with EIA Optical Test Procedure 171 and in the same wavelengths specified for the OTDR tests. These tests shall be conducted in one direction. As shown in Appendix A, the Insertion Loss (1C) shall be calculated. Test results shall be recorded, compared, and filed with the other recordings of the same links. Test results shall be submitted to the Engineer. These values shall be recorded in the Cable Verification Worksheet in Appendix A.

### *OTDR Testing*

Once the passive cabling system has been installed and is ready for activation, 100 percent of the fibers shall be tested with the OTDR for attenuation at wavelengths of both 1310 nm and 1550 nm. OTDR testing shall be performed in both directions (bidirectional), on all fibers. Test results shall be generated from software of the test equipment, recorded, dated, compared and filed with previous copies. The average of the two losses shall be calculated, and recorded in the Cable Verification Worksheet in Appendix A. The OTDR shall be capable of recording and displaying anomalies of at least 0.02 dB. All connector losses must be displayed on the OTDR traces. Two hard copy printouts and two electronic copies on ISO 9660 Recordable Compact Discs of traces, test results and trace analysis software shall be submitted to the Engineer. The analysis software shall be able to compare files, print traces and operate in a Java environment, a Microsoft Windows XP or another environment approved by the Engineer.

### *Cable Verification Worksheet*

The Cable Verification Worksheet shown in Appendix A shall be completed for all links in the fiber optic system, using the data gathered during cable verification. The completed worksheets shall be included as part of the system documentation.

### *Test Failures*

If the link loss measured from the power meter and light source exceeds the calculated link loss, or the actual location of the fiber ends does not agree with the expected location of the fiber ends (as would occur with a broken fiber), the fiber optic link will not be accepted. The unsatisfactory segments of cable, or splices shall be replaced with a new segment of cable or splice at the Contractor's expense. The OTDR testing, power meter and light source testing and Cable Verification Worksheet shall be completed for the repaired link to determine acceptability. Copies of the test results shall be submitted to the Engineer. The removal and replacement of a segment of cable shall be interpreted as the removal and replacement of a single contiguous

length of cable connecting two splices and two connectors. The removal of a small section containing the failure and therefore introducing new unplanned splices, will not be allowed.

### *Passive Component Package Testing and Documentation*

All components in the passive component package (FDUs, pigtails, jumpers, couplers, and splice trays) shall be from a manufacturer who is ISO9001 registered.

In developing the passive component package, each connector termination (pigtail, or jumper) shall be tested for insertion attenuation loss using an optical power meter and source. In addition, all singlemode terminations shall be tested for return reflection loss. These values shall meet the loss requirements specified earlier and shall be recorded on a tag attached to the pigtail or jumper.

Once an assembly is complete, the manufacturer shall visually verify all tagging of loss values is complete. As a final quality control measure, the manufacturer shall do an "end to end" optical power meter/light source test from pigtail end to end to the terminating point assure continuity and overall attenuation loss valued.

The final test results shall be recorded, along with previous individual component values, on a special form assigned to each FDU. The completed form shall be dated and signed by the Manufacturer's Quality Control supervisor. One copy of this form will be attached in a plastic envelope to the assembled FDU unit. Copies will be provided separately to the Contractor and to the Engineer, and shall also be maintained on file by the manufacturer or supplier.

The assembled and completed FDU unit shall then be protectively packaged for shipment to the Contractor for installation.

### *Fiber Optic System Performance Margin Design Criteria*

The installed system performance margin shall be at least 6 dB for every link. If the design system performance margin is less than 6 dB, the Engineer shall be notified and informed of the Contractor's plan to meet that requirement.

### *Active Component Testing*

The transmitters and receivers shall be tested with a power meter and light source, to record the transmitter average output power (dBm) and receiver sensitivity (dBm). These values shall be recorded in the Fiber System Performance Margin Calculations Worksheet in Appendix B, section C, number 6 and submitted to the Engineer for approval.

# APPENDIX A

## Cable Verification Worksheet

*End-to-End Attenuation (Power Meter and Light Source) Testing and OTDR Testing*

Contract No. _____ Contractor: _____

Operator: _____ Date: _____

Link Number: _____ Fiber Number: _____

Test Wavelength (Circle one): 1310 nm 1550 nm

Expected Location of fiber ends: End 1: _____ End 2: _____

Power Meter and Light Source Test Results:

| | | |
|---|---|---|
| Power In: | _____ dBm | 1A |
| Output Power: | _____ dBm | 1B |
| Insertion Loss [1A - 1B]: | _____ dB | 1C |

OTDR Test Results:

| | | |
|---|---|---|
| Forward Loss: | _____ dB | 2A |
| Reverse Loss: | _____ dB | 2B |
| Average Loss [(2A + 2B)/2]: | _____ dB | 2C |

---

To Be Completed by Caltrans:

Resident Engineer's Signature: _____

Cable Link Accepted: _____

# APPENDIX B

# Fiber System Performance Margin Calculations Worksheet

## A. Calculate the Passive Cable Attenuation

| | | |
|---|---|---|
| 1. Calculate Fiber Loss at Operating Wavelength: _____ nm | Cable Distance (times)<br>Individual Fiber Loss (equal)<br>@ 1310 nm (0.4 dB/km)<br>@ 1550 nm (0.3 dB/km) | _____ km x ___dB/km = |
| | **Total Fiber Loss:** | _____ dB |

## B. Calculate the Total Connector/Splice Loss

| | | |
|---|---|---|
| 2. Calculate Connectors/couplers Loss:<br>(exclude Tx and Rx connectors) | Individual Connector Loss (times)<br>Number of Connector Pairs (equal)<br>**Total Connector Loss:** | 0.4 dB x ____ =<br>_____ dB |
| 3. Calculate Splice Loss: | Individual Splice Loss (times)<br>Number of Splices (equal)<br>**Total Splice Loss:** | 0.1 dB x ____ =<br>_____ dB |
| 4. Calculate Other Components Loss: | **Total Components:** | _____ dB |
| 5. Calculate Total Losses: | Total Connector Loss (plus)<br>Total Splice Loss (plus)<br>Total Components (equal) | + ___ dB<br>+ ___ dB<br>+ ___ dB = |
| | **Total Connector/Splice Loss:** | _____ dB |

## C. Calculate Active Component Link Loss Budget

| | | |
|---|---|---|
| System Wavelength:<br>Fiber Type:<br>Average Transmitter Output (Launch Power): | | _____ nm<br>singlemode<br>_____ dBm |
| Receiver MAX Sensitivity ($10^9$ BER) (minus)<br>Receiver MIN Sensitivity (equal)<br>**Receiver Dynamic Range:** | | _____ dBm<br>- _____ dBm =<br>_____ dB |
| 6. Calculate Active Component Link Loss Budget: | Average Transmitter Output (Launch Power) (minus)<br>Receiver MAX Sensitivity (equal) | _____ dBm<br>- _____ dBm = |
| | **Active Component Link Loss Budget:** | _____ dB |

## D. Verify Performance

| | | |
|---|---|---|
| 7. Calculate System Performance Margin to Verify Adequate Power: | Active Component Link Loss Budget **[C]** (minus) | _____ dB |
| | Passive Cable Attenuation **[A]** (minus) | - _____ dB |
| | Total Connector/Splice Lost **[B]** (equal) | - _____ dB = |
| | **System Performance Margin:** | _____ dB |

### *FIBER OPTIC SPLICE VAULT*

Splice vaults must be the size shown on the plans and must conform to Section 86-2.06, "Pull Boxes," of the Standard Specifications and these special provisions. Enclosures, covers and extensions must be concrete gray color. Splice vaults must be constructed of reinforced portland cement concrete.

Covers must be 2 piece torsion assisted sections with a cast in frame. Cover marking must be "CALTRANS FIBER OPTIC" on each cover section. Each cover section must have inset lifting pull slots. Cover hold down bolts or cap screws and nuts must be of brass, stainless steel, or other non-corroding metal material. Covers must be hot dipped galvanized steel.

Splice vaults must be installed as shown on the plans. Splice vaults and covers must have an AASHTO HS 20-44 rating except in areas protected from vehicular traffic, which may be rated for AASHTO H5 loads (25 percent of HS 20-44).

Splice vaults must be installed at grade in paved areas, and 1 inch above grade in unpaved areas.

Splice vaults shown on the plans in the shoulder are shown for general location only. Exact location will be determined by the Engineer.

Metallic or non-metallic cable racks must be cast-in on the interior of all sides of the splice vaults as shown on the plans. Racks must be capable of supporting a load of 100 lb-f minimum, per rack arm. Racks must be supplied in lengths appropriate for the vault in which they will be placed. Rack arms must not be less than 6 inches in length. Metallic cable racks must be fabricated from ASTM Designation: A36 steel plate and must be hot-dipped galvanized after fabrication. Metallic cable racks must be bonded and grounded. Steel plate, hardware and galvanizing must conform to the requirements in Section 75, "Miscellaneous Metal," of the Standard Specifications.

### *FIBER OPTIC PULL BOX*

Fiber optic pull boxes must be the size shown on the plans and must conform to Section 86-2.06, "Pull Boxes," of the Standard Specifications and these special provisions. Enclosures, covers, and extensions must be concrete gray color. Fiber optic pull boxes must be constructed of reinforced portland cement concrete.

Covers must be 2 piece torsion assisted sections with a cast in frame. Cover marking must be "CALTRANS FIBER OPTIC" on each cover section. Each cover section must have inset lifting pull slots. Cover hold down bolts or cap screws and nuts must be of brass, stainless steel, or other non-corroding metal material. Covers must be hot dipped galvanized steel.

Fiber optic pull boxes must be installed as shown on the plans. Fiber optic pull boxes and covers must have an AASHTO HS 20-44 rating except in areas protected from vehicular traffic, which may be rated for AASHTO H5 loads (25 percent of HS 20-44).

Fiber optic pull boxes must be installed at grade in paved areas, and 1 inch above grade in unpaved areas.

Fiber optic pull boxes shown on the plans in the shoulder are shown for general location only. Exact location will be determined by the Engineer.

Metallic or non-metallic cable racks must be cast-in on the interior of all sides of the fiber optic pull boxes as shown on the plans. Racks must be capable of supporting a load of 100 lb-f minimum, per rack arm. Racks must be supplied in lengths appropriate to the box in which they will be placed. Rack arms must not be less than 6 inches in length. Metallic cable racks must be fabricated from ASTM Designation: A36 steel plate and must be hot-dipped galvanized after fabrication. Metallic cable racks must be bonded and grounded. Steel plate, hardware and galvanizing must be in accordance with the requirement of Section 75, "Miscellaneous Metal," of the Standard Specifications.