

**UNIFORM STANDARD SPECIFICATIONS
CLARK COUNTY AREA**

**REVISION SET I
1997 Release**

<u>SPECIFICATION NUMBER AND TITLE</u>	<u>PAGE NUMBER(S)</u>	<u>NATURE OF CHANGE</u>	<u>APPROVAL DATE</u>
704 Base Aggregates	704-2	Editorial revision to table in Subsection 704.03.02.	6/9/94
705 Aggregates for Bituminous Courses	705-2	Editorial revision to table in Subsection 705.03.01.	6/9/94
625 Construction Signs	625-(1-2)	Added provisions addressing the use of temporary stop signs.	7/14/94
610 Slope and Channel Protection	610-(1-9)	Retitled; revision to rip-rap materials; added specifications for gabions and gabion-joining materials.	9/8/94
609 Catch Basins, Manholes, and Inlets	609-2	Added provision to 609.03.02 allowing use of steel riser rings for manhole adjustment.	2/9/95
105 Control of Work	105-5	Editorial revision to Subsection 105.08, 7th paragraph.	10/12/95
501 Portland Cement Concrete	501-6	Editorial revision to Table 1.	"
630 Sanitary Sewers	630-15	Editorial revisions to "Specification Time" table.	"
704 Base Aggregates	704-3	Editorial revision to test requirements in Subsection 704.03.04.	"
111 Soils and Aggregate Tests	111-1	Updated Subsection 111.02 to use current test procedures.	6/13/96
704 Base Aggregates	704-1	Added provision to Subsection 704.02.01 allowing use of crushed P.C.C. and A.C. pavement.	7/11/96

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**UNIFORM STANDARD
SPECIFICATIONS**

**FOR
PUBLIC WORKS'
CONSTRUCTION
OFF-SITE IMPROVEMENTS**

**CLARK COUNTY AREA
NEVADA**

FOREWORD

Publication of these Uniform Standard Specifications for Public Works Construction Off-site Improvements, Clark County Area, Nevada, is the third edition of this important document and will supersede the 1986 edition. All revisions to these specifications approved by the Regional Transportation Commission through June 1997 have been included in this publication.

This edition modified to fit local conditions and problems follows the format of the Nevada Department of Transportation Specifications for Road and Bridge construction. It is felt this similarity of general makeup will be an aid to all those using both specifications.

Special provisions and drawings will be provided, when necessary, to supplement or modify these standard specifications.

The Uniform Standard Specifications for Public Works Construction may be revised by issuance of a supplement to correct errors and omissions found in these specifications and to reflect advanced thinking and the changing technology of the construction industry. Each supplement will supersede any previous supplement by inclusion of all pertinent portions.

To implement this end, a Specifications Committee has been established as a permanent organization to continually study and recommend changes to the standard specifications. Interested parties may address suggested changes and questions to the Uniform Standard Specifications Committee c/o Regional Transportation Commission, 301 E. Clark Avenue, Suite 300, Las Vegas, Nevada 89101.

The following participating entities of the Clark County, Nevada area have adopted these specifications, as revised, by Resolution or Council or Board Action of the governing bodies as follows:

CLARK COUNTY

Adopted by Resolution July 20, 1993

CITY OF LAS VEGAS

Adopted by Resolution R32-93 June 16, 1993

CITY OF NORTH LAS VEGAS

Adopted by Resolution No. 1685 June 16, 1993

CITY OF HENDERSON

Adopted by Ordinance No. 549 August 20, 1984

Revisions Adopted By Council Action (3rd Edition) June 15, 1993

CITY OF BOULDER CITY

Adopted by Resolution No. 2379 March 22, 1994

CITY OF MESQUITE

Adopted by Resolution No. 26 January 8, 1987

Revisions Adopted By Council Action (3rd Edition) June 10, 1993

REGIONAL TRANSPORTATION COMMISSION

Adopted by Resolution No. 7 June 14, 1984

Revisions Adopted By Commission Action Various Dates

April 4, 1997

Regional Transportation Commission
301 East Clark Avenue, #300
Las Vegas, Nevada 89101

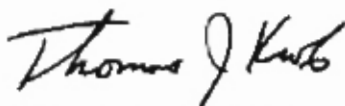
Attention: Kurt Weinrich, P.E., Director

Reference: Uniform Standard Drawings and Specifications Pertaining to
Streetlighting

Dear Kurt:

I have reviewed the electrical portions of Volume I, Volume II, and Specification Section 623 of the Uniform Standard Drawings and Specifications. The drawings and specifications meet with my approval and are ready for distribution. I have affixed my stamp and signature on those drawings that are electrical in content. In addition, I have reviewed the electrical grounding portion of foundation detail drawing standards 321, 325 & 404.261, 202, 203, 205, 206, 207, 208, 209, 211, 213. These details also meet my approval.

Sincerely,
T J Krob Consulting Engineers, Inc.



Thomas J. Krob, P.E.
TJK/dm



4-4-97

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TABLE OF CONTENTS

(Released June 1997)

DIVISION I - GENERAL REQUIREMENTS

SECTION 101 -- DEFINITIONS AND TERMS

101.01	ABBREVIATIONS	101-1
101.02	ADDENDUM	101-2
101.03	ADVERTISEMENT	101-2
101.04	ASSESSMENT ACT CONTRACT	101-2
101.05	AWARD	101-2
101.06	BASE COURSE	101-2
101.07	BIDDER	101-2
101.08	BOARD	101-2
101.09	BRIDGE	101-2
101.10	CALENDAR DAY	101-2
101.11	CONTRACT CHANGE ORDER OR FIELD CHANGE ORDER	101-2
101.12	CHANNEL	101-2
101.13	CONTRACT	101-2
101.14	CONTRACTING AGENCY	101-3
101.15	CONTRACT ITEM (PAY ITEM)	101-3
101.16	CONTRACTOR	101-3
101.17	CONTRACT TIME	101-3
101.18	CULVERT	101-3
101.19	DETOUR	101-3
101.20	DIVIDED HIGHWAY	101-3
101.21	EMPLOYEE	101-3
101.22	ENGINEER	101-3
101.23	EQUIPMENT	101-4
101.24	EXTRA WORK	101-4
101.25	FRONTAGE ROAD OR FRONTAGE STREET	101-4
101.26	GUARANTEE BOND	101-4
101.27	HIGHWAY	101-4
101.28	HOLIDAYS	101-4
101.29	INSPECTOR	101-4
101.30	LABORATORY	101-4
101.31	MAJOR CONTRACT ITEM	101-4
101.32	MATERIALS	101-4
101.33	MEDIAN	101-4
101.34	NOTICE TO BIDDERS	101-4
101.35	NOTICE TO PROCEED	101-4
101.36	PAVEMENT STRUCTURE	101-4
101.37	LABOR AND MATERIAL BOND	101-5
101.38	PERFORMANCE BOND	101-5
101.39	PLANS	101-5
101.40	PROFILE GRADE	101-5
101.41	PROJECT	101-5
101.42	PROPOSAL	101-5
101.43	PROPOSAL FORM	101-5
101.44	PROPOSAL GUARANTEE	101-5
101.45	RIGHT-OF-WAY OR EASEMENT	101-5
101.46	ROAD	101-5
101.47	ROADBED	101-5
101.48	ROADSIDE	101-6

CONTENTS

GENERAL REQUIREMENTS -- *CONTINUED*

101.49	ROADSIDE DEVELOPMENT	101-6
101.50	ROADWAY	101-6
101.51	SHOULDER	101-6
101.52	SIDEWALK	101-6
101.53	SPECIAL PROVISIONS	101-6
101.54	SPECIFICATIONS	101-6
101.55	STREET	101-6
101.56	BLANK	101-6
101.57	SUBCONTRACTOR	101-6
101.58	SUBGRADE	101-6
101.59	SUBSTRUCTURE	101-6
101.60	SUPERINTENDENT	101-6
101.61	SUPERSTRUCTURE	101-6
101.62	SUPPLEMENTAL AGREEMENT	101-7
101.63	SUPPLEMENTAL SPECIFICATIONS	101-7
101.64	SURETY	101-7
101.65	SURFACE COURSE	101-7
101.66	TRAFFIC LANE	101-7
101.67	TRAVELED WAY	101-7
101.68	UTILITY	101-7
101.69	WORK	101-7
101.70	WORKING DAY	101-7
101.71	WORKING DRAWINGS	101-7
101.72		101-7

SECTION 102 -- BIDDING REQUIREMENTS AND CONDITIONS

102.01	NOTICE TO CONTRACTORS	102-1
102.02	PREQUALIFICATION OF BIDDERS	102-1
102.03	CONTENTS OF PROPOSAL FORMS	102-1
102.04	INTERPRETATION OF QUANTITIES IN THE PROPOSAL	102-2
102.05	EXAMINATION OF PLANS, SPECIFICATIONS, CONTRACT DOCUMENTS, AND SITE OF WORK	102-2
102.06	PREPARATION OF PROPOSAL	102-3
102.07	IRREGULAR PROPOSALS	102-3
102.08	PROPOSAL GUARANTEE	102-3
102.09	DELIVERY OF PROPOSALS	102-4
102.10	WITHDRAWAL OR REVISION OF PROPOSALS	102-4
102.11	PUBLIC OPENING OF PROPOSALS	102-4
102.12	DISQUALIFICATION OF BIDDERS	102-4
102.13	MATERIAL GUARANTEE	102-5

SECTION 103 -- AWARD AND EXECUTION OF CONTRACT

103.01	CONSIDERATION OF PROPOSALS	103-1
103.02	AWARD OF CONTRACT	103-1
103.03	CANCELLATION OF AWARD	103-1
103.04	RETURN OF PROPOSAL GUARANTEE	103-1
103.05	REQUIREMENTS OF CONTRACT BONDS	103-2
103.06	EXECUTION AND APPROVAL OF CONTRACT	103-2
103.07	FAILURE TO EXECUTE CONTRACT	103-2

CONTENTS

GENERAL REQUIREMENTS -- *CONTINUED*

SECTION 104 -- SCOPE OF THE WORK

104.01	INTENT OF THE CONTRACT	104-1
104.02	INCREASED OR DECREASED QUANTITIES AND CHANGE IN CHARACTER OF WORK	104-1
104.03	EXTRA WORK	104-2
104.04	MAINTENANCE OF TRAFFIC	104-2
104.05	RIGHTS IN AND USE OF MATERIALS FOUND ON THE WORK	104-3

SECTION 105 -- CONTROL OF WORK

105.01	AUTHORITY OF THE ENGINEER	105-1
105.02	PLANS AND WORKING DRAWINGS	105-1
105.03	CONFORMITY WITH PLANS AND SPECIFICATIONS	105-1
105.04	COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, AND SPECIAL PROVISIONS	105-2
105.05	COOPERATION BY CONTRACTOR	105-2
105.06	COOPERATION WITH UTILITIES	105-3
105.07	COOPERATION BETWEEN CONTRACTORS	105-4
105.08	CONSTRUCTION STAKES, LINES AND GRADES	105-5
105.09	BLANK	105-6
105.10	DUTIES OF THE INSPECTOR	105-6
105.11	INSPECTION	105-6
105.12	REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK	105-6
105.13	LOAD AND SPEED RESTRICTIONS	105-7
105.14	MAINTENANCE DURING CONSTRUCTION	105-8
105.15	FAILURE TO MAINTAIN ROADWAY OR STRUCTURE	105-8
105.16	FINAL ACCEPTANCE	105-8
105.17	CLAIMS FOR ADJUSTMENT AND DISPUTES	105-8

SECTION 106 -- CONTROL OF MATERIALS

106.01	SOURCE OF SUPPLY AND QUALITY REQUIREMENTS	106-1
106.02	LOCAL MATERIALS	106-1
106.03	POSSIBLE LOCAL MATERIAL SOURCES	106-2
106.04	SAMPLES AND TESTS	106-4
106.05	CERTIFICATE OF COMPLIANCE	106-6
106.06	CITED SPECIFICATIONS	106-6
106.07	PLANT INSPECTION	106-6
106.08	STORAGE OF MATERIALS	106-7
106.09	HANDLING MATERIALS	106-7
106.10	UNACCEPTABLE MATERIALS	106-7
106.11	CONTRACTING AGENCY FURNISHED MATERIAL	106-7

SECTION 107 -- LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01	LAWS TO BE OBSERVED	107-1
107.02	PERMITS, LICENSES, AND TAXES	107-1
107.03	PATENTED DEVICES, MATERIALS, AND PROCESSES	107-1
107.04	RESTORATION OF SURFACES OPENED BY PERMIT	107-1
107.05	BLANK	107-2
107.06	SANITARY PROVISIONS	107-2

CONTENTS

GENERAL REQUIREMENTS – *CONTINUED*

107.07	TRAFFIC AND ACCESS	107-2
107.08	RELATIONS WITH RAILROADS	107-3
107.09	LIABILITY INSURANCE	107-5
107.10	EXPLOSIVES	107-6
107.11	RESPONSIBILITY FOR DAMAGE CLAIMS	107-6
107.12	PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE	107-7
107.13	FIRE PROTECTION	107-8
107.14	DISPOSAL OF MATERIAL OUTSIDE PROJECT RIGHT-OF-WAY	107-8
107.15	RELIEF FROM MAINTENANCE AND RESPONSIBILITY	107-8
107.16	CONTRACTOR'S RESPONSIBILITY FOR THE WORK AND MATERIALS	107-9
107.17	CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICE	107-9
107.18	FURNISHING RIGHT-OF-WAY	107-10
107.19	PERSONAL LIABILITY OF PUBLIC OFFICIALS	107-10
107.20	NO WAIVER OF LEGAL RIGHTS	107-10
107.21	DUST CONTROL	107-11

SECTION 108 – PROSECUTION AND PROGRESS

108.01	SUBLETTING OF CONTRACT	108-1
108.02	NOTICE TO PROCEED	108-2
108.03	PROSECUTION AND PROGRESS	108-2
108.04	LIMITATION OF OPERATIONS	108-2
108.05	CHARACTER OF WORKMEN; METHODS AND EQUIPMENT	108-3
108.06	TEMPORARY SUSPENSION OF WORK	108-4
108.07	PRECONSTRUCTION CONFERENCE	108-4
108.08	DETERMINATION AND EXTENSION OF CONTRACT TIME	108-5
108.09	FAILURE TO COMPLETE THE WORK ON TIME	108-6
108.10	DEFAULT AND TERMINATION OF CONTRACT	108-6
108.11	TERMINATION OF THE CONTRACTOR'S RESPONSIBILITY	108-7
108.12	RIGHT-OF-WAY DELAYS	108-7
108.13	TERMINATION OF CONTRACT	108-7

SECTION 109 – MEASUREMENT AND PAYMENT

109.01	MEASUREMENT OF QUANTITIES	109-1
109.02	SCOPE OF PAYMENT	109-2
109.03	EXTRA AND FORCE ACCOUNT WORK	109-7
109.04	ELIMINATED ITEMS	109-9
109.05	BLANK	109-9
109.06	PARTIAL PAYMENT	109-9
109.07	ACCEPTANCE AND FINAL PAYMENT	109-10
109.08	BLANK	109-11

SECTION 110 – WAGES, HOURS, AND CONDITIONS OF EMPLOYMENT

110.01	WAGES, HOURS AND EMPLOYMENT PRACTICES	110-1
110.02	SAFETY REQUIREMENTS	110-1
110.03	STATE MUSEUMS	110-1

CONTENTS

GENERAL REQUIREMENTS – *CONTINUED*

SECTION 111 – SOILS AND AGGREGATE TESTS

111.01 SIEVE ANALYSIS	111-1
111.02 LABORATORY MAXIMUM DENSITY	111-1
111.03 FIELD DENSITY	111-1
111.04 RELATIVE COMPACTION	111-1

DIVISION II - CONSTRUCTION DETAILS

SECTION 201 - CLEARING AND GRUBBING

DESCRIPTION	
201.01.01 GENERAL	201-1
CONSTRUCTION	
201.03.01 GENERAL	201-1
201.03.02 AREAS TO BE CLEARED	201-1
201.03.03 CLEARING AND GRUBBING	201-1
METHOD OF MEASUREMENT	
201.04.01 MEASUREMENT	201-2
BASIS OF PAYMENT	
201.05.01 PAYMENT	201-3

SECTION 202 -- REMOVAL OF STRUCTURES AND OBSTRUCTIONS

DESCRIPTION	
202.01.01 GENERAL	202-1
CONSTRUCTION	
202.03.01 GENERAL	202-1
202.03.02 REMOVAL	202-1
202.03.03 EXTENSIONS	202-2
202.03.04 CLOSING CULVERTS	202-2
202.03.05 SALVAGE	202-2
202.03.06 DISPOSING OF MATERIALS	202-3
METHOD OF MEASUREMENT	
202.04.01 MEASUREMENT	202-3
BASIS OF PAYMENT	
202.05.01 PAYMENT	202-3

SECTION 203 – EXCAVATION AND EMBANKMENT

DESCRIPTION	
203.01.01 GENERAL	203-1
203.01.02 GRADE TOLERANCE	203-1

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

MATERIALS

203.02.01	ROADWAY EXCAVATION	203-1
203.02.02	DRAINAGE EXCAVATION	203-1
203.02.03	CHANNEL EXCAVATION	203-1
203.02.04	BORROW	203-1
203.02.05	SELECTED BORROW	203-2

CONSTRUCTION

203.03.01	ROADWAY	203-2
203.03.02	UNSUITABLE MATERIAL	203-2
203.03.03	BLASTING	203-2
203.03.04	ROCK CUTS	203-3
203.03.05	OVERBREAK	203-3
203.03.06	SLOPES	203-3
203.03.07	WIDENING CUTS	203-3
203.03.08	SURPLUS MATERIAL	203-3
203.03.09	SELECTED MATERIAL	203-4
203.03.10	SLIDES AND SLIPOUTS	203-4
203.03.11	DRAINAGE	203-4
203.03.12	CHANNELS	203-5
203.03.13	BORROW	203-5
203.03.14	FOUNDATION	203-5
203.03.15	EMBANKMENT MATERIALS	203-6
203.03.16	PLACING EMBANKMENT	203-6
203.03.17	COMPACTION, DIRT EMBANKMENT	203-8
203.03.18	COMPACTION, ROCK EMBANKMENT	203-8
203.03.19	MAINTENANCE	203-9
203.03.20	SUBGRADE TOLERANCE	203-10

METHOD OF MEASUREMENT

203.04.01	MEASUREMENT	203-10

BASIS OF PAYMENT

203.05.01	PAYMENT	203-12

SECTION 204 – **ROUNDED AND TRANSITION SLOPES**

DESCRIPTION

204.01.01	GENERAL	204-1

CONSTRUCTION

204.03.01	GENERAL	204-1

METHOD OF MEASUREMENT

204.04.01	MEASUREMENT	204-1

BASIS OF PAYMENT

204.05.01	PAYMENT	204-1

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

SECTION 205 - BLANK

SECTION 206 - STRUCTURE EXCAVATION

DESCRIPTION	
206.01.01 GENERAL	206-1
206.01.02 CLASSIFICATION	206-1
CONSTRUCTION	
206.03.01 GENERAL	206-1
206.03.02 INSPECTION	206-2
BASIS OF PAYMENT	
206.05.01 PAYMENT	206-2

SECTION 207 -- STRUCTURE BACKFILL

DESCRIPTION	
207.01.01 GENERAL	207-1
MATERIALS	
207.02.01 SELECTED BACKFILL	207-1
207.02.02 GRANULAR BACKFILL	207-1
CONSTRUCTION	
207.03.01 GENERAL	207-2
207.03.02 PLACING AND COMPACTING AT ABUTMENTS, PIERS, WINGWALLS AND RETAINING WALLS	207-3
207.03.03 PLACING AND COMPACTING AT CULVERTS	207-3
207.03.04 PLACING AND COMPACTING OF BIN-TYPE RETAINING WALLS	207-4
BASIS OF PAYMENT	
207.04.01 PAYMENT	207-4

SECTION 208 -- TRENCH EXCAVATION & BACKFILL

DESCRIPTION	
208.01.01 GENERAL	208-1
MATERIALS	
208.02.01 SELECTED BACKFILL	208-1
208.02.02 GRANULAR BACKFILL	208-1
208.02.03 SAND BACKFILL	208-1
208.02.04 TYPE II AGGREGATE BASE BACKFILL	208-1
208.02.05 DRAIN BACKFILL	208-1
208.02.06 FLOWABLE BACKFILL	208-1
208.02.07 CRUSHED ROCK	208-2
CONSTRUCTION	
208.03.01 TRENCH EXCAVATION, GENERAL	208-3

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

208.03.02 PIPE BEDDING	208-4
208.03.03 TRENCH BACKFILL	208-5
208.03.04 SOILS TESTS	208-6
208.03.05 CUTTING AND RESTORING STREET SURFACING	208-6

BASIS OF PAYMENT

208.05.01 BASIS OF PAYMENT	208-8

SECTION 209 -- DRAIN BACKFILL

DESCRIPTION

209.01.01 GENERAL	209-1

MATERIALS

209.02.01 GENERAL	209-1

CONSTRUCTION

209.03.01 GENERAL	209-1

METHOD OF MEASUREMENT

209.04.01 MEASUREMENT	209-1

BASIS OF PAYMENT

209.05.01 PAYMENT	209-1

SECTION 210 -- WATERING

DESCRIPTION

210.01.01 GENERAL	210-1

MATERIALS

210.02.01 GENERAL	210-1

CONSTRUCTION

210.03.01 EQUIPMENT	210-1
210.03.02 GENERAL	210-1

METHOD OF MEASUREMENT

210.04.01 MEASUREMENT	210-2

BASIS OF PAYMENT

210.05.01 PAYMENT	210-2

SECTION 211 -- EROSION CONTROL

DESCRIPTION

211.01.01 GENERAL	211-1

MATERIALS

211.02.01 GENERAL	211-1

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

211.02.02	PLANTING SOIL	211-1
211.02.03	SEED	211-1
211.02.04	FERTILIZER AND AGRICULTURAL MINERALS	211-1
211.02.05	MULCH	211-1
211.02.06	ASPHALT EMULSION	211-2

CONSTRUCTION

211.03.01	PREPARATION	211-2
211.03.02	PLACEMENT OF PLANTING SOIL	211-2
211.03.03	FIRMING OF PLANTING SOIL	211-2
211.03.04	SEEDING AND FERTILIZING	211-3
211.03.05	SPREADING MULCH	211-4
211.03.06	APPLYING ASPHALT EMULSION	211-4
211.03.07	PLACING JUTE MATTING	211-4

METHOD OF MEASUREMENT

211.04.01	MEASUREMENT	211-5

BASIS OF PAYMENT

211.05.01	PAYMENT	211-5

SECTION 212 -- LANDSCAPING

DESCRIPTION

212.01.01	GENERAL	212-1

MATERIALS

212.02.01	GENERAL	212-1
212.02.02	NOMENCLATURE	212-1
212.02.03	QUALITY OF PLANT MATERIALS	212-1
212.02.04	HANDLING AND SHIPPING	212-2
212.02.05	INSPECTION OF PLANT MATERIAL	212-2
212.02.06	SUBSTITUTION OF PLANTS	212-2
212.02.07	TEMPORARY STORAGE	212-3
212.02.08	PLANTING SOIL	212-3
212.02.09	LUMBER	212-3
212.02.10	MULCH	212-3

CONSTRUCTION

212.03.01	SITE PREPARATION	212-3
212.03.02	LAYOUT OF PLANTING	212-3
212.03.03	PREPARATION OF PLANTING AREAS	212-3
212.03.04	PLANTING	212-4
212.03.05	STAKING AND GUYING	212-6
212.03.06	PRUNING	212-6
212.03.07	WATERING	212-6
212.03.08	REPLACEMENTS	212-7
212.03.09	FERTILIZERS, AGRICULTURAL MINERALS AND ADDITIVES	212-8
212.03.10	PROTECTION OF EXISTING FACILITIES	212-8
212.03.11	PLANT ESTABLISHMENT WORK	212-8

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

METHOD OF MEASUREMENT

212.04.01 MEASUREMENT	212-9

BASIS OF PAYMENT

212.05.01 PAYMENT	212-9

SECTION 213 – IRRIGATION SYSTEMS

DESCRIPTION

213.01.01 GENERAL	213-1

MATERIALS

213.02.01 GENERAL	213-1
213.02.02 PIPE AND FITTINGS	213-1
213.02.03 CONTROL TUBING	213-2
213.02.04 AUTOMATIC CONTROLLERS	213-2
213.02.05 SPRINKLER HEADS	213-2
213.02.06 BLANK	213-2
213.02.07 GATE VALVES	213-2
213.02.08 CONTROL VALVES	213-3
213.02.09 QUICK COUPLER VALVES	213-3
213.02.10 VALVE BOXES	213-3
213.02.11 BACKFLOW PREVENTERS	213-3
213.02.12 DRAIN VALVES	213-3
213.02.13 HOSE BIBS	213-4
213.02.14 VACUUM BREAKERS	213-4
213.02.15 AIR RELIEF VALVE	213-4

CONSTRUCTION

213.03.01 GENERAL	213-4
213.03.02 EXCAVATION	213-5
213.03.03 EXCAVATION ADJACENT TO TREES	213-5
213.03.04 PIPING	213-5
213.03.05 JOINTING	213-5
213.03.06 CONTROL TUBING	213-5
213.03.07 INSTALLATION	213-5
213.03.08 CONTROL TUBING PLACEMENT	213-7
213.03.09 FLUSHING AND TESTING	213-7
213.03.10 ADJUSTING SYSTEM	213-7
213.03.11 BACKFILL	213-8
213.03.12 AS-BUILT RECORD DRAWINGS	213-8

METHOD OF MEASUREMENT

213.04.01 MEASUREMENT	213-8

BASIS OF PAYMENT

213.05.01 PAYMENT	213-8

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

SECTION 214 -- LIME TREATED SUB-BASE THIS SECTION HAS BEEN DELETED.

SECTION 215 - QUICKLIME TREATED SUB-BASE THIS SECTION HAS BEEN DELETED.

SECTION 301 -- SELECTED MATERIAL BASE OR SURFACE

DESCRIPTION

301.01.01 GENERAL	301-1

MATERIALS

301.02.01 GENERAL	301-1

CONSTRUCTION

301.03.01 SUBGRADE PREPARATION	301-1
301.03.02 PLACING	301-1
301.03.03 WATERING	301-1
301.03.04 COMPACTION	301-1

METHOD OF MEASUREMENT

301.04.01 MEASUREMENT	301-2

BASIS OF PAYMENT

301.05.01 PAYMENT	301-2

SECTION 302 -- AGGREGATE BASE COURSES

DESCRIPTION

302.01.01 GENERAL	302-1

MATERIALS

302.02.01 GENERAL	302-1

CONSTRUCTION

302.03.01 SUBGRADE PREPARATION	302-1
302.03.02 SPREADING AGGREGATES	302-1
302.03.03 WATERING AND MIXING AGGREGATES	302-1
302.03.04 WATERING	302-2
302.03.05 COMPACTION	302-2
302.03.06 TOLERANCE FOR FINISHED SURFACE	302-2

METHOD OF MEASUREMENT

302.04.01 MEASUREMENT	302-2

BASIS OF PAYMENT

302.05.01 PAYMENT	302-2

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

SECTION 303 -- PLANTMIX BITUMINOUS BASE

DESCRIPTION	
303.01.01 GENERAL	303-1
MATERIALS	
303.02.01 GENERAL	303-1
CONSTRUCTION	
303.03.01 GENERAL	303-1
303.03.02 SPREADING AND FINISHING	303-1
303.03.03 SURFACE TOLERANCES	303-1
METHOD OF MEASUREMENT	
303.04.01 MEASUREMENT	303-1
BASIS OF PAYMENT	
303.05.01 PAYMENT	303-2

SECTION 304 -- PORTLAND CEMENT TREATED BASE

DESCRIPTION	
304.01.01 GENERAL	304-1
MATERIALS	
304.02.01 GENERAL	304-1
CONSTRUCTION	
304.03.01 PROPORTIONING	304-1
304.03.02 MIXING - ROADMIX METHOD	304-1
304.03.03 MIXING - PLANTMIX METHOD	304-2
304.03.04 SPREADING	304-3
304.03.05 COMPACTION	304-3
304.03.06 FINISHED SURFACE	304-4
304.03.07 TIME REQUIREMENTS	304-4
304.03.08 CONSTRUCTION JOINTS	304-4
304.03.09 PROTECTION AND CURING	304-5
304.03.10 WEATHER LIMITATIONS	304-5
BASIS OF PAYMENT	
304.05.01 PAYMENT	304-5

SECTION 305 -- BLANK

SECTION 306 -- LIME STABILIZED SUBGRADE

DESCRIPTION	
306.01.01 GENERAL	306-1
MATERIALS	
306.02.01 SUBGRADE MATERIAL	306-1

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

306.02.02 LIME	306-1
306.02.03 WATER	306-2
CONSTRUCTION	
306.03.01 PROPORTIONING	306-2
306.03.02 SUBGRADE PREPARATION	306-2
306.03.03 LIME APPLICATION	306-2
306.03.04 MIXING	306-3
306.03.05 COMPACTION	306-3
306.03.06 FINISHING AND CURING	306-4
METHOD OF MEASUREMENT	
306.04.01 PAYMENT	306-4
BASIS OF PAYMENT	
306.05.01 PAYMENT	306-4

SECTION 401 -- PLANTMIX BITUMINOUS PAVEMENTS -- GENERAL

DESCRIPTION	
401.01.01 GENERAL	401-1
MATERIALS	
401.02.01 COMPOSITION OF MIXTURES	401-1
401.02.02 AGGREGATES	401-4
401.02.03 COMMERCIAL MINERAL FILLER	401-4
401.02.04 BITUMINOUS MATERIALS	401-4
CONSTRUCTION	
401.03.01 BITUMINOUS MIXING PLANT	401-5
401.03.02 HAULING EQUIPMENT	401-9
401.03.03 PAVERS	401-9
401.03.04 ROLLERS	401-10
401.03.05 WEATHER LIMITATIONS	401-10
401.03.06 PREPARATION OF EXISTING SURFACE	401-10
401.03.07 PREPARATION OF BITUMINOUS MATERIALS	401-11
401.03.08 PREPARATION OF AGGREGATES	401-11
401.03.09 MIXING	401-14
401.03.10 SPREADING AND FINISHING	401-14
401.03.11 ROLLING AND COMPACTION	401-15
401.03.12 ACCEPTANCE SAMPLING AND TESTING OF BITUMINOUS MIXTURE (COMPACTION)	401-15
401.03.13 MAINTAINING TRAFFIC	401-16
401.03.14 JOINTS	401-16
401.03.15 SURFACE TOLERANCES	401-16
401.03.16 SURFACING MISCELLANEOUS AREAS	401-16
METHOD OF MEASUREMENT	
401.04.01 MEASUREMENT	401-17
BASIS OF PAYMENT	
401.05.01 PAYMENT	401-17

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

SECTION 402 -- PLANTMIX BITUMINOUS SURFACE

DESCRIPTION	
402.01.01 GENERAL	402-1
MATERIALS	
402.02.01 GENERAL	402-1
CONSTRUCTION	
402.03.01 GENERAL	402-1
402.03.02 SPREADING AND FINISHING	402-1
402.03.03 SURFACE TOLERANCES	402-1
METHOD OF MEASUREMENT	
402.04.01 MEASUREMENT	402-2
BASIS OF PAYMENT	
402.05.01 PAYMENT	402-2

SECTION 403 -- PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

DESCRIPTION	
403.01.01 GENERAL	403-1
MATERIALS	
403.02.01 GENERAL	403-1
403.02.02 COMPOSITION OF MIXTURE	403-1
CONSTRUCTION	
403.03.01 GENERAL	403-2
403.03.02 ROLLERS	403-2
403.03.03 JOINTS	403-3
403.03.04 SURFACE TOLERANCES	403-3
METHOD OF MEASUREMENT	
403.04.01 MEASUREMENT	403-3
BASIS OF PAYMENT	
403.05.01 PAYMENT	403-3

SECTION 404 -- RECYCLED BITUMINOUS AGGREGATE PAVEMENT

DESCRIPTION	
404.01.01 GENERAL	404-1
MATERIALS	
404.02.01 COMPOSITION OF MIXTURES	404-1
404.02.02 AGGREGATES	404-2
404.02.03 BITUMINOUS MATERIAL	404-2
404.02.04 RECYCLING AGENT	404-2

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

CONSTRUCTION	
404.03.01 GENERAL	404-4
404.03.02 BITUMINOUS MIXING PLANT	404-4
404.03.03 PREPARATION OF AGGREGATES	404-4

METHOD OF MEASUREMENT	
404.04.01 MEASUREMENT	404-4

BASIS OF PAYMENT	
404.05.01 PAYMENT	404-5

SECTION 405 – TACK COAT

DESCRIPTION	
405.01.01 GENERAL	405-1

MATERIALS	
405.02.01 BITUMINOUS MATERIAL	405-1

CONSTRUCTION	
405.03.01 EQUIPMENT	405-1
405.03.02 WEATHER LIMITATIONS	405-1
405.03.03 PREPARATION OF SURFACE	405-1
405.03.04 APPLICATION OF ASPHALTIC EMULSION	405-2

METHOD OF MEASUREMENT	
405.04.01 MEASUREMENT	405-2

BASIS OF PAYMENT	
405.05.01 PAYMENT	405-2

SECTION 406 – PRIME COAT

DESCRIPTION	
406.01.01 GENERAL	406-1

MATERIALS	
406.02.01 BITUMINOUS MATERIAL	406-1
406.02.02 SAND BLOTTER	406-1

CONSTRUCTION	
406.03.01 EQUIPMENT	406-1
406.03.02 WEATHER LIMITATIONS	406-1
406.03.03 PREPARATION OF SURFACE	406-1
406.03.04 APPLICATION OF BITUMINOUS MATERIAL	406-1
406.03.05 APPLICATION OF BLOTTER MATERIAL	406-2
406.03.06 MAINTENANCE	406-2

METHOD OF MEASUREMENT	
406.04.01 MEASUREMENT	406-3

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

BASIS OF PAYMENT	
406.05.01 PAYMENT	406-3

SECTION 407 – SEAL COAT

DESCRIPTION	
407.01.01 GENERAL	407-1

MATERIALS	
407.02.01 BITUMINOUS MATERIAL	407-1
407.02.02 SAND BLOTTER	407-1

CONSTRUCTION	
407.03.01 EQUIPMENT	407-1
407.03.02 WEATHER LIMITATIONS	407-1
407.03.03 PREPARATION OF SURFACE	407-1
407.03.04 APPLICATION OF BITUMINOUS MATERIAL	407-1
407.03.05 APPLICATION OF BLOTTER MATERIAL	407-2

METHOD OF MEASUREMENT	
407.04.01 MEASUREMENT	407-2

BASIS OF PAYMENT	
407.05.01 PAYMENT	407-2

SECTION 408 – SURFACE TREATMENT

DESCRIPTION	
408.01.01 GENERAL	408-1

MATERIALS	
408.02.01 BITUMINOUS MATERIAL	408-1
408.02.02 SCREENINGS	408-1

CONSTRUCTION	
408.03.01 DISTRIBUTORS	408-1
408.03.02 AGGREGATE SPREADER	408-1
408.03.03 ROLLING AND COMPACTION	408-1
408.03.04 WEATHER LIMITATIONS	408-2
408.03.05 MAINTAINING TRAFFIC	408-2
408.03.06 PREPARATION OF SURFACE	408-2
408.03.07 APPLICATION OF BITUMINOUS MATERIAL	408-2
408.03.08 APPLICATION OF SCREENINGS	408-3

METHOD OF MEASUREMENT	
408.04.01 MEASUREMENT	408-3

BASIS OF PAYMENT	
408.05.01 PAYMENT	408-3

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

SECTION 409 -- PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

409.01.01 GENERAL	409-1

MATERIALS

409.02.01 GENERAL	409-1
409.02.02 GRADATION REQUIREMENTS	409-1
409.02.03 CONCRETE PROPERTIES AND TESTS	409-1

CONSTRUCTION

409.03.01 CLASSIFICATION AND PROPORTIONS	409-2
409.03.02 EQUIPMENT	409-4
409.03.03 BLANK	409-8
409.03.04 BLANK	409-8
409.03.05 REINFORCEMENT	409-8
409.03.06 BLANK	409-8
409.03.07 PLACING CONCRETE	409-8
409.03.08 SPREADING, COMPACTING AND SHAPING	409-9
409.03.09 JOINTS	409-10
409.03.10 CURING	409-11
409.03.11 PROTECTION OF PAVEMENT	409-11

METHOD OF MEASUREMENT

409.04.01 MEASUREMENT	409-12

BASIS OF PAYMENT

409.05.01 PAYMENT	409-12

SECTION 495 -- PRESTRESSING CAST-IN-PLACE CONCRETE

DESCRIPTION

495.01.01 GENERAL	495-1

MATERIALS

495.02.01 GENERAL	495-1

CONSTRUCTION

495.03.01 GENERAL	495-2
495.03.02 ANCHORAGES AND DISTRIBUTION	495-2
495.03.03 DUCTS	495-3
495.03.04 PRESTRESSING	495-4
495.03.05 BONDING AND GROUTING	495-5
495.03.06 SAMPLES FOR TESTING	495-6

METHOD OF MEASUREMENT

495.04.01 MEASUREMENT	495-7

BASIS OF PAYMENT

495.05.01 PAYMENT	495-7

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

SECTION 501 – PORTLAND CEMENT CONCRETE

DESCRIPTION

501.01.01 GENERAL	501-1

MATERIALS

501.02.01 GENERAL	501-1
501.02.02 GRADATION REQUIREMENTS	501-1
501.02.03 ADMIXTURES	501-1
501.02.04 CONCRETE MAKING PROPERTIES	501-3

CONSTRUCTION

501.03.01 EQUIPMENT	501-3
501.03.02 PROTECTING AND SAMPLING CEMENT	501-5
501.03.03 STORAGE OF AGGREGATES	501-5
501.03.04 CLASSIFICATION AND PROPORTIONS	501-5
501.03.05 PROPORTIONING METHODS	501-7
501.03.06 MACHINE MIXING	501-9
501.03.07 HAND MIXING	501-13
501.03.08 RETEMPERING	501-13
501.03.09 CURING	501-13
501.03.10 WEATHER LIMITATIONS	501-14
501.03.11 GENERAL	501-16

BASIS OF PAYMENT

501.05.01 PAYMENT	501-17

SECTION 502 – CONCRETE STRUCTURES

DESCRIPTION

502.01.01 GENERAL	502-1

MATERIALS

502.02.01 GENERAL	502-1

CONSTRUCTION

502.03.01 DEPTH OF FOOTINGS	502-1
502.03.02 FORMS	502-1
502.03.03 FALSEWORK	502-5
502.03.04 REINFORCEMENT	502-5
502.03.05 COFFERDAMS AND CRIBS	502-5
502.03.06 PUMPING WATER	502-6
502.03.07 MIXING CONCRETE	502-6
502.03.08 HANDLING AND PLACING CONCRETE	502-6
502.03.09 CONCRETE DEPOSITED UNDER WATER	502-9
502.03.10 CONSTRUCTION JOINTS	502-9
502.03.11 REMOVAL OF FALSEWORK AND FORMS	502-10
502.03.12 EXPANSION AND FIXED JOINTS AND BEARINGS	502-11
502.03.13 CURING	502-13
502.03.14 PATCHING	502-13
502.03.15 FINISH OF HORIZONTAL SURFACES	502-13

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

502.03.16 FORMED SURFACES REQUIRING FINISHING	502-16
502.03.17 ORDINARY SURFACE FINISH	502-16
502.03.18 FINE SURFACE FINISH	502-16
502.03.19 LIVE LOADS	502-17

METHOD OF MEASUREMENT

502.04.01 MEASUREMENT	502-18

BASIS OF PAYMENT

502.05.01 PAYMENT	502-20

SECTION 503 - PRECAST PRESTRESSED CONCRETE MEMBERS

DESCRIPTION

503.01.01 GENERAL	503-1

MATERIALS

503.02.01 GENERAL	503-1

CONSTRUCTION

503.03.01 PRESTRESSING METHODS	503-1
503.03.02 FORMS	503-1
503.03.03 ANCHORAGES AND DISTRIBUTION	503-2
503.03.04 ENCLOSURES	503-2
503.03.05 PRESTRESSING	503-2
503.03.06 CURING	503-4
503.03.07 SHIPPING	503-5
503.03.08 HANDLING	503-5
503.03.09 TOLERANCES	503-5

METHOD OF MEASUREMENT

503.04.01 MEASUREMENT	503-8

BASIS OF PAYMENT

503.05.01 PAYMENT	503-8

SECTION 504 – LIGHTWEIGHT CONCRETE FOR STRUCTURES

DESCRIPTION

504.01.01 GENERAL	504-1

MATERIALS

504.02.01 GENERAL	504-1
504.02.02 ADMIXTURES	504-1
504.02.03 CONCRETE MAKING PROPERTIES	504-1

CONSTRUCTION

504.03.01 GENERAL	504-2
504.03.02 STORAGE OF AGGREGATES	504-2
504.03.03 CLASSIFICATION AND PROPORTIONS	504-2
504.03.04 MIXING	504-3

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

METHOD OF MEASUREMENT

504.04.01 MEASUREMENT	504-5

BASIS OF PAYMENT

504.05.01 PAYMENT	504-6

SECTION 505 – REINFORCING STEEL

DESCRIPTION

505.01.01 GENERAL	505-1

MATERIALS

505.02.01 GENERAL	505-1
505.02.02 SAMPLES	505-1

CONSTRUCTION

505.03.01 REINFORCING STEEL LIST	505-1
505.03.02 PROTECTION OF MATERIALS	505-1
505.03.03 BENDING	505-2
505.03.04 PLACING AND FASTENING	505-2
505.03.05 SPLICING	505-2
505.03.06 SUBSTITUTIONS	505-2

METHOD OF MEASUREMENT

505.04.01 MEASUREMENT	505-3

BASIS OF PAYMENT

505.05.01 PAYMENT	505-3

SECTION 506 – STEEL STRUCTURES

DESCRIPTION

506.01.01 GENERAL	506-1

MATERIALS

506.02.01 GENERAL	506-1

CONSTRUCTION

506.03.01 SHOP DRAWINGS	506-1
506.03.02 NOTICE OF BEGINNING WORK	506-2
506.03.03 INSPECTION AND TESTING	506-2
506.03.04 STORAGE	506-3
506.03.05 STRAIGHTENING	506-3
506.03.06 RIVET HOLES	506-4
506.03.07 RIVETS	506-4
506.03.08 SHOP RIVETING	506-4
506.03.09 SUBPUNCHING, DRILLING, AND REAMING	506-5
506.03.10 BOLTS AND BOLTED CONNECTIONS	506-5
506.03.11 SHOP ASSEMBLY	506-6
506.03.12 EDGE PLANING	506-6
506.03.13 FACING OF BEARING SURFACES	506-6

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

506.03.14	ABUTTING JOINTS	506-7
506.03.15	FLAME CUTTING	506-7
506.03.16	END CONNECTION ANGLES	506-7
506.03.17	LACING BARS	506-7
506.03.18	WEB PLATES	506-7
506.03.19	STUD SHEAR CONNECTORS	506-7
506.03.20	WELDING	506-10
506.03.21	FIT OF STIFFENERS	506-10
506.03.22	ANNEALING AND STRESS RELIEVING	506-10
506.03.23	PINS AND PIN HOLES	506-10
506.03.24	SHOP PAINTING	506-11
506.03.25	MARKING AND SHIPPING	506-11
506.03.26	ERECTION METHODS AND EQUIPMENT	506-11
506.03.27	FALSEWORK	506-12
506.03.28	BEARING AND ANCHORAGE	506-12
506.03.29	FIELD ASSEMBLING AND RIVETING	506-12
506.03.30	MISFITS	506-13
506.03.31	FIELD PAINTING	506-13
METHOD OF MEASUREMENT		
506.04.01	MEASUREMENT	506-13
BASIS OF PAYMENT		
506.05.01	PAYMENT	506-15

SECTION 507 -- TIMBER STRUCTURES

DESCRIPTION		
507.01.01	GENERAL	507-1
MATERIALS		
507.02.01	GENERAL	507-1
CONSTRUCTION		
507.03.01	STORAGE OF MATERIALS	507-1
507.03.02	WORKMANSHIP	507-1
507.03.03	TREATED TIMBER	507-2
507.03.04	UNTREATED TIMBER	507-2
507.03.05	HOLES FOR BOLTS, DOWELS, RODS, AND LAG SCREWS	507-2
507.03.06	BOLTS AND WASHERS	507-2
507.03.07	FRAMING	507-2
507.03.08	CAPS	507-3
507.03.09	BRACING	507-3
507.03.10	STRINGERS	507-3
507.03.11	PLANK FLOORS	507-3
507.03.12	LAMINATED FLOORS	507-4
507.03.13	TRUSSES	507-4
507.03.14	PAINTING	507-4
METHOD OF MEASUREMENT		
507.04.01	MEASUREMENT	507-4

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

BASIS OF PAYMENT	
507.05.01 PAYMENT	507-5

SECTION 508 – PILING

DESCRIPTION	
508.01.01 GENERAL	508-1
MATERIALS	
508.02.01 GENERAL	508-1
CONSTRUCTION	
508.03.01 DETERMINATION OF LENGTH	508-1
508.03.02 TEST PILES	508-1
508.03.03 EQUIPMENT	508-2
508.03.04 DRIVING OF PILES	508-2
508.03.05 BEARING VALUE AND PENETRATION	508-3
508.03.06 CUT OFF AND EXTENSIONS	508-4
508.03.07 LOAD TESTING	508-5
508.03.08 TIMBER PILES	508-5
508.03.09 PRECAST CONCRETE PILES	508-6
508.03.10 CAST-IN-PLACE CONCRETE PILES	508-7
508.03.11 COVERING HOLES	508-9
508.03.12 STEEL PILES	508-9
METHOD OF MEASUREMENT	
508.04.01 MEASUREMENT	508-9
BASIS OF PAYMENT	
508.05.01 PAYMENT	508-9

SECTION 601 – PIPE CULVERTS – GENERAL

DESCRIPTION	
601.01.01 GENERAL	601-1
MATERIALS	
601.02.01 GENERAL	601-1
CONSTRUCTION	
601.03.01 EARTHWORK	601-1
601.03.02 HEADWALLS	601-2
601.03.03 END SECTIONS	601-2
601.03.04 JACKED PIPES	601-2
601.03.05 LAYING CULVERT PIPE	601-2
601.03.06 EXTENDING EXISTING CULVERTS	601-2
METHOD OF MEASUREMENT	
601.04.01 MEASUREMENT	601-3

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

BASIS OF PAYMENT	
601.05.01 PAYMENT	601-3

SECTION 602 – NON-REINFORCED CONCRETE AND CLAY PIPE

DESCRIPTION	
602.01.01 GENERAL	602-1
MATERIALS	
602.02.01 GENERAL	602-1
CONSTRUCTION	
602.03.01 GENERAL	602-1
METHOD OF MEASUREMENT	
602.04.01 MEASUREMENT	602-2
BASIS OF PAYMENT	
602.05.01 PAYMENT	602-2

SECTION 603 – REINFORCED CONCRETE PIPE

DESCRIPTION	
603.01.01 GENERAL	603-1
MATERIALS	
603.02.01 GENERAL	603-1
CONSTRUCTION	
603.03.01 GENERAL	603-1
603.03.02 EARTHWORK	603-1
603.03.03 LAYING CULVERT PIPE	603-2
603.03.04 RUBBER GASKETED JOINTS	603-3
603.03.05 SIPHONS AND PRESSURE PIPE	603-3
METHOD OF MEASUREMENT	
603.04.01 MEASUREMENT	603-3
BASIS OF PAYMENT	
603.05.01 PAYMENT	603-4

SECTION 604 – CORRUGATED METAL PIPE AND METAL ARCH PIPE

DESCRIPTION	
604.01.01 GENERAL	604-1
MATERIALS	
604.02.01 GENERAL	604-1

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

CONSTRUCTION

604.03.01 GENERAL	604-1
604.03.02 LAYING CULVERT PIPE	604-1
604.03.03 SIPHONS	604-2
604.03.04 SLOTTED PIPE	604-2
604.03.05 RELAY CULVERT PIPES	604-3

METHOD OF MEASUREMENT

604.04.01 MEASUREMENT	604-3

BASIS OF PAYMENT

604.05.01 PAYMENT	604-3

SECTION 605 -- THERMOPLASTIC PIPE CULVERTS

DESCRIPTION

605.01.01 GENERAL	605-1

MATERIALS

605.02.01 GENERAL	605-1

CONSTRUCTION

605.03.01 GENERAL	605-1
605.03.02 LAYING CULVERT PIPE	605-1
605.03.03 JUNCTIONS	605-2
605.03.04 DEFLECTION TESTING	605-2

METHOD OF MEASUREMENT

605.04.01 MEASUREMENT	605-2

BASIS OF PAYMENT

605.05.01 PAYMENT	605-2

SECTION 606 - STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

DESCRIPTION

606.01.01 GENERAL	606-1

MATERIALS

606.02.01 GENERAL	606-1

CONSTRUCTION

606.03.01 PLATE DESCRIPTION	606-2
606.03.02 FABRICATION	606-2
606.03.03 FIELD INSPECTION	606-2
606.03.04 EARTHWORK	606-2
606.03.05 ASSEMBLING	606-3
606.03.06 STRUTTING	606-3
606.03.07 WORKMANSHIP	606-3
606.03.08 HEADWALLS	606-4
606.03.09 EXTENDING EXISTING STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS	606-4

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

METHOD OF MEASUREMENT	
606.04.01 MEASUREMENT	606-4

BASIS OF PAYMENT	
606.05.01 PAYMENT	606-4

SECTION 607 – UNDERDRAINS

DESCRIPTION	
607.01.01 GENERAL	607-1

MATERIALS	
607.02.01 GENERAL	607-1

CONSTRUCTION	
607.03.01 EARTHWORK	607-1
607.03.02 LAYING PIPES	607-2
607.03.03 UNDERDRAIN OUTLETS	607-2
607.03.04 BLIND DRAINS	607-2

METHOD OF MEASUREMENT	
607.04.01 MEASUREMENT	607-2

BASIS OF PAYMENT	
607.05.01 PAYMENT	607-2

SECTION 608 – DOWNDRAINS

DESCRIPTION	
608.01.01 GENERAL	608-1

MATERIALS	
608.02.01 GENERAL	608-1

CONSTRUCTION	
608.03.01 METAL DOWNDRAINS	608-1
608.03.02 BITUMINOUS MIXTURES AND GROUTED RIPRAP	608-2

METHOD OF MEASUREMENT	
608.04.01 MEASUREMENT	608-2

BASIS OF PAYMENT	
608.05.01 PAYMENT	608-2

SECTION 609 – CATCH BASINS, MANHOLES AND INLETS

DESCRIPTION	
609.01.01 GENERAL	609-1

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

MATERIALS

609.02.01 GENERAL	609-1

CONSTRUCTION

609.03.01 GENERAL	609-1
609.03.02 ADJUSTING CATCH BASIN, MANHOLE, AND INLET COVERS	609-2
609.03.03 CLEAN OUT	609-2
609.03.04 EARTHWORK	609-2

METHOD OF MEASUREMENT

609.04.01 MEASUREMENT	609-2

BASIS OF PAYMENT

609.05.01 PAYMENT	609-2

SECTION 610 -- SLOPE AND CHANNEL PROTECTION

DESCRIPTION

610.01.01 GENERAL	610-1

MATERIALS

610.02.01 GENERAL	610-1
610.02.02 GROUT	610-1
610.02.03 SACKED CONCRETE	610-1
610.02.04 STONES FOR RIPRAP	610-2
610.02.05 STONES FOR GABIONS	610-2
610.02.06 FILTER MATERIAL	610-3
610.02.07 FILTER FABRIC	610-3
610.02.08 WIRE MESH GABIONS	610-3

CONSTRUCTION

610.03.01 EARTHWORK	610-6
610.03.02 FILTER PLACEMENT	610-6
610.03.03 RIPRAP	610-7
610.03.04 GROUTED RIPRAP	610-7
610.03.05 SACKED CONCRETE RIPRAP	610-7

METHOD OF MEASUREMENT

610.04.01 MEASUREMENT	610-9

BASIS OF PAYMENT

610.05.01 PAYMENT	610-9

SECTION 611 -- CONCRETE SLOPE PAVING

DESCRIPTION

611.01.01 GENERAL	611-1

MATERIALS

611.02.01 GENERAL	611-1

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

CONSTRUCTION	
611.03.01 EARTHWORK	611-1
611.03.02 GENERAL	611-2
METHOD OF MEASUREMENT	
611.04.01 MEASUREMENT	611-2
BASIS OF PAYMENT	
611.05.01 PAYMENT	611-2

SECTION 612 – PNEUMATICALLY PLACED CONCRETE MORTAR

DESCRIPTION	
612.01.01 GENERAL	612-1
MATERIALS	
612.02.01 GENERAL	612-1
CONSTRUCTION	
612.03.01 PREPARATION OF SUBGRADE	612-1
612.03.02 PLACING	612-2
612.03.03 FINISHING	612-2
METHOD OF MEASUREMENT	
612.04.01 MEASUREMENT	612-3
BASIS OF PAYMENT	
612.05.01 PAYMENT	612-3

SECTION 613 – CONCRETE CURB, WALK, GUTTERS, DRIVEWAYS AND ALLEY INTERSECTIONS

DESCRIPTION	
613.01.01 GENERAL	613-1
MATERIALS	
613.02.01 GENERAL	613-1
CONSTRUCTION	
613.03.01	613-1
613.03.02	613-1
613.03.03 DRAINAGE OUTLETS THROUGH CURB	613-1
613.03.04 DRIVEWAY ENTRANCES AND ALLEY INTERSECTIONS	613-1
613.03.05 STANDARD FORMS	613-1
613.03.06 SLIP FORMS	613-2
613.03.07 PLACING CONCRETE	613-3
613.03.08 JOINTS	613-4
613.03.09 EXPANSION JOINTS	613-4
613.03.10 WEAKENED PLANE JOINTS	613-4
613.03.11 FINISHING	613-5
613.03.12 CURB	613-5

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

613.03.13 WALK	613-5
613.03.14 GUTTER	613-6
613.03.15 CURING	613-6
613.03.16 REPAIRS AND REPLACEMENTS	613-6
613.03.17 BACKFILLING AND CLEANUP	613-6

METHOD OF MEASUREMENT

613.04.01 MEASUREMENT	613-6

BASIS OF PAYMENT

613.05.01 PAYMENT	613-7

SECTION 614 – PAINTING

DESCRIPTION

614.01.01 GENERAL	614-1

MATERIALS

614.02.01 GENERAL	614-1
614.02.02 NUMBER OF COATS	614-1

CONSTRUCTION

614.03.01 WEATHER CONDITIONS	614-2
614.03.02 APPLICATION – GENERAL	614-2
614.03.03 SURFACE PREPARATION OF STEEL	614-2
614.03.04 PAINTING STRUCTURAL STEEL	614-4
614.03.05 PAINTING TIMBER	614-5

SECTION 615 – PRESERVATIVE TREATMENTS FOR TIMBER

BASIS OF PAYMENT

614.05.01 PAYMENT	614-6

DESCRIPTION

615.01.01 GENERAL	615-1

MATERIALS

615.02.01 GENERAL	615-1

CONSTRUCTION

615.03.01 TREATMENT	615-1
615.03.02 AMOUNT OF PRESERVATIVE	615-1
615.03.03 PRESERVATIVE TREATMENT BY THE HOT-COLD SOAKING METHOD	615-1
615.03.04 INSPECTION	615-2

BASIS OF PAYMENT

615.05.01 PAYMENT	615-2

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

SECTION 616 -- FENCING

DESCRIPTION	
616.01.01 GENERAL	616-1
MATERIALS	
616.02.01 GENERAL	616-1
CONSTRUCTION	
616.03.01 GENERAL	616-1
616.03.02 STANDARD FENCE	616-2
616.03.03 CHAIN-LINK FENCE	616-3
616.03.04 RECONSTRUCT FENCE	616-3
616.03.05 GATES	616-3
METHOD OF MEASUREMENT	
616.04.01 MEASUREMENT	616-4
BASIS OF PAYMENT	
616.05.01 PAYMENT	616-4

SECTION 617 -- CATTLE GUARDS

DESCRIPTION	
617.01.01 GENERAL	617-1
MATERIALS	
617.02.01 GENERAL	617-1
CONSTRUCTION	
617.03.01 EARTHWORK	617-1
617.03.02 GENERAL	617-1
METHOD OF MEASUREMENT	
617.04.01 MEASUREMENT	617-2
BASIS OF PAYMENT	
617.05.01 PAYMENT	617-2

SECTION 618 -- GUARDRAIL

DESCRIPTION	
618.01.01 GENERAL	618-1
MATERIALS	
618.02.01 GENERAL	618-1
618.02.02 REFLECTORS	618-1
CONSTRUCTION	
618.03.01 GENERAL	618-2

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

618.03.02 PAINTED GUARDRAIL	618-3
618.03.04 RECONSTRUCTED GUARDRAIL	618-4
METHOD OF MEASUREMENT	
618.04.01 MEASUREMENT	618-4
BASIS OF PAYMENT	
618.05.01 PAYMENT	618-5

SECTION 619 – OBJECT MARKERS AND GUIDE POSTS

DESCRIPTION	
619.01.01 GENERAL	619-1
MATERIALS	
619.02.01 GENERAL	619-1
CONSTRUCTION	
619.03.01 GENERAL	619-1
619.03.02 RESET	619-1
METHOD OF MEASUREMENT	
619.04.01 GENERAL	619-1
BASIS OF PAYMENT	
619.05.01 PAYMENT	619-1

SECTION 620 – RIGHT-OF-WAY MARKERS

DESCRIPTION	
620.01.01 GENERAL	620-1
MATERIALS	
620.02.01 GENERAL	620-1
CONSTRUCTION	
620.03.01 GENERAL	620-1
METHOD OF MEASUREMENT	
620.04.01 MEASUREMENT	620-1
BASIS OF PAYMENT	
620.05.01 PAYMENT	620-1

SECTION 621 – MONUMENTS

DESCRIPTION	
621.01.01 GENERAL	621-1

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

MATERIALS

621.02.01 GENERAL	621-1
621.02.02 INSTALLATION	621-1

METHOD OF MEASUREMENT

621.04.01 MEASUREMENT	621-1

BASIS OF PAYMENT

621.05.01 PAYMENT	621-1

SECTION 622 – BLANK

SECTION 623 – TRAFFIC SIGNALS AND STREET LIGHTING

DESCRIPTION

623 G.01.01 GENERAL	623-1
623 G.01.02 REGULATIONS AND CODE	623-1
623 G.01.03 EQUIPMENT LIST AND DRAWINGS	623-1
623 G.01.04 WARRANTIES, GUARANTEES, AND INSTRUCTION SHEETS	623-2

MATERIALS

623 G.02.01 CONDUIT	623-2
623 G.02.02 PULL BOXES	623-3
623 G.02.03 EXPANSION FITTINGS	623-3
623 G.02.04 CONDUCTORS AND CABLE	623-3
623 G.02.05 SPLICING	623-3
623 G.02.06 COLOR CODING	623-4

CONSTRUCTION

623 G.03.01 MAINTENANCE OF EXISTING AND TEMPORARY ELECTRICAL SYSTEMS	623-4
623 G.03.02 SCHEDULING OF WORK	623-7
623 G.03.03 SAFETY PRECAUTIONS	623-7
623 G.03.04 EXCAVATING AND BACKFILLING	623-7
623 G.03.05 REMOVING AND REPLACING IMPROVEMENTS	623-8
623 G.03.06 FOUNDATIONS	623-8
623 G.03.07 WIRING	623-8
623 G.03.08 SERVICE	623-10

TRAFFIC SECTION

MATERIALS

623 T.02.01 CABINETS	623-10
623 T.02.02 CABINET EQUIPMENT	623-12
623 T.02.03 TRAFFIC SIGNAL CONTROLLERS	623-15
623 T.02.04 LOOP DETECTORS	623-25
623 T.02.05 VEHICLE SIGNAL FACES	623-28
623 T.02.06 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES	623-31
623 T.02.07 PEDESTRIAN SIGNAL FACES	623-31
623 T.02.08 FLASHERS	623-33
623 T.02.09 STANDARD, STEEL PEDESTALS, AND POSTS	623-33
623 T.02.10 LAS VEGAS AREA SYSTEM REQUIREMENTS	623-36

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

623 T.02.11 PEDESTRIAN PUSH BUTTONS	623-42
623 T.02.12 EMERGENCY VEHICLE PRIORITY CONTROL SYSTEM	623-42

CONSTRUCTION

623 T.03.01 PAINTING	623-45

STREET LIGHTING SECTION

MATERIALS

623 L.02.01 MATERIALS, STANDARDS AND POSTS	623-46
623 L.02.02 ANCHOR BOLTS	623-49
623 L.02.03 LIGHTING LUMINAIRES	623-49
623 L.02.04 FUSEHOLDERS AND FUSES	623-51
623 L.02.05 LOW VOLTAGE UNDERGROUND STREET LIGHTING SYSTEM	623-51
623 L.02.06 PHOTO-ELECTRIC CONTROLS	623-51
623 L.02.07 PAINT	623-52

CONSTRUCTION

623 L.03.01 GENERAL	623-53
623 L.03.02 BONDING AND GROUNDING	623-53
623 L.03.03 TESTING	623-53

METHOD OF MEASUREMENT

623.04.01 MEASUREMENT	623-54

BASIS OF PAYMENT

623.05.01 PAYMENT	623-54

SECTION 624 -- ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 GENERAL	624-1

MATERIALS

624.02.01 GENERAL	624-1

CONSTRUCTION

624.03.01 SPECIAL DETOURS	624-1
624.03.02 FLAGGERS	624-1
624.03.03 PILOT CARS	624-2
624.03.04 MAINTAIN BASE	624-2
624.03.05 EQUIPMENT RENTAL	624-2

METHOD OF MEASUREMENT

624.04.01 MEASUREMENT	624-2

BASIS OF PAYMENT

624.05.01 PAYMENT	624-2

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED* SECTION 625 – CONSTRUCTION SIGNS

DESCRIPTION	
625.01.01 GENERAL	625-1
MATERIALS	
625.02.01 GENERAL	625-1
625.02.02 SIGN DIMENSIONS	625-1
CONSTRUCTION	
625.03.01 GENERAL	625-1
625.03.02 SIGN PLACEMENT	625-2
625.03.03 SIGN SUPPORTS	625-2
625.03.04 CHANNELIZING DEVICES	625-2
METHOD OF MEASUREMENT	625-2
BASIS OF PAYMENT	625-2

SECTION 626 – FINAL CLEAN UP

DESCRIPTION	
626.01.01 GENERAL	626-1
MATERIALS	
626.03.01 FINAL CLEAN UP	626-1
METHOD OF MEASUREMENT	
626.04.01 MEASUREMENT	626-1
BASIS OF PAYMENT	
626.05.01 PAYMENT	626-1

SECTION 627 -- PERMANENT SIGNS

DESCRIPTION	
627.01.01 GENERAL	627-1
627.01.02 SHOP DRAWINGS	627-1
MATERIALS	
627.02.01 GENERAL	627-1
627.02.02 REFLECTORIZATION	627-1
627.02.03 OVERHEAD GUIDE SIGNS	627-2
627.02.04 CUT-OUT LETTERS, NUMERALS, SYMBOLS, AND ACCESSORIES FOR GUIDE POSTS	627-2
CONSTRUCTION	
627.03.01 PANEL FASTENINGS	627-2
627.03.02 CLOSURE STRIPS	627-2
627.03.03 INSTALLATION	627-2

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

627.03.04 TESTS	627-3
627.03.05 RELOCATION	627-3

METHOD OF MEASUREMENT

627.04.01 MEASUREMENT	627-3

BASIS OF PAYMENT

627.05.01 PAYMENT	627-3

SECTION 628 -- PAINTING TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

DESCRIPTION

628.01.01 GENERAL	628-1

MATERIALS

628.02.01 PAINT FOR TRAFFIC STRIPING, PAVEMENT MARKING AND CURB MARKING	628-1
628.02.02	628-1
628.02.03 RETROREFLECTIVE PREFORMED PAVEMENT MARKINGS	628-2

CONSTRUCTION

628.03.01 WEATHER CONDITIONS	628-2
628.03.02 EQUIPMENT	628-2
628.03.03 GEOMETRY, STRIPES, AND TRAFFIC LANES	628-3
628.03.04 PREPARATION OF EXISTING SURFACES	628-3
628.03.05 LAYOUT, ALIGNMENT, AND SPOTTING	628-3
628.03.06 APPLICATION OF PAINT	628-4
628.03.07 PROTECTION OF WORK, WORKMEN AND THE PUBLIC	628-4
628.03.08 DEFECTIVE WORKMANSHIP OR MATERIAL	628-5
628.03.09 INSTALLATION OF RETROREFLECTIVE PREFORMED PAVEMENT MARKINGS	628-5

METHOD OF MEASUREMENT

628.04.01 MEASUREMENT	628-5

BASIS OF PAYMENT

628.05.01 BASIS OF PAYMENT	628-5

SECTION 629 -- WATER DISTRIBUTION FACILITIES

DESCRIPTION

629.01.01 GENERAL	629-1
629.01.02 STANDARDS	629-1
629.01.03 SHOP DRAWINGS	629-1
629.01.04 CONSTRUCTION LINES AND GRADES	629-1
629.01.05 OPERATION OF VALVES	629-2
629.01.06 JOINT USE TRENCHES	629-2

MATERIALS

629.02.01 GENERAL	629-2
629.02.02 ASBESTOS CEMENT PIPE	629-2
629.02.03 CAST IRON FITTINGS	629-2

CONTENTS

CONSTRUCTION DETAILS – *CONTINUED*

629.02.04	STEEL FITTINGS	629-2
629.02.05	STEEL PIPES	629-3
629.02.06	AIR-VACUUM AND AIR RELEASE VALVES	629-4
629.02.07	PIPE CASING	629-5
629.02.08	PLASTIC SERVICE LATERALS	629-5
629.02.09	RED BRASS PIPE AND FITTINGS	629-5
629.02.10	COPPER SERVICE LATERALS	629-5
629.02.11	METER BOXES	629-6
629.02.12	SERVICE SADDLE	629-6
629.02.13	FLANGE GASKETS	629-6
629.02.14	TAPPING SLEEVES	629-6
629.02.15	BOLTS	629-6
629.02.16	MECHANICAL TYPE COUPLINGS	629-6
629.02.17	SLEEVE-TYPE COUPLINGS	629-6
629.02.18	INSULATING FLANGE JOINTS	629-6
629.02.19	VALVE BOXES AND COVERS	629-7
629.02.20	PRECAST CONCRETE MANHOLES	629-7
629.02.21	MANHOLE FRAMES AND COVERS	629-7
629.02.22	CORPORATION STOPS AND ACCESSORIES	629-7
629.02.23	VALVES	629-7
629.02.24	CONCRETE	629-9
629.02.25	REINFORCING STEEL	629-10
629.02.26	PAINTINGS AND COATINGS	629-10

CONSTRUCTION

629.03.01	GENERAL	629-12
629.03.02	EXCAVATION	629-12
629.03.03	PIPE BEDDING	629-12
629.03.04	TRENCH BACKFILL	629-12
629.03.05	SOILS TEST	629-12
629.03.06	CUTTING AND RESTORING STREET SURFACING	629-12
629.03.07	BACKFILL AROUND STRUCTURES	629-12
629.03.08	CONCRETE	629-12
629.03.09	CONNECTIONS TO EXISTING FACILITIES	629-12
629.03.10	INSTALLATION OF VALVES	629-13
629.03.11	INSTALLATION OF ASBESTOS CEMENT PIPING	629-13
629.03.12	TESTING	629-14
629.03.13	DISINFECTION	629-14
629.03.14	FIRE HYDRANT INSTALLATIONS	629-15
629.03.15	ABANDONING OF VALVES	629-15
629.03.16	INSTALLATION OF PIPE CASING	629-15

METHOD OF MEASUREMENT

629.04.01	MEASUREMENT	629-15

BASIS OF PAYMENT

629.05.01	PAYMENT	629-15

SECTION 630 – SANITARY SEWERS

DESCRIPTION

630.01.01	WORK INVOLVED	630-1

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

630.01.02	CONFORMANCE WITH LINE AND GRADE	630-1
630.02.03	EXISTING UNDERGROUND UTILITIES	630-1
630.01.04	SEWER REPLACEMENT PROJECTS	630-1
630.01.05	PROHIBITION OF DIVERSION	630-1
630.01.06	COMPENSATION FOR MAINTENANCE OF FLOW	630-1
630.01.07	MECHANICAL COMPRESSION JOINT-VITRIFIED CLAY PIPE	630-2
630.01.08	CONCRETE PIPE	630-2
630.01.09	JOINTS FOR REINFORCED CONCRETE PIPE	630-2
630.01.10	PVC SEWER PIPE	630-2

MATERIALS

630.02.01	GENERAL	630-2
630.02.02	MANHOLES	630-2
630.02.03	VITRIFIED CLAY PIPE SEWERS AND FITTINGS	630-2
630.02.04	JOINTING VITRIFIED CLAY PIPE	630-5
630.02.05	STOPPERS	630-5
630.02.06	REINFORCED CONCRETE PIPE	630-5
630.02.07	PVC SEWER PIPE	630-7

CONSTRUCTION

630.03.01	EXCAVATION AND BACKFILL	630-9
630.03.02	TRENCHES	630-9
630.03.03	PIPE BEDDING AND LAYING	630-9
630.03.04	DEWATERING	630-10
630.03.05	JACKING	630-10
630.03.06	TUNNELING	630-11
630.03.07	SEWER LATERALS	630-11
630.03.08	HOUSE CONNECTIONS	630-12
630.03.09	APPURTENANCES	630-12
630.03.10	ABANDONMENT OF EXISTING SEWERS	630-12
630.03.11	VITRIFIED CLAY PIPE FITTINGS	630-13
630.03.12	VITRIFIED CLAY PIPE AT MANHOLES OR STRUCTURES	630-13
630.03.13	BLANK	630-13
630.03.14	TEST FOR LEAKAGE AND INFILTRATION	630-13
630.03.15	TESTS FOR ALIGNMENT AND GRADE, AND DAMAGED OR DEFECTIVE PIPE IN PLACE	630-16

METHOD OF MEASUREMENT

630.04.01	MEASUREMENT	630-16

BASIS OF PAYMENT

630.05.01	PAYMENT	630-16

SECTION 631 -- STREET NAME SIGNS

DESCRIPTION

631.01.01	GENERAL	631-1
631.01.02	STREET NAME SIGN FACES	631-1

MATERIALS

631.02.01	GENERAL	631-1
631.02.02		631-1

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

CONSTRUCTION

631.03.01 STREET NAME SIGN INSTALLATION	631-2
631.03.02 EXCEPTIONS	631-2

METHOD OF MEASUREMENT

631.04.01 METHOD OF MEASUREMENT	631-2

BASIS OF PAYMENT

631.05.01 BASIS OF PAYMENT	631-2

SECTION 632 -- HEADLIGHT GLARE SCREEN

DESCRIPTION

632.01.01 GENERAL	632-1

MATERIALS

632.02.01 GENERAL	632-1

CONSTRUCTION

632.03.01 GENERAL	632-4

METHOD OF MEASUREMENT

632.04.01 MEASUREMENT	632-4

BASIS OF PAYMENT

632.05.01 PAYMENT	632-4

SECTION 633 - PAVEMENT MARKERS

DESCRIPTION

633.01.01 GENERAL	633-1

MATERIALS

633.02.01 NON-REFLECTIVE PAVEMENT MARKERS	633-1
633.02.02 REFLECTIVE PAVEMENT MARKERS	633-2
633.02.03 HOT APPLIED FLEXIBLE PAVEMENT MARKER ADHESIVE	633-2

CONSTRUCTION

633.03.01 INSTALLATION	633-3

METHOD OF MEASUREMENT

633.04.01 MEASUREMENT	633-3

BASIS OF PAYMENT

633.05.01 PAYMENT	633-3

SECTION 634 -- TEMPORARY PAVEMENT STRIPING TAPE

DESCRIPTION

634.01.01 GENERAL	634-1

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

MATERIALS

634.02.01 TEMPORARY PAVEMENT STRIPING TAPE	634-1

CONSTRUCTION

634.03.01 INSTALLATION	634-1

METHOD OF MEASUREMENT

634.04.01 MEASUREMENT	634-2

BASIS OF PAYMENT

634.05.01 PAYMENT	634-2

SECTION 635 -- ASBESTOS CEMENT PIPE

DESCRIPTION

635.01.01 GENERAL	635-1

MATERIALS

635.02.01 GENERAL	635-1

CONSTRUCTION

635.03.01 GENERAL	635-2

635.03.02 STRUCTURES	635-2

635.03.03 LAYING CULVERT PIPE	635-2

METHOD OF MEASUREMENT

635.04.01 MEASUREMENT	635-2

BASIS OF PAYMENT

635.05.01 PAYMENT	635-3

SECTION 637 -- POLLUTION CONTROL

DESCRIPTION

637.01.01 GENERAL	637-1

MATERIALS

637.02.01 GENERAL	637-1

CONSTRUCTION

637.03.01 GENERAL	637-1

METHOD OF MEASUREMENT

637.04.01 MEASUREMENT	637-2

BASIS OF PAYMENT

637.05.01 PAYMENT	637-3

CONTENTS

CONSTRUCTION DETAILS -- *CONTINUED*

SECTION 646 -- WATERPROOFING AND DAMPPROOFING

DESCRIPTION	
646.01.01 GENERAL	646-1
MATERIALS	
646.02.01 GENERAL	646-1
CONSTRUCTION	
646.03.01 GENERAL	646-1
646.03.02 MEMBRANE WATERPROOFING	646-1
646.03.03 DAMPPROOFING	646-2
METHOD OF MEASUREMENT	
646.04.01 MEASUREMENT	646-2
BASIS OF PAYMENT	
646.05.01 PAYMENT	646-2

SECTION 660 -- METAL BIN-TYPE RETAINING WALLS

DESCRIPTION	
660.01.01 GENERAL	660-1
MATERIALS	
660.02.01 GENERAL	660-1
CONSTRUCTION	
660.03.01 FABRICATION	660-1
660.03.02 EARTHWORK	660-1
660.03.03 ASSEMBLY	660-2
METHOD OF MEASUREMENT	
660.04.01 MEASUREMENT	660-2
BASIS OF PAYMENT	
660.05.01 PAYMENT	660-2

DIVISION III -- MATERIALS DETAILS

SECTION 701 -- PORTLAND CEMENT

SCOPE	
701.01.01 MATERIALS COVERED	701-1
MATERIALS	
701.02.01 GENERAL	701-2
PHYSICAL PROPERTIES AND TESTS	
701.03.01 REQUIREMENTS	701-2

CONTENTS

MATERIALS DETAILS – *CONTINUED*

SECTION 702 – CONCRETE CURING MATERIALS AND ADMIXTURES

SCOPE

702.01.01 MATERIALS COVERED	702-1

PHYSICAL PROPERTIES AND TESTS

702.03.01 CURING MATERIALS	702-1
702.03.02 BLANK	702-1
702.03.03 AIR-ENTRAINING ADMIXTURES	702-1
702.03.04 ADMIXTURE OTHER THAN AIR-ENTRAINING	702-1
702.03.05 HYDRATED LIME	702-2
702.03.06 BLANK	702-2
702.03.07 WHITE PIGMENTED CURING COMPOUND - CHLORINATED RUBBER BASE	702-2
702.03.08 FLY ASH	702-2

SECTION 703 – BITUMINOUS MATERIALS

SCOPE

703.01.01 MATERIALS COVERED	703-1

REQUIREMENTS

703.02.01 CONTRACTOR'S RESPONSIBILITY	703-1
703.02.02 SHIPPING NOTICE	703-1

PHYSICAL PROPERTIES AND TESTS

703.03.01 REFINERY TEST REPORT	703-1
703.03.02 ASPHALT CEMENTS	703-2
703.03.03 LIQUID ASPHALTS	703-2
703.03.04 EMULSIFIED ASPHALT	703-2

SECTION 704 – BASE AGGREGATES

SCOPE

704.01.01 MATERIALS COVERED	704-1

REQUIREMENTS

704.02.01 GENERAL	704-1
704.02.02 DEFICIENCIES	704-1
704.02.03 PLASTIC LIMITS	704-1

PHYSICAL PROPERTIES AND TESTS

704.03.01 DRAIN BACKFILL	704-2
704.03.02 TYPE I AGGREGATE BASE	704-2
704.03.03 BLANK	704-3
704.03.04 TYPE II AGGREGATE BASE	704-3
704.03.05 BLANK	704-3
704.03.06 BLANK	704-3
704.03.07 BLANK	704-3
704.03.08 AGGREGATE FOR PORTLAND CEMENT TREATED BASE	704-4

CONTENTS

MATERIALS DETAILS -- *CONTINUED*

SECTION 705 -- AGGREGATES FOR BITUMINOUS COURSES

SCOPE

705.01.01 MATERIALS COVERED	705-1

REQUIREMENTS

705.02.01 GENERAL	705-1
705.02.02 DEFICIENCIES	705-1

PHYSICAL PROPERTIES AND TESTS

705.03.01 PLANTMIX AND ROADMIX BITUMINOUS BASE AND SURFACE AGGREGATE, TYPES TWO FINE AND COARSE AND THREE	705-2
705.03.03 PLANTMIX BITUMINOUS OPEN-GRADED SURFACE AGGREGATE	705-3
705.03.04 COMMERCIAL MINERAL FILLER	705-3
705.03.05 SCREENINGS	705-3
705.03.06 SAND BLOTTER	705-4

SECTION 706 -- AGGREGATES FOR PORTLAND CEMENT PRODUCTS

SCOPE

706.01.01 MATERIALS COVERED	706-1

REQUIREMENTS

706.02.01 GENERAL	706-1

PHYSICAL PROPERTIES AND TESTS

706.03.01 COARSE AGGREGATE	706-2
706.03.02 LIGHTWEIGHT AGGREGATES	706-4
706.03.03 FINE AGGREGATE	706-5
706.03.04 GROUT AND MORTAR SAND	706-6
706.03.05 STONE FOR MASONRY AND RIPRAP	706-7

SECTION 707 -- JOINT MATERIAL

SCOPE

707.01.01 MATERIAL COVERED	707-1

PHYSICAL PROPERTIES AND TESTS

707.03.01 JOINT FILLERS	707-1
707.03.02 RUBBER GASKETS	707-1
707.03.03 WATERSTOPS	707-1
707.03.04 POURABLE JOINT SEALER	707-2
707.03.05 ASPHALT PLANK	707-3
707.03.06 PREFORMED ELASTIC JOINT SEALER	707-3

SECTION 708 -- CONCRETE AND CLAY PIPE AND DRAINS

SCOPE

708.01.01 MATERIALS COVERED	708-1

CONTENTS

MATERIALS DETAILS -- *CONTINUED*

PHYSICAL PROPERTIES AND TESTS

708.03.01	REINFORCED CONCRETE PIPE	708-1
708.03.02	NONREINFORCED CONCRETE PIPE	708-2
708.03.03	PERFORATED CONCRETE PIPE	708-2
708.03.04	CLAY PIPE	708-2
708.03.05	ACRYLONITRILE-BUTADIENE-STYRENE COMPOSITE PIPE	708-2
708.03.07	ASBESTOS CEMENT PRESSURE PIPE	708-2
708.03.08	ASBESTOS CEMENT PIPE	708-2
708.03.09	REINFORCED CONCRETE PRESSURE PIPE	708-2

SECTION 709 -- METAL AND THERMOPLASTIC PIPE

SCOPE

709.01.01	MATERIAL COVERED	709-1

PHYSICAL PROPERTIES AND TESTS

709.03.01	CORRUGATED METAL PIPE AND PIPE ARCHES	709-1
709.03.02	BITUMINOUS COATED CORRUGATED METAL PIPE AND PIPE ARCHES	709-1
709.03.03	ALUMINIZED TYPE 2 COATED CORRUGATED STEEL PIPE	709-2
709.03.04	CONCRETE LINED CORRUGATED STEEL PIPE	709-2
709.03.05	CORRUGATED ALUMINUM PIPE	709-2
709.03.06	CORRUGATED METAL PIPES FOR DOWNDRAINS	709-2
709.03.07	CORRUGATED METAL PIPE FOR UNDERDRAINS	709-2
709.03.08	BITUMINOUS COATED CORRUGATED METAL PIPE FOR UNDERDRAINS	709-3
709.03.09	THERMOPLASTIC, PLASTIC PIPE CULVERTS AND DRAINS	709-3
709.03.10	CORRUGATED POLYETHYLENE PIPE FOR PERFORATED UNDER DRAINS	709-5
709.03.11	STRUCTURAL PLATE PIPE AND PIPE ARCHES	709-5
709.03.12	CAST IRON PIPE	709-5
709.03.13	STEEL WATER PIPE	709-5

SECTION 710 -- STRUCTURAL AND EYEBAR STEEL

SCOPE

710.01.01	MATERIAL COVERED	710-1

REQUIREMENTS

710.02.01	DEFECTS	710-1
710.02.02	CHARPY V-NOTCH TEST	710-1

PHYSICAL PROPERTIES AND TESTS

710.03.01	STANDARD STEEL	710-1
710.03.02	HIGH STRENGTH-LOW ALLOY STRUCTURAL MANGANESE VANADIUM STEEL	710-1
710.03.03	HIGH TENSILE STRENGTH BOLTS	710-1
710.03.04	STAINLESS STEEL BOLTS	710-1
710.03.05	WELDED SEAMLESS STEEL PIPE	710-1
710.03.06	COLD-FORMED WELDED AND SEAMLESS CARBON STEEL STRUCTURAL TUBING IN ROUNDS AND SHAPES	710-1
710.03.07	SHEAR CONNECTOR STUDS	710-2
710.03.08	PINS AND ROLLERS	710-2

CONTENTS

MATERIALS DETAILS -- *CONTINUED*

SECTION 711 -- ALUMINUM FOR BRIDGE RAIL

SCOPE

711.01.01 MATERIAL COVERED	711-1

PHYSICAL PROPERTIES AND TESTS

711.03.01 ALUMINUM ALLOY FOR PIPE	711-1
711.03.02 ALUMINUM ALLOY TUBING	711-1
711.03.03 CAST ALUMINUM TUBING	711-1
711.03.04 ALUMINUM ALLOY SHIMS	711-1

SECTION 712 -- MISCELLANEOUS METAL

SCOPE

712.01.01 MATERIAL COVERED	712-1

PHYSICAL PROPERTIES AND TESTS

712.03.01 STEEL CASTINGS	712-1
712.03.02 GRAY IRON CASTINGS	712-1
712.03.03 MALLEABLE CASTINGS	712-1
712.03.04 WROUGHT IRON PLATES	712-1
712.03.05 BRONZE CASTINGS	712-1
712.03.06 WELDING MATERIALS	712-1
712.03.07 STEEL PILES	712-1
712.03.08 STEEL SHELL FOR PILES	712-1

SECTION 713 -- REINFORCEMENT

SCOPE

713.01.01 MATERIALS COVERED	713-1

PHYSICAL PROPERTIES AND TESTS

713.03.01 BAR STEEL REINFORCEMENT	713-1
713.03.02 FABRICATED STEEL BAR OR ROD MATS REINFORCEMENT	713-1
713.03.03 WELDED STEEL WIRE FABRIC REINFORCEMENT	713-1
713.03.04 PRESTRESSING STEEL	713-1
713.03.05 COLD-DRAWN STEEL WIRE FOR SPIRAL REINFORCEMENT	713-2

SECTION 714 -- PAINT AND PAVEMENT MARKINGS

SCOPE

714.01.01 MATERIALS COVERED	714-1

REQUIREMENTS

714.02.01 CERTIFICATES	714-1

PHYSICAL PROPERTIES AND TESTS

714.03.01 IRON AND STEEL USE ITEMS	714-1
714.03.02 TIMBER USE ITEMS	714-3
714.03.03 CONCRETE USE ITEMS	714-4
714.03.04 ALUMINUM USE ITEM	714-4

CONTENTS

MATERIALS DETAILS -- *CONTINUED*

714.03.05	PAINT FOR TRAFFIC STRIPING, PAVEMENT MARKING, AND CURB MARKING - GENERAL	714-4
714.03.06	THERMOPLASTIC PAINT AND PAVEMENT MARKINGS	714-6
714.03.07	FAST DRY TRAFFIC PAINT	714-11
714.03.07a	ALL PURPOSE BLACK TRAFFIC PAINT - PAINT FORMULA 235	714-11
714.03.08	READY-MIXED TRAFFIC STRIPE PAINTS	714-11
714.03.09	REFLECTIVE MATERIAL	714-11
714.03.10	AIR POLLUTION	714-11
714.03.11	TEST REPORTS AND CERTIFICATION	714-11

SECTION 715 -- GALVANIZING

SCOPE

715.01.01	MATERIALS COVERED	715-1

PHYSICAL PROPERTIES AND TESTS

715.03.01	PRODUCTS ONE-EIGHTH (1/8) INCH (0.3 CENTIMETERS) THICK AND THICKER	715-1
715.03.02	GUARD RAIL ELEMENTS	715-1
715.03.03	HARDWARE	715-1

SECTION 716 - SIGN MATERIALS

SCOPE

716.01.01	MATERIALS COVERED	716-1

REQUIREMENTS

716.02.01	GENERAL	716-1
716.02.02	CERTIFICATES	716-1

PHYSICAL PROPERTIES AND TESTS

716.03.01	REFLECTIVE SHEETING	716-1
716.03.02	BLANK	716-4
716.03.03	ALUMINUM SIGN PANELS (FOR REFLECTIVE SHEETING)	716-4
716.03.04	BLANK	716-4
716.03.05	OVERHEAD SIGN STRUCTURES AND SIGN FRAMES	716-4
716.03.06	SIGN HARDWARE AND RELATED MATERIALS	716-6

SECTION 717 -- TIMBER PILES

SCOPE

717.01.01	MATERIALS COVERED	717-1

REQUIREMENTS

717.02.01	CERTIFICATES	717-1

PHYSICAL PROPERTIES AND TESTS

717.03.01	GENERAL	717-1

CONTENTS

MATERIALS DETAILS -- *CONTINUED*

SECTION 718 -- TIMBER

SCOPE

718.01.01 MATERIALS COVERED	718-1

REQUIREMENTS

718.02.01 GRADES	718-1
718.02.02 CERTIFICATES OF INSPECTION	718-1

PHYSICAL PROPERTIES AND TESTS

718.03.01 SPECIES	718-1
718.03.02 GRADES	718-1

SECTION 719 -- TIMBER PRESERVATIVES

SCOPE

719.01.01 MATERIALS COVERED	719-1

PHYSICAL PROPERTIES AND TESTS

719.03.01 PRESERVATIVES	719-1

SECTION 720 -- GUARDRAIL MATERIALS

SCOPE

720.01.01 MATERIALS COVERED	720-1

REQUIREMENTS

720.02.01 CERTIFICATES	720-1

PHYSICAL PROPERTIES AND TESTS

720.03.01 RAIL MEMBERS	720-1
720.03.02 FITTINGS	720-1
720.03.03 REFLECTOR PLATES	720-1
720.03.04 CABLE END ANCHOR ASSEMBLIES	720-2

SECTION 721 -- OBJECT MARKERS AND GUIDE POSTS

SCOPE

721.01.01 MATERIALS COVERED	721-1

REQUIREMENTS

721.02.01 CERTIFICATES	721-1

PHYSICAL PROPERTIES AND TESTS

721.03.01 METAL POSTS	721-1
720.03.02 TARGET PLATES	721-1
721.03.03 REFLECTORS	721-2

CONTENTS

MATERIALS DETAILS – *CONTINUED*

SECTION 722 – WATER

SCOPE

722.01.01 MATERIAL COVERED	722-1

REQUIREMENTS

722.02.01 GENERAL	722-1

PHYSICAL PROPERTIES AND TESTS

722.03.01 CONCRETE USE	722-1

SECTION 723 – HARDWARE

SCOPE

723.01.01 MATERIALS COVERED	723-1

PHYSICAL PROPERTIES AND TESTS

723.03.01 GALVANIZING	723-1

723.03.02 BOLTS, NUTS, DOWELS, AND DRIFT BOLTS	723-1

723.03.03 WASHERS	723-1

SECTION 724 – FENCE MATERIALS

SCOPE

724.01.01 MATERIALS COVERED	724-1

REQUIREMENTS

724.02.01 SAMPLES AND CERTIFICATES OF INSPECTION	724-1

PHYSICAL PROPERTIES AND TESTS

724.03.01 WOOD POSTS	724-1

724.03.02 METAL POSTS	724-2

724.03.03 BARBED WIRE	724-4

724.03.04 WOVEN WIRE	724-4

724.03.05 CHAIN-LINK FABRIC	724-4

724.03.06 STAPLES, BRACE WIRE, AND NAILS	724-4

724.03.07 METAL GATES	724-4

SECTION 725 – ELASTOMERIC BEARING PADS

SCOPE

725.01.01 MATERIALS COVERED	725-1

REQUIREMENTS

725.02.01 CERTIFICATE OF INSPECTION	725-1

PHYSICAL PROPERTIES AND TESTS

725.03.01 GENERAL	725-1

CONTENTS

MATERIALS DETAILS -- *CONTINUED*

SECTION 726 -- ROADSIDE MATERIALS

SCOPE

726.01.01 MATERIALS COVERED	726-1

REQUIREMENTS

726.02.01 CERTIFICATES AND SAMPLES	726-1

PHYSICAL PROPERTIES AND TESTS

726.03.01 PLANTING SOIL	726-2
726.03.02 FERTILIZER	726-2
726.03.03 ORGANIC MATERIAL	726-2
726.03.04 MULCH	726-3
726.03.05 JUTE MATTING	726-4
726.03.06 PLANTS	726-4
726.03.07 SEEDS	726-4
726.03.08 TREE TIES	726-4
726.03.09 PIPE AND FITTINGS	726-5
726.03.10 CONTROL TUBING	726-6
726.03.11 GATE VALVES	726-6
726.03.12 QUICK COUPLER VALVES	726-6
726.03.13 MASONRY	726-6

SECTION 727 - CONCRETE SURFACE FINISHING MATERIAL

SCOPE

727.01.01 MATERIAL COVERED	727-1

PHYSICAL PROPERTIES AND TESTS

727.02.01 REQUIREMENTS	727-1

SECTION 728 -- EPOXY

SCOPE

728.01.01 MATERIALS COVERED	728-1

REQUIREMENTS

728.02.01 SAMPLING AND TESTING	728-1
728.02.02 CERTIFICATES	728-1
728.02.03 PACKAGING, LABELING AND STORING	728-1
728.02.04 DIRECTIONS FOR USE	728-2

TYPES OF EPOXIES

728.03.01 BINDER (ADHESIVE), EPOXY RESIN BASE	728-2
728.03.02 COAL TAR MODIFIED EPOXY RESIN	728-2
728.03.03 EPOXY RESIN ADHESIVE FOR BONDING NEW CONCRETE TO OLD CONCRETE	728-3
728.03.04 BLANK	728-4
728.03.05 BLANK	728-4
728.03.06 BINDER (ADHESIVE), EPOXY RESIN BASE, ALKYL BENZENE EXTENDED	728-4
728.03.07 BINDER (ADHESIVE), EPOXY RESIN BASE, FAST SETTING	728-4

CONTENTS

MATERIALS DETAILS – *CONTINUED*

728.03.08 BINDER (ADHESIVE), EPOXY RESIN BASE, FAST SETTING, ALKYL BENZENE
EXTENDED 728-4

728.03.09 EPOXY SEALANT FOR INDUCTIVE LOOPS 728-5

SECTION 729 – FLY ASH

SCOPE

729.01.01 MATERIALS COVERED 729-1

PHYSICAL PROPERTIES AND TESTS

729.02.01 REQUIREMENTS 729-1

and the costs involved in the removal and disposal shall be absorbed in the bid for the items of work necessitating such removals.

When feasible, the owners responsible for utilities within the area affected by the work shall complete their necessary installations, relocations, repairs or replacements before commencement of work by the Contractor. When the Special Provisions or plans indicate that a utility installation is to be relocated, altered or constructed by others, the Contracting Agency will conduct all negotiations with the owners and the work will be done at no cost to the Contractor, except as provided in Subsection 107.17. Utilities which are relocated in order to avoid interference with the proposed permanent work shall be protected in their relocated position and the cost of such protection shall be absorbed in the various items of the contract.

A utility company installing a new line is responsible for relocation of other utility company facilities if the new line conflicts with existing locations.

When the plans or specifications provide for the Contractor to alter, relocate, or reconstruct a utility, all costs for such work shall be included in the bid for the items of work necessitating such work. Temporary or permanent relocation or alteration of utilities requested by the Contractor for his own convenience shall be his responsibility, and he shall make all arrangements and bear all costs.

The utility owner will relocate service connections as necessary within the limits of the work or within temporary construction or slope easement unless otherwise specified. When directed by the Engineer, the Contractor shall arrange for the relocation of service connections as necessary between the meter and property line, or between a meter and the limits of temporary construction or slope easements. The relocation of such service connections will be paid for in accordance with provisions of Subsection 104.03. Payment will include the restoration of all existing improvements which may be affected thereby. The Contractor may, for his own convenience or to expedite the work, agree with the owner of any utility to disconnect and reconnect interfering service connections. The Contracting Agency will not be involved in any such agreement.

The Contractor shall notify the Contracting Agency of his construction schedule insofar as it affects the protection, removal or relocation of utilities. Said notification shall be in writing and shall be included as a part of the construction schedule required by Subsection 108.03. He shall notify the Contracting Agency in writing of any subsequent changes in his construction schedule which will affect the time available for protection, removal or relocation of utilities.

The Contractor will not be entitled to damages or additional payment for delays attributable to utility relocations or alterations if correctly located, noted and completed. The Contractor may be given an extension of time for unforeseen delays attributable to utility relocations or alterations not shown or incorrectly shown on the plans, or for unreasonably protracted interference by utilities in performing work correctly shown on the plans. If the Contractor sustains loss due to delays attributable to interferences, relocations or alterations which could not have been avoided by the judicious handling of forces, equipment or plant, there shall be paid to the Contractor such amount as the Contracting Agency may find to be fair and reasonable compensation for such part of the Contractor's actual loss as was unavoidable as provided in Subsection 108.12.

When necessary, the Contractor shall so conduct his operations as to permit access to the work site and provide time for utility work to be accomplished during the progress of the contract work.

105.07 COOPERATION BETWEEN CONTRACTORS: The Contracting Agency reserves the right at any time to contract and perform other or additional work on or near the work covered by the contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by the other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Rev. October 12, 1995

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the Contracting Agency from any and all damages or claims that may arise because of inconvenience, delay or loss experienced by him because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange his work and shall place and dispose of the materials being used so as not to interfere with the operations of other Contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

105.08 CONSTRUCTION STAKES, LINES AND GRADES: The Contractor shall notify the Engineer at least seven (7) days before starting work in order that the Engineer may take necessary measures to insure the preservation of survey monuments and bench marks. The Contractor shall not disturb permanent survey monuments or bench marks without the consent of the Engineer, and shall bear the expense of replacing any that may be disturbed without permission. Replacement shall be done only by the Engineer.

When a change is made in the finished elevation of the pavement of any roadway in which a permanent survey monument is located, the Contractor shall adjust the monument cover to the new grade unless otherwise specified.

The Contractor shall preserve property line and corner survey markers except where their destruction is unavoidable, and the Contractor is proceeding in accordance with accepted practice. Markers that otherwise are lost or disturbed by his operations shall be replaced at the Contractor's expense by a Registered Land Surveyor.

Except for private contracts, the Engineer will perform and be responsible for the accuracy of surveying adequate for construction. The Contractor shall be responsible for preserving construction survey stakes and marks for the duration of their usefulness. If any construction survey stakes are lost or disturbed and need to be replaced, such replacement shall be by the Engineer at the expense of the Contractor.

The Contractor shall notify the Engineer at least two (2) working days before he will require survey services in connection with the laying out of any portion of the work. The Contractor shall dig all holes necessary for line and grade stakes.

The Engineer will furnish and set construction stakes establishing lines and grades for street excavation, finished base gravel, curb and gutter, walks, structures and utilities, and will furnish the Contractor all the necessary information relating to the lines and grades. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall govern and execute the work.

The line and grade stakes will be off-set from the construction area. They will show the off-set distance, stationing and required cut or fill to the finished grade or flow line as indicated on the plans. Grade stakes shall be set by the Engineer to the finished grade of the subgrade and also of the base gravel and the tops of these stakes marked blue or red. All stakes and grade shall be set with a surveyor's level or transit.

The Contractor shall construct the work in accordance with the Engineer's stakes and marks, making use of them before they are disturbed, and shall be charged with full responsibility for conformity and agreement of the work with such stakes and marks. The Contractor shall be held responsible for the preservation of all stakes and marks, and if, in the opinion of the Engineer, any of the stakes or marks have been carelessly or willfully destroyed or disturbed by the Contractor the cost of replacing them shall be charged against, and deducted from, the payment for the work.

Surveying by private engineers on work under the control of the Contracting Agency shall conform to the quality and practice required by the Engineer.

Work upon completion shall conform to the lines, elevations, and grades shown on the plans, or as ordered by the Engineer.

106.08 STORAGE OF MATERIALS: Materials shall be so stored as to assure the preservation of their quality and fitness for the work. When considered necessary by the Engineer, they shall be stored in waterproof buildings, placed on wooden platforms or other hard, clean surfaces, and not on the ground, and shall be covered when directed. Stored materials, even though approved for use before storage, may be inspected prior to their use in the work, and they shall meet the requirements of the specifications at the time of this proposed use. Stored materials shall be located so as to facilitate their prompt inspection. Upon approval of the Engineer, that portion of the right-of-way not required for public travel may be used for storage purposes and for placing of the Contractor's plant and equipment, but any additional space required therefor must be provided by the Contractor at his expense. Private or public property shall not be used for storage purposes without written permission of the owner or lessee. All storage sites shall be restored to their original condition by the Contractor at his expense. This shall not apply to the stripping and storing of top soil or to other material salvaged from the work or specifically prescribed under the specifications. Construction materials may not be stored in streets, roads, or highways for more than five (5) days after unloading. All materials or equipment not installed or used in the construction within five (5) days after unloading shall be stored elsewhere by the Contractor at his expense unless he is authorized additional storage time.

Construction equipment shall not be stored at the work site before its actual use on the work nor for more than five (5) days after it is no longer needed on the work unless he is authorized additional storage time. Time necessary for repair or assembly of equipment may be authorized by the Engineer.

Excavated material, except that which is to be used as backfill in the adjacent trench, may not be stored in public streets, roads, or highways unless otherwise permitted. After placing backfill, all excess material shall be removed immediately from the site.

106.09 HANDLING MATERIALS: All materials shall be handled in such manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operation.

106.10 UNACCEPTABLE MATERIALS: All materials not conforming to the requirements of the specifications at the time they are used shall be considered as unacceptable and all such materials will be rejected and shall be removed immediately from the site of the work unless otherwise instructed by the Engineer. No rejected material, the defects of which have been corrected, shall be used until approval has been given by the Engineer.

106.11 CONTRACTING AGENCY FURNISHED MATERIAL: The Contractor shall furnish all materials required to complete the work, except those specified to be furnished by the Contracting Agency. Material furnished by the Contracting Agency will be delivered or made available to the Contractor at the points specified in the Special Provisions.

The cost of handling and placing all materials after they are delivered to the Contractor shall be considered as included in the contract price for the item in connection with which they are used.

The Contractor will be held responsible for all material delivered to him, and deductions will be made from any money due to him to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery and for any demurrage charges.

SECTION 107

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 LAWS TO BE OBSERVED: The Contractor shall keep fully informed of all federal and state laws, all local bylaws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, bylaws, ordinances, regulations, orders, and decrees, and shall protect and indemnify the Contracting Agency and its representative against any claim or liability arising from or based on the alleged violation of any such law, bylaw, ordinance, regulation, order, or decree, whether by himself or his employees, or agents.

107.02 PERMITS, LICENSES, AND TAXES: The Contractor shall obtain all permits and licenses, and give all notices necessary and incident to the due and lawful prosecution of the work, including vehicular registration or prorate registration and carrier licensing as applicable. Privilege taxes are in addition to the above fees.

107.03 PATENTED DEVICES, MATERIALS, AND PROCESSES: If the Contractor employs any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the Contracting Agency, and affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the Contracting Agency for any costs, expenses, and damages which it may be obliged to pay by reason of any alleged infringement, at any time during the prosecution or after the completion of the work.

107.04 RESTORATION OF SURFACES OPENED BY PERMIT: The right to construct or reconstruct any utility service in the public right-of-way, or to grant permits for same, at any time, is hereby expressly reserved by the Contracting Agency or the proper authorities of the municipality or other political subdivision in which the work is done and the Contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby.

Any individual, firm, or corporation wishing to make an opening in the highway or street must secure a permit from the proper authority. The Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highways or streets. The Contractor shall, when ordered by the Engineer, make in an acceptable manner, all necessary repairs due to such openings, and such necessary work will be paid for as extra work, or as provided in these specifications, and will be subject to the same conditions as original work performed.

The Contracting Agency, the Contractor, and each of such workmen, contractors, and others, shall coordinate their operations and cooperate to minimize interference.

The Contractor shall absorb in his bid all costs involved in his part as a result of coordinating his work with others. The Contractor will not be entitled to additional compensation from the Contracting Agency for damages resulting from such simultaneous, collateral and essential work. If necessary to avoid or minimize such damage or delay, the Contractor shall redeploy his work force to other parts of the work.

Should the Contractor be delayed by the Contracting Agency, and such delay could not reasonably have been

foreseen and prevented by the Contractor, the Engineer will determine the extent of the delay, the effect of the delay on the project as a whole, and recommend to the Board any time extension indicated.

107.05 BLANK

107.06 SANITARY PROVISIONS: The Contractor shall provide and maintain in a neat, sanitary condition, such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the District Board of Health and of other bodies or tribunals having jurisdiction thereover. He shall commit no public nuisance.

107.07 TRAFFIC AND ACCESS: The Contractor's operations shall cause no unnecessary inconvenience. The access right of the public shall be considered at all times. Unless otherwise authorized, traffic shall be permitted to pass through the work, or an approved detour shall be provided.

Safe and adequate pedestrian and vehicular access shall be provided and maintained to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, hospitals, and establishments of similar nature. Access to these facilities shall be continuous and unobstructed unless otherwise approved by the Engineer.

Safe and adequate pedestrian zones and pedestrian crossings of the work at intervals not exceeding 300 feet shall be maintained unless otherwise approved by the Engineer.

Safe and adequate access shall be maintained to existing bus or transit stops throughout duration of road construction in accordance with the following minimum requirements:

1. Unless otherwise specified in the Special Provisions, no public bus or transit stop shall be temporarily closed without the written consent of the Regional Transportation Commission Director or his designee. The RTC shall be notified at least 10 working days prior to the proposed temporary closure of any bus or transit stop, including those listed in the Special Provisions.
2. No bus stops at transfer points shall be closed during construction. Bus stops at transfer points can, however, be temporarily relocated with the approval of the RTC Director or his designee.
3. If bus or transit stop is temporarily relocated, the existing bus or transit stop sign panels shall be relocated to temporary bus or transit stops and shall remain until temporary stop is removed. Temporary relocation of sign panels shall conform to Subsection 627.03.05, "Relocation."
4. The Contractor shall maintain access which is in conformance to the requirements of the Americans with Disabilities Act to and from bus or transit stops which remain open at all times during construction.

Vehicular access to residential driveways shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time. If backfill has been completed to such extent that safe access may be provided, and the street is opened to local traffic, the Contractor shall immediately clear the street and driveways and provide and maintain access.

The Contractor shall cooperate with the various parties involved in the delivery of mail and the collection and removal of trash and garbage to maintain existing schedules for these services.

Grading operations, roadway excavation and fill construction shall be conducted by the Contractor in a manner to provide a satisfactory surface for traffic. When rough grading is completed, the roadbed surface shall be brought to a smooth, even condition satisfactory for traffic.

Unless otherwise authorized, work shall be performed in only one half the roadway at one time. One half shall be kept open and unobstructed until the opposite side is ready for use. If one half a street only is being improved,

Rev. May 8, 1997

the other half shall be conditioned and maintained as a detour.

The Contractor shall absorb in his bid all costs for the above requirements.

Construction materials may not be stored in streets, roads, or highways for more than five (5) days after unloading. All materials or equipment not installed or used in the construction within five (5) days after unloading shall be stored elsewhere by the Contractor at his expense unless he is authorized additional storage time.

Construction equipment shall not be stored at the work site before its actual use on the work nor for more than five (5) days after it is no longer needed on the work. Time necessary for repair or assembly of equipment may be authorized by the Engineer.

Excavated material, except that which is to be used as backfill in the adjacent trench, may not be stored in public streets, roads, or highways unless otherwise permitted. After placing backfill, all excess material shall be removed immediately from the site.

The Contractor shall comply with all applicable state, county, and city requirements for closure of streets. He shall provide barriers, guards, lights, signs, temporary bridges, flagmen and watchmen, advising the public of detours and construction hazards. He shall also be responsible for compliance with additional public safety requirements which may arise during construction. He shall furnish and install, and upon completion of the work, promptly remove all temporary signs and warning devices.

At least forty-eight (48) hours in advance of closing, or partially closing, or of reopening, any street, alley, or other public thoroughfare, the Contractor shall notify the Police, Fire, Traffic and Engineering Departments having jurisdiction and comply with their requirements, and notify the Regional Transportation Commission. Deviations must first be approved in writing by the Engineer.

All costs involved shall be absorbed in the Contractor's bid. All barricades, warning signs, lights, temporary signals, and other protective devices must conform with the Traffic Control Plans for Highway Work Zones for the Clark County Area and the current edition of the Manual for Uniform Traffic Control Devices.

107.08 RELATIONS WITH RAILROADS:

- (a) **Definitions.** The following definitions shall apply to the terms as herein used.

Railroad: The railway or railroad company whose tracks are crossed or whose property is adjacent to the work or upon whose property the work is performed.

Chief Engineer: The Chief Engineer of the railroad or his authorized representatives.

Railroad Crossing: A crossing at grade of the tracks of a railroad and the highway.

Grade Separation: A permanent structure to affect the separation of grade between the highway and the railroad.

- (b) **Work or Operations.**

- (1) Work or operations on grade separations, railroad crossings, or upon railroad property shall be subject to inspection by the Chief Engineer and shall be conducted and performed in a manner satisfactory to the Chief Engineer.
- (2) Construction operations shall be so arranged and conducted as to insure safe and uninterrupted operation of the railroad traffic. The Contractor shall be responsible for any damages which result either directly or indirectly from the Contractor's operations.

- (3) The Contractor shall notify the Chief Engineer in writing, at least forty-eight (48) hours before starting any work in the proximity of the tracks, setting forth specifically the time at which it is planned to start such work.
- (4) Unless otherwise provided, the Contractor shall not pile or store any material, or park or use Contractor's equipment closer than ten (10) feet from the centerline of the tracks.
- (5) The track zone shall be kept clean of all loose material or debris at all times. The Contractor shall be responsible for any fouling of railroad ballast resulting from sandblasting and painting operations and shall reimburse the railroad for the replacement of all ballast so fouled.
- (6) In advance of any blasting, the Contractor shall notify the Chief Engineer in order that proper flagging protection may be provided by the railroad. Excavations in the proximity of the tracks shall be sheeted in a manner satisfactory to the Chief Engineer and plans therefor shall be submitted to and approved by him before any such excavation is commenced.
- (7) The Contractor shall make arrangements with the railroad for crossing railroad tracks at locations other than existing public crossings and shall bear all costs relative thereto.
- (8) The Contractor shall submit detail plans of falsework and of forms for track spans and piers or abutments to the Chief Engineer and no work thereon shall be commenced unless and until such plans have been approved by the Chief Engineer. Falsework plans thus approved shall not be deviated from without permission of the Chief Engineer. The temporary vertical and horizontal clearances specified by the Chief Engineer in approving the plans shall be maintained at all times. In the case of impaired vertical clearances above the top of rail, the railroad shall have the option to install telltales, or other such protective devices the railroad deems necessary, for the protection of trainmen or rail traffic.
- (9) The Contractor shall comply with the rules and regulation of the railroad with respect to the Contractor's work or operation on or adjacent to railroad property. The Contractor shall arrange with the railroad for the services of such qualified railroad employees as the Chief Engineer may prescribe to protect and safeguard the railroad's property, engines, trains and cars. The costs incurred for the services of such railroad employees as may be prescribed by the Chief Engineer for necessary safeguard and protection and the costs of installing telltales or other protective devices in the case of impaired vertical clearance, shall be borne by the Contractor without expense to the Contracting Agency or railroad. Payment for such services, including compensation, insurance, vacation and holiday time, railroad retirement and unemployment taxes, health and welfare, accounting and billing charges, may be paid by the Contracting Agency directly to the railroad and the amount thereof shall be deducted by the Contracting Agency from money due or which may become due the Contractor under the awarded contract. Rates of pay for qualified railroad employees will be the railroad's rates for the various classes of labor customarily used and in effect at the time the work is performed. The Contractor's reimbursement for personnel and protective devices required as set forth herein shall be considered as included in the contract unit prices bid for other items of work.

(10) Upon completion of the work covered by the awarded contract to be performed by the Contractor upon railroad's property, the Contractor shall promptly remove from the railroad's property all tools, equipment, and other materials, whether brought upon said property by the Contractor or any subcontractor, and shall cause said property to be left in a clean and presentable condition.

- (c) **Work or Operations Performed by Railroad.** The railroad may undertake certain work or operations incident to the project which are the subject of an agreement between the Contracting Agency and the railroad. Details of such work or operations will be set forth in the Special Provisions and the Contractor shall discuss such items with the Chief Engineer in order to develop a plan whereby the Contractor and the railroad accomplish the work or operations in their logical sequence and order.

Movement or adjustment of telephone, telegraph, or signal facilities owned, operated, or maintained by the railroad and not otherwise provided for on the plans or in the Special Provisions shall be at the cost and expense of the Contractor.

- (d) **Insurance.** The Contractor shall provide and maintain during the effective life of the awarded contract such special or additional insurance as is required by Subsection 107.11, "Responsibility for Damage Claims" herein. The Contractor shall furnish such evidence as may be required that such insurance has been provided.
- (e) **Qualification.** As a prerequisite to award, the Contractor shall be satisfactory as to responsibility to perform work upon the railroad's property.
- (f) **Reference.** The provisions of Subsections 624.03.02, "Flaggers" and 624.03.03, "Pilot Cars," Subsection 107.11, "Responsibility for Damage Claims" and the Special Provisions shall inure directly to the benefit of the railroad.

107.09 LIABILITY INSURANCE:

- (a) **Contractor's Public Liability and Property Damage Liability Insurance.** The Contractor shall provide and maintain during the effective life of the awarded contract, regular Contractor's Public Liability and Property Damage Liability Insurance, the limits for which may be set by the special provisions to protect the Contractor and all of the Contractor's construction subcontractors from claims for personal injury, accidental death, and damage to property, which may arise from operations under said contract, whether such operations be by the Contractor or by such subcontractor or by anyone directly or indirectly employed by either of them. The successful bidder shall furnish the Contracting Agency a policy or certificate of liability insurance in which the Contracting Agency shall be named insured or be named as an additional insured with the Contractor. The successful bidder shall also furnish a Certificate of Workman's Compensation Insurance, Nevada Industrial Commission.

Whenever construction operations covered under said contract are to be performed upon or in proximity to railroad property, the Contractor's Public Liability and Property Damage Insurance shall provide for limits of coverage not less than specified in the Railroad Protective Insurance Endorsement appended to the Special Provisions.

The Contractor shall furnish the Contracting Agency with one (1) certified copy of all insurance required under this paragraph.

- (b) **Railroad's Protective Public Liability and Property Damage Insurance.** In all cases where construction operations covered by the awarded contract are to be performed upon or adjacent to the property of the railroad, the Contractor shall furnish evidence to the Contracting Agency that, with respect to the operations the Contractor or any of the Contractor's subcontractors perform, the Contractor has provided for and in favor of the railroad a policy of Public Liability and Property Damage Insurance, to which is attached an endorsement, in the same form and with the same limits of coverage as the Railroad Protective Insurance Endorsement appended to the Special Provisions.
- (c) **General.** The insurance required under paragraph (b) above shall apply only to that portion of the project upon or adjacent to the railroad property.

Railroad's Protective Public Liability and Property Damage Insurance shall be subject to approval by the railroad before any work is commenced on or adjacent to the railroad property.

Such insurance shall be carried, and the premiums therefor paid by the Contractor until all work required to be performed under the terms of said contract is satisfactorily completed as evidenced by the formal acceptance of the Contracting Agency and thereafter until all said tools, equipment, and materials have been removed from the property of the railroad and such property left in a clean and presentable condition. The insurance shall be non-cancelable and non-alterable for any cause whatsoever (including failure to pay premiums) either by the Contractor or by the insurance company without thirty (30) days written notice to the railroad and the Contracting Agency. In the event such insurance is canceled as herein provided, the Contractor shall provide other insurance, subject to the same conditions as provided herein, which shall be effective as of the day of such cancellation and cover the unexpired period of the term herein required. The Contractor shall furnish the Contracting Agency at the time of execution of said contract, three (3) copies of each policy to which is attached an endorsement the same as the Railroad Protective Insurance Endorsement appended to the Special Provisions. Two (2) copies of each of such policies shall be forwarded by the Contracting Agency to the Chief Engineer for the railroad's approval.

107.10 EXPLOSIVES: Explosives may be used only when authorized in writing by the Engineer, or as otherwise stated in the Special Provisions. Explosives shall be handled, used, and stored in accordance with all applicable regulations.

The Engineer's approval of the use of explosives shall not relieve the Contractor from his liability for claims caused by his blasting operations.

All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and in general not closer than 1,000 feet (300 meters) from the road or from any building or camping area or place of human occupancy.

The Contractor shall notify each public utility company having structures or pipelines in proximity to the site of the work of his intention to use explosives. Such notice shall be given in writing a week in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

Rev. May 8, 1997

107.11 RESPONSIBILITY FOR DAMAGE CLAIMS: The Contractor shall indemnify and save harmless the Contracting Agency, its officers and employees, from all suits, actions, claims, losses, or expenses of any character brought because of any injuries or damages alleged to have been received or sustained by any person, persons or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any claims or amount recovered under the "Nevada Industrial Insurance Act," or any other law, ordinance, order, or decree; and so much of the money due the Contractor under and by virtue of his contract as may be considered necessary by the Contracting Agency for such purpose, may be retained for the protection of the Contracting Agency; or in case no money is due, his surety may be held until all such suits, actions, claims, losses, or expenses for the injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Contracting Agency; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

Reimbursement to the Contractor by the Contracting Agency in whole or in part for costs of protecting traffic shall not serve to relieve the Contractor of his responsibility as set forth in these Standard Specifications.

The Contractor guarantees the payment of all just claims for materials, supplies, and labor, and all other just claims against him or any subcontractor, in accordance with this contract.

107.12 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE: The Contractor shall be responsible for the preservation from injury or damage resulting directly or indirectly from the work under his contract of all public and private property, crops, trees, vegetation, monuments, fences, highway signs and markers, etc., along and adjacent to the project, and shall use every precaution necessary to prevent damage to water lines, sewers, and other underground structures, to poles, wires, cables, and other overhead structures, whether shown on the plans or not, shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location, and shall not remove them until directed. The Contractor shall not willfully or maliciously injure or destroy trees or shrubs and he shall not remove or cut them without proper authority.

He shall be responsible for all damage or injury to property of any character during the prosecution of the work resulting from any act, omission, neglect, or misconduct in his manner or method of executing said work, or at any time due to defective work or materials, and such responsibility shall not be released until the project shall have been completed and accepted.

The Contractor shall be responsible for the preservation of archeological and paleontological objects, including all ruins, sites, buildings, artifacts, fossils, or other objects of antiquity encountered during construction. When such objects are encountered, the Contractor shall immediately cease operations and notify the Engineer that such objects exist. Construction operations shall be rescheduled to avoid the section until the removal of the artifacts or the gathering of historical data has been accomplished by the appropriate authority. When directed by the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper authorities. Such excavation will be considered and paid for in accordance with Subsection 104.03, "Extra Work."

Extension of contract time will be allowed for any delay to the Contractor due to preservation of archeological and paleontological objects.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work, or in consequence of the non-execution thereof on the part of the Contractor or his agents, suppliers, or subcontractors, he shall restore at his expense such property to a condition similar or equal to that existing before such damage or injury was done by repairing,

rebuilding, or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner. In case of failure on the part of the Contractor to restore such property or make good such damage or injury within ten days, the Contracting Agency may, upon forty-eight (48) hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary and the cost thereof shall be deducted from any money due, or which become due the Contractor under the contract.

The Contractor shall restrict the movement of his vehicles and other construction equipment and personnel to the construction area and designated roads. Every precaution shall be taken to prevent the marking of the natural ground with equipment tracks or other means outside of the staked area and in median areas where it is not required to disturb the existing ground. Where such markings of the natural ground are caused either by the Contractor's equipment, personnel, or operations, the Contractor, at his own expense, shall eradicate such marks to the satisfaction of the Engineer.

All roads from flat bottom ditches and material deposits shall be spaced at least 1,000 feet (300 meters) apart, except that such roads may also be located in ditch and dike areas. When roads are located in ditch and dike areas, equipment shall not be allowed to travel outside the area to be occupied by said ditch or dike, except as provided for in Subsection 203.03.12, "Channels." The crossing of median areas shall be at structures or areas approved by the Engineer.

Where there is a high potential for erosion and subsequent water pollution, the area of erosive land that may be exposed by construction operations at any one time shall be held to a minimum, and the duration of the exposure of the uncompleted construction to the elements shall be as short as practicable. Erosion control features shall be constructed concurrently with other work and at the earliest practicable time.

Disturbance of the lands and of waters that are outside the limits of the construction as staked is prohibited, except as may be found necessary and approved by the Engineer.

107.13 FIRE PROTECTION: There shall be no open burning unless approval has been given in writing by the Clark County Air Pollution Control Officer and concurred in by the Engineer. Before setting any fires whatsoever, the Contractor shall notify the responsible agency having jurisdiction for the area concerned. The Engineer shall have authority to enforce correction of any condition which is, in his opinion, unsafe.

107.14 DISPOSAL OF MATERIAL OUTSIDE PROJECT RIGHT-OF-WAY: The Contractor shall make his own arrangements for disposal of materials outside the project right-of-way and he shall pay all costs involved.

When any material is to be disposed of outside the project right-of-way, the Contractor shall first obtain a written permit from the property owner on whose property the disposal is to be made and he shall file in writing with the Engineer said permit or the certified copy thereof together with a written release from the property owner absolving the agency of any and all responsibility in connection with the disposal of material on said property.

When material is disposed of as above provided and the disposal location is visible from the project, the Contractor shall dispose of the material in a neat and uniform manner to the satisfaction of the Engineer.

Unless otherwise provided in the Special Provisions, full compensation for all costs involved in disposing of material as specified in this section, including all costs of hauling, shall be considered as included in the price paid for the contract items of work involving such materials and no additional compensation will be allowed therefor.

107.15 RELIEF FROM MAINTENANCE AND RESPONSIBILITY: Upon the written request of the Contractor, or upon order of the Engineer, the Contractor may be relieved of the duty of maintaining and protecting certain portions of the work as described below, which have been completed in all respects in accordance with the requirements of the contract and to the satisfaction of the Engineer, and thereafter except with his consent,

Rev. May 8, 1997

the Contractor will not be required to do further work thereon. In addition, such action by the Engineer will relieve the Contractor of responsibility for injury or damage to said completed portions of the work resulting from use by the public traffic or from the action of the elements or from any other cause, but not from injury or damage resulting from the Contractor's own operations or from his negligence.

Portions of the work for which the Contractor may be relieved of the duty of maintenance and protection as provided in the above paragraph include but are not limited to the following:

- (a) A bridge or other structure of major importance.
- (b) A complete unit of a traffic control signal system or of a highway or street lighting system.
- (c) Non-project facilities constructed for other agencies.

However, nothing in this subsection providing for relief from maintenance and responsibility will be construed as relieving the Contractor of full responsibility for making good defective work or materials found at any time before the formal written acceptance of the entire project by the Contracting Agency.

107.16 CONTRACTOR'S RESPONSIBILITY FOR THE WORK AND MATERIALS: Until the acceptance of the contract, the Contractor shall have the charge and care of the work and of the materials to be used therein (including materials for which he has received partial payment as provided in Subsection 109.06, "Partial Payments," or materials which have been furnished by the agency) and shall bear the risk of injury, loss or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work, except as provided in Subsection 107.15, "Relief from Maintenance and Responsibility." The Contractor shall rebuild, repair, restore, and make good all injuries, losses, or damages to any portion of the work or the materials occasioned by any cause before its completion and acceptance and shall bear the expense thereof, except as otherwise expressly provided in Subsection 203.03.10, "Slides and Slip-outs," and Subsection 619.05.01, "Payment," for Object Markers and Guide Posts, and except for such injuries, losses, or damages as are directly and proximately caused by acts of the federal government or the public enemy. The Contractor shall, at his expense, provide suitable drainage for the project and erect such temporary structures as are necessary to protect the work or materials from damage. The suspension of the work from any cause whatever shall not relieve the Contractor of his responsibility for the work and materials as herein specified. If ordered by the Engineer, the Contractor shall, at his expense, properly store materials which have been fully or partially paid for and furnished by the Contracting Agency. Such storage by the Contractor shall be on behalf of the Contracting Agency and the Contracting Agency shall at all times be entitled to the possession of such materials, and the Contractor shall promptly return the same to the site of the work when requested. The Contractor shall not dispose of any of the materials so stored except on written authorization from the Engineer.

107.17 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICE: At points where the Contractor's operations are adjacent to properties of railroad, telegraph, telephone, and power companies, or are adjacent to or in conflict with other property or utilities, damage to which might result in considerable expense, loss, or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall not begin any operations which may interfere with or impair the normal service being rendered by public or private utility operations, until such operators have been notified, and shall cooperate with the owners of any underground or overhead utilities in their removal and re-arrangements operations in order that these operations may progress in a reasonable manner, and that duplication of rearrangements work may be reduced

to a minimum, and that services rendered by those parties will not be unnecessarily interrupted. The Contractor will be held responsible for the protection of the property of public or private utilities within the limits of the work.

In general, the repair and adjustment of street structures such as water lines, sewers, telephone, telegraph, gas, and electric lines, above or below the ground, will be made by the owners thereof as specified in Subsection 105.06, Paragraph 11. When included in the proposal, the adjustment of sewer manhole frames and covers, inlets and catch basin frames and covers and the like, will be within the Contractor's responsibility. The Contractor shall see that they are adjusted to conform to the lines, grades, and typical cross sections as shown on the plans, or as prescribed, without respect to whether the repairs and the roughing-in work have been performed by the Contractor or others.

Pipes or other construction shall be maintained in continuous service as far as practicable and shall be properly protected and supported. In no case shall interruption of the water service be allowed to exist outside of working hours.

Fire hydrants shall be accessible at all times to the fire department. No material or other obstruction shall be placed closer to a fire hydrant than permitted by ordinances, rules, or regulations, or within 15 feet (4.6 meters) of the fire hydrant in the absence of such ordinances, rules, or regulations.

The Contractor shall give notice in writing to the proper authorities in charge of streets, gas, water pipes, sewer lines, electric, and other conduits, railroads, poles, manholes, catch basins, and all other property that may be affected by the Contractor's operations, at least forty-eight (48) hours before breaking ground.

In the event of interruption to water or utility services as a result of accidental breakage, the Contractor shall promptly notify the proper authority. He shall cooperate with said authority in the restoration of service as promptly as possible.

Attention is directed to Subsection 105.06, "Cooperation with Utilities."

107.18 FURNISHING RIGHT-OF-WAY: The Contracting Agency will be responsible for the securing of all right-of-ways shown in the plans. Any exceptions will be indicated in the contract.

107.19 PERSONAL LIABILITY OF PUBLIC OFFICIALS: In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the officers or employees of the Contracting Agency, either personally or as officials of the County or Municipality, it being understood that in all such matters they act solely as agents and representatives of the Political Subdivision.

107.20 NO WAIVER OF LEGAL RIGHTS: The Contracting Agency shall not be precluded or estopped by any measurements, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefor, from showing the true amount and character of the work performed, and materials furnished by the Contractor, nor from showing that any such measurement, estimate, or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Contracting Agency shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate, and payment in accordance therewith, from recovering from the Contractor or his sureties, or both, such damages as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the Contracting Agency, or any representative of the Contracting Agency, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Contracting Agency, shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

107.21 DUST CONTROL: Dust that originates from the Contractor's operations either inside or outside the right-of-way, shall be controlled at all times by the Contractor in accordance with Federal, State and local laws, ordinances and regulations at the sole expense of the Contractor.

A permit from the Clark County Air Pollution Officer shall be obtained by the Contractor prior to the start of construction operations.

Reference is made to Section 637, "Pollution Control."

- (c) The provisions of this Section shall be made known to all private contractors performing such excavation or work for any agency of the State or its political subdivisions.
- (d) The contractor shall also, immediately, report any historic, pre-historic or paleoenvironmental evidence found on the site to the owner or owner's representative.

SECTION 111

SOILS AND AGGREGATE TESTS

111.01 SIEVE ANALYSIS: Sieve analysis shall be performed in accordance with ASTM C 136, C 117.

111.02 LABORATORY MAXIMUM DENSITY: Laboratory compaction procedures will be performed in accordance with ASTM D 1557, Procedure "A", "B", or "C". The procedure shall be determined by the gradation of the material, as indicated in the test method.

111.03 FIELD DENSITY: Field density of soil shall be determined in accordance with either ASTM D 1556 (sand cone method) or ASTM D 2922 and ASTM D 3017 (nuclear method).

111.04 RELATIVE COMPACTION: The words "relative compaction" shall be the ratio of the field dry density to the laboratory maximum dry density expressed as a percentage.

Special care shall be taken in placing and thoroughly compacting the material under the haunches of all pipe culverts.

Unless otherwise directed, the backfilling shall continue as directed to the level of the ground or to an elevation six (6) inches (150 millimeters) above the structure in the case of a pipe culvert in projection, or even with the top of the structure in the case of reinforced concrete box culvert in projection.

No construction equipment or other traffic shall be permitted to cross any culvert until a safe minimum depth of fill above the culvert has been placed and compacted in accordance with these specifications. The Contractor shall be solely responsible for protecting the structure from superimposed loading by construction equipment and shall repair any damage to the structure or replace the structure as ordered without extra compensation.

Special care shall be taken in backfilling arches, particularly half-circle arches. The arch shall be covered in layers, each layer conforming to the shape of the arch and tamped thoroughly.

207.03.04 PLACING AND COMPACTING OF BIN-TYPE RETAINING WALLS: Placing and compacting backfill material for bin-type retaining walls shall progress concurrently with the assembly of the bins, and backfilling around the outer sides thereof shall be kept approximately level with the inside fills. The materials shall be thoroughly tamped and meet the density requirements as set forth in Subsection 207.03.01, "General." Care shall be exercised to completely fill the depressions of stringers and spacers without displacing them from established line and batter.

BASIS OF PAYMENT

207.04.01 PAYMENT: Unless otherwise provided in the Special Provisions or Proposal, no payment will be made for structure excavation or backfill as such; the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill is incidental or appurtenant. Payment for such excavation or backfill will be made when the Special Provisions or Proposal provides.

SECTION 208

TRENCH EXCAVATION AND BACKFILL

DESCRIPTION

208.01.01 GENERAL: This work shall consist of the excavation and backfill of trenches for the accommodation of substructures including, but not limited to electrical conduits, telephone conduits, television cable, traffic signal conduits, gas lines, sewer lines, water lines, and storm drains.

When the terms "Backfill" or "Trench Backfill" are used herein, they shall be construed to mean one or more of the types of backfill specified below under "MATERIALS."

MATERIALS

208.02.01 SELECTED BACKFILL: Selected backfill shall be as specified in Subsection 207.02.01, "Selected Backfill."

208.02.02 GRANULAR BACKFILL: Granular backfill shall be as specified in Subsection 207.02.02, "Granular Backfill."

208.02.03 SAND BACKFILL: Sand backfill shall consist of natural sand or a mixture of sand with gravel or stone. In addition thereto, the material shall conform to the following gradation requirements:

Sieve Sizes	Percentage of Weight Passing
3/8"	100
No. 4	80-100
No. 200	0-20

The plasticity index of the material shall be as specified in Subsection 704.02.03, "Plastic Limits." The soluble sulfate content shall not exceed 0.3% by dry weight of soil.

208.02.04 TYPE II AGGREGATE BASE BACKFILL: Type II aggregate base backfill shall be as specified in Subsection 704.03.04, "Type II Aggregate Base". The soluble sulfate content shall not exceed 0.3% by dry weight of soil.

208.02.05 DRAIN BACKFILL: Drain backfill shall be as specified in Subsection 704.03.01, "Drain Backfill." The type shall be as shown on the plans or approved by the Engineer.

208.02.06 FLOWABLE BACKFILL: Flowable backfill shall consist of a low-strength, self-leveling concrete material composed of various combinations of cement, fly ash, aggregate, water, and chemical admixtures. It shall have a design compressive strength of 50 to 150 psi at 28 days when tested in accordance with ASTM D 4832.

The mix shall result in a product having a slump in the range of 7 to 10 inches at the time of placement. The Contractor shall submit a mix design for approval by the Engineer prior to placement. The mix design shall be supported by laboratory test data verifying compliance with the 28 day compressive strength requirements.

Flowable backfill will be proportioned using materials that meet the requirements specified below.

Cement shall meet the requirements of Section 701, "Portland Cement". Other types of cement may be used if prior testing indicates acceptable results.

Fly ash shall meet the requirements of Section 729, "Fly Ash". Fly ash not meeting the requirements of Section 729 may be used if prior testing indicates acceptable results.

Aggregates shall meet the requirements of Section 706, "Aggregates for Portland Cement Products". When coarse aggregate is used, 100% shall pass the one (1) inch sieve, and it shall comprise not more than 40% of the total aggregate content. Other aggregate products such as Type II aggregate base, crushed rock, pea gravel, or reject sand which has no more than 20% passing the #200 sieve and is free of organic material and other deleterious substances, may be used if a flowable, workable mix can be produced without segregation of the aggregate.

Water shall meet the requirements of Section 722, "Water".

Chemical admixtures shall meet the requirements of Subsection 702.03.03, "Air-Entraining Admixtures", and Subsection 702.03.04, "Admixtures Other Than Air-Entraining." Other admixtures specifically approved for flowable backfill may be used.

All materials shall be proportioned and mixed in accordance with the requirements of Section 501, "Portland Concrete."

Flowable backfill should be discharged directly from the truck into the space to be filled, or by other methods approved by the Engineer. The mix may be placed part depth or full depth as conditions at the site dictate. When used as backfill in the pipe zone, care should be taken to prevent flotation or misalignment of the pipe by means of straps, soil anchors or other approved means of restraint. Material may be placed in stages with initially lesser flowability, to prevent movement or flotation of pipe.

Placement of pavement materials or vehicle traffic shall not be allowed until the flowable backfill has achieved a penetration resistance of at least 600 psi using a hand-held penetrometer, in accordance with ASTM C 403. This penetration resistance shall be considered achieved when a person weighing at least 150 pounds, by use of their body weight as an axial load, cannot penetrate the flowable backfill with the square cut end of a No. 4 steel reinforcing bar.

208.02.07 CRUSHED ROCK: Crushed rock shall be the product from approved aggregate deposits. The mineral aggregate shall be clean, hard, durable, free from any frozen lumps, deleterious matter, and harmful coatings. In addition thereto, the material shall conform to the following gradation requirements:

Sieve Sizes	Percentage of Weight Passing
3/8"	100
No. 4	20-80
No. 200	0-15

The percentage of wear (500 revolutions) in accordance with ASTM C 131 shall not exceed 45%.

CONSTRUCTION

208.03.01 TRENCH EXCAVATION, GENERAL: Excavation including the manner of supporting excavation and provisions for access to trenches, shall comply with the current regulations and determined by NOSHA. Excavation shall include, without classifications, the removal of all materials of whatever nature encountered, including all obstructions of any nature that would interfere with the proper execution and completion of the work. The removal of said materials shall conform to the lines and grade shown. Excavation for pipe, wire, or conduits shall be by open trench unless otherwise specified or shown on the plans. However, should the Contractor elect to tunnel or jack any portion not so specified, he shall first obtain approval from the Engineer. The Contractor shall furnish, place, and maintain all supports and shoring that may be required for the sides of the excavation, and all pumping, ditching, or other approved measures for the removal or exclusion of water, including storm water and waste water reaching the site of the work from any source so as to prevent damage to the work or adjoining property. The Contractor shall be responsible for any damage to persons or property due to interruption or diversion of storm or waste water on account of his operations. If due to delays in delivery of materials or for other reasons, and the Contractor is not expected to fully complete the work within any excavated area in a reasonable length of time as determined by the Engineer, the Engineer may require the Contractor to backfill the excavation and re-excavate when the work can be completed expeditiously, with no additional payment therefore.

- (a) Except as otherwise shown or provided herein, excavation shall be open cut trenches with vertical sides up to the top of the pipe, and from the top of the pipe to the ground surface. The bottom of the trench shall have a maximum width equal to the outside diameter of the pipe plus 24 inches (600 millimeters) or as shown on the plans. If the maximum trench width is exceeded, the Contractor shall provide either additional bedding, another type of bedding, or a higher strength of pipe if required by the Engineer, with no additional payment therefor. Trench widths greater than the outside diameter of the pipe plus 24 inches (600 millimeters) may be required by the Engineer for flexible pipe to compensate for low stability soils, with payment for the additional work to be paid for in accordance with Subsection 104.03, "Extra Work."

Except when otherwise specified or ordered by the Engineer, the bottom of the trench shall be excavated uniformly to the grade or depth indicated on the drawings. The maximum amount of open trench permitted in any one location shall be 500 feet (152 meters), or the length necessary to accommodate the amount of pipe installed in a single day, whichever is greater, unless otherwise approved by the Engineer. Trench shall be considered open until backfilled to finish surface. Trenches across streets shall be completely backfilled as soon as possible after pipe, wire, or conduit installation.

Substantial bridging, properly anchored, capable of carrying the legal limit loading, in addition to adequate trench bracing, shall be used to bridge across trenches at street crossings where trench backfill and temporary patches have not been completed during regular working hours. Safe and convenient passage for pedestrians and access to all properties shall be provided.

- (b) **Trench Overexcavation.** Wherever the excavation is made below the grade shown on the drawings, or below the grade ordered by the Engineer, it shall be refilled to the required grade with suitable bedding material as specified in Subsection 208.03.02.

Trench overexcavation below the specified level of bedding material, and additional backfill material, ordered by the Engineer because unsuitable materials are encountered, shall be paid by the appropriate contract item. If no price is included in the contract, the work may be paid for according to the provisions of Subsection 104.03, "Extra Work."

Trench overexcavation and backfill to control groundwater or to facilitate ponding or jetting shall be at the option and expense of the Contractor.

- (c) **Disposal of Unsuitable and Excess Excavated Materials.** Excess material and excavated material unsuitable for backfill, shall be removed from the site of the work by the end of each working day unless otherwise approved by the Engineer and disposed of by the Contractor as specified in Subsection 107.14, "Disposal of Material Outside Project Right-of-Way."
- (d) **Changes in Alignment or Grade.** In the event that changes in elevation of the trench of less than six (6) inches (150 millimeters) are ordered by the Engineer no changes in the contract amount will be allowed. When such changes in elevation are more than six (6) inches (150 millimeters) or changes in alignment are made that change the character of the work required, the work shall be performed as specified in Subsection 104.02, "Increased or Decreased Quantities and Change in Character of Work."

208.03.02 PIPE BEDDING: Except as otherwise provided herein or in the Special Provisions, or as otherwise shown on the plans, the trench shall be excavated to a depth of at least four (4) inches (100 millimeters) below the bottom of the pipe barrel and to a depth which will be sufficient to provide at least two (2) inches (50 millimeters) clearance under the pipe bell, and backfilled to the required grade of the bottom of the pipe with "Type II Aggregate Base Backfill," "Sand Backfill," or with "Crushed Rock." When "Crushed Rock" is used in the presence of groundwater, the Contractor shall follow the same procedures described later in this subsection when "drain backfill" is used to control groundwater.

The bedding shall be compacted to at least 90% of maximum density. Pipe bedding shall be placed and prepared in such a manner that there will be a firm, continuous support along the entire length of the pipe barrel. Bell holes in the bedding shall provide at least two (2) inches (50 millimeters) clearance beneath pipe joints.

Unless otherwise specified, laying pipe on mounds of the approved bedding material compacted firmly in place will be allowed whenever pipe eighteen (18) inches in diameter or smaller is being used, excepting sanitary sewer pipe and storm drain pipe; when "Type II Aggregate Base Backfill" or "Sand Backfill" is used for bedding material; and when the character of the bedding material and adjacent native material is such that ponding or jetting will be used for compaction. The mounds shall be a minimum of six (6) inches (150 millimeters) along the length of the pipe and of adequate size to hold the pipe in alignment and to maintain a two (2) inch (50 millimeter) minimum clearance from the bottom of the coupling to the trench bottom. Each pipe shall be laid on two mounds with the center of each mound placed approximately one-fifth of the pipe length from each end. The clearance between the trench bottom and the bottom of the coupling and/or pipe barrel shall be properly backfilled utilizing "Type II Aggregate Base Backfill" or "Sand Backfill" and the material shall be compacted utilizing appropriate methods and equipment to provide a firm and uniform bedding throughout the entire length of the pipe.

In the event that "Drain Backfill" is used to control groundwater, the Contractor shall at his expense, construct dams within the drain rock bedding material at maximum intervals of 600 feet (180 meters). The dams shall be constructed to the top of the pipe or the level of groundwater, whichever is greater, with Class "B" Portland cement concrete conforming to the requirements of Section 501, and shall have a minimum thickness of six (6) inches (150

TRENCH EXCAVATION AND BACKFILL

millimeters). All pipe shall be placed directly on the drain rock bedding material unless otherwise required or approved by the Engineer.

If groundwater is present or anticipated to be present, a filter material as specified in Subsection 207.03.01, "General," may be required by the Engineer.

208.03.03 TRENCH BACKFILL: Except as otherwise provided or approved by the Engineer, after the pipe or conduit is laid, trenches shall be backfilled with "Sand Backfill," "Type II Aggregate Base Backfill," "Crushed Rock," or with "Flowable Backfill" in the pipe zone as defined in the following table:

Pipe or Conduit	Pipe Zone
2 inch (50 millimeters) or less diameter	Subgrade to 6 inches (150 millimeters) above the top of the pipe
Greater than 2 inch (50 millimeters) diameter, except vitrified clay pipe	Subgrade to 12 inches (300 millimeters) above the top of the pipe
Vitrified clay pipe	Subgrade to 24 inches (600 millimeters) above the top of the pipe

The partially backfilled trench shall be compacted to not less than 90% of maximum density except when "Flowable Backfill" is used. Jetting or ponding methods of compaction performed in accordance with the provisions of Subsection 207.03.01 will be permitted in the pipe zone, except for corrugated metal pipe and thermoplastic pipe.

- (a) In unpaved areas and areas outside the existing or proposed street right-of-way, the remaining backfill shall be "Flowable Backfill," "Granular Backfill," or "Selected Backfill," except that no stones or lumps greater than three (3) inches will be permitted if "Selected Backfill" is used in trenches two (2) feet (600 millimeters) or less in width. Except when "Flowable Backfill" is used, the material shall be compacted to not less than 85% of maximum density, except for the top twelve (12) inches (300 millimeters) which shall be compacted to 90% of maximum density unless otherwise approved by the Engineer. Compaction of backfill by ponding or jetting methods will be permitted when performed in accordance with the provisions described in Subsection 207.03.01, but shall not be restricted by the amount of material passing the No. 200 sieve.

The upper twelve (12) inches (300 millimeters) below the existing grade in the traveled portion of an unpaved road shall be by mechanical means only.

- (b) In paved areas and areas within the existing or proposed street right-of-way, the remaining backfill shall consist of one of the following types as determined by the Engineer.
 - (1) **Granular or Selected Backfill.** Backfill material from the pipe zone to a plane which is a minimum of 16 inches (400 millimeters) below the bottom of pavement shall be "Granular Backfill," or "Selected Backfill."

If "Selected Backfill" is used in trenches two (2) feet (600 millimeters) or less in width, no stones or lumps greater than three (3) inches will be permitted. The material shall be compacted to not less than 90% of maximum density.

Trench backfill may be compacted by ponding or jetting methods performed in accordance with the requirements of Subsection 207.03.01, "General" when the character of the backfill material and adjacent native materials are as specified in Subsection 207.03.01, "General," except ponding or jetting methods will not be permitted in the trench sixteen (16) inches (400 millimeters) below the bottom of an existing pavement.

Backfill material for the minimum of 16 inches (400 millimeters) beneath the pavement shall consist of "Type II Aggregate Base" conforming to the requirements of Subsection 704.03.04. The material shall be mechanically compacted to not less than 95 % of maximum density.

- (2) **Flowable Backfill.** "Flowable Backfill" shall be placed from the top of the pipe zone to the bottom of the pavement. In deep trenches, backfill material from the pipe zone to a plane which is a minimum of 24 inches (600 mm) below the bottom of the pavement may be "Selected Backfill," "Granular Backfill," or "Flowable Backfill."

If ponding or jetting is used to compact the backfill, the Contractor shall take all necessary precautions to prevent the pipe from floating including the filling or partially filling of the pipe with water if necessary. Adequate sumps and pumping shall be provided, as determined by the Engineer, for removing excess water from the trench. Any free standing water in a partially backfilled trench shall be allowed to completely drain away before the remaining backfill is placed.

Ponding or jetting methods shall be supplemented by the use of vibratory or other mechanical compaction equipment when necessary to obtain the required compaction.

Compaction not accomplished by ponding and jetting shall be done by mechanical means. Mechanically compacted backfill shall be placed in layers of thickness compatible with the characteristics of the backfill and the type of equipment being used, but not exceeding eight (8) inches (200 millimeters) in loose thickness before compaction when hand-directed compaction equipment is used unless otherwise approved by the Engineer. Each layer shall be evenly spread, moistened, and tamped or rolled until the specified relative compaction has been attained.

208.03.04 SOILS TESTS: Where backfill is required to be compacted to a specified density, field tests for compliance may be made by the Contracting Agency using the test procedure prescribed in Section 111, "Soils and Aggregate Tests." For density determination tests the Contractor shall excavate at his expense in accordance with Subsection 208.03.01 any trench horizon the Contracting Agency may request. Where tests reveal non-compliance with the requirements of the contract, the Contractor shall bear the costs of subsequent recompaction and retesting until the required density is obtained.

208.03.05 CUTTING AND RESTORING STREET SURFACING:

- (a) Prior to beginning work within any public right-of-way, or cutting any street surfacing therein, an encroachment permit and barricade plan approval shall be obtained from the governmental entity or agency

having jurisdiction over that right-of-way.

Permit fees and construction restrictions shall be in accordance with the rules, regulations, and ordinances of the entity or agency having jurisdiction.

- (b) While undergoing improvements, all streets upon or within which any work is being done shall be kept open to all traffic by the Contractor, as specified in Subsection 104.04, "Maintenance of Traffic," unless otherwise approved by the Engineer, or as provided in the Special Provisions.

Prior to beginning the work, barricading and traffic control devices conforming to the latest editions of the Nevada Traffic Control Manual and the Manual on Uniform Traffic Control Devices shall be in place, and shall be in compliance with the governmental agency approved traffic control and barricade plan.

- (c) Pavement in the area of the trench excavation may be wheel cut or spade cut. Trench excavation and backfill shall be per the applicable sections of the Uniform Standard Specifications and Standard Drawings. "Flowable Backfill" shall be used in the following cases:
 - (1) All trenches eight (8) inches (200 millimeters) or less in width for installation of conduit (full depth to bottom of asphalt surface).
 - (2) Trenches for service laterals on developed major streets (greater than 60 feet of planned right-of-way) as determined by the Engineer.
- (d) Whenever permanent pavement patches are not constructed immediately following trench backfilling operations, temporary pavement patches consisting of a minimum of two (2) inches (50 millimeters) of hot or cold plantmix or plates must be utilized to provide the required number of paved travel lanes. Plates may be left in place for the short duration as approved by the Engineer. Temporary pavement patches may be left in place for a maximum of thirty (30) working days following completion of backfilling operations unless otherwise approved by the Engineer.

The following surface tolerance for temporary patches shall be observed. When a twelve (12) foot (4 meter) straight edge is laid across the temporary patch parallel to the centerline of the street and in a direction transverse to the centerline, a rut, hump, or depression of more than three-fourths (3/4) inch (20 millimeters) shall not be evident. Deteriorated temporary patches exhibiting ruts, humps, or depressions shall be repaired or replaced immediately upon notification of the Engineer. If the existing street exceeds the above tolerances, then the temporary patch shall be equal to or better than the condition of the surrounding pavements.

- (e) Prior to placing the permanent patch, the existing pavement shall be sawcut to a neat line and to a minimum nine (9) inches (225 millimeters) outside of the trench area. Existing aggregate base, if disturbed, shall be recompacted to meet the requirements of Section 302 of the Uniform Standard Specifications. Compaction by rolling with vehicle tires will not be permitted.

- (f) Existing asphalt concrete shall be replaced with the same depth on major streets (80 feet or more planned right-of-way) except that the minimum depth shall be four (4) inches (100 millimeters). Existing asphalt concrete shall be replaced with the same depth in local streets (less than 80 feet planned right-of-way) except that the minimum depth shall be three (3) inches (75 millimeters).
- (g) Completion of the permanent patch in areas where an opengraded surface course exists, shall include placement of a surface course to match the existing surface texture.
- (h) Existing asphalt pavement or concrete shall be replaced with like material. In areas where lime treated sub-base, cement modified sub-base, soil cement, or similar materials have been used, the Contractor may substitute a lean concrete mix or asphalt concrete equivalent, subject to approval of the Engineer.

Upon completion of the permanent patch, including the surface treatment, the surface shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. When a straightedge twelve (12) feet (4 meters) long is laid across the permanent patch parallel to the centerline of the street and in a direction transverse to the centerline, the surface shall not vary more than one-quarter ($\frac{1}{4}$) inch from the lower edge of the straightedge. Patches exhibiting deviations greater than one-quarter ($\frac{1}{4}$) inch shall be replaced prior to acceptance of the patch. If the existing street exceeds the above tolerances, then the patch shall be equal to or better than the condition of the surrounding pavement.

- (j) Any concrete improvements disturbed or damaged during construction shall be replaced prior to placement of the permanent pavement patch. Damaged sections of concrete sidewalk shall be removed and replaced to the nearest expansion joint or score line. Damaged concrete curb and gutter shall be removed and replaced to the nearest expansion joint, or as approved by the Engineer. Replacement of less than a ten (10) foot length of curb and gutter will not be permitted. Under no circumstances will sawcutting of concrete valley gutters be allowed. Valley gutters shall be replaced in their entirety.
- (k) All traffic control devices removed or disturbed during construction must be replaced upon completion of the permanent patch including but not limited to delineation, paint, thermoplastic pavement markings, and traffic signal detector loops. Temporary lane lines and other markings used during construction shall be permanently removed, to the satisfaction of the Engineer, prior to placing the new traffic stripes or markings.

BASIS OF PAYMENT

208.05.01 BASIS OF PAYMENT: Unless otherwise provided in the Special Provisions or Proposal, no payment will be made for trench excavation or backfill as such; the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill is incidental or appurtenant.

Payment for such excavation or backfill will be made only when the Special Provisions or Proposal provides.

SECTION 209

DRAIN BACKFILL

DESCRIPTION

209.01.01 GENERAL: This work shall consist of furnishing, hauling, placing, and compacting drain backfill material around structures, pipes or perforated underdrains to the lines designated on the plans or established by the Engineer.

MATERIALS

209.02.01 GENERAL: Material shall conform to the requirements as set forth in Subsection 704.03.01, "Drain Backfill."

CONSTRUCTION

209.03.01 GENERAL: The trench shall be excavated and drain backfill placed in accordance with provisions of Section 607, "Underdrains."

Where drain backfill is part of the structural section, it shall be compacted to not less than ninety (90) percent maximum density. Test method to be determined by the Engineer.

Compacting by ponding or jetting will not be permitted.

METHOD OF MEASUREMENT

209.04.01 MEASUREMENT: The quantity of drain backfill to be measured for payment will be the number of cubic yards (cubic meters) measured in accordance with the dimensions shown on the plans or established by the Engineer complete and in place.

All measurement will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

209.05.01 PAYMENT: Payment for drain backfill will be made only when provided for in the Special Provisions or Proposal.

The accepted quantities of drain backfill measured as provided in Subsection 209.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard (cubic meters) of drain backfill.

Full compensation for furnishing, hauling, placing, and compacting drain backfill shall be considered as included in the contract price paid for drain backfill.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Payment per linear foot of conduit involved shall be full compensation for furnishing and installing pipe conduit, bedding and backfilling, caps, markers, and incidentals necessary to install the conduit complete in place including as-built drawings.

The above payment will be full compensation for furnishing all the material and labor necessary to install the system. Such payment shall include excavation, backfill, restoring sidewalk, curb, gutter, pavement, and appurtenances damaged or destroyed by construction and making all required tests.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

PAY ITEM**PAY UNIT**

(size) (type) Pipe	Linear Foot (Linear Meter)
(size) (type) (name of attachment)	Each

214

Rev. July 11, 1996

SECTION 214

LIME TREATED SUB-BASE

**This section has been deleted.
Refer to new Section 306, "Lime Stabilized Subgrade."**

SECTION 215

QUICKLIME TREATED SUB-BASE

**This section has been deleted.
Refer to new Section 306, "Lime Stabilized Subgrade."**

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PORTLAND CEMENT TREATED BASE

304

Payment will be made under:

PAY ITEM	PAY UNIT
Portland Cement for Cement Treated Base	Hundred Weight (Kilogram)
Cement Treated Base	Square Yard (Square Meter)

SECTION 305 - BLANK**SECTION 306****LIME STABILIZED SUBGRADE****DESCRIPTION**

306.01.01 GENERAL: This work consists of stabilizing in place subgrade material, by combining lime and water with the pulverized subgrade material to the specified depth, and compacting the mixture to the specified density in conformance to the lines, grades and dimensions shown on the plans and as specified in these specifications and the Special Provisions.

MATERIALS

306.02.01 SUBGRADE MATERIAL: Subgrade material shall be the native in-situ soil or imported embankment material. The material to be stabilized shall be free of organic materials or other deleterious matter, and shall be limited to such a size that all the material can be passed through the mixing machine at each operation. When sulfates are found in the subgrade and embankment material, the subgrade shall be stabilized in accordance with the following table for recommended mellowing time. Soluble sulfate content to be determined in accordance with California Test Method 417 modified to use ten (10) parts water to one (1) part soil.

**HYDRATED LIME SLURRY
SULFATE CHART**

AMOUNT OF SULFATES %	RECOMMENDED MELLOW TIME
0.0 - 0.3	None
0.3 - 0.5	1 Day
0.5 - 0.8	2 - 3 Days
0.8 - 1.0	*Double Application

When sulfate rate is above 0.8 percent, Engineer review and approval is required.

*Double Application - One half of the specified hydrated lime shall be applied, mixed, and mellowed for five (5) days at above optimum moisture conditions. The second half of the slurry shall then be applied, mixed, and compacted.

306.02.02 LIME: Lime shall be either a hydrated lime or quicklime, and shall conform to the requirements of ASTM C 977. Lime may only be used in the production of a lime slurry. The direct use of dry hydrated lime or quicklime to the subgrade material is strictly prohibited. All lime shall come from a single source. If the source

is changed, new information shall be submitted for the Engineer's approval. All batches of lime furnished to the project shall have the supplier's certificate of compliance.

306.02.03 WATER: Water used for mixing lime slurry or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water shall be tested in accordance with and shall meet the requirements of AASHTO T 26. Water known to be of potable quality may be used without test.

CONSTRUCTION

306.03.01 PROPORTIONING: Before commencing lime treatment work, the Contractor shall furnish in writing to the Engineer a proposed mix design determined by a testing laboratory under the direction and control of a Registered Professional Engineer. The mix design shall be determined using the in-place soils to be stabilized and lime from the proposed supplier and shall determine the following:

- (a) Percent of lime and rate of application of lime slurry in the treated subgrade material
- (b) Optimum water content during mixing, curing, and compaction
- (c) Gradation of in-situ mixture after treatment
- (d) Additional mixing or equipment requirements
- (e) Mellowing time requirements if needed

The mix design shall comply with the following requirements:

- (a) Minimum pH: 12.4 after completion of initial mixing with lime at ambient temperature, in accordance with Eades-Grim pH test method (ASTM C 977 APPENDIX)
- (b) Plasticity Index: Less than 3, per ASTM D 4318 after 16 hours cure time with the lime.
- (c) Swell Potential: One (1) percent or less vertical expansion of an air dried soil when inundated with water and allowed to swell at a confined pressure of 60 psf (2.88 kPa)
- (d) Minimum Hydrated Lime Content: 5.0 percent by dry weight of the combined lime/soil mixture, per ASTM D 3155
- (e) Minimum Unconfined Compressive Strength: At least 160 psi (1104 kPa) in five days curing at 100° F (38° C) when tested in accordance with ASTM D 1633 Method A.

306.03.02 SUBGRADE PREPARATION: Subgrade material to be stabilized shall be scarified and thoroughly broken up to the full depth and width to be lime treated. The material shall then be shaped and sized for the addition of lime slurry.

When the design requires treatment to a depth greater than 1 foot (300 millimeters), the subgrade soil shall be treated in two equal layers. The top layer of soil shall be treated in place, and then removed and stockpiled. The moisture content of the stockpile shall be maintained at the specified moisture. The lower layer of soil to be treated shall then be treated and allowed to mellow in place. After final mixing, the lower layer shall be compacted. The stockpiled lime-soil mixture shall then be placed, mixed, and compacted.

306.03.03 LIME APPLICATION: Lime shall be applied as a slurry to the subgrade material at the rate specified for the depth of subgrade treatment shown. The treatment rate shall be determined from a design using the subgrade materials, and shall meet the requirements found in Subsection 306.03.01. Rate of application shall be verified using methods outlined by ASTM D 3155. Lime slurry shall be spread only on that area where the mixing

operations can be completed during the same working day. Lime slurry shall not be left exposed to the air for more than four hours. No traffic other than the mixing equipment will be allowed to pass over the spread lime slurry until after completion of mixing.

The Engineer reserves the right to vary the rate of application of lime from the specified application rates during the progress of construction as necessary to maintain a pH of the lime/soil mixture above 12.4 and the desired characteristics of the treated subgrade.

The lime shall be mixed with water in approved slakers and applied as a slurry by approved trucks with distributors or applicators approved by the Engineer. When using dry hydrate to make a slurry, agitators are mandatory in distributor trucks. The distribution of lime slurry shall be attained by successive applications over a measured section of subgrade until the proper amount of lime has been spread. The amount of lime spread shall be the amount required for mixing to the specified depth which will result in the percentage determined in the mix design.

306.03.04 MIXING: The lime stabilized subgrade shall not be mixed when the ambient air temperature at ground level is below 40 degrees F (4 degrees C) or as approved by the Engineer, or when it is rainy, or when the temperature of the subgrade material is below 35 degrees F (2 degrees C). The lime subgrade shall be maintained at a temperature of 35 degrees F (2 degrees C) or above until the lime stabilized material has been compacted.

The full depth of the stabilized subgrade layer shall be mixed with an approved mixing machine. The use of disc plows or blades are strictly prohibited except in areas specified by the Engineer. The mixing machine shall make two (2) or more coverages, as determined by the Engineer. Water shall be added to the subgrade material during mixing to provide a moisture content at least 3 percent above the optimum moisture content as determined by the mix design to ensure chemical reaction of the lime and subgrade material. This moisture content shall be maintained throughout the mellowing and curing time. During the mellowing period, the material shall be sprinkled as directed.

Mixing and remixing will be done as necessary to assist the lime-soil reaction, and shall continue until the combination of lime slurry and subgrade materials is free of streaks or pockets of lime, and the mixture is of uniform consistency and contains no clods or lumps greater than one inch or less than 60 percent passing the No. 4 sieve when tested dry.

After the required mellowing time, the lime stabilized subgrade material shall be uniformly mixed for final mixing.

After final mixing, the treated subgrade material shall be tested for plasticity index in accordance with ASTM D 4318 and for compressive strength. The lime mixture shall develop compressive strength of at least 160 psi (1104 kPa) in five days curing at 100° F (38° C) when tested in accordance with ASTM D 1633 Method A. Cylinders shall be molded from treated soil within two hours of final mixing with the material compacted to at least 95 percent compaction at the field moisture content. Moisture density field relationships for the treated soil shall be determined in accordance with ASTM D 698.

The treated subgrade shall then be tested for lime content. When the percentage of lime is found to be deficient less than 0.5 percent from the design, the material may be left in place. When the percentage of lime is deficient between 0.5 percent and 1.0 percent, payment will be made in accordance with Section 306.05.01. When the percentage of lime is deficient more than 1.0 percent, the entire area shall be reprocessed at the Contractor's expense.

306.03.05 COMPACTION: Compaction of the lime stabilized subgrade shall begin immediately after final mixing. The material shall be aerated or sprinkled as necessary to maintain the moisture content of the mixture between

0 to 3 percent above the optimum moisture content. The field density of the compacted mixture shall be at least 95 percent of the maximum laboratory density. The optimum moisture content and maximum laboratory density shall be determined in accordance with ASTM D 698.

Initial compaction shall be by means of sheep or segmented wheel rollers. Final rolling shall be of steel-wheeled or pneumatic-tired rollers. Areas inaccessible to rollers shall be compacted to the required compaction by other means satisfactory to the Engineer.

In addition to the requirements specified for density, the full depth of the lime treated subgrade shown on the drawings shall be compacted to the extent necessary to remain firm and stable under construction equipment. All irregularities, depressions, or weak spots which develop as determined by the Engineer shall be corrected immediately by scarifying the areas affected, adding or removing materials as required, reshaped, and recompacted by moisture conditioning and rolling. After each section is completed, tests will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked to meet these requirements. Should the material, due to any reason or cause, lose the required stability, density, or finish before the next course or pavement is placed, it shall be recompacted and refinished at the Contractor's expense.

306.03.06 FINISHING AND CURING: The surface of each layer of lime treated material shall be kept moist for a minimum of one (1) day before further courses are added or any traffic is permitted, unless otherwise directed by the Engineer. The moisture cured duration may be reduced if a non-yielding surface is obtained to support construction traffic and either the next layer of treated soils are placed or the pavement layer is constructed, as approved by the Engineer.

After the final layer of lime stabilized subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. If the surface of the finished layer is above the grade tolerance specified in this section, the excess material shall be trimmed, removed, and disposed of. No loose material shall be left in place. After trimming, the material shall be rolled with steel-wheeled or pneumatic-tired rollers. The finished surface shall not deviate by more than 0.04 feet (12 millimeters) from the actual finish grade. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

The finish thickness of the lime stabilized subgrade shall not be deficient by more than 1 inch (25 millimeters) from the planned thickness at any point. If the thickness is deficient by more than 1 inch (25 millimeters), the pavement structural section shall be adjusted by the contractor to compensate for the deficiency in stabilized subgrade thickness, subject to the approval of the Engineer at no added cost to the contracting agency.

METHOD OF MEASUREMENT

306.04.01 MEASUREMENT: The area of lime stabilized subgrade will be measured by the square yard (square meter) complete in place and accepted.

BASIS OF PAYMENT

306.05.01 PAYMENT: Payment shall be made at the contract unit price per square yard (square meter) for the lime stabilized subgrade of the thickness specified. The price shall be full compensation for furnishing all labor, material including the lime, tools, equipment and incidentals, and for doing all the work involved in constructing the lime stabilization complete in place, as shown on the plans, and as specified in these specifications and the

Rev. July 11, 1996

special provisions, and as directed by the Engineer. The pavement structural section shall be adjusted by the contractor to compensate for any deficiency in stabilized subgrade thickness.

Payment will be made under:

PAY ITEM**PAY UNIT**

Lime Stabilized Subgrade Square Yard (Square Meter)

Payment Table

**% Deviation from design
Lime Content**

**Pay Schedule
% of Unit Price**

less than 0.5%	100%
minus 0.51 to 0.6%	80%
minus 0.61 to 0.7%	60%
minus 0.71 to 0.8%	40%
minus 0.81 to 0.9%	20%
minus 0.91 to 1.0%	0%

SECTION 401

PLANTMIX BITUMINOUS PAVEMENTS - GENERAL

DESCRIPTION

401.01.01 GENERAL: These specifications include general requirements that are applicable to all types of bituminous pavements of the plantmix type irrespective of gradation of aggregate, kind, and amount of bituminous material, or pavement use. Deviations from these general requirements will be indicated in the specific requirements for each type.

This work shall consist of one or more courses of bituminous mixture constructed on the prepared foundation in accordance with these specifications and the specific requirements of the type under contract, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer.

MATERIALS

401.02.01 COMPOSITION OF MIXTURES: The bituminous plantmix shall be composed of a mixture of aggregate, mineral filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job-mix formula.

Before starting work, the Contractor shall submit a proposed job-mix formula in writing, for use by the Engineer in setting the job-mix formula to be used. The proposed job-mix formula shall be determined by a testing laboratory under the direction and control of a Registered Professional Engineer, based on tests performed in accordance with the "Marshall Method of Mix Design" as described in the Asphalt Institute Manual Series No. 2 (MS-2), Latest Edition. The number of compaction blows to be applied to the specimens will be based on the appropriate traffic category. Traffic Category I will use a 75 blow design and will apply to all arterial streets and wherever "heavy" traffic is expected. Traffic Category II will use a 50 blow design and will apply to collector and local streets. Voids determinations and effective asphalt contents will be determined and reported in accordance with procedures described in this publication unless otherwise amended in the Special Provisions.

The job-mix formula shall be selected in accordance with the following procedures:

- (a) Determine asphalt content required for 4 percent air voids, and
- (b) Determine the average asphalt content for: (1) maximum density, (2) maximum stability, and (3) 4 percent air voids, and
- (c) The lower of the asphalt contents obtained for (a) or (b) will be used as the design asphalt content for the job-mix formula.

PLANTMIX BITUMINOUS PAVEMENTS - GENERAL

The job-mix formula asphalt content shall satisfy all Marshall design criteria as shown in the following table:

MARSHALL DESIGN CRITERIA

TRAFFIC CATEGORY*	I DAILY ESAL 100 OR MORE		II DAILY ESAL LESS THAN 100	
COMPACTION BLOWS EACH END OF SPECIMEN	75		50	
TEST PROPERTY	Min.	Max.	Min.	Max.
STABILITY, LB.	1800	----	1500	----
FLOW, 0.01 IN.	8	14	8	16
PERCENT TOTAL AIR VOIDS	3	5	3	5
PERCENT VOIDS FILLED WITH ASPHALT	65	75	65	78
MINIMUM VOIDS IN MINERAL AGGREGATE - PERCENT	See Table	In Asphalt	Institute MS-2	Manual

ESAL = Equivalent Single Axle Load

*Traffic Category I - Applies to heavily trafficked arterial streets or truck routes with a daily ESAL of 100 or more or for streets with signalized intersections regardless of ESAL.

Traffic Category II - Applies to local streets with a daily ESAL of less than 100.

The applicable Traffic Category will be designated in the Special Provisions for each project.

In addition to the Marshall Design Criteria set forth herein, the job-mix formula shall also meet the following tensile strength requirements for all traffic categories:

TEST PROPERTY	TEST METHOD	REQUIREMENTS
INDIRECT TENSILE STRENGTH (Unconditioned)	AASHTO T283	65 p.s.i. minimum (50 p.s.i. minimum with AC-10 asphalt)
INDIRECT TENSILE STRENGTH (Retained Strength)	AASHTO T283	70% minimum

Should the job-mix formula fail to meet the tensile strength requirements, the Contractor shall add hydrated lime (hereinafter referred to as mineral filler) to the plantmix bituminous aggregates as specified in Subsection 401.03.08. If the addition of mineral filler fails to achieve the minimum tensile strengths, the Contractor will be required to change sources of material, and submit a new job-mix formula that will satisfy all design criteria.

The test report shall show the curves and data tabulations used to determine the following characteristics:

1. Unit weight per cubic foot
2. Percentage of air voids
3. Percent voids filled with asphalt
4. Marshall stability
5. Percent voids in mineral aggregate (VMA)
6. Marshall flow
7. Indirect tensile strength (Unconditioned and Retained strength)

Data tabulations shall include indications of the water absorption, aggregate bulk specific gravities for both coarse (retained on No. 8 sieve) and fine (passing No. 8 sieve) aggregate, theoretical specific gravity of bituminous mixture, absorbed asphalt, and effective asphalt content as determined in accordance with referenced Asphalt Institute procedures. ASTM Test Method D 2041 will be used for determination of theoretical maximum specific gravity of bituminous paving mixtures.

The test report shall give the recommended asphalt content and the values for:

1. Unit weight per cubic foot (bulk density)
2. Stability
3. Flow
4. Air voids
5. Voids filled with asphalt
6. Voids in mineral aggregate (VMA)
7. Indirect tensile strength (Unconditioned and Retained strength)

The formula submitted shall propose definite single values for:

- (A) The percentage of aggregate passing each specified sieve
- (B) The percentage of bitumen to be added (to 0.1 percent) based on weight of total mix
- (C) The percentage of mineral filler to be added to the aggregate
- (D) The temperature of the mixture leaving the mixer
- (E) The temperature of the mixture in the hopper of the paving machine

The job-mix formula aggregate with the allowable tolerances herein shall conform to the requirements of Section 705 "Aggregates for Bituminous Courses," for plantmix bituminous base aggregates, plantmix bituminous surface aggregate, or plantmix bituminous open-graded aggregate, as the case may be.

The Engineer will determine a job-mix formula with single values for (A), (B), (C), (D) and (E) above and so notify the Contractor in writing. This job-mix formula shall not be modified except with the written approval of

Rev. July 11, 1996

the Engineer. The mix furnished shall conform to this job-mix formula, within the following range of tolerances:

Aggregate passing the No. 4 and larger sieves	±7%
Aggregate passing the No. 8 to 100 sieves	±4%
Aggregate passing the No. 200 sieve *	± 2%, but not to exceed upper limit of specification
Bitumen content	±0.3%
Temperature leaving the mixer	± 20 degrees F. (11 degrees C.)
Temperature in hopper of paving machine	± 20 degrees F. (11 degrees C.)

*Mineral filler is not considered as part of the aggregate.

Should there be a change in sources of materials, a new job-mix formula shall be established before the new material is used. Check tests of properties of the plantmix bituminous materials shall be made on the first day of production and as requested by the Engineer during period of construction to confirm that all properties are in compliance with Marshall Design Criteria and tensile strength requirements. Adjustments in gradation, mineral filler content and asphalt content shall be made as necessary in order to meet design criteria.

The temperature of the bituminous material just prior to mixing and of the completed mixture in the hauling vehicle just prior to leaving the plant shall conform to the following table:

PLANTMIX BITUMINOUS MIXTURE WITH ASPHALT CEMENT

Grade Of Asphalt Cement	Bituminous Material		Plantmix Bituminous Base of Surface Mixtures		Plantmix Bituminous Open-Graded Mixtures	
	Min.	Max.	Min.	Max.	Min.	Max.
AC-40	275°F 135°C	350°F 177°C	255°F 124°C	350°F 177°C	245°F 118°C	275°F 135°C
AC-20, AC-30	265°F 129°C	330°F 166°C	245°F 118°C	325°F 163°C	245°F 118°C	275°F 135°C
AC-10	255°F 124°C	325°F 163°C	235°F 112°C	325°F 163°C		
AC-20P	280°F 138°C	350°F 177°C	300°F 149°C	350°F 177°C	300°F 149°C	350°F 177°C

401.02.02 AGGREGATES: Aggregates shall meet the applicable requirements of Section 705, "Aggregates for Bituminous Courses."

401.02.03 COMMERCIAL MINERAL FILLER: Commercial mineral filler shall meet the requirements of Subsection 705.03.04, "Commercial Mineral Filler."

401.02.04 BITUMINOUS MATERIALS: The bituminous material shall meet the applicable requirements of Section 703, "Bituminous Materials." Bituminous material may be conditionally accepted at the source.

Unless otherwise specified in the Special Provisions for Category I pavements, the grade of bituminous material for dense-graded mixes shall be AC-30 asphalt cement. An AC-30, or AC-20P asphalt cement shall be used for open-graded mixes as specified in Section 403.02.02. The grade may be changed one step by the Engineer.

Unless otherwise specified in the Special Provisions, for Category II pavements the grade of bituminous material for dense-graded mixes shall be AC-20 asphalt cement. The grade may be changed one step by the Engineer.

Certificates of Compliance for the asphalt, showing test values necessary for specification compliance, shall be made available upon request by the Engineer.

CONSTRUCTION

401.03.01 BITUMINOUS MIXING PLANT: Sufficient storage space shall be provided for the aggregate, or for each size aggregate when required. The storage yard shall be maintained neat and orderly and the stockpile, or separate stockpiles when required, shall be readily accessible for sampling.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (A). In addition, batch mixing plants shall conform to the requirements under (B) and drum drier plants shall conform to the requirements under (C).

(A) Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed bituminous construction.

- (1) **Equipment for Preparation of Bituminous Material.** Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank or contents. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provisions shall be made for measuring and sampling storage tanks.
- (2) **Drier.** The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process.
- (3) **Thermometric Equipment.** An armored thermometer of adequate range in temperature reading shall be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit.

The plant shall also be equipped with either an approved dial-scale, mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregate.

The Engineer may require replacement of any thermometer by an approved temperature-recording apparatus for better regulation of the temperature of aggregates.

- (4) **Smoke and Dust Control.** The Contractor will be required to install satisfactory precipitation devices, or use other methods which will meet local conditions, city and county regulations as set forth by the Clark County Air Pollution Control Officer, and state laws pertinent to air pollution.

Rev. July 11, 1996

- (5) **Truck Scales.** Except as allowed in Subsection 401.04.01, "Measurements," bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Such scales shall be platform scales and conform to the provisions of Subsection 109.01, "Measurement of Quantities."
- (6) **Safety Requirements.** Adequate and safe stairways to the mixer platform and sampling points shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device to enable the Engineer to obtain sampling and mixture temperature data. A hoist or pulley system shall be provided to raise scale calibration equipment, sampling equipment, and other similar equipment from the ground to the mixer platform and return. All gates, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept from drippings from the mixing platform.

(B) **Requirements for Batching Plants**

- (1) **Plant Scales.** Scales shall be accurate to 0.5 percent of the minimum load that may be required. Poises shall be designed to be locked in any position to prevent unauthorized change of position.

Scales shall be as described in Subsection 109.01 "Measurement of Quantities." In lieu of truck scales, the Contractor may provide an approved automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching control system. Such weights shall be evidenced by a weight ticket for each load.

The amount of filler material shall be determined by weighing on springless dial scales separate from the plant weigh hopper or by some method that uniformly feeds the mixer within ten (10) percent of the required amount.

- (2) **Feeder for Drier.** The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and uniform temperature will be obtained.
- (3) **Screens.** Plant screens capable of screening the aggregate to the specified sizes will be required.
- (4) **Bins.** The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for mineral filler when used and the plant shall be equipped to feed such material into the mixer.

Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate constructed so that when closed there shall be no leakage. The gates shall

cut off quickly and completely. Bins shall be so constructed that samples representative of the entire material in the bin can be readily obtained.

- (5) **Weigh Box or Hopper.** All materials shall be proportioned by weight. Aggregate scales shall be either (1) a multiple beam scale, (2) a springless dial type scale, or (3) a fully automatic solid-state digital strain gage transducer measuring device having a capacity exceeding 1-1/4 times the total amount of materials to be weighed in one operation. Each scale gradation shall be approximately 1/1000 of the total capacity of the scale.

All scales used for proportioning materials shall be accurate to within one (1) percent. They shall be sealed and certified by the State Sealer of Weights and Measures. These certifications shall be dated within the past twelve (12) months and shall be renewed whenever required by the Engineer. In the event the plant is moved, a new certificate will be required.

All scales shall be of such size and so arranged that they may be read easily from the operator's platform. They shall indicate the true net weight without the application of any factor. The dials of scales shall not be less than twelve (12) inches (300 millimeters) in diameter and the figure thereon, shall be clearly legible.

Weighing equipment shall be so insulated against the vibration or movement of other operating equipment in the plant, that the error in weighing with the entire plant running will not exceed one and one-half (1-1/2) percent for any batch.

- (6) **Bituminous Control Unit.** Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.
- (7) **Bituminous Control.** The equipment used to measure the bituminous material shall be accurate to plus or minus 0.5 percent. The bituminous material bucket shall be a non-tilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than three-fourths the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve or valves, and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least fifteen (15) percent in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.

Bituminous material shall be measured by means of springless dial scales or metering devices. Springless dial scales shall have a capacity of not more than one thousand (1,000) pounds (450 kilograms) in two (2) pound (1 kilogram) gradations.

The indicator dial shall have a capacity of at least fifteen (15) percent in excess of the quantity of

bituminous material used in a batch. The controls shall be constructed so that they may be locked at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than fifteen (15) seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the accuracy of the meter when a metering device is substituted for a bituminous material bucket.

- (8) **Mixer.** The batch mixer shall be of a twin pugmill type, steam jacketed, or heated by other approved means and capable of producing uniform mixtures within the specified tolerances. It shall be equipped with a sufficient number of paddles or blades set in proper order and operated at such speed as to produce a properly and uniformly mixed batch. At the beginning of the mixing operation, the clearance between paddle tips and liner shall not exceed half the maximum aggregate diameter for the specified job-mix. The clearance of the paddles or blades from all fixed and moving parts shall not exceed one (1) inch (25 millimeters). Badly worn or defective paddles or blades shall not be used in mixing operations.
- (9) **Control of Mixing Time.** The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the mixer gates throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material. The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

The mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall measure the time of mixing within an accuracy of two (2) seconds. A suitable automatic device for counting the number of completely mixed batches shall be provided and maintained in proper working condition.

When the aggregate and the bituminous material have been combined, the entire mass shall be mixed in a approved mixer. The mixing shall continue until homogeneity and a uniform coating are achieved. The output rate shall not exceed the manufacturer's capacity rating.

(C) Requirements for Dryer Drum Mixing Plants

- (1) **Aggregate Stockpiles.** The first paragraph of Subsection 401.03.08, "Preparation of Aggregates," shall apply.
- (2) **Aggregate Proportioning.** The plant shall include a means for accurately proportioning each bin size of aggregate prior to the drying operation.

The plant shall have a mechanical feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive means. Indicators shall be provided for each gate to show the respective gate opening in inches (millimeters).

A meter for determining the rate of each feeder, or a revolution counter, shall be provided.

Commercial filler material introduced into the mixer shall be drawn from storage bins by a continuous mechanical feeder which will uniformly feed the mixer within ten (10) percent of the required amount.

- (3) **Weight Calibration of Aggregate.** The plant shall include a means for calibration for each aggregate feeder by weighing test samples.
- (4) **Bituminous Metering Device.** The bituminous material shall be introduced into the mixer through a gallonage meter by a positive displacement metering device. This metering device shall be equipped with a ready means of varying the bituminous material delivery rate.
- (5) **Synchronization of Aggregate Feed and Bituminous Material Feed.** Satisfactory means shall be provided to afford a positive interlocking control between the flow of aggregate from each feeder and the flow of bituminous material. The interlocking control shall indicate a visible or audible signal when the level of material in any one feeder approaches the strike off capacity of the feed gate, or shut the plant down.
- (6) **Mixer.** The plant shall include a mixing device which will obtain homogeneity and a uniform coating. The mixing output shall not exceed the manufacturer's capacity rating. The moisture content of the bituminous mixture shall not exceed 3 % at the discharge end of the dryer.
- (7) **Surge Bins.** The plant will be equipped with an approved surge bin at the discharge. This surge bin will be in excess of twenty (20) tons (18 metric tons), and shall be equipped with an approved surge batcher or other approved method satisfactory to the Engineer that will prevent segregation of the bituminous mixture as it is being discharged into the hauling vehicle.

401.03.02 HAULING EQUIPMENT: Trucks used for hauling bituminous mixtures shall have tight, clean, smooth beds which have been thinly coated with a minimum amount of paraffin oil, lime solution, or other approved material to prevent the mixture from adhering to the beds.

401.03.03 PAVERS: Bituminous pavers shall be self-contained, self-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading the finishing courses of bituminous plantmix material in lane widths applicable to the specified typical section and thicknesses shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plantmix material in widths shown on the plans.

The asphalt paver shall operate independently of the vehicle being unloaded and shall be capable of propelling the vehicle being unloaded in a satisfactory manner and, if necessary, the load of the haul vehicle shall be limited

Rev. July 11, 1996

to that which will insure satisfactory spreading. While being unloaded, the haul vehicle shall be in contact with the machine at all times and the brakes on the haul vehicle shall not be depended upon to maintain contact between the vehicle and the machine.

Pavers shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

Pavers shall be capable of placing the bituminous mixture to meet the surface tolerances specified under the respective sections of bituminous pavement.

401.03.04 ROLLERS: Rollers shall be vibratory, steel-wheeled or pneumatic-tired type. They shall be in good condition, capable of reversing without backlash, and operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the completed material as determined by the Engineer. Attention is directed to Subsection 401.03.11, "Rolling and Compaction."

401.03.05 WEATHER LIMITATIONS: The bituminous mixture shall not be placed upon any wet surface or when the surface temperatures of the underlying course is less than specified in Table I. The temperature requirements may be modified, but only when so directed by the Engineer.

TABLE I - BASE TEMPERATURES LIMITATIONS

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 INCHES OR GREATER	40	4
GREATER THAN 1 INCH BUT LESS THAN 3 INCHES	45	7
1 INCH OR LESS	50	10

The open-graded plantmix surface shall be placed only when the pavement surface temperature is above sixty (60) degrees F. (15.5 degrees C.).

401.03.06 PREPARATION OF EXISTING SURFACE: When the surface of the existing pavement or old base is irregular, it shall be brought to a uniform grade and cross section as shown on the plans.

The subgrade to receive asphalt concrete or asphalt concrete base immediately prior to applying prime coat, shall conform to the compaction and elevation tolerance specified for the material involved and shall be free of loose or extraneous material.

If the plantmix bituminous surface is being constructed directly upon an existing hard-surfaced pavement, a tack

coat of grade CSS-1h or SS-1h emulsified asphalt diluted 50/50 at an approximate rate of 0.05 to 0.10 gallon per square yard (0.23 to 0.45 liters per square meter), shall be uniformly applied upon the existing pavement preceding the placement of the asphalt concrete. The surface shall be free of water, foreign material, or dust when the tack coat is applied. To minimize public inconvenience, no greater area shall be treated in any one day than is planned to be covered by plantmix during the same day, unless otherwise authorized by the Engineer.

A similar tack coat shall be applied to the surface of any previous course placed longer than 24 hours, or if the surface is such that a satisfactory bond cannot be obtained between it and a succeeding course, as determined by the Engineer.

The contact surfaces of all cold pavement joints, curbs, gutters, manholes, and the like, shall be painted with grade CSS-1h or SS-1h emulsified asphalt immediately before the new asphalt concrete is placed. Reference is made to Section 405, "Tack Coat."

When specified in the contract, longitudinal and transverse joints and cracks shall be sealed by the application of an approved joint sealing compound before spreading the mixture upon a Portland cement concrete surface. Excess bituminous material shall be removed from joints and cracks prior to spreading the mixture.

401.03.07 PREPARATION OF BITUMINOUS MATERIALS: The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature at all times.

401.03.08 PREPARATION OF AGGREGATES: Aggregates proportioned prior to the heating and drying process, shall be separated into at least two general sizes (1) that portion of the material having a minimum of 80% passing No. 4 sieve, and (2) that portion of the material having a minimum of 80% retained on a No. 4 sieve. The material shall be maintained within these limits with a uniformity of plus or minus 5%. Each portion of the material shall be stored separately. When moving the aggregate from storage to compartment bins, any method may be used which will not cause segregation, degradation, or combinations of aggregate which fail to meet the specified gradation requirement. Plantmix operations shall not commence until sufficient aggregate material is stockpiled to insure one day's run.

Aggregate proportioned immediately after the heating and drying process shall be screened into a minimum of two fractions in the case minus 1/2" aggregate is used, and into a minimum of three fractions when larger sized aggregate is used. The screened material shall be conveyed to separate compartments ready for proportioning and mixing with bituminous material.

If the CONTRACTOR elects to introduce baghouse fines into the mix, the material shall be drawn from a storage facility in which the material is kept in a uniform free flowing condition. The baghouse fines for delivery to the plant shall be from a vane type metering device which is interlocked, (electrical driven feeders shall be activated from the same circuit) to the flow of each aggregate feeder. The drive shaft on the baghouse fines vane feeder shall be equipped with a revolution counter accurate to one tenth (1/10) of a revolution, and a means for varying the rate.

In a continuous mix and/or dryer drum plant the baghouse fines shall be added at the asphalt feed line to insure a uniform mix.

In batch plants the baghouse fines shall be added by the use of a separate bin.

The baghouse fines shall be introduced at a point as approved by the Engineer at a percentage determined by the Engineer, not to exceed two (2) percent by dry weight of the aggregate.

Baghouse fines shall be considered as part of the aggregate, and not as a mineral filler.

Rev. July 11, 1996

If mineral filler is required to meet the tensile strength requirements of the job-mix formula, it shall be added by one of the following methods:

- (a) **Cold Feed Method.** Hydrated lime (hereinafter referred to as mineral filler) shall be added to all plantmix bituminous aggregates at the rate of not less than one (1) percent nor more than two and one-half (2-1/2) percent of the weight of the dry aggregate. The exact rate of application shall be as determined by the job mix formula.

Mineral filler shall be drawn from a storage facility in which the mineral filler is agitated by air or other means to keep it in a uniform free flowing condition. The mineral filler for delivery to the mixer shall be from a vane type metering device which is interlocked, (electrical driven feeders shall be actuated from the same circuit) to the flow of each aggregate feeder. The drive shaft on the mineral filler vane feeder shall be equipped with a revolution counter reading to one tenth (1/10) of a revolution, and a means for varying the rate.

In continuous mix and/or drum dryer plants the mineral filler shall be added to the aggregate after the aggregate is proportioned.

In batch plants the mineral filler shall be added to the aggregate prior to drying.

Regardless which type of plant is used the following methods shall be utilized:

Prior to the introduction of the mineral filler sufficient moisture shall be added by way of spray bars at the aggregate bins to bring the aggregate to a moisture content where enough free surface moisture is available to thoroughly wet the aggregate and wet the lime. This content shall be a minimum of four (4) percent. The actual amount of moisture required will be determined by the ENGINEER. After the addition of water and mineral filler the aggregate shall be mixed using a horizontal twin-shaft pugmill. The mixing paddles shall be adjustable for angular position on the shaft to permit altering of the mixing pattern or retarding the flow to assure that the aggregate is thoroughly coated with mineral filler. The volume of material in the pugmill shall not extend above the vertical position of the blade tips. The completed mixture shall be directly introduced into the hot plant. Stockpiling of the completed mixture is strictly prohibited.

The moisture control valve shall be interlocked with the hot plant control room so the moisture control valve is automatically turned off when the cold feed belts are shut off. The control valve shall also turn on automatically when the cold feed belts are activated.

- (b) **Marination Method.** Hydrated lime (hereinafter referred to as mineral filler) shall be added to all fractions of the plantmix bituminous aggregates. The coarse aggregates are to be wet cured with mineral filler at a rate of one (1) percent of the weight of dry aggregate. The fine aggregates are to be wet cured with mineral filler at a minimum rate of two (2) percent of the weight of the dry aggregate. The aggregates are to be marinated (wet cured) in the stockpiles for a minimum of forty-eight (48) hours.

The wet cured aggregate in the stockpile shall be used within forty-five (45) calendar days. Material

marinated in stockpile in excess of forty-five (45) calendar days shall not be used for the production of plantmix bituminous aggregates unless otherwise approved by the Engineer.

Prior to the introduction of the mineral filler sufficient moisture shall be added to by way of spray bars at the aggregate bins to bring the aggregates to a moisture content where enough free surface moisture is available to thoroughly wet the aggregate and activate the lime. This content is recommended to be a minimum of three (3) percent for coarse aggregates and six (6) percent for the fine aggregates. The actual amount of moisture required will be determined by the ENGINEER. After the addition of water and mineral filler the aggregate shall be mixed using a horizontal twin-shaft pugmill. The mixing paddles shall be adjustable for angular position on the shaft to permit altering of the mixing pattern or retarding the flow to assure that the aggregate is thoroughly coated with mineral filler. The volume of material in the pugmill shall not extend above the vertical position of the blade tips.

Mineral filler shall be drawn from a storage facility in which the mineral filler is agitated by air or other means to keep it in a uniform free flowing condition. The mineral filler for delivery to the mixer shall be from a vane type metering device which is interlocked, (electrical driven feeders shall be actuated from the same circuit) to the flow of each aggregate feeder. The drive shaft on the mineral filler vane feeder shall be equipped with a revolution counter reading to one tenth (1/10) of a revolution, and a means for varying the rate.

- (c) **Slurry Method.** Hydrated lime or slaked quicklime (hereinafter referred to as mineral filler) shall be added to all plantmix bituminous aggregates in slurry form at a rate of not less than one (1) percent nor more than two and one-half (2-1/2) percent of dry mineral filler based on the weight of the dry aggregate. The exact rate of application shall be as determined by the job-mix formula.

A slurry containing one (1) part mineral filler and two (2) parts water by weight is recommended. The actual amount of water required in the production of the slurry will be determined by the Engineer after a visual inspection to assure that the aggregate is thoroughly and uniformly coated with the mineral filler. The addition of moisture to the aggregate prior to mixing of the mineral filler and aggregate will not normally be required.

The slurry shall be prepared in a central mixing tank provided with agitation for keeping the mineral filler in suspension until applied to the aggregate. The slurry mixing tanks must be capable of producing sufficient slurry for the hot mix asphalt manufacturing facility production rate, and shall produce a uniform slurry consistency. The plant shall be equipped with suitable pumps and meters for introducing the required amount of slurry to the aggregate. A suitable device shall be provided to the Engineer for determining the weight of mineral filler per gallon of slurry.

If quicklime is used as the mineral filler, it shall be converted to hydrated lime by using one or more slaking tanks. The slaking unit must be capable of complete slaking or hydration of the quicklime, and shall be capable of providing agitation for mixing and keeping the mineral filler in suspension until use.

After the addition of the mineral filler slurry, the aggregate shall be mixed using a horizontal twin-shaft pugmill. The mixing paddles shall be adjustable for angular position of the shaft to permit altering of

Rev. July 11, 1996

the mixing pattern or retarding the flow to assure that the aggregate is thoroughly coated with mineral filler. The volume of material in the pugmill shall not extend above the vertical position of the blade tips. The completed mixture shall be directly introduced into the hot plant. Stockpiling of the completed mixture is strictly prohibited.

401.03.09 MIXING: The permissible moisture content of the bituminous mixture just behind the paver shall not exceed one and one-half (1-1/2) percent as determined by test method ASTM D 1461 or equivalent. Should the aggregate contain excessive moisture when heated within the temperature limits, the Contractor will be required to take satisfactory corrective action before resuming plantmix operations. When an approved dryer drum mixing process is used, the moisture content of the bituminous mixture at discharge from the mixer shall not exceed three (3) percent, and the resulting product at the discharge end of the drier shall be a homogenous mixture of uniformly distributed and properly coated aggregates of unchanging appearance.

The drier aggregate shall be combined in the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous material shall be measured or gaged and introduced into the mixer in the amount specified by the job-mix formula.

Commercial filler material, when required, shall be added to the mixer separately and shall be thoroughly dry. If the materials are mixed in a batching plant, the filler material shall be fed directly into the mixer as near the center as possible.

The time of mixing a batch shall begin on the charging stroke of the weight hopper dumping mechanism and shall end when discharge is started. Mixing shall continue until a homogenous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced. In general, the time of mixing shall not be less than thirty (30) seconds, except that the time may be reduced when in the opinion of the Engineer the sizes of aggregates are uniformly distributed and all particles are thoroughly and uniformly coated with asphalt binder. The output rate shall not exceed the manufacturer's capacity rating.

Should the mixture, at the plant or in place, show an excess or deficiency of bitumen, show injury or damage due to burning or overheating, or show an improper combination of aggregates, due to the Contractor's failure to conform to the specified requirements, it shall be rejected and if still in the truck shall be disposed of as required. If an unsatisfactory mix, as referred to above, has been placed, it shall be disposed of and replaced as directed. No compensation will be allowed for rejected material.

401.03.10 SPREADING AND FINISHING: The mixture shall be laid upon an approved surface, and shall be spread and struck off to the grade, and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

The forward rate of travel of the paving machine(s) shall be regulated to a speed dependent upon the capacity of the mixing plant to furnish the mixture and the rate at which the rollers can obtain the required compaction. The machine shall be operated so that material does not accumulate and remain along the sides of the receiving hopper.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, and compacted by hand tools. For such areas, the mixture shall be dumped, spread, and screeded to give the required compacted thickness, correct grade, and cross section.

The Contractor may windrow plantmixed bituminous base or surface material in front of the spreading and finishing machine, provided that the following conditions and requirements are strictly adhered to:

- (a) The windrow is properly sized, thereby insuring the delivery of the correct amount of material to the

spreading and finishing machine at all times.

- (b) The bituminous mixture shall be transferred from the windrow to the spreading and finishing machine in such a manner that the materials in the spreading machine will be a uniform mixture. The base, upon which the windrow was formed shall not be disturbed and there shall be no paving material remaining on this base between the pickup device and the spreading and finishing machine.
- (c) The temperature requirements for the material in the hopper of the spreading and finishing machine are complied with. Plantmix bituminous mixture that does not meet the minimum temperatures specified shall not be incorporated in the work, but shall be waste in a manner satisfactory to the Engineer.

Should any course of bituminous mixture placed by utilizing a windrow be inferior, as determined by the Engineer, to that placed by transferring the bituminous mixture directly from the hauling vehicle to the spreading machine, the use of a windrow shall be discontinued.

The bituminous mixture spread through the paving machine during one day's operation shall come from a single plant manufacturer. Intermixing from more than one source shall not be allowed.

401.03.11 ROLLING AND COMPACTION: The initial or breakdown rolling shall consist of one complete coverage of the bituminous mixture with a steel-wheeled roller. Initial rolling shall commence at the lower edge and shall progress toward the highest portion of the roadbed. Under no circumstances shall the center be rolled first. The initial or breakdown rolling shall be followed by rolling such that uniform density is obtained throughout the depth of the layer of the material being compacted. At least two rollers, one steel-wheeled, the other pneumatic-tired, shall be used and the total number of rollers used shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The final rolling of the bituminous mixture shall be performed with the same type of roller used for breakdown rolling. Rolling shall be performed in such a manner that cracking, shoving, or displacement will be avoided. All rollers shall be in good condition, and the reversing mechanism so maintained that the roller is capable of changing directions smoothly. The roller shall be kept in continuous motion while rolling so that all parts of the pavement shall receive equal compression. The motion of the roller shall be slow enough at all times to avoid displacement of the pavement. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by the use of rakes and fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly maintained. The use of diesel oil on pneumatic-tired rollers shall be kept to a minimum as determined by the Engineer. Preferably water soluble oil or an asphalt release agent shall be used.

401.03.12 ACCEPTANCE SAMPLING AND TESTING OF BITUMINOUS MIXTURE (COMPACTION): Field density determinations of the bituminous mixture shall be made in lots, each lot representing one day's placement. A lot shall be divided into five (5) equal sublots, and one (1) test may be made for each subplot. The location of the field density tests may be chosen on a random basis through the use of an appropriate random numbers table.

Determination of the field density of the compacted bituminous mixture shall be accomplished by either ASTM D 2950, "Density of Bituminous Concrete in Place by Nuclear Method," or ASTM D 1188, "Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens." Zinc stearate may be substituted for paraffin. When the nuclear method is used, the nuclear device shall first be correlated with the density of core samples. In case of dispute, ASTM D 1188 test method shall control.

The theoretical maximum density of the bituminous mixture shall be determined by taking random samples of the mixture delivered to the job site and testing in accordance with ASTM D 2041, "Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures." At least two theoretical maximum density determinations shall be made for each day's production of bituminous mixture used in the work, unless the day's production is less than 500 tons

(454 metric tons), then only one theoretical maximum density determination is required.

Each lot of the compacted bituminous mixture will be accepted when the average of the five density determinations is equal to or greater than 93% for Category I pavements, and 92% for Category II pavements, and when no individual determination is lower than 90% of the theoretical maximum density.

As a quality control measure, the Contractor may, at his expense, make periodic checks of the field density of the compacted bituminous mixture at any time during paving operations. The optional testing performed by the Contractor shall not replace the acceptance testing to be done by the Engineer.

401.03.13 MAINTAINING TRAFFIC: Traffic shall not be allowed on newly placed pavement for at least 24 hours or until the bituminous paving mix in-place temperatures has dropped below 104°F (60°C).

Exceptions shall be made at the discretion of the Engineer. Artificial means to reduce the pavement temperature may be used as approved by the Engineer.

401.13.14 JOINTS: Placing of the bituminous paving shall be as continuous as possible. Rollers shall not pass over the unprotected end of the freshly laid mixture unless authorized by the Engineer. Transverse joints shall be conformed by cutting back on the previous run to expose the full depth of the course. A brush coat of asphalt emulsion shall be used on contact surface of transverse joints just before additional mixture is placed against the previously rolled material.

Longitudinal joints shall be spaced in such a manner that joints in succeeding courses will be at least six (6) inches (150 millimeters) horizontally from joints in any preceding course. Lanes will be evened up each day to eliminate cold longitudinal joints insofar as practicable.

Transverse joints shall be spaced in such a manner that joints in succeeding courses will be a minimum of five (5) feet (1.5 meters) horizontally from joints in any adjacent course. Lanes shall be evened up each day to eliminate cold transverse joints insofar as practicable.

Attention is directed to Subsection 401.03.10, "Spreading and Finishing."

401.03.15 SURFACE TOLERANCES: Surface tolerances will be specified under the respective sections of bituminous pavement.

401.03.16 SURFACING MISCELLANEOUS AREAS: Surfacing of road approaches and connections, street intersection areas, frontage roads, island areas, sidewalks, dikes, curbs, gutters, gutter flares, ditches, downdrains, spillways, aprons at the ends of drainage structures, and other designated areas outside the travelled way shall conform to the provisions specified in these specifications.

The combined aggregate grading for bituminous mixtures placed on miscellaneous areas shall conform to that specified for the bituminous mixture placed on the travelled way, except the aggregates used in the construction of island areas and dikes shall be constructed of aggregate conforming to the requirements of Plantmix Surface Aggregate, Type 3. The amount of bituminous material used in the bituminous mixture placed in dikes, gutters, gutter flares, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the travelled ways shall be increased not less than one (1) percent by weight of the aggregate over the amount of bituminous material used in the bituminous mixture placed on the travelled way. Submittal of a revised job-mix formula will not be necessary.

The bituminous mixture placed in island areas, sidewalks, dikes, gutters, gutter flares, ditches, downdrains, spillways, aprons at the end of drainage structures, and other designated areas outside the travelled way may be spread in one layer. The material shall be compacted to the required lines, grades, cross section, and density.

Dikes shall be shaped and compacted with an extrusion machine or other equipment capable of shaping and compacting the material to the required correct grade and cross section.

METHOD OF MEASUREMENT

401.04.01 MEASUREMENT: The quantity of bituminous plantmix to be measured for payment shall be the number of tons used in the accepted work, and will be determined by weighing the completed mixture of aggregate, mineral filler if required, and bituminous material.

The quantity of shoulder dikes constructed of bituminous plantmix to be measured for payment shall be the number of linear feet (meters) and will be determined from measurement taken along the top of the completed dikes to the nearest one (1) foot (meter) length.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantity." Batch weights will not be permitted as a method of measurement unless the alternate provisions of Subsection 401.03.01(b)1, "Plant Scales," are met, in which case the cumulative weight of all the acceptable batches will be used for payment.

Due to possible variations in the specific gravity and voids of the payment, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

BASIS OF PAYMENT

401.05.01 PAYMENT: All accepted work and materials measured as prescribed above will be paid for as provided in the representative sections for each type specified.

Full compensation for furnishing and applying bituminous material or asphaltic emulsion as provided for in Subsection 401.03.06, "Preparation of Existing Surface" including "Tack Coat" and 401.03.14, "Joints" shall be considered as included in the contract price paid for the principal items involved and no further compensation will be allowed.

When bituminous plantmix, Type III, is used in the construction of island areas, or dikes, and there is no separate payment for said mixture, this bituminous plantmix shall be included in the payment for plantmix bituminous surface of the major type shown in the list of bid items and the proposal.

SECTION 402

PLANTMIX BITUMINOUS SURFACE

DESCRIPTION

402.01.01 GENERAL: This work shall consist of constructing one or more courses of bituminous pavement on a prepared base in accordance with these specifications, and in conformity with the lines, grades, thickness, and typical cross sections shown on the plans or established by the Engineer. The prepared base shall be prime coated or tack coated as specified in Section 405 and 406 prior to the placement of any plantmix bituminous surface. The cured prime coat shall have no raw asphalt exposed and shall be cleaned of all loose material.

The requirements of Section 401, "Plantmix Bituminous Pavements - General" shall be applicable to this work, except as hereinafter specified.

MATERIAL

402.02.01 GENERAL: The material shall conform to the requirements as specified in Subsections 401.02.01 through 401.02.04, inclusive, of Section 401, "Plantmix Bituminous Pavements - General."

CONSTRUCTION

402.03.01 GENERAL: The construction requirements shall conform to the requirements as specified in Subsections 401.03.01 through 401.03.15, inclusive, of Section 401, "Plantmix Bituminous Pavements - General," with the exception contained in the following two subsections.

402.03.02 SPREADING AND FINISHING: Unless otherwise specified, bituminous plantmix surface shall be placed in courses not exceeding four (4) inches (100 millimeters) in compacted thickness. When more than one course is placed, the courses shall be of approximately equal thickness.

Bituminous plantmix surface to be placed on shoulders and other areas of the travelled way having a width of eight (8) feet (2.4 meters) or more, shall be spread as specified in Subsection 401.03.10, "Spreading and Finishing." When the areas are less than eight (8) feet (2.4 meters) in width the material may be deposited and spread in one or more layers by other mechanical means that will provide a uniform smoothness and texture. Stockpiling bituminous mixture on contiguous pavement that might be stained thereby will not be permitted.

402.03.03 SURFACE TOLERANCES: The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. When a straightedge ten (10) feet (3 meters) long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than one quarter inch (6 millimeters) from the lower edge of the straightedge.

The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than one quarter inch (6 millimeters) are present when tested with a straightedge ten (10) feet (3 meters) long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot (3.6 meters) traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor.

METHOD OF MEASUREMENT

402.04.01 MEASUREMENT: Plantmix bituminous surface will be measured as specified in Subsection 401.04.01, "Measurement."

BASIS OF PAYMENT

402.05.01 PAYMENT: The accepted quantity of plantmix bituminous surface will be paid for at the contract unit price bid per ton (metric ton) of plantmix bituminous surface, which price shall include all asphalt cement.

The above prices shall be full compensation for furnishing all the material, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous surface as shown on the plans or established by the Engineer.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Partial payments for plantmix bituminous surface may be made as set forth under Subsection 109.06, "Partial Payments."

Payment will be made under:

PAY ITEM

PAY UNIT

Plantmix Bituminous Surface	Ton (Metric Ton)
Plantmix Bituminous Shoulder Dikes	Linear Foot (Linear Meter)

SECTION 403

PLANTMIX BITUMINOUS OPEN-GRADED SURFACE

DESCRIPTION

403.01.01 GENERAL: This work shall consist of placing plantmix bituminous open-graded surface in one course in accordance with these specifications and in conformity with the lines, grades, thickness, and the typical cross sections shown on the plans or established by the Engineer. This shall not be started until the Contractor has completed all motor patrol and power loader equipment work or any other work that could scar or mar the finished open-graded surface.

The requirements of Section 401, "Plantmix Bituminous Pavements - General," shall be applicable to this work, except as hereinafter specified.

MATERIALS

403.02.01 GENERAL: The materials shall conform to the requirements as specified in Subsections 401.02.02 and 401.02.04, "Plantmix Bituminous Pavements - General."

403.02.02 COMPOSITION OF MIXTURE: The plantmix open-graded mixture shall be composed of aggregates and bituminous material as described in these specifications.

Before starting work, the Contractor shall submit a proposed job-mix formula in writing for use by the Engineer in setting the job-mix formula to be used. The proposed job-mix formula shall be determined by a testing laboratory under the direction and control of a Registered Professional Engineer based on tests required to determine the gradation and surface capacity for coarse aggregate. The initial design asphalt content for open-graded mixes shall be determined in accordance with applicable sections of California Testing Method 303, latest edition (State of California, Department of Transportation, Manual of Test Volume 2), except that the formula shall be:

$$\text{Asphalt content, percent by weight of total mix} = 2.0(K_c) + 4.$$

Modifications in the asphalt content will be made by the Engineer as necessary based on field observations made during construction.

Test reports for determination of the job-mix formula shall include the following information:

- (A) Aggregate Gradation
- (B) Surface Capacity, K_c

The grade of asphalt to be used for all mixes shall be AC-30 or AC-20P as specified in Subsection 703.03.02 unless otherwise stipulated in the Special Provisions.

The formula submitted shall propose definite single values for:

- (A) The percentage of aggregate passing each specified sieve.
- (B) The percentage of bitumen to be added (to 0.1 percent)
- (C) The temperature of the mixture leaving the mixer.

The temperature of the open-graded mixture at the hopper of the paver shall conform to the following table, except the temperature shall not be more than 20°F (11°C) lower than the temperature of the completed mixture leaving the plant.

**TEMPERATURES OF PLANTMIX BITUMINOUS OPEN-GRADED MIXTURES
AT THE PAVER**

Grade of Asphalt Cement	Minimum	Maximum
AC-30	225°F 107°C	275°F 135°C
AC-20P	280°F 138°C	350°F 177°C

The mixture furnished shall conform to the job-mix formula within the following range of tolerances:

Aggregate passing the No. 4 and larger sieves	±7%
Aggregate passing the No. 8 sieve	±4%
Aggregate passing the No. 200 sieve, not exceed	3%
Bitumen Content	±0.3% of volume or batch weight of aggregate

Should there be a change in sources of materials, a new job-mix formula shall be established before the new mix is used.

The temperature of the bituminous material just prior to mixing shall conform to the requirements of Subsection 401.02.01.

CONSTRUCTION

403.03.01 GENERAL: The construction requirements shall conform to the requirements as specified in Subsections 401.03.01 through 401.03.15, inclusive of Section 401, "Plantmix Bituminous Pavements - General," with the exceptions contained in the following three Subsections.

403.03.02 ROLLERS: There shall be operating with each paver two (2) tandem rollers weighing not less than eight (8) nor more than ten (10) tons (7.25 nor more than 9 metric tons). When two (2) pavers are paving in echelon, within four hundred (400) feet (122 meters) of each other, no additional rollers will be required, and generally not over two passes will be required.

403.03.03 JOINTS: Longitudinal joints shall be constructed only on the shoulders, or at the edge of travel lanes.

403.03.04 SURFACE TOLERANCES: The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. When a straightedge ten (10) feet (3 meters) long is laid on the finished surface and parallel with the centerline of the highway, the surface shall not vary more than one quarter inch (6 millimeters) from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than one quarter inch (6 millimeters) are present when tested with a straightedge ten twelve (12) feet (3.7 meters) long laid in a direction transverse to the centerline and extending from edge to edge of a twelve (12) foot (3.7 meters) traffic lane.

Any ridges, indentations, or other objectionable marks left in the surface of the bituminous mixture by blading or other equipment shall be eliminated by rolling or other means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the bituminous mixture shall be discontinued and other acceptable equipment shall be furnished by the Contractor..

METHOD OF MEASUREMENT

403.04.01 MEASUREMENT: Plantmix bituminous open-graded surface will be measured as specified in Subsection 401.04.01, "Measurement," or if the contract documents specify payment by area, the quantity of Plantmix Bituminous Surface to be measured for payment shall be the number of square yards (square meters), including the asphalt cement, used in the accepted work.

BASIS OF PAYMENT

403.05.01 PAYMENT: The accepted quantity of plantmix bituminous open-graded surface will be paid for at the contract price bid per square yard (square meter) of plantmix bituminous open-graded surface, which price shall include the bituminous material (asphalt cement) or it will be paid for at the contract unit price bid per ton (metric ton) which price will include the cost of all bituminous material (asphalt cement).

The above prices shall be full compensation for furnishing all the materials, mixing, loading, hauling, placing, compacting, and incidentals necessary for doing all the work involved in constructing plantmix bituminous open-graded surface as shown on the plans or established by the Engineer.

All payments will be made in accordance with Subsection 109.01, "Scope of Payment."

Partial payments for plantmix bituminous open-graded surface may be made as set forth under Subsection 109.06, "Partial Payments."

Payment will be made under:

PAY ITEM

PAY UNIT

Plantmix Bituminous Open-Graded Surface	Square Yard (Square Meter)
Plantmix Bituminous Open-Graded Surface	Ton (Metric Ton)

TABLE I

Class of Concrete	Cement Range Sacks Per Cubic Yard	Kg. Per Cubic Meter	Coarse Agg. Size No.	Max. Water Gallons Per Sack Cement*	Liters Per Kg.	Min. Compressive Strength (28 Day) PSI	Min. Compressive Strength (28 Day) Mpa	Slump Range Inches** ASTM C 143	Centimeters	Unit Air Range %	Weight Variation Pounds	Kg.	Use
A	6.0 - 7.5	334 - 419	467	6	0.53	3000	20.7	1 - 4	2.5 - 10	--	±3	1.4	General use and reinforced structures
AA	6.0 - 7.5	334 - 419	467	6	0.53	3000	20.7	1 - 4	2.5 - 10	4 - 7	±3	1.4	
B	5.5 - 7.5	307 - 419	467	6	0.53	3000	20.7	1 - 5	2.5 - 12.5	--	±3	1.4	Massive or lightly reinforced sections
BA	5.5 - 7.5	307 - 419	467	6	0.53	3000	20.7	1 - 4	2.5 - 10	4 - 7	±3	1.4	
C	5.0 - 6.5	279 - 363	357	6.75	0.60	2500	17.2	1 - 5	2.5 - 12.5	--	±3	1.4	Massive unreinforced and backfilled
CA	5.5 - 7.0	307 - 391	357	5.75	0.51	2500	17.2	1 - 5	2.5 - 12.5	4 - 7	±2	1.4	
D	6.0 - 7.5	334 - 419	67	6	0.53	3000	20.7	1 - 4	2.5 - 10	--	±3	1.4	Thin reinforced sections
DA	6.0 - 8.0	334 - 446	67	6	0.53	3000	20.7	1 - 4	2.5 - 10	4 - 7	±3	1.4	handrails, etc.
E	6.0 - 7.5	334 - 419	57	6	0.53	3000	20.7	1 - 4	2.5 - 10	--	±3	1.4	Reinforced sections
EA	6.0 - 8.0	334 - 446	57	6	0.53	3000	20.7	1 - 4	2.5 - 10	4 - 7	±3	1.4	curbs, etc.
PAA	6.0 - 8.0	334 - 446	67	6	0.53	Specified on Plans	--	0 - 4	0 - 10	Specified on Plans	±3	1.4	Prestressed Members
Modified A & AA	6.0 - 8.0	334 - 446	467	6	0.53	Specified on Plans	--	1 - 4	2.5 - 10	4 - 7 (AA only)	±3	1.4	Where specified on plans
Modified D & DA	6.0 - 8.0	334 - 446	67	6	0.53	Specified on Plans	--	1 - 4	2.5 - 10	4 - 7 (DA only)	±3	1.4	Where specified on plans

* NOTE: Based on aggregate in a saturated dry condition.

** NOTE: When the deck of a structure is used as a riding surface, the slump shall conform to that specified in Subsection 409.03.01, "Classification and Proportions." The difference in slump, determined by comparing slump tests on two samples of mixed concrete for each individual batch tested, shall not exceed two (2) inches (5) centimeters. When the difference in slump does exceed two (2) inches (5) centimeters, procedure and equipment used in producing the concrete shall be adjusted to reduce the difference in slump to not more than two (2) inches (5) centimeters).

Samples will not exceed five hundred (500) pounds (200 kilograms) for each separate grading.

Before beginning concrete work, the Contractor shall submit in writing to the Engineer the proposed concrete mix design giving the cement factor in sacks per cubic yard (cubic meter) indicating the proportions of cement, water, admixtures and the gradation of the primary aggregate nominal sizes which he proposes to furnish. When the primary coarse aggregate is separated into two sizes, the gradation shall consist of the gradation for each individual size, and the proposed proportions of each individual size, combined mathematically with the fine aggregate to indicate one proposed gradation. Such gradation shall meet the grading requirements shown in the following table. (Not applicable to light-weight concrete). If the Contractor proposes to use an admixture other than an air-entraining agent, he shall state its complete brand name and the quantity proposed to be used per sack of cement.

GRADING LIMITS OF COMBINED AGGREGATES

Sieve Size	Percent Passing	
	1½" Maximum	¾" Maximum
2	100	---
1-1/2	87-100	---
1	65-90	100
¾	48-82	80-100
3/8	39-58	46-70
4	30-45	34-50
8	23-38	24-42
16	15-33	17-34
30	8-24	10-25
50	4-13	5-15
100	1-5	2-7
200	0-3	0-3

Portland cement concrete shall be proportioned using the aggregates tested such that the compressive strength requirements in Table 1 of this subsection will be satisfied. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions.

Batches of concrete shall not vary more than $\pm$ three (3) pounds per cubic foot ($\pm$ 48 kilograms per cubic meter) in unit weight from design mix. The cement factor of any individual batch placed in the work shall not be more than 0.15 sack per cubic yard less, nor more than 0.25 sack per cubic yard (8.4 kilograms per cubic meter less or 14.0 kilograms per cubic meter more) greater than the designated factor (sacks of cement per cubic yard) (kilograms of cement per cubic meter). The weights used may be varied as necessary to comply with the above tolerances in cement factor and unit weight.

501.03.05 PROPORTIONING METHODS: Except as hereinafter noted, aggregate bins shall conform to either (a) or (b) as follows:

- (a) Each specified size of aggregates shall be stored in a separate bin. Except as hereinafter specified, each bin shall be provided with an individual outlet gate, designed and constructed to prevent leakage when closed. The gates shall cut off quickly and completely.

CORRUGATED METAL PIPE AND METAL ARCH PIPE

604

Payment will be made under:

PAY ITEM	PAY UNIT
(Size) Corrugated Metal Pipe (type)	Linear Foot (Meter)
(Size) Corrugated Metal Pipe (type) Jacked	Linear Foot (Meter)
(Size) Relay Culvert Pipe (type)	Linear Foot (Meter)
(Size) Corrugated Metal Arch Pipe (type)	Linear Foot (Meter)
(Size) Corrugated Metal Siphon Pipe (type)	Linear Foot (Meter)
(Size) Corrugated Metal Slotted Pipe (type)	Linear Foot (Meter)
(Size) Corrugated Metal End Section (type)	Each
(Size) Corrugated Metal Arch End Section (type)	Each

SECTION 605

THERMOPLASTIC PIPE CULVERTS

DESCRIPTION

605.01.01 GENERAL: This work shall consist of furnishing and installing thermoplastic pipe culverts, storm drains, and conduits of the size, dimensions and at locations shown on the plans or established by the Engineer and in accordance with the requirements of these specifications.

MATERIALS

605.02.01 GENERAL: Materials and their use shall conform to the applicable requirements of Subsection 601.02.01 of Section 601, "Pipe Culverts - General," and in addition thereto, the following requirements shall apply.

Thermoplastic pipe shall be, at the option of the Contractor, either corrugated polyethylene pipe (Type S, Type D, or Type C), ribbed profile wall polyethylene pipe, or ribbed profile or solid wall polyvinyl chloride pipe, except that corrugated polyethylene pipe (Type C) may be used only at locations designated on the plans.

HDPE flared end sections shall conform to the details and dimensions shown on the plans and except for shape, shall conform to the requirements of this section for corrugated polyethylene pipe culverts.

CONSTRUCTION

605.03.01 GENERAL: Construction methods shall conform to the requirements of Subsections 601.03.01 through 601.03.06 of Section 601, "Pipe Culverts - General," and in addition thereto shall meet the requirements in the following subsections.

605.03.02 LAYING CULVERT PIPE: All pipes shall be laid upgrade, unless otherwise permitted by the Engineer.

All pipes shall be laid true to the designated line, grade, and camber.

The bottom of the trench shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of the pipe. Blocking shall not be used to bring the pipe to grade.

Joints for non-pressure pipe shall be specified on the plans per the following table:

Pipe Type	Joint Type	Description	Test Pressure	Application
CHDPE (S,C)	1	Corr. Split Band	0	Culvert, drainage
CHDPE (D), (S)	2	Bell/Spig. O-Ring	5 psi	Storm, Sanitary, Irrig.
RHDPE, RPVC				
SWPVC, CHDPE	3	Bell/Spig. O-Ring	10.8 psi	Storm, Sanitary, Irrig.

605.03.03 JUNCTIONS: All junctions of laterals with a main line or junctions of two or more main lines, which are not made in a manhole or concrete junction structure, shall be in a manufactured wye or tee of the same material as the conduits to which they are joined, and shall have the same or greater stiffness as the pipe.

605.03.04 DEFLECTION TESTING: After the thermoplastic pipe has been installed, the Engineer may require that a deflection test be made. The Contractor may request the deflection test be performed before a minimum 30 days has elapsed. In this case, the pipe shall have been in place from 7 through 29 days. Any deflection in excess of 7-1/2 percent after 30 days, or if requested by the Contractor, 5 percent after 7 through 29 days, of the base inside diameter shall be corrected at the contractor's cost. The use of a rerounding machine will not be permitted.

After the pipe has been bedded and backfilled to subgrade level for the selected period of time, the line may be cleaned and tested for deflection with a certified "go, no-go" mandrel or other devices, including but not limited to, electronic deflectometers and calibrated television or video cameras, subject to approval by the Engineer. If the deflection test fails, the pipe shall be removed, reinstalled, and retested. Any pipe found to be damaged shall not be reinstalled.

All deflection testing shall be at the Contractor's expense.

605.04.01 MEASUREMENT: Method of measurement shall conform to the requirements of Subsection 601.04.01, "Measurement" and in addition thereto, the following requirements shall apply.

The quantity of HDPE end sections for culvert pipe measured for payment will be the number of units of each size of each class complete and in place.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

605.05.01 PAYMENT: Payment shall conform to the requirements of Subsection 601.05.01, "Payment," and in addition thereto, the following requirements shall apply.

The accepted quantities of thermoplastic pipe, measured as specified in Subsection 605.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot (meter) for the types and sizes specified. End sections will be paid for at the contract unit price bid per each for the kind and size specified which shall include structure excavation and backfill for the end sections.

Compensation for supplying certified mandrels or other deflection testing devices shall be considered to be included in the contract unit price paid for the appropriate thermoplastic pipe item and no separate payment will be made therefor.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Payment will be made under:

PAY ITEM

PAY UNIT

(Size) Thermoplastic Pipe (type)	Linear Foot (Meter)
(Size) Thermoplastic Pipe End Section (type)	Each

SECTION 606

STRUCTURAL PLATE PIPE AND PIPE ARCH CULVERTS

DESCRIPTION

606.01.01 GENERAL: This work shall consist of furnishing and installing structural plate pipe and pipe arch culverts conforming to the requirements of these specifications, and of the sizes and dimensions required in the plans, and installing such structures at locations designated in the plans or established by the Engineer, and in conformity with the lines and grades established by the Engineer. The work shall also include the reinstallation of salvaged structural plate pipe and pipe arch culverts.

Plates for a pipe arch shall form a cross section made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis. The top shall be an arc of not more than one hundred eighty (180) degrees nor less than one hundred fifty-five (155) degrees. The bottom shall be an arc of not more than fifty (50) degrees nor less than ten (10) degrees. The top shall be joined at each end to the bottom by an arc having a radius between sixteen (16) and twenty-one (21) inches (41 and 53 centimeters) and of not more than eighty-seven and one-half (87-1/2) degrees nor less than seventy-five (75) degrees.

MATERIAL

606.02.01 GENERAL: Materials meeting the requirements of AASHTO Designation M 167, "Structural Plate Pipe and Pipe Arches."

If called for in the bid schedule, plates for pipes and pipe arches shall be bituminous coated in accordance with AASHTO Designation M 190, Type A, B or C.

When bituminous coating is applied to plates for structural steel plate pipe, arches and pipe arches, each plate shall have the thickness painted on the inner surface so that the plate thickness can be readily identified.

The portion of nuts and bolts, used for assembly of bituminous coated structural steel plate pipes, arches and pipe arches outside the pipe shall be bituminous coated after installation. The portion of the nuts and bolts inside the pipe need not be bituminous coated.

Damaged bituminous coating shall be repaired by the Contractor by applying bituminous material conforming to the provisions of AASHTO Designation M 190 or other approved material.

The bottom plates of structural plate pipes and arches shall be one gage heavier than the gage specified in the bid schedule, which will apply to top and side plates. When gage one (1) is specified, the bottom plates shall also be gage one (1).

Plates shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHTO Designation M 36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL-P-15145. The paint shall be properly compounded in a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

Planned lengths and sizes are approximate. The Contractor shall not order and deliver the plates until a list of sizes and lengths is furnished him by the Engineer.

SECTION 609

CATCH BASINS, MANHOLES, AND INLETS

DESCRIPTION

609.01.01 GENERAL: This work shall consist of constructing or reconstructing catch basins, manholes, inlets, and similar structures, consisting of Portland cement concrete with necessary reinforcement, metal frames, grates, and lids, including required excavation and backfilling.

MATERIALS

609.02.01 GENERAL: Materials shall conform to the requirements specified in the following sections:

Portland Cement Concrete	Section 501
Reinforcing Steel	Section 505
Miscellaneous Metals.	Section 712
Gray Iron Castings	Subsection 712.03.02

Portland cement concrete shall be Class A or Class AA unless otherwise provided.

Casting shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting strength and value for the service intended. Casting shall be boldly filletted at angles and the arises shall be sharp and perfect. Casting shall be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface.

The Contractor shall obtain from the fabricator of the structural steel grates, frames, and gray iron castings a Certificate of Compliance stating that the fabrications meet the requirements of these specifications, and giving certified shop weights for the fabrications.

Mortar for setting grates shall be mixed in the proportions of one part cement to three parts of fine aggregate.

Pipe crossbars for drop inlets shall be unpainted standard weight black pipe conforming to the requirements of ASTM Designation A 53 or A 120. Straps shall be unpainted A 36 steel.

CONSTRUCTION

609.03.01 GENERAL: Catch basins, inlets, and manholes shall be constructed in accordance with all of the requirements of Section 501, "Portland Cement Concrete." Inlet and outlet pipes shall be placed prior to pouring concrete.

Grates shall be set in full mortar beds or otherwise secured as shown on the plans. Grates shall be set accurately to the final elevations so that no subsequent adjustments will be necessary. Concrete covers, when indicated on the plans, shall be constructed in such manner that they will fit snugly and be readily removable. Structural steel grates shall be painted as specified in Section 614, "Painting."

Rev. February 9, 1995

Pipe or tile placed in masonry for inlet or outlet connections shall extend through the walls and beyond the outside surfaces of the walls a sufficient distance to allow for connections with conduit and the masonry shall be carefully constructed around them so as to prevent leakage around their outer surfaces.

Commercially prefabricated frames and grates of equal or greater capacity and strength may be substituted for the design shown on the plans for drop inlets provided prior approval is obtained in writing from the Engineer.

Frames and grates shall be matchmarked in pairs before delivery to the work and grates shall fit into their frames without rocking.

609.03.02 ADJUSTING CATCH BASIN, MANHOLE, AND INLET COVERS: Unless otherwise provided on the plans or by the contract, existing covers, including frames, grates, or lids shall be adjusted to the required elevation by removing such existing covers and adjusting the top of the existing structures by removing or adding concrete, brick masonry or concrete block masonry, or by using steel or cast iron adaptor rings, as the case may be, reinstalling the fixtures by supporting them on a satisfactory collar of Class A concrete constructed as to hold them firmly in place.

609.03.03 CLEAN OUT: All catch basins, manholes, inlets, and similar structures shall be thoroughly cleaned of any accumulations of silt, debris, or foreign matter of any kind, and shall be clean of such accumulations at the time of final inspection.

609.03.04 EARTHWORK: Structure excavation and structure backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Backfill."

METHOD OF MEASUREMENT

609.04.01 MEASUREMENT: The quantities of castings and structural steel grates measured for payment will be the number of pounds (kilograms) complete and in place. The weight of castings shall be computed from the dimensions shown on the approved shop drawings assuming the cast iron to weigh four hundred fifty (450) pounds per cubic foot (7.2 grams per cubic centimeter), with an allowance of ten (10) percent for fillets and overrun. The weight of structural steel grates shall be computed from the dimensions shown on the approved shop drawings, in accordance with Section 506, "Steel Structures." Certified shop weights will be acceptable in lieu of computed weights.

Adjusting covers for catch basins, manholes, and inlets will be measured per each complete and in place.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

Pipe crossbars and straps for drop inlets shall be included in the measurement for payment by the contract bid price per pound (kilogram) for Structural Steel Grates.

BASIS OF PAYMENT

609.05.01 PAYMENT: The accepted quantities of grates measured as provided in Subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per pound (kilogram) for types and sizes specified.

The work for adjusting covers measured as specified in Subsection 609.04.01, "Measurement," will be paid for at the contract unit price bid per each for adjusting covers for catch basins, manholes, and inlets, which price shall be full compensation for furnishing all materials, tools, incidentals, and labor required to adjust the covers.

Portland cement concrete used in new structures of catch basins and inlets will be paid for as specified in

Section 502, "Concrete Structures."

Reinforcing steel in catch basins and inlets will be paid for as specified in Section 505, "Reinforcing Steel."

The accepted quantity of precast manholes measured as provided in Subsection 609.04.01, "Measurement" will be paid for at the contract unit price bid per each for types and sizes specified. This price shall be full compensation for furnishing all materials including structure excavation and structure backfill, Portland cement concrete, steel, castings, and incidentals necessary to complete the work.

Structure excavation and structure backfill for catch basins and inlets will be paid for as specified in Section 206, "Structure Excavation" and 207, "Backfill."

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Payment will be made under:

PAY ITEM**PAY UNIT**

Castings	.Pound (Kilogram)
Structural Steel Grates	.Pound (Kilogram)
(Size) Precast Reinforced Concrete Manhole (type)	.Each
Adjusting Covers.	.Each

SECTION 610
SLOPE AND CHANNEL PROTECTION

DESCRIPTION

610.01.01 GENERAL: This work shall consist of constructing slope and channel protection structures to the lines and grades established by the Engineer using riprap or wire mesh gabions in accordance with the design shown on the plans and these specifications.

Riprap construction shall consist of furnishing and placing riprap (with or without grout), or sacked Portland cement concrete riprap, as the case may be.

Wire mesh gabion construction shall consist of furnishing, assembling, tying, and filling open mesh wire baskets with stone.

MATERIALS

610.02.01 GENERAL: All materials shall conform to the requirements specified in the following sections:

Water	Section 722
Stone for Masonry and Riprap.	Subsection 706.03.05
Portland Cement.	Section 701
Grout and Mortar Sand.	Subsection 706.03.04

When so provided and with prior approval of the engineer, crushed concrete may be substituted for the above designated stone. In such a case, the concrete shall be sound and meet all requirements as specified for stone.

610.02.02 GROUT: Grout shall be composed of one part by volume of Portland cement and three parts by volume of sand and shall be of such consistency that it will fill all voids in the riprap.

610.02.03 SACKED CONCRETE: Sacked concrete shall be composed of sacks filled with Portland cement concrete. The mixed concrete shall contain a minimum of three hundred seventy-six (376) pounds (170 kilograms) (four sacks) of Portland cement per cubic yard. The amount of water added at the time of mixing shall be such as will produce a mixture with a slump of from three (3) inches (75 millimeters) to five (5) inches.

Unless otherwise provided in the special provisions, aggregate for use in sacked concrete riprap shall consist of river run material of a sandy, gravelly nature, clean and free from roots, vegetable matter, and other deleterious substances. When tested on laboratory sieves, river run material shall conform to the following grading requirements.

Passing a 2-inch (50 millimeters) Sieve.	80 to 100 Percent
Passing a No. 200 Sieve.	0 to 4 Percent

Sacks for concrete riprap shall be made of at least 10 ounce (285 gram) burlap, and shall be approximately 19 1/2 x 36 inches (495 x 915 millimeters) measured inside the seams when the sack is laid flat. The capacity of each sack shall be approximately 1.25 cubic feet (35 liters). Sound reclaimed sacks may be used.

610.02.04 STONES FOR RIPRAP: Stones used for riprap shall be hard, durable, angular in shape, resistant to weathering and erosion, and free from spoils, cracks and organic matter. The stone should be crushed (rounded stone should be avoided) with neither width nor thickness of a single stone less than one-third its length. The specific gravity of the riprap shall not be less than 2.45. The nominal stone size shall be as follows:

Riprap

D₁₅ shall be a minimum of 6 inches.

D₅₀ shall be a minimum of 12 inches.

D₈₅ shall be a minimum of 18 inches.

Heavy Riprap

D₁₅ shall be a minimum of 9 inches.

D₅₀ shall be a minimum of 18 inches.

D₈₅ shall be a minimum of 24 inches.

This stone shall conform to the following requirements:

Source Requirements	Test Method	Requirements
Percent of Wear (500 rev)	ASTM C 131	45% Maximum
Bulk Specific Gravity	ASTM C 127	2.5 Minimum

Control of gradation will be by visual inspection. Upon request by the Engineer the Contractor shall provide a sample of stone of at least 5 tons (4.54 metric tons) meeting the gradation for each location riprap is indicated. Each sample shall be located at the construction site near the location where the riprap is to be placed. The sample shall be used as a frequent reference for judging the gradation of the riprap supplied. The sample riprap shall be in place and acceptable to the Engineer before riprap placing work begins. The Contractor shall maintain the placed riprap until the project is completed and any material displaced by any cause shall be repaired to the lines and grades indicated on the plans.

Caliche stone or cementitious materials meeting the requirements of this section may be used as riprap with prior approval of the Engineer. The riprap shall be fully cemented material. Only materials designated as hard (scratches leave only dust, requires many hammer blows to break) or very hard (difficult to scratch or break), shall be utilized. Moderately hard (crumbles with several hammer blows) or partially cemented materials are not acceptable.

The Contractor may be required to provide riprap test results from an approved testing laboratory and a Certificate of Compliance in accordance with Subsection 106.05, "Certificate of Compliance".

610.02.05 STONES FOR GABIONS: Stones for filling the gabions shall be well graded, hard stones, conforming to the requirements specified in Subsection 706.03.05, "Stone for Masonry and Riprap".

Rev. September 8, 1994

Size and gradation shall be such that the predominant size is between 4 to 8 inches (100 to 200 millimeters), eighty-five percent by weight. Minimum stone dimensions shall be 3 inches (75 millimeters) and maximum stone dimension shall be 8 inches (200 millimeters). For gabion baskets less than 1 foot (0.3 meters) in height, the maximum stone dimension shall be 6 inches (150 millimeters).

610.02.06 FILTER MATERIAL: When filter material is specified or shown on the plans, it shall consist of mineral aggregate that is clean, hard, durable, and free of any deleterious matter or harmful adherent coatings. Gradation of the filter material shall conform to the requirements specified by the Engineer, or as shown in the special provisions.

610.02.07 FILTER FABRIC: When filter fabric is specified or shown on the plans, it shall consist of a geotextile that is made from synthetic fibers. The filter shall conform to the requirements specified by the Engineer or as outlined in the special provisions.

610.02.08 WIRE MESH GABIONS: Wire mesh gabions shall be fabricated from either twisted wire mesh or welded wire mesh. Only one type of wire mesh may be used in any one structure.

Gabion dimensions of width, height, and length shall be as shown on the plans. Each gabion unit shall not vary more than five percent from the dimensions shown on the plans.

Where the length of the gabion basket exceeds its width, the basket shall be equally divided into cells equal to or less than the basket width using diaphragms of the same type and size mesh as the basket panels. Each basket shall be prefabricated with the necessary panels and diaphragms secured to the base in such a manner that no additional tying at this juncture is required.

Fabrication of the wire mesh gabion baskets shall be as follows:

(a) **Twisted Wire Mesh Panels**

Gabion panels of the twisted mesh style shall be manufactured from galvanized steel wire, Class 3, soft temper, conforming to ASTM A641, or from aluminized steel wire, soft temper, conforming to ASTM A809. The wire shall have a minimum tensile strength of 60,000 psi (415 MPa) when tested in accordance with ASTM A370.

The mesh shall be formed with non-raveling double twists by twisting each pair of wires through two 360 degrees turns. The mesh openings shall be hexagonal in shape and uniform in size, with the maximum line dimension of any hexagonal opening not to exceed 5 inches (125 millimeters), and the maximum area of any mesh opening not to exceed 10 square inches (6450 square millimeters).

All perimeter edges of the mesh panels forming the gabion basket shall be securely tied to a selvage wire so that the selvage is at least the same strength as the body of the mesh. Selvage wire shall be the same kind and type of material used for the mesh.

When specified by the Engineer, the galvanized or aluminized wire shall be coated with a polyvinyl chloride (PVC) material. The coating shall be accomplished by using either extruded or extruded and bonded PVC material, and shall be applied prior to twisting the wire into mesh panels.

All wire used shall meet the following nominal diameter requirements:

<u>Type of Basket</u>	<u>Mesh Wire</u>	<u>Selvedge Wire</u>
Baskets 1 foot (0.3 meter) or greater in height	0.120 inch (3.05 mm)	0.148 inch (3.76 mm)
Baskets 1 foot (0.3 meter) or greater in height with PVC coating	0.106 inch (2.69 mm)	0.134 inch (3.40 mm)
Baskets less than 1 foot (0.3 meter) in height	0.087 inch (2.21 mm)	0.106 inch (2.69 mm)
Baskets less than 1 foot (0.3 meter) in height with PVC coating	0.087 inch (2.21 mm)	0.106 inch (2.69 mm)

(b) **Welded Wire Mesh Panels**

Gabion panels for the welded mesh style shall be manufactured from welded wire fabric conforming to ASTM A185, except that the welded joints of the wire mesh shall have a minimum shear strength of 600 pounds (2.7 kilonewtons).

Galvanized wire shall have a Class 3 coating as indicated in ASTM A641. Aluminized wire shall have a minimum coating as indicated in ASTM A809. The wire shall have a minimum tensile strength of 60,000 psi (415 MPa) when tested in accordance with ASTM A370.

The mesh shall form a square or rectangular grid pattern, and the maximum diagonal dimension of any grid opening shall not exceed 4 3/4 inches (120 millimeters).

When specified by the Engineer, the welded wire mesh shall be coated with a polyvinyl chloride (PVC) material. The PVC coating shall be fusion bonded to the galvanized or aluminized wire after fabrication of the gabion basket.

All wire used shall conform to the following size numbers in accordance with ASTM A82:

<u>Type of Basket</u>	<u>Wire Size Number</u>
Baskets greater than 1.5 feet (0.5m) in height	W1.2 or W1.7 (11-gage) (9-gage)
Baskets 1.5 feet (0.5m) or less in height	W1.2 (11-gage)

For polyvinyl chloride (PVC) coated gabions, the wire coating shall have a nominal thickness of 0.020 inches (0.51 mm) and a minimum thickness of 0.015 inches (0.38 mm). The coating shall be colored black, grey, or silvery, and conform to the following:

- Abrasion Resistance, ASTM D1242
Maximum weight loss. 0.19 gram
- Salt Crock, ASTM G8
Maximum disbondment diameter
90 days, 1.5 volts, 3% solution. 45 mm
- Chemical Resistance, ASTM G20
Coating loss after 45 days at 21°C,
3 molar CaCl, 3 molar NaOH,
Saturated Ca(OH)₂. No Coating Loss
- Weatherometer, ASTM G23
Minimum hours to surface chalk. 2,000 hours

610.02.09 INTERNAL CONNECTING WIRES: Internal connecting wires to reinforce the side panels of individual gabion baskets shall meet the same specifications as the wire used in the gabion body, excepts its nominal diameter shall be 0.087 inches (2.21 millimeters) or larger. Alternate preformed stiffeners acceptable to the gabion manufacturer and the Engineer may also be used.

610.02.10 LACING WIRE: Lacing wire to assemble individual gabion baskets, and to interconnect adjacent baskets shall meet the same specifications as the wire used in the gabion body except its nominal diameter shall be 0.087 inches (2.21 millimeters) or larger.

610.02.11 WIRE FASTENERS: As an alternative to lacing wire, wire fasteners including interlocking fasteners, overlapping ring fasteners, twist ties, and spiral binders may be used subject to the approval of the Engineer. The Contractor shall demonstrate:

- (a) The proposed fastener can consistently resist an opposed tension force of at least 600 pounds (2.7 kilonewtons) without pulling apart;
- (b) The proposed fastener system can consistently produce a joint with a strength of at least 1,400 pounds per linear foot (20.4 kilonewtons per linear meter) while encompassing the number of wires intended for its use. When PVC-coated wire is used, the joint strength shall be at least 1,200 pounds per lineal foot (17.5 kilonewtons per lineal meter);
- (c) The proposed fastener system does not cause damage to the protective coating on the wire;
- (d) The Contractor has the proper equipment and trained employees to correctly install the fasteners;
- (e) Proper installation can be readily verified by visual inspection.

The Contractor shall provide a complete description of the fastener system, including the number of fasteners required, the number and size of wires that the fastener is capable of properly joining, and a description of a

properly installed fastener, including drawings or photographs, if necessary. Properly formed fasteners shall meet the following requirements:

- (a) Each interlocking fastener shall be locked and closed.
- (b) Each overlapping ring fastener shall be closed and the free ends shall overlap a minimum of one (1) inch (25 millimeters).
- (c) Spiral binders shall be crimped to secure the spiral in place.
- (d) Twist ties shall have a minimum of five (5) complete revolutions.

If gages or other aids are needed to verify the proper installation of the fasteners, the Contractor shall furnish the Engineer such gages or aids, in such numbers as may reasonably be required. If more than one wire fastener is proposed, e.g. different gage or length of wire, for different joints, the fasteners shall be readily distinguishable. Wire fasteners shall not be used to join more wires, or larger wires, than for which they were tested and approved. As a minimum, a fastener shall be installed at intervals of 4 to 6 inches (100 to 150 millimeters) at the location where mesh wire meets selvedge or edge wire.

Galvanized wire fasteners shall be used with galvanized gabions. Aluminized wire fasteners shall be used with aluminized gabions. Stainless steel fasteners shall be used for PVC-coated gabions.

Galvanized wire fasteners, except twist tie and spiral binder fasteners, shall conform to ASTM A764 with Type III coating. Aluminized wire fasteners shall conform to ASTM A809 for wire diameter and coating, with tensile strength equal to ASTM A764, Table 2. Stainless steel wire fasteners shall conform to ASTM A313, Grade 302. Spiral binder fasteners shall be formed with wire having at least the same thickness and coating as the basket mesh. Twist tie fasteners shall meet the requirements of lacing wires as specified in Subsection 610.02.10. Use of extruded or extruded and bonded PVC-coated twist tie fasteners shall be prohibited for gabions with PVC-coated wire.

CONSTRUCTION

610.03.01 EARTHWORK: The areas where riprap or wire mesh gabions are to be placed shall be graded to the required lines and grades as shown on the plans or as directed by the Engineer. Any excavations or backfill required to achieve such grade shall conform to the provisions of Section 206, "Structure Excavation", and Section 207, "Structure Backfill".

610.03.02 FILTER PLACEMENT: Filter material shall be spread uniformly on the prepared foundation surface in a manner satisfactory to the Engineer, and to the slopes, lines, and grades as shown on the plans, or as specified by the Engineer. Placing of a filter material by methods which will tend to segregate particle sizes will not be permitted. Any damage to the foundation surface during filter placement shall be repaired before proceeding with the work. The filter materials shall be placed and placement shall be repaired before proceeding with the work. The filter materials shall be placed and finished to present a reasonable even surface free from mounds or windrows. Compaction of the filter materials shall conform to the requirements shown on the plans or as outlined in the special provisions.

Filter fabric shall be installed in accordance with the manufacturer's recommendations, and in manner that will not tear, puncture, or shift the fabric. Joining edges of the filter fabric shall be overlapped a minimum of 18 inches (460 millimeters).

Rev. September 8, 1994

610.03.03 RIPRAP: Stone for riprap shall be placed in a manner which will produce a well-graded mass of stone with a minimum percentage of voids. The entire mass of stone shall be placed in conformance with the lines, grades, and thicknesses shown on the plans. Riprap shall be placed to its course thickness in one operation and in such a manner as to avoid displacing underlying material. When filter fabric is used under the riprap, the height from which the stone is dropped shall be minimized to avoid fabric damage. Placement of stones shall begin at the bottom of the slope and proceed upward to the top.

The large stones shall be well distributed and the entire mass of stone shall conform to the gradation specified. All material placed as riprap protection shall be so placed and distributed that there will be no large accumulation of either the larger or smaller sizes of stone. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

610.03.04 GROUTED RIPRAP: When grouted riprap is specified, the stone shall be laid as set forth above for riprap. The spaces between the stones shall then be filled with grout. Sufficient grout shall be used to completely fill all voids, except that the face surface of the stone shall be left exposed. After grouting is completed, the surface shall be cured as specified in Section 502, "Concrete Structures" for a period of at least three (3) days.

610.03.05 SACKED CONCRETE RIPRAP: The sacks shall be filled with concrete, loosely placed so as to leave room for folding at the top, the fold to be just enough to retain the concrete at the time of placing. Not more than one (1) cubic foot (28 liters) of concrete shall be placed in each sack. Immediately after being filled with concrete, the sacks shall be placed and lightly trampled to cause them to conform with the earth face and with adjacent sacks in place.

The slopes on which the sacked concrete riprap is to be placed shall be finished true to line and grade. The first course shall consist of a double row of stretchers laid in a neatly trimmed trench, and the second course shall consist of a single row of headers. The third and remaining courses shall consist of stretchers and shall be placed in such a manner that joints in succeeding courses are staggered. All dirt and debris shall be removed from the top of the sacks before the next course is laid thereon. Stretchers shall be placed so that the folded ends will not be adjacent. Headers shall be placed with the folds toward the earth face. Not more than four vertical courses of sacks shall be placed in any tier until initial set has taken place in the first course of any such tier.

When, in the opinion of the Engineer, there will not be proper bearing or bond for the concrete due to delays in placing succeeding layers of sacks or due to the work having been hampered by storms or mud or for any cause, a small trench shall be excavated back of the row of sacks already in place, which trench shall be filled with fresh concrete before the next layer of sacks is laid.

Sacked concrete riprap shall be cured by covering with a blanket of wet earth or by sprinkling with a fine spray of water every two (2) hours during the daytime for a period of four (4) days.

610.03.06 WIRE MESH GABIONS: Prior to the assembly and placement of the wire mesh gabions, a representative of the manufacturer shall be present at the construction site to demonstrate the method of assembling individual baskets, the method of fastening adjacent baskets to one another, and the method of filling each basket with stone, unless otherwise specified in the special provisions. Construction of the gabion structure shall not proceed until the Engineer approves the Contractor's assembly and placement methods.

Gabion baskets shall first be assembled individually as empty units. The panels and diaphragms shall be rotated into position and joined along the edges with lacing wire or wire fasteners. When joined with lacing wire, the lacing wire shall be tightly looped at intervals of not more than 6 inches (150 millimeters) along the seams in such a manner that single and double loops are alternated. When joined with wire fasteners, the wire fasteners shall be

properly installed as specified in Subsection 610.02.11, "Wire Fasteners". For either method, there shall not be any opening greater than 2 inches (50 millimeters) (maximum line dimension) along the joined edges or at the corner of the gabion basket.

Empty gabion baskets shall be placed into position on the prepared foundation. Individually constructed empty gabion baskets shall be joined successively to the next empty gabion basket before filling with stone. Each row, tier, or layer of baskets shall be reasonably straight and shall conform to the line and grade shown on the plans or established by the Engineer. The empty gabion baskets shall be fastened to the adjacent baskets along the top and vertical edges. Each layer shall be fastened to the underlying layer along the front, back, and ends. Unless otherwise shown on the plans, the vertical joints between basket units of adjacent tiers or layers shall be staggered by at least one cell along the length of the structure.

All fastening of adjacent baskets shall be done with lacing wire or wire fasteners in order to obtain a monolithic structure. The method of fastening shall meet the same requirements as that specified for assembling individual gabion baskets.

Fastening shall be made through selvedge-to-selvedge or selvedge-to-edge wire connection. Mesh-to-mesh or selvedge-to-mesh wire connection is allowed along vertical edges or in the case where baskets are offset or stacked, and selvedge-to-mesh or mesh-to-mesh wire connection would be necessary.

Before filling each gabion basket with stone, tension may be applied to the empty baskets to achieve a uniform alignment and shall be accomplished in such a manner as to prevent any possible unraveling. The finished gabion structure shall have no gaps along the perimeter of the contact surfaces between adjoining gabion basket units.

The gabion cells shall be carefully filled with stone placed by hand and/or machine in such a manner that the alignment of the structure will be maintained so as to avoid bulges and to minimize voids. All exposed stone surfaces shall have a reasonable smooth and neat appearance. No sharp stone edges shall project through the wire mesh.

The gabion cells in any row or layer shall be filled in stages so that local deformations may be avoided. At no time shall any cell be filled to a depth exceeding 12 inches (300 millimeters) more than any adjacent cell. The maximum height from which the stone may be dropped into the basket units shall be 3 feet (1 meter).

During filling operations, internal connecting wires shall be placed in all exposed front and side gabion units in the following manner:

- (a) For gabion cells with a 36 inch (915 millimeter) height, stone shall be placed to a depth of one third (12 inches) (305 millimeters) after which a minimum of two equally spaced internal connecting wires shall be placed in each cell, connecting the front and back faces of the compartment. For corner units, internal connecting wires shall be placed in both directions. The connecting wires shall be looped around two twisted wire mesh openings, or a welded wire joint, at each basket face, and the wire terminals shall be securely twisted to prevent their loosening. This operation shall be repeated when the cell is two thirds full.
- (b) For thinner gabion cells, internal connecting wires are not required except when 18 inch (460 millimeter) baskets are used to build exposed vertical surfaces. In this case, the procedures under (a) above shall be followed, except that the internal connecting wires shall be placed at 9 inches (230 millimeters) from the base.

The layer of stone shall completely fill the gabion basket so that the lid will bear on the stone when it is secured. The lid shall be joined to the sides, ends, and diaphragms in the same manner as specified for joining the vertical

edges. The gabion basket lid shall be secured so that not more than a 1 inch (25 millimeter) gap remains at any connection.

METHOD OF MEASUREMENT

610.04.01 MEASUREMENT: The quantity of riprap, grouted riprap, and wire mesh gabions measured for payment will be the number of cubic yards (cubic meters) or square yards (square meters) complete and in place.

The quantity of sacked concrete riprap to be measured for payment will be the number of cubic yards (cubic meters) at the mixer or the number of square yards (square meters) of sacked riprap in the completed work. Only work placed within the dimensions shown on the plans or ordered by the Engineer, will be measured for payment.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

610.05.01 PAYMENT: The accepted quantities of riprap, grouted riprap, sacked concrete riprap, and wire mesh gabions measured as provided in Subsection 610.04.01, "Measurement" will be paid for at the contract unit price bid per cubic yard (per cubic meter) or square yard (square meter) for the type specified which payment shall be full compensation for furnishing and placing stone, grout, concrete, wire mesh gabions, filter material, filter fabric, and all other miscellaneous items that are appurtenant to the construction of riprap or gabion structures, including the cost incurred for a manufacturer's representative at the construction site. The above prices shall also include all excavation, grading, and backfill necessary to complete the work.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Payment will be made under:

PAY ITEM

PAY UNIT

Riprap.	Cubic Yard or Square Yard (Cubic Meter or Square Meter)
Heavy Riprap.	Cubic Yard or Square Yard (Cubic Meter or Square Meter)
Grouted Riprap.	Cubic Yard or Square Yard (Cubic Meter or Square Meter)
Sacked Riprap.	Cubic Yard or Square Yard (Cubic Meter or Square Meter)
Wire Mesh Gabions.	Cubic Yard or Square Yard (Cubic Meter or Square Meter)

SECTION 622 - BLANK

SECTION 623

TRAFFIC SIGNALS AND STREET LIGHTING

DESCRIPTION

623 G.01.01 GENERAL: Electrical work shall consist of furnishing and installing, modifying or removing traffic signals, school flashers, flashing beacon systems, street and highway lighting systems, sign illumination systems, traffic count stations, electrical equipment in structures, falsework lighting, partial installations for future systems, or combinations thereof, all as shown on the plans, and as specified in these specifications and the Special Provisions. Standard Drawings for Street Lighting and Traffic Signals shall be the "Uniform Standard Drawings, Volumes I and II."

Unless otherwise indicated on the plans or specified in the Special Provisions, all materials shall be new.

The locations of signals, beacons, standards, lighting fixtures, signs, controls, services, and appurtenances shown on the plans are approximate and the exact locations will be established by the Engineer in the field.

All materials furnished and used shall conform to the provisions in Section 106. The materials shall be manufactured, handled, and used in a manner to insure completed work in accordance with the plans, specifications, and Special Provisions.

All systems shall be complete and in satisfactory operating condition at the time of acceptance of the contract.

Where an existing system is to be modified, the existing material shall be reused in the revised system, removed, salvaged, and stockpiled or abandoned as shown on the plans, as specified in the Special Provisions or as directed by the Engineer.

623 G.01.02 REGULATIONS AND CODE: All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), and listed by Underwriters' Laboratories, Inc. (UL), or the Electronic Industries Association (EIA), wherever applicable. In addition to the requirements of the plans, these specifications, and the Special Provisions, all materials and workmanship shall conform to the requirements of the National Electrical Code (NEC); National Electrical Safety Code (NESC); Standards of the American Society for Testing and Materials (ASTM); American National Standards Institute (ANSI) manuals; International Municipal Signal Association (IMSA) cable specifications; Institute of Electronic and Electrical Engineers (IEEE); Illumination Engineering Society (IES); Rural Electrification Association (REA); Nevada Occupational Safety and Hazard Act (NOSHA); National Board of Fire Underwriters (NBFU); Uniform Standard Drawings, Clark County Area; and any local ordinance which may apply.

Wire sizes shall be indicated in American Wire Gage (AWG).

623 G.01.03 EQUIPMENT LIST AND DRAWINGS: Unless otherwise permitted in writing by the Engineer, the Contractor shall within fifteen (15) days following approval of the contract, submit to the Engineer for approval, a list of equipment and materials which he proposes to install. The list shall be complete as to name of manufacturer, size, and identifying number of each item. The list shall be supplemented by such other data as may

Rev. December 12, 1996

be required, including scale drawings of cabinets showing location and spacing of shelves, terminal blocks and equipment, including dimensioning.

All of the above data shall be submitted, in triplicate, for review. Where electrical equipment is constructed as detailed on the plans, the submission of detailed drawings and diagrams will not be required.

Where a basic controller cabinet wiring diagram is provided, circuit diagrams for detector plug connections, peripheral equipment, and external solid-state logic shall be provided.

The Contractor shall furnish five (5) blue-line and one (1) mylar reproducible set of cabinet schematic wiring diagrams 24 inches x 36 inches in size, multiple sheets may be used. The diagrams shall show the location of the installation and shall list all equipment installed in each cabinet. In addition, for each signal installation, the Contractor shall furnish an intersection sketch showing poles, detectors, field wire connection terminals and phasing as shown on the plans. The Contractor shall also furnish a minimum of five (5) operating manuals and five (5) maintenance manuals with each controller and cabinet type. The manuals shall include any and all peripheral equipment specified herein or in the Special Provisions to be installed with the controller, such as preempt system, if specified.

All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams, and all operation manuals shall be submitted at the time the controllers are delivered for testing, or, if ordered by the Engineer, previous to purchase. This diagram shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

623 G.01.04 WARRANTIES, GUARANTEES, AND INSTRUCTION SHEETS: Manufacturers warranties, guarantees, and certifications for materials used in the work and instruction sheets and parts list shall be supplied with materials and shall be delivered to the Engineer prior to acceptance of the project.

MATERIALS

623 G.02.01 CONDUIT: Underground conductors shall be installed in conduit unless otherwise specified in the Special Provisions or the drawings. Conduit shall be listed by the Underwriters' Laboratories Inc., and shall bear the U.L. label on each length.

Signal conductors and low voltage conductors shall not be installed in high voltage light standards.

The conduit sizes to be used will be indicated on the plans, or specified in the Special Provisions. Conduit shall be 1-1/4 inches (32 millimeters) minimum diameter, unless otherwise indicated on the plans or Special Provisions.

The Contractor may, at his own expense with Engineer approval, use larger size conduit, and where used, it shall be for the entire length of the run from outlet to outlet with no reducing couplings permitted.

P.V.C. coated rigid steel conduit shall consist of galvanized rigid steel conduit conforming to applicable federal specifications and Underwriter's Laboratories. The exterior surface of the conduit shall be acid-treated to provide an acceptable surface for plastic coating with a heat polymerizing lacquer with a thickness not to exceed 0.0005 inch (0.01 millimeter) thick. A polyvinyl chloride compound shall then be bonded to the prepared conduit with a thickness not less than 0.035 inch (0.9 millimeter) for the full length of the conduit except the threads. The bond between the metal and the plastic shall be equal or greater than the tensile strength of the plastic coating. In addition, the P.V.C. compound shall have the following physical characteristics:

- (a) Hardness: 85+ Shore A Durometer
- (b) Dielectric Strength: 400 (Volts/mil @ 60 cycles)
- (c) Tensile Strength: 3500 psi

623 G.02.02 PULL BOXES: Pull boxes shall be precast reinforced concrete or composite boxes of the sizes and details shown on the plans and standard drawings. Reinforcement shall be 3/4 inch (19 millimeters) mesh, No. 20 U.S. gage, hardware cloth or bar reinforcement. Either steel, cast iron or non-conductive lids shall be used. For traffic signal systems, pull box covers shall be inscribed "TRAFFIC SIGNALS," and for lighting systems the covers shall be inscribed "STREET LIGHTING." Any voltage over 600 shall be inscribed "HIGH VOLTAGE."

Pull boxes for structure installation shall conform to the dimensions and locations shown on the plans. Boxes or vaults formed in concrete shall have metal frames and covers with wording inscribed on the covers as shown on the plans.

All metal parts shall be hot-dip galvanized and shall conform to the applicable portions of ASTM Designation A 153, after fabrication. Gasket surfaces shall form a true plane. Gaskets shall be one piece neoprene 1/8 inch (3 millimeters) thick, and shall cover the contact surface between the frame and cover.

All metal parts shall have provisions for attaching an equipment grounding conductor.

623 G.02.03 EXPANSION FITTINGS: Expansion fittings, as detailed on the plans, shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a bonding jumper of No. 6 AWG copper wire, or equal. Expansion fittings shall be used where they exit a structure or bridge abutment.

623 G.02.04 CONDUCTORS AND CABLE: Conductors and cable shall conform to the following specifications:

- (a) Insulation for multiple circuit lighting conductors shall be rated at 600 volts, 75 degrees C. minimum. Conductors, unless otherwise specified, shall be single conductor, solid or stranded copper of the gage shown, or indicated herein, insulated with THW grade plasticized polyvinyl chloride.

Copper wire shall conform to the applicable portions of ASTM Designation D 2220, B3 and B8.

- (b) Conductors for series lighting shall be No. 8 AWG, solid copper wire insulated with 10/64 inch (4 millimeters) approved polyethylene compound and rated at 5000 volts.

Conductors for traffic signals shall be IMSA approved signal cable of proper size for the required installation unless otherwise shown on the drawings or specified in the Special Provisions.

623 G.02.05 SPLICING: Overhead wire shall be No. 6 M.H.D. solid bare copper continuous from standard to standard with no splices.

Double wire circuits shall have pressed steel conductor arms at 45 degrees from the pole and 180 degrees from the direction of service.

Where overhead lines change direction, up to 45 degrees, they shall be bisected by rotating feeder arms; for angles of change greater than 45 degrees an additional set of feeder arms shall be provided to maintain proper wire separation.

Rev. December 12, 1996

623 G.02.06 COLOR CODING: For traffic signals and signs, insulation shall be of solid color, or of basic colors with a permanent colored stripe, to identify conductors as detailed below, unless otherwise specified.

CONDUCTORS COLORS AND SEQUENCE -- I.M.S.A. SPECIFICATIONS -- #19-2 OR #19-1

Conductor	Base Color	First Tracer
1	Black	
2	White	
3	Red	
4	Green	
5	Orange	
6	Blue	
7	White	Black
8	Red	Black
9	Green	Black
10	Orange	Black
11	Blue	Black
12	Black	White
13	Red	White
14	Green	White
15	Blue	White
16	Black	Red
17	White	Red
18	Orange	Red
19	Blue	Red
20	Red	Green

CONSTRUCTION

623 G.03.01 MAINTENANCE OF EXISTING AND TEMPORARY ELECTRICAL SYSTEMS: Existing electrical systems (traffic signal, ramp metering, highway and street lighting, flashing beacon and sign illumination), or approved temporary replacements thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the systems. Traffic signal shutdown shall be as specified in the Special Provisions or as requested by the Engineer. Lighting system shutdowns shall not interfere with the regular lighting schedule, unless otherwise permitted by the Engineer. The Contractor shall notify the Operating Engineer's Agency in writing three (3) normal working days prior to performing any work on existing systems.

The Contracting Agency and/or Agency's Operating Engineer shall be notified in writing three (3) normal working days in advance by the Contractor prior to any operational shutdown of a traffic signal system.

The Contracting Agency will continue operation and maintenance of existing electrical facilities.

Where damage is caused by the Contractor's operations, the Contractor shall at his expense, repair or replace, at the direction of the Engineer, damaged facilities promptly in accordance with these specifications. Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements

will be deducted from any monies due or to become due the Contractor.

The exact location of existing conduits and pull boxes shall be ascertained by the Contractor before using equipment that may damage such facilities or interfere with any system.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the lighting systems shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

Temporary electrical installations shall be kept in effective operation until the temporary installations are no longer required for the traveling public.

These provisions will not relieve the Contractor in any manner of his responsibilities as provided in Subsection 107.11, "Responsibility for Damage," and Subsection 107.16, "Contractor's Responsibility for the Work and Materials."

A temporary overhead cable system may be used for the existing signal system circuitry in lieu of maintaining the underground installations during construction if approved by the Operating Engineer's Agency.

Where an existing system is being modified, work not shown on the plans or specified in the Special Provisions and which is considered by the Engineer as necessary to keep all or any part of the existing system in effective operation shall be considered as included in the prices paid for the systems, or units, therefore no additional compensation will be allowed.

MAINTAINING LAS VEGAS AREA COMPUTER TRAFFIC SYSTEM (LVACTS) INTERCONNECT CABLE: The exact location of existing conduits and pull boxes shall be ascertained by the Contractor before using any equipment that may damage such facilities or interfere with the LVACTS. Any damage to the traffic system interconnect cable is considered by the Contracting Agency to constitute an emergency.

Where damage is caused by the Contractor's operations, the Contractor shall, at his expense, begin temporary repairs immediately after the damage occurs and shall proceed with repairs expeditiously until complete. Repairs may be delayed up to five (5) calendar days if approved by the designated officers of each local agency maintaining a traffic signal served by the damaged cable.

Permanent restoration shall be completed within forty-five (45) calendar days after the break occurs.

Should the Contractor fail to perform the required repairs or replacements, the cost of performing such repairs or replacements will be deducted from any monies due or to become due the Contractor.

Each conductor in all cable runs in which damage occurs shall be tested for continuity and resistivity to ensure no latent damage exists elsewhere in the cable.

Cable meeting the LVACTS Specification, 22 AWG, has a D.C. resistivity of 17.4 ohms/1000 feet at 20 degrees C. Any cable exhibiting a D.C. resistivity in excess of 18.3 ohms/1000 feet at 20 degrees C. in more than one (1) pair of conductors shall be deemed to be damaged when tested hereunder and shall be replaced/repared in accordance with this provision.

ACCEPTABLE METHODS OF REPAIR AND RESTORATION: Temporary repairs of damage at a single discrete point in the interconnect cable may consist of a splice made with a re-enterable splice kit in a standard pull box placed temporarily. Direct burial of a temporary splice is not permitted. The Contractor shall be responsible for maintaining the temporary repair until such time as the permanent repairs are completed.

Temporary repairs of damage to an extended length of cable or of damage at more than a single discrete point may consist of placing cable overhead until permanent replacement is completed.

Rev. December 12, 1996

Permanent restoration of a damaged interconnect cable shall be made in one (1) of the following methods:

Method 1. Splicing in a new standard pull box at the location of the damage using non-re-enterable splice kit suspended from the wall of the pull box if sufficient slack cable exists. No more than one (1) permanent splice will be permitted between termination boards. If a second splice must be made in a cable length previously spliced, the old splice shall be removed and the new splice made there. The damaged cable between the splice and the next termination board shall be removed and replaced in accordance with Method 2.

Interconnect cable shall be replaced in kind unless otherwise approved by the designated officers of the local agency maintaining the cable that is damaged.

Method 2. Pulling out all damaged cable and replacing with a new cable conforming to R.E.A. Specification 39, 22 AWG, between existing terminal boards housed in controller, junction cabinets, or engineering office at each end of the damaged cable run. The new cable shall be tested after installing for continuity and with a "megger" to ensure no damage resulted from the installation process.

Method 3. Install a new standard junction cabinet if the damage occurs within a street intersection no closer than 300 feet to an existing junction, controller cabinet, JMC or TMC.

The selection of the permanent restoration method for damage at a single discrete point shall be made in accordance with the following table:

Number of Pairs of Conductors in Cable	Minimum Length of Cable Run at which Method 1 is Permitted*	Size of Pull box when Method 1 is Used
less than 15	6,700 feet	7
16 - 24	5,000 feet	7
25 - 49	2,500 feet	7
50 - 70	1,700 feet	9
more than 70	**Only Method 3 is permitted**	

* Any length less than this requires use of Method 2 or 3.

Cable that is damaged continuously over a length or at more than one (1) discrete point shall be permanently restored only by Method 2.

All damaged cable removed from the system under any of the restoration methods shall be removed from the conduit in continuous lengths, wound on a reel and returned to the local agency.

All cable repairs or restoration made under Methods 1 or 2 shall be made only under continuous inspection by the local agency in whose jurisdiction the repair is being made.

All materials, equipment and workmanship incorporated into any cable repair or restoration shall be guaranteed for a period of one (1) year after the final acceptance of the work or equipment. If during the guarantee period any defects or faulty materials are found the Contractor shall immediately, upon notification by the local agency,

proceed at his own expense to replace and repair same, together with any damage to all finishes, fixtures, equipment and furnishings that may be damaged as a result of this defective equipment or workmanship.

623 G.03.02 SCHEDULING OF WORK: Traffic signals shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.

Traffic signals shall not be placed in operation until all discrepancies are corrected and the roadways to be controlled are open to public traffic, unless otherwise directed by the Engineer.

Roadway lighting and traffic signals shall not be placed in operation, including flashing operation, prior to commencement of the functional test period specified in Subsection 623 T.02.03(e),(f), and (g), "Field Tests," unless ordered otherwise by the Engineer.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, and metallic conduit bonded.

In vehicular undercrossings, soffit lights shall be placed in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

If the Engineer orders soffit lights or lighting for pedestrian structures placed in operation before permanent power service is available, the cost of installing and removing temporary power service will be paid for as extra work as provided in Subsection 104.03, "Extra Work."

623 G.03.03 SAFETY PRECAUTIONS: Before starting work on existing series street lighting circuits, the Contractor shall obtain daily a safety circuit clearance from the responsible local agency. By-pass shall be switched to the "off" position, fuses shall be removed, and signs posted at the switch box before any work is done.

623 G.03.04 EXCAVATING AND BACKFILLING: Excavations required for the installation of conduit, foundations and other facilities, shall be performed in such a manner as to cause the least possible damage to the streets, sidewalks, and other improvements. Excavations shall not be larger than necessary for the proper installation of conduit, electrical facilities and foundations. Excavating shall not be performed until immediately before installation of conduit, facilities, and foundations.

The material from the excavation shall be placed in a position where the least disruption and obstruction to vehicular and pedestrian traffic will be realized and the least interference with surface drainage will occur.

Surplus excavated material shall be removed and disposed of by the Contractor outside of the right-of-way.

At the end of each day's work, and at other times when construction operations are suspended, equipment and other obstructions shall be removed from the right-of-way.

Structural excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and 207, "Structure Backfill."

Trench excavations shall be backfilled in conformance with the requirements of Section 208, "Trench Excavation and Backfill."

Backfilled excavations shall be kept well filled and maintained in a smooth and well-drained condition, until permanent resurfacing is completed as specified in Subsection 208.03.05, "Cutting and Restoring Street Surfacing."

Unless otherwise specified in the Special Provisions, excavation in the street and highway shall be performed in such a manner that not more than one lane of traffic is restricted in either direction at any time, unless otherwise approved by the Engineer.

All streets upon or within which any work is being done shall be kept open to all traffic by the Contractor, as

Rev. December 12, 1996

specified in Subsection 104.04, "Maintenance of Traffic," unless otherwise provided in the Special Provisions, or as approved by the Engineer.

Barricading shall conform to the latest edition of the Nevada Traffic Control Manual and/or the Manual On Uniform Traffic Control Devices.

623 G.03.05 REMOVING AND REPLACING IMPROVEMENTS: Improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material and other improvements removed, broken or damaged by the Contractor, shall be replaced or reconstructed in compliance with the applicable sections of these specifications.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, it shall be repaired in accordance with Subsection 202.03.02, "Removal of Structures and Obstructions."

The outline of all areas to be removed in Portland cement concrete sidewalks and in pavements shall be cut to a minimum depth of 1-1/2 inches (38 millimeters) with an abrasive type saw prior to removing the sidewalk and pavement material. Cut for the remainder of the required depth may be made by any method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

623 G.03.06 FOUNDATIONS: Foundations for posts, standards, and pedestals shall be Class A concrete conforming to the applicable requirements of Section 501, "Portland Cement Concrete."

For posts, standards, and pedestals, a topping of four (4) inches (100 millimeters) minimum shall be poured after the post, standard, or pedestal is in proper position. The exposed portions shall be formed to present a neat appearance. The bottom of concrete foundations shall rest on firm undisturbed ground.

Forms shall be true to line and grade. Tops of footings for posts and standards, except special foundations, shall be finished one (1) inch (25 millimeters) above grade of curb or sidewalk or as ordered by the Engineer.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be held in place by means of a template until the concrete sets. Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Ordinary surface finish shall be applied to exposed surfaces of concrete. Where the edge of a concrete foundation extends within eighteen (18) inches (450 millimeters) of any existing concrete improvement, a slab with a minimum thickness of four (4) inches (100 millimeters) shall be extended to meet said existing improvement.

Concrete for Type XX poles and/or XX-A poles shall set for a minimum of ten (10) days unless otherwise approved by the Engineer. Concrete for smaller bases shall set for a minimum time of seventy-two (72) hours.

623 G.03.07 WIRING: Wiring shall conform to appropriate articles of the National Electrical Code. Wiring within cabinets, junction boxes, etc., shall be neatly arranged and laced. Powdered soapstone, talc, or other approved lubricant shall be used when installing conductors in conduit.

Each conductor shall have eighteen (18) inches (450 millimeters) of slack coiled within each standard and at least two feet (600 millimeters) of slack coiled in each pull box.

Series lighting cable shall be installed without splices from luminaire to luminaire and from service to luminaire unless otherwise specified. Multiple lighting conductors may be spliced in the base of standards or in pull boxes adjacent thereto. Signal cable shall run from terminal to terminal without splices unless otherwise indicated on the plans.

Conductors shall be joined by the use of a connector approved by the Engineer.

Conductor insulation shall be well penciled, trimmed to conical shape, and roughened before applying splice

insulation. Splice insulation shall be designated by the Engineer.

When conductors and cables are pulled into the conduit, all ends of the conductors and cables shall be taped to exclude moisture. Ends of spare conductors shall be taped. When no cable is to be installed, Contractor shall install string at both ends.

The ends of all conduits shall be well reamed to remove burrs and rough edges. Field conduit cuts shall be made square and true so that the ends will butt or come together for the full circumference in the couplings or adapters. Slip joints or running threads shall not be permitted for coupling metal conduit.

When a standard coupling can not be used, an approved union coupling shall be used.

Couplings for steel conduit shall be tightened until the ends of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run.

Conduit ends shall be threaded and capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings.

Manual or power-operated equipment normally used for cutting rigid steel conduit is acceptable for use in cutting P.V.C. coated rigid steel conduit. P.V.C. shall not be peeled back before cutting and all cuts shall be reamed. Threading shall be the same as for non-coated rigid conduit. All scarred and grip marked areas shall be touched up with approved heavy consistency coating compound.

For P.V.C. coated rigid steel, all couplings and threaded fittings shall be hand tightened before using a wrench. Use strap wrench for the final two turns only. All wrench marks and scores shall be recoated and joints must be sealed with heavy consistency P.V.C. compound. Ensure that the final installation does not have any exposed metal areas.

Conduits shall be bent, without crimping or flattening, and no single run shall include more than two 45 degree bends and two 90 degree bends without prior approval of the Engineer.

P.V.C. coated rigid steel conduit, 2 inches (51 millimeters) in diameter or larger, shall be used for all bends, except for 90 degree bends at street light pole foundations. Standard field bending techniques shall be used which typically uses a shoe one size larger to accommodate the larger pipe diameter. The minimum radius of the bend shall be 36 inches (914 millimeters) for P.V.C. coated rigid steel conduit.

Conduit shall be placed to a depth of not less than 24 inches (600 millimeters) below the finished grade in all areas with the following exceptions. Conduit may be laid on top of and secured to the existing pavement where such pavement is covered by a raised dividing strip having concrete curb. Conduit under railroad tracks shall be installed to railroad specifications. Conduit shall be placed under existing pavement by approved jacking or drilling method. Pavement shall not be disturbed without the approval of the Engineer, and then only in the event obstructions are encountered; however, upon approval of, or as required by the Engineer, small test holes may be cut into the pavement. Jacking or drilling pits shall be kept two (2) feet (600 millimeters) from the edge of any type of pavement whenever possible. Use of water which might undermine pavement, or soften subgrade, will not be permitted.

Conduit terminating in pedestals shall be a minimum of two (2) inches (50 millimeters) and a maximum of four (4) inches (100 millimeters) above the foundation and should be sloped toward the handhole opening.

Conduit shall enter concrete pull boxes from the bottom and shall terminate two (2) inches (50 millimeters) inside the box wall and not less than two (2) inches (50 millimeters) nor more than four (4) inches (100 millimeters) above the bottom, and shall be sloped to facilitate pulling of conductors. Conduit entering the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run.

Existing underground conduit to be incorporated into a new system shall be cleaned by blowing out with compressed air, or by other methods required by the Engineer.

Rev. December 12, 1996

Conduit runs shown on the plans are for bidding purposes only and may be changed with the approval of the Engineer to avoid underground obstructions.

623 G.03.08 SERVICE: Service points when required by the Contracting Agency for street lighting, traffic signals, etc. shall be as indicated on the drawings.

Since service points indicated by those other than the Contracting Agency may be subject to change (subdivision street lighting) the Contractor shall obtain the points of attachment from the serving utility company and shall be as close to the center of the circuit as possible.

Padmount service, when called for, shall conform to Uniform Standard Drawings, Clark County Area as applicable.

The Contractor shall furnish and install conduit and conductors to the service point as shown on the plans or as required to complete the installation.

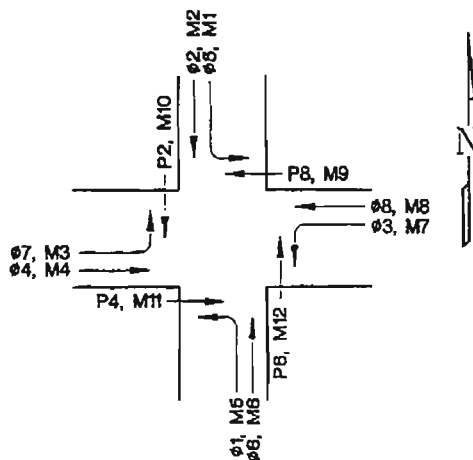
No service point will be considered acceptable unless approved in writing by the serving utility company and the Contracting Agency Engineer or his designee.

TRAFFIC SECTION

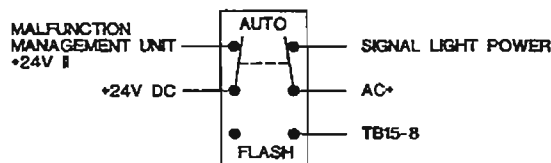
MATERIAL

623 T.02.01 CABINETS: The type of cabinet to be furnished shall be as indicated on the traffic signal plans, or as specified in the contract.

- (a) All cabinet harnesses and wiring shall be neat and firm, and laced or bound (with ty-rap) together.
- (b) All terminals shall be numbered and identified in accordance with the cabinet wiring diagram.
- (c) The cabinet shall be equipped with a plastic envelope to house wiring diagrams.
- (d) The cabinet wiring diagrams shall show and identify the connectors for all equipment, switches, terminal blocks, relays, flashers, and signal control bases.
- (e) The cabinet wiring diagram shall have an intersection sketch with signal heads and push-buttons identified as related to the intersection sketch shown below. The cabinet "controller" phasing shall be as indicated below; also refer to Subsection 623T.02.10(g).



- (f) All mechanical relays shall have clear dust covers.
- (g) The following equipment shall be furnished and wired in all cabinets:
 - (1) Two single-pole surface-mount circuit breakers: a 50 amp breaker for control of all power to the controller and its auxiliary equipment and a 20 amp breaker for the fan, light, and utility plug. The power panel input shall be able to accept No. 2 stranded copper wire from the service power meter or have a terminal block adapter that can. There shall be a terminal, unfused, able to accept No. 2 wire for the neutral wire of power supply line and a terminal, unfused, able to accept No. 2 wire for the chassis ground wire of the power supply line.
 - (2) Terminal blocks for connection of traffic and pedestrian signal light field wires specified for flashing operation.
 - (3) Terminal blocks for connection of traffic and pedestrian signal light field wires NOT specified for flashing operation.
 - (4) Terminal blocks for connection of loop detectors and pedestrian push-button field conductors.
 - (5) Terminal blocks for all pins of all connectors of the controller and all related equipment; all connector pins shall be wired and terminated.
 - (6) Copper Ground Strip, mounted and grounded to cabinet wall, for connection of all common conductors and shall have a terminal able to accept No. 2 wire for the neutral ground wire. A mechanical ground strip shall be mounted on and grounded to the cabinet wall for connection of all mechanical grounds.
 - (7) Terminal blocks for connecting tie points and inter-cabinet terminations.
 - (8) A dual circuit solid state NEMA jack-mounted flasher having a flash rate of 50 to 60 flashes per minute. The flasher circuit shall be wired in the cabinet in accordance with the standard auxiliary cabinet equipment wiring drawing.
 - (9) A duplex "U" ground type of convenience outlet shall be furnished for test equipment, tools, and lighting. It shall have an integral ground fault protection device.
 - (10) Police Panel Switches. A Flash switch behind the police auxiliary door identified "Auto/Flash". With the switch placed in the "Flash" position, the switch shall:
 - (a) be wired to de-energize signal light power and place the intersection signals on "flash", but to keep controller power energized.
 - (b) the controller shall be activated to stop-time. (Stop-time signal from Malfunction Management Unit - Refer to (10)(d) below)
 - (c) the switch shall provide +120 volts AC to TB15-8 (or equipment terminal) to inform the Sonex Unit that the Police Flash Switch has been put on "flash."
 - (d) de-energize +24 V II to the Malfunction Management Unit to cause it to fail (and have Malfunction Management Unit provide Logic Ground to TB14-11 and Stop-Time to controller-diode isolated).

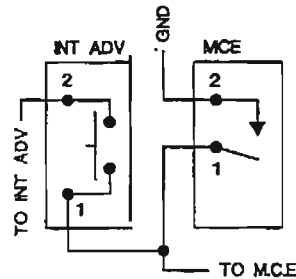


When the switch is placed back into the "Auto" position, the intersection shall be removed from "Flash" and reset to normal operation.

Rev. December 12, 1996

(11) Interior Cabinet Switches.

- (a) "Controller Power Switch", identified "On-Off", wired to de-energize controller power when switched to the "off" position.
- (b) "Tech Flash Switch", identified "Auto-Flash". With the switch placed in the "Flash" position, the switch shall be wired to de-energize signal light power and place the intersection signals on "flash", but to keep controller power energized and the controller shall be activated to NOT stop-time and shall provide +120 volts AC to TB15-8 to inform the Sonex Unit that the Tech Flash Switch has been put on flash.
When the switch is placed back into the "Auto" position, the intersection shall be removed from "Flash" and reset to normal operation.
- (c) "Stop-Timing Switch", identified "On-Off", wired to stop-time the controller when switched to the "On" position.
- (d) "Manual Advance Switch": A "Momentary ON" switch, identified "Manual Advance", enabled by the MCE switch and wired to manually step the controller. The Manual Advance Switch shall have a guard to prevent accidentally advancing the controller.
- (e) "Manual Control Enable Switch", identified "MCE", wired to enable "MCE on controller" and "Manual Advance Switch."



- (f) All switches, voice communications phone jacks and convenience outlets may be combined on a single panel and mounted on the inside cabinet door behind the police auxiliary panel.
- (h) Radio line filter or filters for filtering AC + lights and control power for solid state equipment and controller operation shall be used in all cabinets.
- (i) Thyractor, solid state or gas-filled surge protectors to shunt lightning or high voltage surges to ground shall be used for the protection of all solid state components. Clamp voltage shall be 250 volts at 20,000 amps peak current. Operating temperature shall be at -40°C to +85°C.
- (j) A fuse block for four fuses for streetlights and street name signs.

623 T.02.02 CABINET EQUIPMENT:

- (a) All cabinets shall be provided as a complete unit to include all shelves, foundations, anchor bolts with template, locks, door stops, etc., and to be completely painted inside and outside as specified on each cabinet Standard Drawing.

- (b) All cabinets shall be weatherproof, properly ventilated, and have two vent fans. All cabinets shall have each and every door mounted with hinges welded to door and jamb as shown in the Standard Drawings.
- (c) Each cabinet must fit the anchor bolt locations and foundations as specified on the Standard Drawings, without modification to the cabinet or foundation.
- (d) Cabinets shall have a fluorescent fixture and light mounted in the cabinet interior, preferably over the door, at a location least likely to be damaged. The length shall be determined by the cabinet width. The fixture shall have an "on-off" switch operated automatically with light on when the door is opened and off when the door is closed.
- (e) Each cabinet shall have a vehicle and pedestrian detector test panel located on the inside of the cabinet door, equipped with toggle switches (on-off-momentary on) wired for permitting the introduction of manual calls into the controller for each vehicle or pedestrian detector input. Each toggle switch, in the "up" position, shall permit calls into the controller from the vehicle and pedestrian detection source. Each toggle switch, in the "center" position, shall disconnect the vehicle and pedestrian detection source and permit calls into the controller only via manual push down actuation. Each vehicle and pedestrian detector circuit shall have a separate toggle switch. Toggle switches shall be provided for all future phases and wired to the terminal blocks.
- (f) **Solid state load switches and sockets:**
 - (1) All necessary cabinet wiring, connecting cables, terminal blocks and sockets shall be provided for 8 vehicle, 4 pedestrian, and 4 overlap phasing.
 - (2) A load switch shall be provided with each socket for future operation. Refer to NEMA standard publication TS2, Type 2 or later version for operational and dimensional requirements. A wide angle, high intensity LED, clearly visible in sunlight, shall be provided for each load switch indication.
- (g) **Pedestrian Push Button Circuit Isolation.** For each Pedestrian movement provided, solid state isolation shall be provided in the cabinet to separate the pedestrian detector input circuits to the controller from the pedestrian push button circuits in the fields. The Field push button circuits shall be energized by a 12 volt AC source. The isolation circuits shall be mounted on an edge connector-type P.C. board with all required components (i.e., transformers, chips, etc.) The cabinet shall be equipped with six channels; channels five and six shall be spares and be terminated to allow access from the front side of the detector panel.
- (h) **Malfunction Management Units (MMU):**
 - (1) All malfunction management units shall meet all requirements of NEMA standard publication TS2, Type 2 or later version. In addition, all MMU's shall be equipped with the features defined below:
 - (2) Minimum vehicle clearance time monitoring with a time value of 0.0 to 4.0 seconds (selectable on a per channel basis).

Rev. December 12, 1996

- (3) Separate indicators for activity on each of the red, amber, green and walk inputs of each MMU channel.
 - (4) Front panel indicators showing active channel(s), date, time and description of the current status of six or more of the most recent failures. All such data shall be stored in a non-volatile memory.
 - (5) Liquid crystal front panel displays shall be provided.
 - (6) Failure status indicators for CVM, 24-1, 24-2, conflict, red failure, clearance failure, minimum green failure, dual indication, and program card insertion.
 - (7) The MMU shall provide a front panel display of the approximate time and date of the occurrence of any power failure in excess of 500 milliseconds duration and the date and time of power restoration. The MMU program shall have computed and logged this data in non-volatile memory by the end of the power restart flash interval.
 - (8) Each MMU shall be silk screen printed on the side of the equipment housing with a quick reference guide, describing the operation of each keyboard entry, switch setting, etc., as necessary to activate all functions of which the equipment is capable.
 - (9) Front panel connectors "A" and "B" mounted directly to printed circuits will not be accepted.
 - (10) Base mounted cabinets shall be equipped with a MMU harness completely wired in the cabinet for eighteen (18) channels of operation. MMU's shall be provided in all cabinets.
 - (11) For every integrated circuit custom-programmed device, or any sole source component, within the unit which is of such special design that replacement units would not be available from any local wholesale electronics distributors, one fully programmed duplicate of each IC/device contained therein shall be furnished directly for each MMU delivered.
 - (12) All MMU's shall have RS-232 capability. The vendor shall supply a software program which when run on an IBM compatible computer will communicate with the MMU for the downloading of failure event information and any other programmable event including timing, etc.
- (i) Emergency Vehicle Priority Control System shall be free standing and operate without any special module in the controller and shall be wired to operate in accordance with Subsection 623 T.02.12.
- (j) **Door Stops:**
- (1) Type M-1 cabinets shall have a hook-type door stop.
 - (2) Type R cabinets shall have a door stop device located at the top or bottom of the door that will allow secure fastening of the door in the open position.
- (k) All cabinets shall be wired for a Video Detection System with appropriate cameras (minimum one per vehicular direction) and cables mounted according to the manufacturer's specifications for each direction of vehicular travel. The following requirements must be met by the supplier of the equipment:
- (1) The Video Detection System shall be an above ground vehicle detection system that utilizes machine vision when interfaced with standard monochrome or color CCD cameras to provide complete intersection and roadway detection.
 - (2) One or more chassis shall be supplied for each Video Detection System to provide a minimum of eight camera inputs for vehicle detection. All interface equipment including interface panels, connectors, and cabling shall be provided and wired in the controller cabinet to accommodate a minimum of eight camera operation.

- (3) Each Video Detection System will include 4 standard monochrome cameras. Camera resolution, imagery size, and lens angle will be determined by the manufacturer based on optimum system performance. Each camera shall have a minimum of 8 user programmable detection zones and include heater, blower, sunshield and mounting brackets.
- (4) The Video Detection System shall provide quick and easy configuration and setup of detection zones at the intersection via standard notebook/laptop computers.
- (5) All delay and extension functions for an approach must be performed within the video unit.
- (6) The units must be capable of detecting vehicles 300 feet from the stop bars on each approach.
- (7) The Video Detection System shall have remote access capability to transmit video and detector information. The Video Detection System shall have the capability to remotely reconfigure detection zones, access logging and statistics, and transmit video via phone line, twisted pair, coaxial cable and fiber optic interconnect.
- (8) The Video Detection System will provide traffic counts including right and left turn counts. The system shall classify these counts in a minimum of 3 storage bins.
- (9) The Video Detection System shall provide incident detection capabilities with full statistics, logging, and report generation. The System shall be able to initiate alarms which are triggered by user defined thresholds.
- (10) All software and hardware for installation, operation and maintenance will be supplied along with necessary technical support upon setup. Technical support shall, as a minimum, consist of 8 hours of end-user training provided by the manufacturer.
- (11) The Video Detection System shall utilize standard 24 volt logic signal outputs to interface with NEMA TS1/TS2, 170/179, 2070, or other future ATC controllers.
- (12) All of the system's microprocessing functions must be performed in the controller cabinet.
- (13) All schematics and technical material must accompany any equipment supplied to the administering entity.
- (14) All 30' poles shall have camera cables pulled to the top of them from the cabinet with enough slack to reach the luminaire regardless of whether a camera is used or not (for future).

623 T.02.03 TRAFFIC SIGNAL CONTROLLERS:

- (a) **Controller Assemblies.** A controller assembly shall consist of a complete mechanism for controlling the operation of a traffic control signal, including the controller unit and all necessary auxiliary equipment, mounted in a cabinet. All equipment required to provide the operation shown on the plans and specifications, shall be provided.
- (b) **Flashing Operations.** All controllers shall be equipped for flashing operation of signal lights. Flashing operations, when required by railroad preemption, flashing emergency traffic control, or other causes, shall be set for flashing red on all approaches unless otherwise specified.
- (c) **Wiring Diagrams.** A schematic wiring diagram of the controllers and auxiliary equipment furnished under the contract shall be submitted at the time the controllers are delivered or, on demand of by the Engineer, prior to purchase. This diagram shall give in detail all circuits and parts, and such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted. Those cabinets that are to be upgraded or increased in phases shall have a table identifying all jumpers to be used.

Rev. December 12, 1996

- (d) **Operating Voltage.** All equipment including interconnection facilities and excepting pedestrian push buttons and pressure detectors, shall be designed to operate on 120 volts, 60 Hz. AC. Operation shall be satisfactory at voltages from 105 to 130. The voltage for pedestrian push buttons shall not exceed 24 volts.
- (e) **Tests.** Prior to completion of the work, the Contractor shall cause the following tests to be made on all electrical circuits, in the presence of the Engineer:
 - (1) Test for continuity of each circuit
 - (2) Test for grounds in each circuit
 - (3) A megohmmeter test on each circuit between the circuit conductor and ground. The insulation resistance shall not be less than 150 megohms at 500 volts.
 - (4) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein.
- (f) Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until no fault appears. After inspection of each traffic signal system as specified in Subsection 623 T.02.03(e) the system shall be activated and required to function without failure for a period of 168 hours. Any fault or failure to the system during this period shall be corrected by the Contractor at his own expense and the system will then be required to function for a period of 168 hours without failure. This procedure will continue until the system successfully operates continuously without failure for 168 hours.
- (g) The Contractor must have approval of the date for turn-on, at least five (5) working days prior, from the Traffic Engineer. Systems generally will not be permitted to be made operational on a Friday, Saturday, Sunday, special events, or holidays.

Controller manuals and cabinet wiring diagrams shall be available to the Signal Maintenance Division at time of turn-on.

The controller manufacturer shall provide a technical representative at the intersection during the turn-on and testing period to provide technical assistance.

- (h) **Controller Construction Specification.** The controller supplied shall meet all requirements of the NEMA standards publication, TS2, Type 2 or later version as well as the following requirements:
 - (1) Phase reversal shall be activated by applying a logic ground to controller connector "B".
 - Pin B shall reverse phase 1 & 2
 - Pin W shall reverse phase 3 & 4
 - Pin X shall reverse phase 5 & 6
 - Pin y shall reverse phase 7 & 8

- (2) Each controller unit shall be provided complete with all of the following components and timing features:

Four keyboard programmable overlaps
Three NEMA connectors "A", "B", "C"
Two DB25-RS232C ports on the front of each controller.
(One port shall be for communications and the second port shall be used for occasional connection to a portable computer having priority over port one.)

- (3) Each controller will be menu driven, with keyboard programming for listing program, status, utilities, and special options; Being able to move between programs, menus, and/or sub-menus and having the ability to copy timing data from one phase to another. The controller shall be able to DIM phase outputs by phase or individual phase color. Readout on the display to be visible in bright sunlight or in the dark with backlighting.
- (4) The equipment housing shall be a completely enclosed painted metal fabrication that is easily removed and replaced. The design shall include vent holes. The unit shall consist of a frame and mother board, with separate printed circuit modules (CPU, Memory, I/O, etc.) which will facilitate simple and rapid maintenance. The connectors for interfacing with the controller shall be part of the input/output module and are to be located on the front of the unit for ease of access.
- (5) The circuit components shall be standard production types that are readily available from any industrial electronics supply house.
- (6) All components mounted to the board shall have their circuit reference symbol clearly marked on the board and be identifiable by referencing to the pictorial assembly drawings.
- (7) The power supply shall be self-contained in a separate and removable module.
- (8) The circuit component design life under continuous duty operation shall not be less than 10 years.
- (9) All programmed timing and operational parameters shall be retained within electrically erasable and programmable read only memories (EEPROM'S) or equivalent. No batteries for any such backup systems will be acceptable, except as necessary to maintain TOD clock timekeeping during power failure.
- (10) A complete operations and repair manual shall be supplied with each controller unit. Each manual shall completely describe all features, keystroke sequences, etc. as necessary to activate all functions provided in the controller. Information included should also contain: complete schematic diagrams by circuit function, and separate diagrams by module, complete block diagrams of equipment circuits, and complete parts listing and detailed circuit-by-circuit description of the operation that follows component-by-component with the schematic diagram or block by block with the logic diagram.
- (11) It shall be possible to perform a series of diagnostic tests of the system, which shall include the following:
- (a) Wrap around Input/Output check of connectors A, B and C.
 - (b) Wrap around Input/Output check of communications and printer ports.
 - (c) RAM memory check.
 - (d) EEPROM check.

Rev. December 12, 1996

Where special test connectors are required, two (2) complete sets of connectors shall be provided per bid order.

- (12) The vendor shall supply a software program to the Agency which when run on an IBM compatible PC connected to the controller will demonstrate to the Agency the controller's communications with respect to baud rates, uploads, downloads, monitoring and activity logging.
- (13) All requisite hardware and software shall be provided fully installed and complete in order to provide the uploading, downloading, monitoring and logging functions required.
- (14) **Double clearance overlaps.** The four NEMA required overlap outputs ("A", "B" and "C") shall provide timed double clearance operation. The settings for this type of operation shall include the ability to select which phases and other overlaps may start timing, or commence the display of their green indications, respectively, during the double clearance timer intervals after the terminating parent phase has completed its "all red". It shall also be possible to program which phases "ON"'s and which phases "next"'s concurrent output shall cause the double clearance green (lag green interval) to be skipped. It shall be possible to specifically program for each overlap:

Compatible phases

Conflicting phases

This will allow the overlap to go red during the timing of a phase conflicting with the overlap in one ring even though the overlap movement is compatible with a phase timing concurrently in the other ring.

Independent amber and "all red" clearance timers shall be provided for each overlap of which shall always operate during an overlap clearance. Output suppression of all drivers during the "green (only)", or green and amber displays of designated phases for use with "Illinois type" right turn overlap or "Florida style" left turn signal indications, respectively. When such operation is selected, the otherwise unused red of the odd phase load switch drivers shall output a "not red" indication for use in red monitor failure prevention.

Each controller shall also internally provide the option to program each of all load switch driver outputs other than overlaps A through D as an overlap of any or all of the timing phases. This shall be true of the red, yellow, and green outputs of phases 1 - 8, outputs and any or all of the eight unused walk, steady pedestrian clear, and flashing pedestrian clear outputs.

- (15) **Power up phase and interval sequence.** The controller start-up point shall be programmable to be either the start of green or the start of amber of any legal phase combination.
- (16) **Scheduled flash.** The scheduled flash shall be generated internal to the controller, and blink the load switch driver inputs independently of the cabinet (Malfunction Management Unit) flash circuitry. It shall be possible to program the following parameters:

Last phases before scheduled flash begins

First phases after scheduled flash ends

The MMU's red enable function shall be active whenever the signal bus is energized, including periods of controller load switch flash. During a scheduled flash, all pedestrian outputs shall remain

dark as stated in MUTCD. Scheduled flash may be provided as a form of internal controller preemption, callable for the internal time base coordinate schedule, as well as by activation of NEMA test input "A". It shall be possible to specify in every other internal preempt program provided whether or not a call for that preempt overrides scheduled flash operation.

- (17) **Primary Phase Assignments.** It shall be possible to program each detector input for phase assignment and as to whether the input places:

- (0) no call
- (1) call only
- (2) extension only
- (3) both call and extension for each phase

Upon bulk initialization, detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.

- (18) **Alternate Phase Assignments.** It shall be possible to program each detector input for phase assignment and as to whether the input places:

- (0) no call
- (1) call only
- (2) extension only
- (3) both call and extension for each phase

Upon bulk initialization, detector inputs 1 - 8 shall default to the conventional NEMA one to one detector input number to phase number correspondence, placing both call and extensions on those phases. The inputs shall be routed according to these phase assignments provided that the conditions for detector switching are not true.

- (19) **Detector Switching.** It shall be possible to program the conditions under which each detector input shall switch to the alternate phases assignments. The conditions for each input shall be defined by the condition of phases 1-8 as to whether each phases, (0) not applicable, (1) has a call, (2) is "on".
- (20) **Recall Mode.** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the type of recall mode required as listed below:

- (0) Memory off
- (1) Memory on
- (2) Minimum recall
- (3) Maximum recall
- (4) Minimum and pedestrian recall
- (5) Maximum and pedestrian recall
- (6) Non-Actuated
- (7) Omit
- (8) Soft recall or No rest w/detector memory off
- (9) Soft recall or No rest w/detector memory on

Rev. December 12, 1996

- (21) **Max Mode.** Each phase shall be programmable as to (code definitions shall be displayed with each entry screen) the maximum green value required as listed below:
 - (0) Max inhibit (code only assignable for background cycle operation)
 - (1) Max I
 - (2) Max II
- (22) **"No skip" phases.** Note that it shall be possible to condition this function to be specific to only those other phases specifically selected (i.e., "Phases always preceded by this one", and "phases always followed by this one").
- (23) Red rest.
- (24) Conditional re-service/service phases, and phases to be either omitted or serviced twice-per-cycle during timing plans called up at certain times of day.
- (25) **Actuated rest in walk operation phases.** When active, such phase shall rest at the end of its "WALK" interval in the absence of any serviceable opposing call, and shall proceed to time the pedestrian clearance interval as soon as any such opposing call is received or becomes serviceable. The phase shall revert to the beginning of, and proceed to retime the "WALK" interval immediately whenever all opposing calls are lost, so long as the phase remains "green" and is not under "pedestrian omit", whether or not the pedestrian clearance has completed timing.
- (26) **Last Car Passage Phases.** The last car passage and subsequent rest intervals shall not be reset or extended by additional vehicle actuation's except in dual ring applications where simultaneous gap is also active and the other ring has not yet reached last car passage or rest.
- (27) Inhibit gap reset after time-out phases (non-simultaneous gap termination).
- (28) **Preemption.** The software shall provide a minimum of handling six unique preempt sequence shall operate similarly and provide for transitional timing and signal display to a programmed preempt condition and exit transition timing and display to a programmed return to normal condition. Preempt input priority and the lower four inputs served on a first come, first-served basis.
- (29) **Coordination.** The software shall provide a minimum of : Four cycle lengths, Three offsets per cycle, Four splits per cycle, "Manual" control, "Free" control and standard interconnect operation.
- (30) **Features Associated with the Internal Time Clock Setting Time/date.** The internal clock shall be accurately programmable to the second. At the time the clock is updated by the user, all internal commands, coordination patterns and offsets shall also be automatically updated.

MANUAL COMMAND - It shall be possible to manually activate the pattern, offset, the system command type, and if external sync input is used. The command shall be activated upon entry and programmable back to the next externally or internally programmed event command when activated.

DAYLIGHT SAVINGS CORRECTION - Provisions shall be made for automatic clock correction for the start and end of daylight savings time (DST), including the ability to revise the month and week of month (1-last) of which DST starts and ends from the keyboard. Sync Pulse Reference Time (Hour/Minute) - This sync pulse shall be calculated from this point in time. The internal time base clock shall contain at least 50 event command entries which shall be displayed in chronological order but need not be entered in that order.

DAY SCHEDULE - The programming of the internal time base coordination event clock shall be of the type in which any event instruction may be directly associated with one or more days of the week or holiday, and not of the type in which day program schedules must be first programmed, and then associated with the calendar days to which they apply. It shall be possible to program any or all of days 0 through 9 for each TOD command with the following association of each number as defined below:

- 0 = Special day program
- 1 = Sunday
- 2 = Monday
- 3 = Tuesday
- 4 = Wednesday
- 5 = Thursday
- 6 = Friday
- 7 = Saturday
- 8 = Special day program
- 9 = Special day program

CONTROLLER CONNECTOR A			
<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
A	Reserved	AA	Test Input B
B	+24 V DC External	BB	Walk Rest Modifier
C	Voltage Monitor	CC	Coded Status Bit A (Ring 1)
D	PH 1 Red	DD	PH 1 Phase ON
E	PH 1 Don't Walk	EE	PH 1 Ped Omit
F	PH 2 Red	FF	Ped Recycle (Ring 1)
G	PH 2 Don't Walk	GG	Max II Selection (Ring 1)
H	PH 2 Ped Clear	HH	Spare 2
J	PH 2 Walk		
K	PH 2 Veh Call Det		
L	PH 2 Ped Call Det		
M	PH 2 Hold		
N	Stop Timing (Ring 1)		
P	Inhibit Max Term (Ring 1)		
R	External Start		
S	Internal Advance		
T	Indicator Lamp Control		
U	AC- Common		
V	Chassis Ground		
W	Logic Ground		
X	Flashing Logic Out		
Y	Coded Status Bit C (Ring 1)		
Z	PH 1 Yellow		
a	PH 1 Ped Clear		
b	PH 2 Yellow		
c	PH 2 Green		
d	PH 2 Check		
e	PH 2 Phase ON		
f	PH 1 Veh Call Det		
g	PH 1 Ped Call Det		
h	PH 1 Hold		
i	Force-off (Ring 1)		
j	Ext Min Recall All PH's		
k	Manual Control Enable		
m	Call to Non Actuated I		
n	Test Input A		
p	AC+ (control)		
q	5 PPS		
r	Coded Status Bit B (Ring 1)		
s	PH 1 Green		
t	PH 1 Walk		
u	PH 1 Check		
v	PH 2 Ped Omit		
w	Omit All Red Clear (Ring 1)		
x	Red Rest Mode (Ring 1)		
y	Spare 1		
z	Call to Non Actuated II		

CONTROLLER CONNECTOR B			
Pin	Function	Pin	Function
A	PH 1 Phase Next	AA	Overlap A Green
B	Phase Reverse 1+2	BB	Overlap B Yellow
C	PH 2 Next	CC	Overlap B Red
D	PH 3 Green	DD	Overlap C Red
E	PH 3 Yellow	EE	Overlap D Yellow
F	PH 3 Red	FF	Overlap C Green
G	PH 4 Red	GG	Overlap B Green
H	PH 4 Ped Clear	HH	Overlap C Yellow
J	PH 4 Don't Walk		
K	PH 4 Check		
L	PH 4 Veh Call Det		
M	PH 4 Ped Call Det		
N	PH 3 Veh Call Det		
P	PH 3 Ped Call Det		
R	PH 3 Phase Omit		
S	PH 2 Phase Omit		
T	PH 5 Ped Omit		
U	PH 1 Phase Omit		
V	Ped Recycle (Ring 2)		
W	Phase Reverse 3+4		
X	Phase Reverse 5+6		
Y	PH 3 Walk		
Z	PH 3 Ped Clear		
a	PH 3 Don't Walk		
b	PH 4 Green		
c	PH 4 Yellow		
d	PH 4 Walk		
e	PH 4 Phase ON		
f	PH 4 Phase Next		
g	PH 4 Phase Omit		
h	PH 4 Hold		
I	PH 3 Hold		
j	PH 3 Ped Omit		
k	PH 6 Ped Omit		
m	PH 7 Ped Omit		
n	PH 8 Ped Omit		
p	Overlap A Yellow		
q	Overlap A Red		
r	PH 3 Check		
s	PH 3 Phase ON		
t	PH 3 Phase Next		
u	Overlap D Red		
v	Phase Reverse 7+8		
w	Overlap D Green		
x	PH 4 Ped Omit		
y	Spare 5		
z	Max II (Ring 2)		

CONTROLLER CONNECTOR C

<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
A	Coded Status Bit A (Ring 2)	AA	PH 6 Ped Clear
B	Coded Status Bit B (Ring 2)	BB	PH 6 Check
C	PH 8 Don't Walk	CC	PH 6 Phase ON
D	PH 8 Red	DD	PH 6 Phase Next
E	PH 7 Yellow	EE	PH 7 Hold
F	PH 7 Red	FF	PH 8 Check
G	PH 6 Red	GG	PH 8 Phase ON
H	PH 5 Red	HH	PH 8 Phase Next
I	PH 5 Yellow	IJ	PH 7 Walk
K	PH 5 Ped Clear	KK	PH 7 Ped Clear
L	PH 5 Don't Walk	LL	PH 6 Walk
M	PH 5 Phase Next	MM	PH 7 Check
N	PH 5 Phase ON	NN	PH 7 Phase ON
P	PH 5 Veh Call Det	PP	PH 7 Phase Next
R	PH 5 Ped Call Det		
S	PH 6 Veh Call Det		
T	PH 6 Ped Call Det		
U	PH 7 Ped Call Det		
V	PH 7 Veh Call Det		
W	PH 8 Ped Call Det		
X	PH 8 Hold		
Y	Force-off (Ring 2)		
Z	Stop Timing (Ring 2)		
a	Inhibit Max Term (Ring 2)		
b	Spare 1		
c	Coded Status Bit C (Ring 2)		
d	PH 8 Walk		
e	PH 8 Yellow		
f	PH 7 Green		
g	PH 6 Green		
h	PH 6 Yellow		
i	PH 5 Green		
j	PH Walk		
k	PH 5 Check		
m	PH 5 Hold		
n	PH 5 Phase Omit		
p	PH 6 Hold		
q	PH 6 Phase Omit		
r	PH 7 Phase Omit		
s	PH 8 Phase Omit		
t	PH 8 Veh Call Det		
u	Red Rest Mode (Ring 2)		
v	Omit All Red (Ring 2)		
w	PH 8 Ped Clear		
x	PH 8 Green		
y	PH 7 Don't Walk		
z	PH 6 Don't Walk		

CONTROLLER SERIAL PORTS			
RS-232 Port 1		RS-232 Port 2	
<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
3	System Detector A1	2	Receive Data
2	System Detector A2	5	Clear to Send
5	System Detector B1	6	Data Set Ready
19	System Detector B2	8	Carrier Detect
4	System Detector C1	3	Transmitted Data
1	System Detector C2	4	Request to Send
7	System Detector D1	20	Data Terminal Ready
8	System Detector D2	7	Signal Ground
18	Local Flash		
16	Door Open - Maint Required		
14	TLM Spare 1		
17	Alarm 1		
21	Alarm 2		
6	TLM Spare 2		
15	External Address Enable		
20	Conflict Flash		
24	Receive 1		
25	Receive 2		
9	TLM Special Function 1		
22	TLM Special Function 2		
10	TLM Special Function 3		
23	TLM Special Function 4		
12	Transmit 1		
13	Transmit 2		

623 T.02.04 LOOP DETECTORS:

- (a) **General.** The term "loop detector" applies to a complete and operating installation consisting of a loop or loops installed in the roadway in accordance with the plans and specifications, a sensor unit with solid state switching output, and a power source. Loop detectors shall meet the requirements and operate in accordance with the latest edition of the NEMA Standards Publication No. TS1, and shall give a constant output with an open loop.

Loop wires shall be installed after the final layer of asphalt concrete and before any seal coat. The loop

Rev. December 12, 1996

or loops shall be installed in slots cut in the pavement and shall be oriented and color-coded or taped in accordance with the Standard Drawings and plans. Sawed slots shall be blown clean of all loose material and dried. Loop wire shall be carefully placed into slot, avoiding damage to the wire insulation. When more than one loop terminates in a pull box, each loop shall have a separate sawed slot for its leads and leads shall be properly marked as shown on the Standard Drawings. A minimum of 5 feet (1.5 meters) shall be provided at both ends of the loop wire to be coiled and stored in the pull box. Sawed slots shall be spaced a minimum of six (6) inches (150 millimeters) apart. The loop system shall be wired with a cable-in-duct assembly, No. 12 AWG minimum, meeting IMSA Specification No. 51-5 as indicated in the Standard Drawings. The loop lead-in cable shall be one (1) pair No. 12 AWG per IMSA Spec. No. 19-2 or 20-2. Each loop system shall have a separate lead-in to the controller cabinet.

(b) **Slot Sealant Tests and Acceptance**

1. **Insulation Test.** Insulation tests for each loop to ground shall be in accordance with the latest edition of the NEMA Standards Publication No. TS-1. Insulation test between loops shall not be less than 5 meg ohms.
2. **Sensitivity Test.** The completed loop detector shall be capable of detecting any vehicle that may be licensed by the State of Nevada.

(c) **Installation of Inductive Detector Loop Sealant.** Detector loop sealant shall be either a two component epoxy, or a polyurethane material that cures in the presence of moisture or a hot-melt, rubberized asphalt material and which conforms to the following specifications. Sealant shall be suitable for use in both asphalt concrete and Portland cement concrete pavements.

1. **Two Component Epoxy Composition:**

Component A	Parts by Weight
Epoxy Resin, Araldite 6010	100.00
Nonyl Phenol	20.00
Alkylbenzene, Alkylate 31	20.00
Titanium Dioxide, Titanox 2015	1.62
Colloidal Silica, Cabosil	3.00
Glycerine	0.5
Silicone Anti-foam, G.E. Viscasil	0.01

Component B	Parts by Weight
Poly Mercaptan, Dion 3800 L C	40.00
N-Aminoethylpiperazine	17.00
2,4,6 - Tri (dimethylaminomethyl) Phenol	2.00
Furnance Black	0.03
Nonyl Phenol	34.60
Alkylbenzene, Alkylate 31	34.60
Colloidal Silica, Cabosil	4.00
Glycerine	0.50
Silicone anti-foam, G.E. Viscasil	0.01

Characteristics of Adhesives:**Component A**

Viscosity, Poise, Brookfield	150-300
Shear Index	2.5 minimum

Component B

Viscosity, Poise, Brookfield	100-250
Shear Index	2.0 minimum

Characteristics of Compounded Adhesive:

Gel Time, Minutes	13 to 16

On 1/8 inch cast sheet, cured 18 hours at 77 degrees F. plus 5 hours at 158 degrees F.:

Tensile Strength Minimum	700 psi
Elongation, Percent, Minimum	70
Shore D Hardness, Minimum	50

Color shall match Federal Standard No. 595. The color range shall be 26081 to 26173.

2. Polyurethane Sealant**Property and Results****Measuring Standard and Conditions**

Hardness (indentation)--65-85	ASTM D 2240 Rex Type A, Model 1700 77°F (25°C) 50% relative humidity
Tensile Strength--500 psi (minimum)	ASTM D 412 Die C, pulled at 20 IPM
Elongation--400%, minimum	ASTM D 412 Die C, pulled at 20 IPM
Flex at -40°F--no cracks	25 mil Free Film Bend (180° C) over ½" Mandrel
Weathering Resistance-- Slight Chalking	ASTM D 822 Weatherometer 350 hrs. Cured 7 days at 77° (25°C) 50% relative humidity
Salt Spray Resistance--500 psi, minimum tensile; 400% minimum elongation	ASTM B 117, 28 days at 100°F(38°C) 5% NaCl, Die C, pulled at 20 IPM
Dielectric Constant--Less than 25% change over a temperature of -30°C to 50°C	ASTM D 150

Chemical Resistance

Chemical and Results	Test Method
De-Icing Chemical--No Effect	ASTM D 471
Gasoline--Slight Swell	ASTM D 471
Hydraulic Brake Fluid--No Effect	ASTM D 471
Motor Oil--No Effect	ASTM D 471
Calcium Chloride (5%)--No Effect	ASTM D 471

Tests conducted on deaerated, 20 mil (0.020"), dry film liquid immersion. 28 days at 77°F (25°C).

3. Hot-Melt, Rubberized Asphalt Sealant

Property and Limits	Measuring Standard and Conditions
Cone Penetration -- 20 - 35 (1/10 mm.) max.	ASTM D5 77° F., 150 g., 5 sec.
Flow -- 5 mm. maximum	ASTM D 3407, Section 6, 140° F.
Resilience --60% minimum	ASTM D3405, 77° F.
Softening Point -- 200° F.	ASTM D 36
Ductility -- 30 - 55 centimeters	ASTM D 113, 77° F., 5 cm./sec.
Flash Point --575° F.	ASTM D 92, COC
Viscosity -- 2500 - 3500 centipoise (Brookfield)	ASTM D 3236 375° F.

TRAFFIC SIGNALS AND FITTINGS

623 T.02.05 VEHICLE SIGNAL FACES: All vehicle signal faces shall consist of individual signal sections rigidly fastened together. Each section shall have a separate and complete housing. The actual number and type of sections shall be shown on the plans and in accordance with the Standard Drawings. Vehicle signal face shall be installed as indicated on the plans. All vehicle signal faces shall be mounted onto their supports by mounting assemblies in accordance with the requirements of the Standard Drawings. All new vehicle signal faces installed at any one intersection shall be the product of the same manufacturer.

- (a) **Optical Units.** Each optical unit shall consist of a lens, a reflector or reflector assembly, a lamp receptacle, and a clear traffic signal lamp. Lenses, reflectors, reflector assemblies, lamp receptacles and

wiring, and candlepower distribution shall conform to the provisions in ANSI Standard D-10.1. Reflectors shall be made of silvered glass or of specular aluminum with an anodic coating. All reflectors shall conform to the provisions in ANSI Standard D-10.1.

- (b) **Lamp receptacles** shall be as specified in Subsection 623 T.02.05 (d), "Electrical Components." Lenses may be made of either glass or an ultraviolet stabilized polycarbonate plastic conforming to the specifications of ASTM Designation D 2473. Plastic lenses shall not distort due to heat from the highest wattage lamp meeting the requirements specified below. Lamps for vehicular signal faces shall conform to the Institute of Traffic Engineers "Standard for Traffic Signal Lamps" and the following. Lamps for the eight (8) inch (200 millimeters) faces shall be 655 lumen rated initial output, 120 volt (~60 watt), 8,000 hour rated life, clear, traffic signal lamps. Lamps for the twelve (12) inch (300 millimeters) faces shall be 1,950 lumen rated initial output, 120 volt (~165 watt), 8,000 hour rated life, clear, traffic signal lamps.
- Krypton-filled, energy-saving lamps must have no less than 80% of total fill gas as Krypton. Energy-saving lamps for the eight (8) inch (200 millimeters) faces shall be 610 lumen rated initial output, 120 volt (~60 watt), 8,000 hour rated life, clear, traffic signal lamps. Lamps for the twelve (12) inch (300 millimeters) faces shall be 1,750 lumen rated initial output, 120 volt (~135 watt), 8,000 hour rated life, clear, traffic signal lamps.
- (c) **Housing.** Each signal section housing shall be either die-cast or permanent mold-cast aluminum conforming to ANSI Standard C-10.1. Maximum height of a signal section shall be ten (10) inches (250 millimeters) for each eight (8) inch (200 millimeters) section and 14-1/16 inches (357 millimeters) for each twelve (12) inch (300 millimeters) section. Each section shall be complete with a one-piece, hinged door mounting for the lens and other parts of the optical system, watertight gaskets, and a simple door-locking device. The optical system shall be so mounted that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and so constructed that sections can be removed or added. There shall be an opening in the top and bottom of each section to receive a 1-1/2 inch (38 millimeters) pipe. All exposed bolts, screws, hinge pins, and door-locking devices shall be stainless steel. All interior screws and fittings shall be stainless steel or approved non-ferrous, corrosion-resistant material. All gaskets, including door, lens and reflector gaskets, but not including lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of material not affected by heat. The lampholder gasket will not be required when the lampholder is not in direct contact with the reflector. Each signal section shall be constructed in such a manner that structural failure of the housing will not occur with a wind load pressure of 25 pounds per square foot (1.2 KPa) on the projected area of the complete signal face housing, including backplate and visors. Any fracture within the housing assembly or a deflection of more than half the lens diameter of the signal section will be considered structural failure.
- (d) **Electrical Components.** Lamp receptacles and wiring shall conform to ANSI Standard D-10.1. Each lamp receptacle shall be wired with a white conductor connected to the shell of the lamp receptacle and a black or colored conductor to the bottom or end terminal of the lamp receptacle. These conductors shall, in turn, be connected to a terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals to terminate all field conductors and lamp conductors independently, with separate screws. The terminals to which field conductors are attached shall be permanently identified or conductors shall be color coded to facilitate field wiring. Lamp receptacle conductors shall be No. 18, or larger, 600 volt, appliance wiring material (AWM), with 30 mil thickness

Rev. December 12, 1996

insulation rated 105 degrees C. or with insulation that conforms to Military Specification MIL W-16878 D, Type B, with vinyl nylon jacket rated 115 degrees C. The manufacturer's name or trademark, conductor size, insulation type letter designation and temperature rating shall be marked on the insulation.

- (e) **Visors.** Each section shall be provided with a removable, full-circle, metal visor conforming to ANSI Standard D-10.1 and the Standard Drawings, unless otherwise shown on the plans.
- (f) **Directional Louvers.** Where shown on the plans, directional louvers shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visors. The outside cylinder shall be constructed of 0.030 inch (0.8 millimeters) nominal thickness, or thicker, sheet steel or the cylinder and vanes shall be constructed of 3003 H14 aluminum alloy of equivalent thickness. Dimensions of louvers and arrangements of vanes shall be as shown on the plans.
- (g) **Backplates.** Where shown on the plans backplates shall be furnished and installed on signal heads. Dimensions, materials and installation details shall be as shown in the Standard Drawings. No background light shall show between the backplate and the signal face or between sections. Where a backplate consists of two or more sections, the section shall be fastened with rivets or with aluminum bolts peened after assembly to prevent loosening.
- (h) **Signal Mounting Assemblies.** Assemblies for the mounting of signal faces shall consist of 1-1/2 inch (38 millimeters) standard steel pipe and necessary fittings, slip-fitters and terminal compartments. Each terminal compartment shall be fitted with a terminal block containing a minimum of 12 poles, each with 2 screw-type terminals. Each terminal shall be designed to accommodate at least 5 No. 14 conductors. A cover shall be provided on the compartment to give ready access to the terminal block. Where used to bracket-mount a signal the terminal compartment shall be designed to bolt securely to a pole or standard. The dimensions of mounting assembly members between the axis through the center of the terminal compartment, or slip-fitter, shall not exceed 11 inches (275 millimeters), except where required to provide proper signal face alignment or permit programming of programmed visibility signal faces or when otherwise directed by the Engineer. Each mounting assembly shall be oriented to provide maximum horizontal clearance to the adjacent roadway. All mounting assembly members shall be either plumb or level, symmetrically arranged and securely assembled. Construction shall be such as to permit all conductors to be concealed. Mounting assemblies shall be water-tight and free of sharp edges or protrusions which might damage conductor insulation. For post-top mounting of signals, a slip-fitter shall be used. Slip-fitter shall fit over a 4-1/2 inch (113 millimeters) outside diameter pipe or tapered standard end. Each slip-fitter shall be provided with cadmium-plated steel set screws, arranged as shown on the plans. Each slip-fitter used to post-top mount signals with brackets shall be provided with an integral terminal compartment. Each mounting assembly shall be provided with positive locking, serrated fittings which, when mated with similar fittings on the signal faces, shall prevent faces from rotating. Fittings shall permit fastening at increments of not more than 7 degrees. Signal faces shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal faces may be mounted if they are not directed toward traffic or if they are covered. During the time period between signal assembly erection and system turn-on, all signal assemblies shall be completely covered by use of six (6) mil minimum thickness black plastic bags.

- (i) **Internally Illuminated Street Name Signs.** Internally illuminated street name signs shall be 6' or 8' (1.83 m or 2.44 m) long, as indicated on the project drawings, by 22 5/16" (568 mm) high. Sign shall be weather-tight and consist of 6063 T-5 alloy aluminum housing with 0.078" (2 mm) minimum thickness and translucent plastic face plate composed of white wide-angle prismatic translucent reflective sheeting, reverse-screened with manufacturers' recommended green ink and clear coating, applied to a 0.060" (1.5 mm) gage polycarbonate clear substrate. Ballast shall be a 200 ma 120V ballast. Lamps shall be 430 ma cool white. Only one ballast per lamp may be used. Two lamps, spaced six inches apart, are required for each lighted sign.

623 T.02.06 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES: Each programmed visibility signal face and the installation thereof shall conform to the provision in Subsection 623 T.02.05, "Vehicle Signal Faces," and Subsection 623 T.02.05(g) "Backplates," and Subsection 623 T.02.07(k).05(h), "Signal Mounting Assemblies." Each programmed visibility signal section shall provide a nominal twelve (12) inch (300 millimeters) diameter circular or arrow indication. Color and arrow configuration shall conform to ANSI Standard D-10.1. Each section shall be provided with a sun visor. Each signal section shall be provided with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mountings. Terminal connection shall permit external adjustment about the mounting axis in 5 degree increments. The signal shall be mountable with ordinary tools and capable of being serviced without tools. Adjustment shall be preset at 4 degrees below the horizontal, unless otherwise specified. The visibility of each programmed visibility signal face shall be capable of adjustment or programming within the face. When programmed, each signal face's indication shall be visible only in those areas or lanes to be controlled, except that during dusk and darkness a faint glow to each side will be permissible. Prior to programming, each signal section with a yellow indication shall provide a minimum luminous intensity of 3,000 candela on the optical axis, and a maximum intensity of 30 candela at 15 degrees horizontal from the axis. Each such signal section shall be capable of having its visibility programmed to achieve the following luminous intensities: a minimum of 3,000 candela on the optical axis, a maximum of 100 candela at from 1/2 to 2 degrees horizontal from the axis and a maximum of 10 candela at from 2 to 15 degrees horizontal from the axis. Under the same conditions, the intensities of the red indication and the green indication shall be at least 19 and 38 percent respectively of the yellow indication. Each signal face or each signal section shall include integral means for regulating its luminous intensity between limits in proportion to the individual background luminance. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 1000 footcandles, and shall reduce to 15±2 percent of maximum intensity at less than one footcandle. The dimming device shall operate over an applied voltage range of 95 to 130 volts, 60 Hz. and a temperature range of -40 to 165 degrees F. (-40 to 73.9 degrees C.). The Contractor shall have a manufacturer's representative program the heads.

623 T.02.07 PEDESTRIAN SIGNAL FACES: Each pedestrian signal face shall conform to the following: Messages shall be Lunar White "WALKING PERSON" and Portland Orange "HAND" conforming to the requirements of the Manual on Uniform Traffic Control Devices. Each pedestrian signal face shall be installed at the location and mounted in the manner shown on the plans. All new pedestrian signal faces installed at any one intersection shall be of the same make and type.

- (a) **Types.** Pedestrian Signal faces shall be one of the following types:

TYPE A - Type A signals shall consist of internally illuminated symbols formed by painting the message

Rev. December 12, 1996

plate except for the area forming the symbols. The message plate on which the symbols are formed shall be either 1/8 inch (3 millimeter) nominal thickness ultraviolet stabilized polycarbonate plastic with external prismatic pattern, or 3/16 inch (5 millimeter) nominal thickness ultraviolet stabilized plastic with extended prismatic pattern, or 1/8 inch (3 millimeter) nominal thickness glass fiber reinforced plastic. Each compartment shall be illuminated by one 67 watt, 120 volt, 67A21/TS incandescent traffic signal lamp with medium screw base.

TYPE B - Type B signals shall consist of internally illuminated symbols formed by painting the message plate except for the area forming the symbols. The message plate on which the symbols are formed shall be either 1/8 inch (3 millimeters) nominal thickness ultraviolet stabilized polycarbonate plastic with external prismatic pattern, or 3/16 inch (5 millimeters) nominal thickness ultraviolet stabilized acrylic plastic with external prismatic pattern, or 1/8 inch (3 millimeters) nominal thickness glass fiber reinforced plastic. The tubing shall extend horizontally across the compartments and be spaced to provide even illumination of letters symbols.

TYPE C - Type C signals shall conform to the provisions for Type B signals, except message plate and tubing shall be formed into an integral weatherproof plug-in module with a molded case of 3/32 inch (2.5 millimeters) minimum thickness, white acrylonitrile butadiene styrene. The message module shall operate in the Type C pedestrian signal head. The module shall not require the use of tools for insertion or removal.

- (b) **Housing.** The housing shall be made of 3003 H14 die cast aluminum alloy with smooth finish on both sides. Thickness shall be 1/8 inch (3 millimeters) minimum at the points of support. The housing shall be corrosion resistant and shall provide for easy access to and replacement of all components. All machine screws, studs and washers shall be either nickel plated brass, stainless steel or other corrosion resistant material. Gaskets shall be provided as required to make the housing rain tight and dust tight. Gaskets shall conform to the provisions in ASTM Designation D 1056, Grade SBE42. The housing shall be provided with top and bottom openings for 1-1/2 inch (38 millimeters) pipe. Unused openings shall be closed with watertight closures painted to match the housing, as shown on the Standard Drawings. The housing construction design may be compatible with clamshell mounting hardware.
- (c) **Sun Phantoms.** A means to stop sun phantoms while not obscuring the image shall be employed and shall be approved by the Engineer. A full vertical divider strip shall be provided between the "HAND" and the "WALKING PERSON" indications.
- (d) **Conductors.** High voltage wiring between the gas discharge tubes and the secondary side of the transformer shall be made with Gas Tube Sign and Oil Burner Ignition Cable, Type GTO-15 labeled by U.L. Other conductors shall be No. 14, or larger, with 30 mils minimum thickness Type TW insulation.
- (e) **Disconnect Switch.** A fused switch consisting of 2 cartridge fuses and a lever for disconnecting the fuses for pedestrian signals shall be mounted within the signal housing to de-energize the transformer primary circuit.
- (f) **Terminal Block.** A light duty terminal block shall be mounted in the housing for field wiring.

- (g) **Transformers.** Transformers shall carry the label of U.L. or Electrical Testing Laboratories. A separate transformer shall be provided for each of the "HAND" and the "WALKING PERSON" indications. The orange symbol "HAND" shall operate from a single transformer. Transformers shall have a minimum power factor of 0.90. Solid state message modules may be substituted for transformer operated modules. Solid state circuitry shall consist entirely of solid state electronic components. Solid state modules shall be provided with surge protection. Surge protectors shall provide a clamping voltage of 280 volts line to neutral at 20,000 amps peak current for all response times.
- (h) **Tube Mounting.** Capped ends of gas tubing in Type B signals shall be mounted in approved heat resistant glass electrode housings.
- (i) **Finish.** The outside of the housing and hood shall be painted.
- (j) **Pedestrian Signal Mounting Assemblies.** Pedestrian signal housing may be mounted with clamshell mounting hardware modified to contain a twelve (12) pole terminal block with compression screw terminal pairs. For post top mounting of pedestrian signals a slip-fitter with an integral terminal compartment shall be used. The requirements for the hardware to post top mount pedestrian signals shall be the same as for post top mounting vehicle signals.

623 T.02.08 FLASHERS:

- (a) **Visors.** Each flashing beacon shall be provided with a tunnel type visor.
- (b) **Flashing Beacon Control Assembly.** Each flashing beacon control assembly shall consist of switches, circuit breakers, terminal blocks, flasher, wiring and electrical components necessary to provide proper operation of the beacons, all housed in a single enclosure. The enclosure shall be as specified in the Special Provisions.
- (c) **Circuit Breakers and Switches.** A single-pole 15 ampere circuit breaker shall be installed to control each ungrounded conductor entering the enclosure. A switch to permit manual operation of the sign lighting circuit shall be provided. Switches shall be of the single-hole-mounting toggle type, single-pole, single-throw, rated at 10 amperes, 125 VAC. Switches shall be furnished with an indicating nameplate reading "Auto-Test" and shall be connected in parallel with the load contacts of the photoelectric control circuit. A 15 ampere circuit breaker may be used in place of the toggle switch.
- (d) **Flasher.** A 20 ampere solid state flasher shall provide for a 2 circuit alternate operation of beacons.
- (e) **Terminal Blocks.** Terminal blocks shall be rated at 25 amperes, 600 volts, shall be molded from phenolic material and shall be the barrier type with plated brass screw terminals and integral type marking strips.

623 T.02.09 STANDARD, STEEL PEDESTALS, AND POSTS:

- (a) Standards for traffic signals and roadway lighting, and steel pedestals for cabinets and other similar equipment shall be located as shown on the plans. Workmanship and finish shall be equal to the best

Rev. December 12, 1996

general practice of the metal fabrication industry. All welding shall conform to AWS D 2.0, Specification for Welded Highway and Railway Bridges," and to the requirements in this Section.

- (b) Types of poles, length of mast arms and height of poles shall be as indicated on the Contract Drawings.
- (c) Standards and steel pedestals for controller cabinets shall be constructed of 0.120 inch (3 millimeters) or thicker steel or 4 inch (100 millimeters) standard pipe or conduit, with the top designed for post-top slip-fitter. Standard pipe shall conform to the specifications of ASTM Designations A 53 or A 120.
- (d) All ferrous metal parts of standards, with shaft length of 15 feet (4.6 meters) and longer, shall conform to the details shown on the standard drawings, and the following requirements:

Standards fabricated from 0.250 inch (6 millimeters) nominal thickness or thicker materials shall be fabricated from:

- (1) Sheet steel conforming to the specifications of ASTM Designation A 283, Grade D.
- (2) Sheet steel of weldable grade having a minimum yield, after fabrication, of 40,000 pounds per square inch (276 MPa).

Standards fabricated from 0.179 inch (4.5 millimeters) nominal thickness or thinner material shall be fabricated from sheet steel conforming to the specifications of ASTM Designation A 570, Grade C, or from sheet steel conforming to alternative (2) above. When material conforming to alternative (2) above is used, 0.120 inch (3 millimeters) nominal thickness, or thicker, steel may be used in lieu of 0.135 inch (3.5 millimeters) nominal thickness, or thicker steel.

Standards may be fabricated of full-length sheets or shorter sections. Each section shall be fabricated from not more than 2 pieces of sheet metal. Where 2 pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt-welded together, the longitudinal welded seams on adjacent sections shall be placed to form a continuous straight seam from base to top of standard. The butt-welded transverse joints shall be strengthened by inserting a metal sleeve at each joint. The sleeve shall be 0.135 inch (3.5 millimeters) nominal thickness, or thicker, steel and made from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of one inch (25 millimeters). The sleeve shall be centered at the joint and have the same taper as the standard with the outside of the sleeve in full contact with the inside of the standard throughout the sleeve length and circumference.

All welds shall be continuous.

The weld metal at the transverse joint shall extend to the sleeve, making the sleeve an integral part of the joint. Longitudinal welds in steel tubular sections will be tested for strength. All exposed welds, except fillet welds and welds on top of mast arms shall be ground flush with the base metal. All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to 1/8 inch (3 millimeters) radius, unless otherwise shown on the plans.

Shafts shall be provided with slip-fitter shaft caps.

Standards shall be straight, with a permissive variation not to exceed one (1) inch (25 millimeters) measured at the midpoint of a 28.5 foot (7.62 meters), 30 foot (9.14 meters), or 35 foot (10.67 meters) standard and not to exceed 3/4 inch (19 millimeters) measured at the midpoint of an 18 foot (5.49 meters), 20 foot (6.10 meters) or 25 foot (7.62 meters) standard.

Mast arms for standards shall be fabricated from standard pipe, reamed, free from burrs, and without intermediate splices or coupling curved to the dimensions shown on the standard drawings and shall be provided with raintight connections to shafts. Standard pipe shall conform to the specifications of ASTM Designations A 53 or A 120.

Tie rods for mast arms for standards shall be manufactured of structural steel and pipe as shown on the Standard Drawings. Structural steel shall conform to the specifications of ASTM Designation A 36. Tie rods shall be provided with 2 nuts and 2 lock washers at each end.

Tie rods shall be installed with no kinks or bends.

- (e) The cast steel option for slip bases shall be fabricated from material conforming to the requirements of ASTM Designation A 27, Grade 70-40. Other comparable material may be used if written permission is given by the Engineer. The casting tolerances shall be in accordance with the Steel Founder's Society of America recommendations (green sand molding).
- (f) Material certifications consisting of physical and chemical properties, and radiographic films of the castings shall be filed at the manufacturer's office. These certifications and films shall be available for inspection upon request.
- (g) Anchor bolts shall conform to ASTM Designation A 576, Grade C-1035 for a minimum yield strength of 48,000 psi (331 MPa) and shall be provided with two nuts and two washers of 2-1/2 inch (64 millimeters) minimum O.D. Not less than twelve (12) inches (300 millimeters) of the upper end of the anchor rods and all nuts and washers shall be galvanized by the hot-dip process conforming to ASTM Designation A 153, or cadmium plated with Type NS coating conforming to ASTM Designation A 165. After galvanizing or plating, the bolt threads shall accept galvanized or plated standard nuts without requiring tools or causing removal of protective coating.
- (h) Handholes in the base of standards shall conform to the details shown on the Standard Drawings. Changes in configuration of mast arms will be permitted provided the mounting height and stability are maintained. Pedestrian push button posts shall be constructed of 2-1/2 inch (64 millimeters) standard pipe conforming to the dimensions shown on the Standard Drawings. Push button posts and guard posts shall be pipe conforming to the specifications of ASTM Designation A 53 or A 120.
- (i) Holes left in the shafts of existing standards, due to removal of equipment or mast arms, shall be repaired by welding in a suitable disk, grinding smooth, and painting as provided for repairing damaged galvanized surfaces. Welding shall be done only after all combustible materials have been removed.

Rev. December 12, 1996

- (j) All standards, steel pedestals and posts required to be galvanized shall be hot-dip galvanized per ASTM A 123.

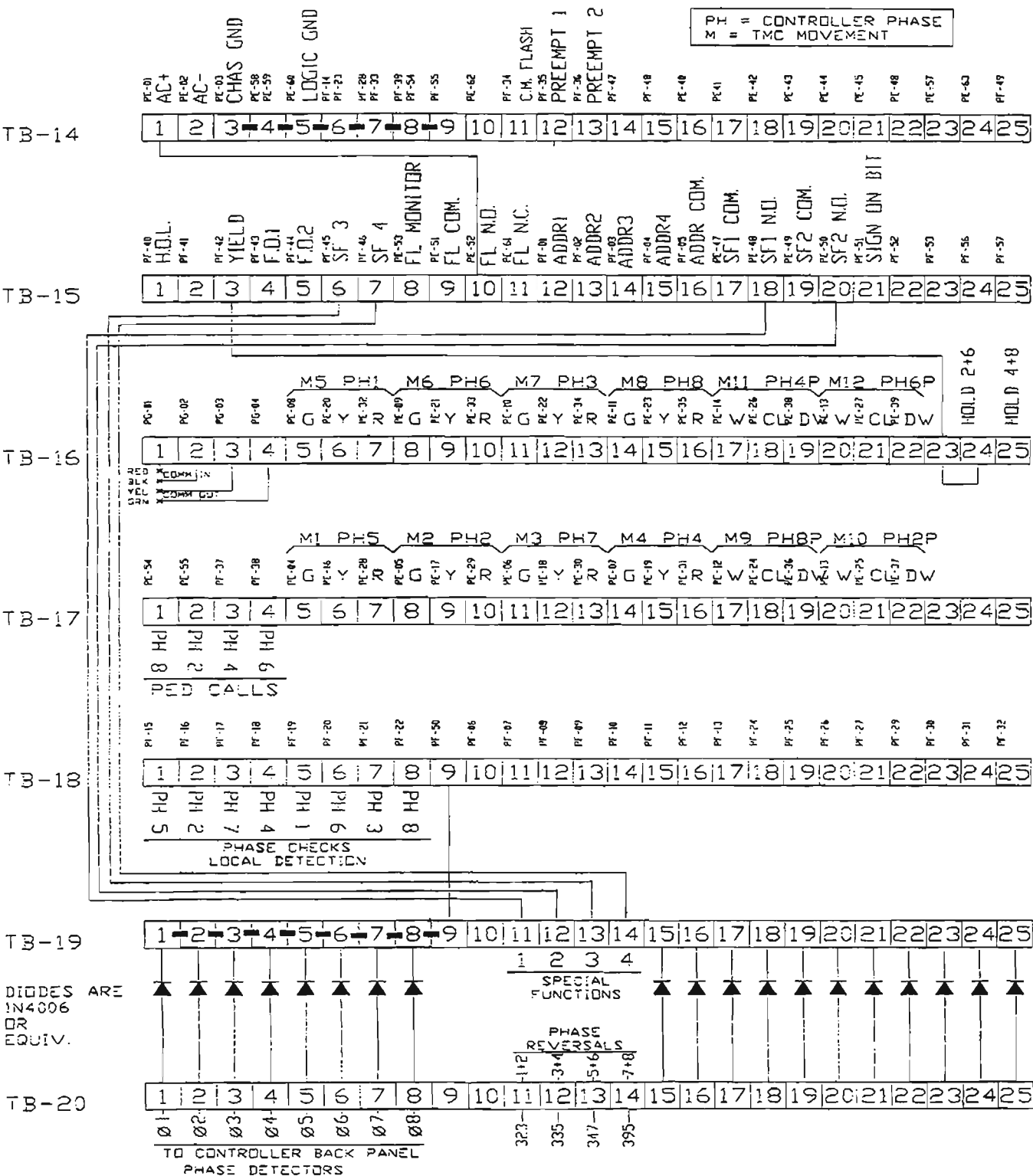
623 T.02.10 LAS VEGAS AREA SYSTEM REQUIREMENTS:

- (a) **General.** The Contractor shall furnish each controller cabinet completely configured and equipped for its intended intersection with a local communications interface unit (LCIU) panel, communication unit, and harnesses. The LCIU interface panel and harnesses are to be wired in accordance with the listing and wiring diagram shown on the following two (2) pages. The communication unit to be used shall be a Sonex Model PTC-122A configured for the Las Vegas Area Computer Traffic System.
- (b) **LCIU Interface Panel.** The interface panel shall be constructed with the LCIU harnesses wired to the back of the panel, and the cabinet interface wiring to the front of the panel. The interface panel shall have 7 terminal strips having binder screws on the top and solder terminals underneath. All wires of the LCIU harnesses shall be terminated to the solder side of the terminal strips. The terminal strips shall be TRW Cinch Jones series 25-141-Y terminals or equivalent. The LCIU harnesses shall have 3 connector ends to mate with the Sonex PTC-122A unit. The connectors shall be AMP "CPC" series connectors, and wired as shown on LCIU connector plug function tables on the following two (2) pages.
- (c) **Interconnect Cable Termination.** Each controller cabinet shall have a telephone terminal block for terminating the system interconnect cable. The terminal block shall be a Reliable Electric #R66B4-25 or equivalent. The first set of terminals shall be used for the TMC phone; the second set shall be used for the JMC phone. The third set shall be data in, and the fourth set shall be data out. The cabinet shall have an ample number of terminal blocks to terminate all system interconnect cables for a given intersection. Each wire pair from the interconnect cable utilized in the cabinet shall have surge protectors installed to shunt power surges to ground (i.e. RX COMM. IN, TX COMM. OUT, VOICE (TMC), and VOICE (JMC)). The surge protector devices shall be TII #317A protectors or equivalent.

TRAFFIC SIGNALS AND STREET LIGHTING

623
Rev. December 12, 1996

PE - J1				PF - J2			
PIN	FUNCTION	FROM	TO	PIN	FUNCTION	FROM	TO
1.02e+0 8	+115 VAC AC- CHASSIS GROUND 1 GREEN (PH 5) 2 GREEN (PH 2)	TB14-01 TB14-02 TB14-03 TB17-05 TB17-08		01 02 03 04 05	ADDRESS BIT 1 ADDRESS BIT 2 ADDRESS BIT 3 ADDRESS BIT 4 ADDRESS BIT COM.	TB15-12 TB15-13 TB15-14 TB15-15 TB15-16	
06 07 08 09 10	3 GREEN (PH 7) 4 GREEN (PH 4) 5 GREEN (PH 1) 6 GREEN (PH 6) 7 GREEN (PH 3)	TB17-11 TB17-14 TB16-05 TB16-08 TB16-11		06 07 08 09 10	SYSTEM DET 1 SYSTEM DET 2 SYSTEM DET 3 SYSTEM DET 4 SYSTEM DET 5	TB18-10 TB18-11 TB18-12 TB18-13 TB18-14	
11 12 13 14 15	8 GREEN (PH 8) 9 WALK (PH 8) 10 WALK (PH 2) 11 WALK (PH 4) 12 WALK (PH 6)	TB16-14 TB17-17 TB17-20 TB16-17 TB16-20		11 12 13 14 15	SYSTEM DET 6 SYSTEM DET 7 SYSTEM DET 8 LOGIC GROUND LOCAL DET 1 (PH 5)	TB18-15 TB18-16 TB18-17 TB14-06 TB18-01	
16 17 18 19 20	1 YELLOW (PH 5) 2 YELLOW (PH 2) 3 YELLOW (PH 7) 4 YELLOW (PH 4) 5 YELLOW (PH 1)	TB17-06 TB17-09 TB17-12 TB17-15 TB16-06		16 17 18 19 20	LOCAL DET 2 (PH 2) LOCAL DET 3 (PH 7) LOCAL DET 4 (PH 4) LOCAL DET 5 (PH 1) LOCAL DET 6 (PH 6)	TB18-02 TB18-03 TB18-04 TB18-05 TB18-06	
21 22 23 24 25	6 YELLOW (PH 6) 7 YELLOW (PH 3) 8 YELLOW (PH 8) 9 DW FL (PH 8) 10 DW FL (PH 2)	TB16-09 TB16-12 TB16-15 TB17-18 TB17-21		21 22 23 24 25	LOCAL DET 7 (PH 3) LOCAL DET 8 (PH 8) LOGIC GROUND COUNT DET 1 COUNT DET 2	TB18-07 TB18-08 TB18-06 TB18-18 TB18-19	
26 27 28 29 30	11 DW FL (PH 4) 12 DW FL (PH 6) 1 RED (PH 5) 2 RED (PH 2) 3 RED (PH 7)	TB16-18 TB16-21 TB17-07 TB17-10 TB17-13		26 27 28 29 30	COUNT DET 3 COUNT DET 4 LOGIC GROUND COUNT DET 5 COUNT DET 6	TB18-20 TB18-21 TB14-07 TB18-22 TB18-23	
31 32 33 34 35	4 RED (PH 4) 5 RED (PH 1) 6 RED (PH 6) 7 RED (PH 3) 8 RED (PH 8)	TB17-16 TB16-07 TB16-10 TB16-13 TB16-16		31 32 33 34 35	COUNT DET 7 COUNT DET 8 LOGIC GROUND C.M.F.L.(GND=FL) PRE-EMT 1 IN	TB18-24 TB18-25 TB14-07 TB14-11 TB14-12	OD1-15
36 37 38 39 40	9 DW (PH 8) 10 DW (PH 2) 11 DW (PH 4) 12 DW (PH 6) OFFSET COMMAND	TB17-19 TB17-22 TB16-19 TB16-22 TB14-16		36 37 38 39 40	PRE-EMT 2 IN 11 PED CALL (PH 4) 12 PED CALL (PH 6) LOGIC GROUND HOLD ON LINE (HOL)	TB14-13 TB17-03 TB17-04 TB14-08 TB15-01	
41 42 43 44 45	OFFSET 1 OFFSET 2 OFFSET 3 CYCLE COMMAND CYCLE 2	TB14-17 TB14-18 TB14-19 TB14-20 TB14-21		41 42 43 44 45	ADVANCE YIELD FORCE OFF (R1) FORCE OFF (R2) S.F. 3 (REV 1+2)	TB15-02 TB15-03 TB15-04 TB15-05 TB15-06	TB16-23
46 47 48 49 50	CYCLE 3 S.F. 1 COMMON S.F. 1 N.O. (REV 3+4) S.F. 2 COMMON S.F. 2 N.O. (REV 7+8)	TB14-22 TB15-17 TB15-18 TB15-19 TB15-20	TB14-4 TB19-11 TB14-4 TB19-12	46 47 48 49 50	S.F. 4 (REV 5+6) PRE-EMT 1 OUT PRE-EMT 2 OUT SPARE CALL ALL	TB15-07 TB14-14 TB14-15 TB14-25 TB18-09	TB19-13 TB19-14
51 52 53 54 55	FLASH COM FLASH N.O. FL-MON.(AC+=FLASH) 9 PED CALL (PH 8) 10 PED CALL (PH 2)	TB15-09 TB15-10 TB15-08 TB17-01 TB17-02		51 52 53 54 55	SIGN ON BIT SPARE SPARE LOGIC GROUND LOGIC GROUND	TB15-21 TB15-22 TB15-23 TB14-08 TB14-09	
56 57 58 59 60	AC- SPARE LOGIC GROUND LOGIC GROUND LOGIC GROUND	TB14-02 TB14-23 TB14-04 TB14-04 TB14-05		56 57	SPARE SPARE PHASE REV 1+2 PHASE REV 3+4 PHASE REV 5+6 PHASE REV 7+8	TB15-24 TB15-25 TB20-11 TB20-12 TB20-13 TB20-14	
61623	FLASH N.C. +24 VAC SPARE HOLD 2+6 HOLD 4+8	TB15-11 TB14-10 TB14-24 TB16-24 TB14-25		PG - J3			
				01 02 03 04	COMM INPUT COMM INPUT COMM OUTPUT COMM OUTPUT	TB16-01 TB16-02 TB16-03 TB16-04	



- (d) **Preemption.** Intersection cabinets utilizing preemption equipment shall be wired in such a manner that the outputs wired to controller and cabinet functions which are common to the outputs of the LCIU shall have proper isolation devices (relay or diode) to prevent improper operation of either unit. Vehicular preemption unit output shall also be wired to the PRE-EMPT 1 (TB14-12) input to the LCIU for traffic system surveillance purposes.
- (e) **Controller Phasing.** It should be noted that for the LCIU inputs related to controller phasing (i.e., green, yellow, red, walk, pedestrian clearance, and don't walk), make reference to compass directions of an intersection rather than actual controller phases. Controller phase outputs to LCIU inputs wiring for each intersection cabinet shall be based on the compass directions for an intersection. See the phasing table below for configuring all cabinets for a given intersection.

Controller Phase	Direction	LCIU Movement
1	North to West	5
2	Southbound	2
3	West to South	7
4	Eastbound	4
5	South to East	1
6	Northbound	6
7	East to North	3
8	Westbound	8
2 Ped	Southbound	10
4 Ped	Eastbound	11
6 Ped	Northbound	12
8 Ped	Westbound	9

Note that the phasing scheme for the LCIU Movement phase inputs DOES NOT correspond to the Standard NEMA Specifications for controller phasing.

Rev. December 12, 1996

For each intersection, a conversion must take place in the wiring of the LCIU phase return inputs vs. the controller phase outputs. This wiring conversion shall take place on the phase return input terminals of the LCIU Interface Panel.

Intersection controller phasing shall be as defined in Subsection 623 T.02.01(e) or the Special Provisions.

(f) **System Control Functions.**

Hold on line (H.O.L.): The hold on line output shall be wired to the Max Inhibits 1 and 2 of the controller, and the Call to Non-Actuated 1 input of the controller.

Yield: The yield output shall be wired to the hold inputs for controller phases (2 and 6) or (4 and 8) jumper selectable on the terminal block TB16-23/24/25, refer to communication panel drawing on previous page for proper wiring). The yield output shall be active only when the H.O.L. output is active. The yield condition shall be a release of the hold inputs to the controllers.

Force-Off 1 and 2: The Force-Off outputs shall be wired to the Force-Off inputs 1 and 2 of the controller.

Call All: This output shall be wired through isolation diodes to the Vehicle Call inputs for all phases of the controller. Refer to Subsection 623 T.02.10(e).

Special Function 1, 2, 3, and 4: Refer to communication panel drawing on previous page for proper wiring.

Flash Command: This output shall be wired to the Flash Control line of the cabinet. When this output is active (AC+), the intersection cabinet shall be put in a "flash" mode.

Walk Rest Modifier: This controller input shall be wired to logic ground in the cabinet.

Terminated Functions: The following LCIU output functions shall be terminated on the LCIU interface panel for the capability of future use: Offset Command, Offset 1, Offset 2, Offset 3, Cycle Command, Cycle 2, Cycle 3, Special Function 1 and 2 relay outputs, and Advance.

- (g) **Controller Sequence Reversal:** Dual ring controllers shall be capable of phase sequence reversal by applying a ground true signal to connector B. Applying ground true signal to pin B shall cause the controller to reverse sequence phases 1 and 2 (lead-lag). Applying ground true signal to pin W shall cause the controller to reverse sequence phase 3 and 4 (lead-lag). Applying ground true signal to pin X shall cause the controller to reverse sequence phase 5 and 6 (lead-lag). Applying ground true signal to pin y shall cause the controller to reverse sequence phase 7 and 8 (lead-lag). Applying ground true signal to both pins B and X simultaneously shall cause the controller to sequence to phases 2 and 6 before phases 1 and 5 (lagging left turns). Applying ground true signal to both pins W and y simultaneously shall cause the controller to sequence to phases 4 and 8 before phases 3 and 7 (lagging left turns).

- (h) **System Control.** A controller operating in a CALL to Non-Actuated mode 1 or 2, with the phase hold active, and the walk rest modifier input active, shall rest in a walk dwell condition until a yield (release of the phase hold input). Upon a yield the controller shall be capable of timing the pedestrian clearance interval followed by the vehicle clearance interval, and all red interval without the need for other input control such as a force-off. The controller shall be capable of responding to yield durations of 500 milliseconds and perform the said function.
- (i) **Inputs and Outputs.** Inputs and outputs related to external devices in the cabinet shall be related to the pin assignments prescribed by NEMA and shall not require cabinet modification for interchangeability with NEMA controllers. Any special functions required for controller operation shall utilize spare pins in the input/output connectors as specified by NEMA.
- (j) **System Monitoring Functions.** Attention should be given to the input signal level for the inputs of the LCIU. Both D.C. and A.C. inputs are used, following is a list of inputs and their required levels:

D.C. Inputs, Ground True

36	Phase Returns (green, yellow, red, pedestrian)
1	Pre-empt 1
1	Pre-empt 2
1	Conflict Flash
4	Pedestrian Calls
8	Local Detectors
8	System Detectors
8	Counter Detectors

A.C. Inputs (115 VAC)

1	Controller Flash

The local LCIU detector inputs shall be wired to the respective Phase Check outputs of the controller. Refer to Subsection 623 T.02.01(e) for cabinet controller phasing.

- (k) **Interconnect Junction Cabinet.** The Interconnect Junction Cabinet shall be a Tesco Enclosure Class 22-000-NR (43"x20"x11") or approved equal, equipped with one (1) Reliable Electric No. R66B4-25 terminal block, or approved equal, having capacity for 25 pairs of No. 22 AWG wire. The terminal block shall be mounted on a painted wood panel secured to the back of the cabinet. The Contractor shall provide and install a door lock with key and all foundation, anchor bolts and hardware in accordance with instructions of the cabinet manufacturer.
- (l) **Interconnect Cable.** Interconnect cable shall be 22 AWG, twisted pairs with cores filled with petroleum jelly, telephone cable per REA Specification RE-39, dated December, 1979. Splices in the cable are prohibited. The cable shall be terminated in the controller cabinet or in the Interconnect Junction Cabinet.

Rev. December 12, 1996

623 T.02.11 PEDESTRIAN PUSH BUTTONS: Where shown on the plans, pedestrian push buttons of substantial tamper-proof construction shall be furnished and installed. The assembly shall be weather-proof and so constructed that it will be impossible to receive any electrical shock under any weather condition.

The pedestrian push button switch shall be a phenolic enclosed precision snap-acting type, switching unit, single-pole, double-throw, with screw-type terminals, rated fifteen (15) amperes at one hundred twenty-five (125) volts, AC, and shall have the following characteristics:

- (a) Switching unit shall have a stainless steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.
- (b) Switch shall have an operating force of 0.56 to 0.81 lbf (2.5 to 3.6 N) and have a minimum release force of 0.25 lbf (1.1 N).
- (c) Pre-travel shall be one sixty-fourth (1/64) inch (0.4 millimeter) maximum.
- (d) Over-travel shall be seven thirty-seconds (7/32) inch (5.5 millimeter) minimum.
- (e) Differential travel shall be four ten-thousandths (0.0004) to two one-thousandths (0.002) inch (0.01 to 0.05 millimeter).

Push buttons shall be 2 inch (51 millimeter) minimum diameter.

Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

Where a pedestrian push button is to be mounted on top of a two and one-half (2 ½) inch (63 millimeter) diameter post, the housing shall be provided with a slip-fitter fitting and screws for securing rigidly to the post.

Push button and sign shall be installed on crosswalk side of the pole.

Arrows on push button sign shall point in same direction of corresponding crosswalk.

623 T.02.12 EMERGENCY VEHICLE PRIORITY CONTROL SYSTEM:

- (a) **System Description.** The system employs optical communication to identify the presence of designated priority vehicles and cause the traffic signal controller to advance and/or hold a desired traffic display selected from phases normally available. The matched set of components which make up the system will cause the existing traffic controller to be manipulated upon recognition of the signal from the vehicle. This communication is effective to the optical detectors at or near the intersection over a line-of-sight path. The system shall require no action of the vehicle operator other than the operation of the "emitter ON" switch located in the vehicle. The switch is to remain "ON" until the end of the emergency run. The system shall operate on a first-come, first-served basis or on a selected priority. The system shall be designed to yield to other priority demands such as railroad, draw-bridge, etc. The system shall interface with existing traffic signal controllers without compromising normal operation or existing safety provisions. The Priority Control System shall consist of an optical emitter, optical detectors, optical detector cable, and priority control unit.

- (b) **Matched System Components.** To assure desired performance, the system shall provide the synergy of the four principal components, matched and proven through integrated testing and extensive functional experience. The matched component system shall offer compatibility with all types of traffic signal controllers. Matched components provide future compatibility of all priority control elements.
- (1) **Optical Emitter.** Shall be a lightweight, weatherproof, light-emitting device with internal, regulated power supply designed to produce high intensity optical energy, from a single source, precisely timed by a crystal controlled circuit.
 - (2) **Optical Detector.** Shall be a light-weight, weatherproof, adjustable, bi-directional optical detector assembly. Internal circuitry shall transform optical energy from the optical emitter assembly into electrical signals for delivery (up to 1000 feet (305 meters)) via optical detector cable to the priority control unit.
 - (3) **Optical Detector Cable.** Shall be a durable, shielded, 3- conductor cable with a drain wire and the necessary electrical characteristics to carry power to the optical detector from the priority control unit and to carry the optical detector signal to the priority control unit.
 - (4) **Priority control unit.** This equipment shall provide interface between the optical detectors and the cabinet controller unit and provide the following functions while not compromising the existing fail-safe provisions:
 - (a) Sufficient Power to all optical detectors required for the intersection.
 - (b) Differentiation of signals by optical detectors from one or more emitters on a first-come, first-served basis.
 - (c) Output signals to the cabinet controller to cause selection of the desired phase green display for the approaching emergency vehicle. To be wired as shown in table.

	OMIT PHASES	CALL	PULSES
CHANNEL A	134578	MCE & TB14-12	INV. ADV.
CHANNEL B	123567	MCE & TB14-12	INV. ADV.

All input and output wires of the priority control system to be terminated on a separate panel then wired to the controller back panel.

- (d) Smooth transition to non-priority operation upon passage of the vehicle through the intersection.
- (c) **System Operation.**
- (1) Priority control system shall be activated by an optically transmitted signal capable of recognizing and discriminating an Optical Emitter flash rate of (Class II) $14.035 \text{ Hz} \pm 0.255 \text{ Hz}$ from a single light source or upon the actuation of a test switch or remote call signal to the phase selector. If a second channel of pre-emption is used it shall respond to a flash rate of (Class I) $9.639 \text{ Hz} \pm 0.119 \text{ Hz}$.
 - (2) The system shall cause the traffic controller to select from normally available green phases by activation of a combination of its inputs such as:

MANUAL CONTROL ENABLE (SOLID LOGIC LOW)
 INTERVAL ADVANCE (PULSING LOGIC LOW)
 PHASE OMITS

Rev. December 12, 1996

- (3) The system shall not require modification or replacement of the existing controller unit beyond adding the necessary system hardware.
- (4) The system shall maintain adequate minimum traffic signal displays when priority control is active.
- (5) The system shall provide for up to 3 optical detectors to be connected to each channel to accomplish the following:
 - (a) To provide adequate optical emitter detection range to allow sufficient time to deliver the desired traffic signal display in accordance with the minimum times required to terminate non-desired traffic signal displays.
 - (b) To provide continuous line-of-sight contact between the emitter and the optical detector units.
- (6) Abnormal sequence of traffic signal displays will not occur.
- (7) Transitions from green to red without the appropriate clearance intervals will not occur.
- (8) The system shall allow the traffic signal controller to resume normal timing operation after the desired signal display is obtained and optical signals have ceased for an appropriate period.
- (9) The system shall not attempt controller manipulation nor retain priority vehicle calls during periods of "Intersection Flash" operation.

(d) **System Component Specification.**

- (1) **Optical Emitter.**
- (2) **Optical Detector.**
 - (a) The optical detector shall be a lightweight, weatherproof device capable of sensing and transforming pulsed optical energy into electrical signals usable by the phase selection equipment.
 - (b) The unit shall be high-impact polycarbonate construction with non-corrosive hardware.
 - (c) The unit shall be designed for simple mounting at or near an intersection on mast arm, pedestal, pipe, or span wire.
 - (d) The unit shall accept optical signals from two directions (northbound and southbound) or (eastbound and westbound) and provide a single electrical output signal.
 - (e) The unit shall include a design feature to allow aiming of the two optical sensing inputs for skewed approaches or slight curves.
 - (f) The unit shall be responsive to the optical emitter at a distance of 1800 feet (550 meters).
 - (g) The unit shall be capable of providing the necessary electrical signal to the priority control unit through up to 1000 feet (305 meters) of optical detector cable.
- (3) **Optical Detector Cable.**
 - (a) The cable must guarantee delivery of the necessary quality signal from the optical detector to the phase selector over a non-spliced distance of 1000 feet (305 meters).
 - (b) The cable shall have 3 No. 20 AWG (minimum gage) stranded copper conductors and one bare, individually tinned, copper color coded as follows:

Orange for delivery of optical detector power (+)

Bare for optical detector power return (-)

Yellow for optical detector signal

Blue for spare second optical detector signal

- (4) **Priority Control Equipment.** The Emergency Vehicle Priority Control System shall be a self-contained stand alone unit which shall recognize input signals for up to four separate channels of emergency vehicle preemption and to contain the following major parts:
- (a) A card rack which shall contain the power supply (to be powered from AC mains in cabinet and contain its own internal power supply to feed Optical Detectors), plug-in card edge connectors, appropriate plugs and connector harnesses to connect the whole unit to the cabinet wiring assembly.
 - (b) **Priority control Discriminator Plug-in Module:** This module Unit shall be a plug-in two-channel device designed to be used with optical Emitters and Detectors. It shall be capable of recognizing and discriminating Optical Emitter flash rates, as described in Subsection 623 T.02.12 (c), "System Operations", via Optical Detectors connected to each channel. The primary function of the Preempt Module is to provide priority emergency vehicle preemption for NEMA traffic signal controllers with or without preempt timing capability.
 - (c) Circuits to interface with the cabinet controller unit as described in Subsection 623 T.02.12 (c)(3).
- (e) **Reliability.** All equipment supplied as part of the optical priority remote traffic control system intended for use in the controller cabinet shall meet the electrical and environmental specifications spelled out in the NEMA standards publication TS2, Type 2 or later version.

CONSTRUCTION

623 T.03.01 PAINTING:

- (a) The stainless steel latching devices shall not be painted. The preparation and finishing of new equipment shall be as follows:
- (b) Galvanized and non-ferrous surfaces to be painted, shall be cleaned and coated with Vinyl Wash Primer. Ferrous metal surfaces shall be cleaned and immediately coated with the primer specified in Subsection 714.03.01(b).
- (c) If an approved primer coat has been applied by the manufacturer and is in good condition, additional primer application by the Contractor, other than for repairs, will not be required.
- (d) All traffic signal standards shall be steel poles which have been hot-dip galvanized by the manufacturer in accordance with Subsection 715.03.01. If required in the Special Provisions, standards shall also be painted as specified therein.

Directional louvers and backplates shall be painted flat black.

- (e) Cabinets or controller boxes shall have a finish on all surfaces, both interior and exterior, consisting of a minimum of one shop coat of primer on all surfaces by the manufacturer of the cabinets or boxes and as approved by the Engineer, and unless otherwise shown on the drawings or specified in the Special

Rev. December 12, 1996

Provisions, two coats of white enamel paint on interior surfaces and two coats of white enamel on exterior surfaces. The white enamel shall be that specified in Subsection 714.03.01(o). Aluminum cabinets shall be painted, inside and outside, using white electrostatic powder coating.

- (f) Factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer.
- (g) Existing equipment and material to be repainted whether remaining in place or to be relocated, shall be cleaned of all rust, scale, grease, dirt and poorly bonded paint by any method satisfactory to the Engineer.

Immediately after cleaning, all bare metal shall be primed as appropriate, or as specified for new material. A finish coat shall then be applied over newly primed areas followed by one or more finishing coats over the entire surface.

- (h) Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.
- (i) Paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators, except that no spraying shall be done at the jobsite. The work shall be done in a neat and workmanlike manner, and the Engineer reserves the right to require the use of brushes for the application of paint should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.
- (j) The thickness of each paint coat shall be limited to that which will result in uniform drying throughout the film. Skips, holidays, thin areas, or other deficiencies in any one coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.
- (k) The final coat shall present a smooth surface, uniform in color, free of runs, sags or excessive brush marks.

STREET LIGHTING SECTION

MATERIALS

623 L.02.01 MATERIALS, STANDARDS AND POSTS:

- (a) Standards and posts for street lighting standards, cabinets, etc. shall be as specified in the Special Provisions or as shown on the plans or the Standard Drawings and shall conform to the following requirements:

The street lighting standard shall consist of a continuous tapered round steel pole assembly, base cover, mast arm, pole top, anchor rods and necessary bolts, nuts and washers. Workmanship and finish shall be equal to the best general practice of modern metal fabrication.

- (b) **Pole Assembly.** The pole shaft shall be of round cross section with a minimum outer diameter of eight (8) inches (200 millimeters) at the base and shall uniformly decrease in diameter at the rate of 0.14 inches per foot (3.5 millimeters per 300 millimeters) of length. The shaft shall be formed from not more than three (3) pieces of sheet steel. Only one (1) piece of sheet steel shall be used for each section.

A maximum of two (2) circumferential welds and one (1) longitudinal weld will be permitted in assembling the shaft. Where the sections are butt welded together, the welded seams of adjacent sections shall be placed

to form a continuous weld from the base to top of standard. After welding, all surplus weld material or protrusions shall be ground off smooth to present an indiscernible joint.

Ground joints shall maintain the strength of the surrounding unwelded metal. Butt joints shall be reinforced in the corresponding gage by three (3) inch (75 millimeters) wide tapered sleeves of the same composition as the steel in the standard. The sleeves shall be centered at the joint and have the same taper as the standard so that the outside of the sleeve is in full contact throughout its length and circumference. All welds shall be continuous. Welding shall be done by A.W.S. certified welders and shall conform to the best accepted practice. Longitudinal welds shall be performed by the submerged arc process. Exposed welds, except fillet welds, shall be ground flush with the base metal.

Standards shall be straight, with a permissive variation not to exceed 3/4 inch (19 millimeters) measured at the midpoint of 30 foot (9.1 meters) standards or poles, or 1/2 inch (13 millimeters) measured at the midpoint of 20 foot (6.1 meters) standard or poles. Standards shall be round with an out-of-round variation not to exceed 1/8 inch (3 millimeters).

Sheet steel used shall have an initial minimum yield of 48,000 psi (331 MPa), or which after forming or cold rolling shall develop a minimum of 48,000 psi (331 MPa), in accordance with ASTM Designation E 8, and shall be of not less than #11 gage (0.119 inch) (3 millimeters), #7 gage (0.179 inch) (4.5 millimeters) or #3 gage (0.250 inch) (6 millimeters) as called for on the plans.

- (c) The pole base plate shall be a 1 inch (25 millimeters) thick by 11-1/2 inches (290 millimeters) square steel plate for #11 gage standards and 1-1/8 inch (29 millimeters) thick by 11-1/2 inch (290 millimeters) square steel plate for #7 gage standards, conforming to ASTM Designation A 27, Grade 65-35 cast steel or ASTM Designation A 36 steel plate or A 283, Grade D steel plate slotted to accommodate four (4) one (1) inch (25 millimeters) or 1-1/8 inch (29 millimeters) anchor rods equally spaced on an eleven (11) inch (275 millimeters) bolt circle. All exposed edges of plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to 1/8 inch (3 millimeters) radius unless otherwise shown on the plans. The pole shaft shall telescope through the base plate and shall be secured by two continuous welds, one on the inside at the bottom of the plate and the other on the outside on top of the plate.
- (d) The luminaire arm shall be formed with a single radius bend from two (2) inch (50 millimeters) schedule 40 pipe 8 feet (2.45 meters) in length, conforming to ASTM Designation A 120. A minimum straight portion of five (5) inches (125 millimeters) shall be provided to attach the luminaire. The shaft end of the

Rev. December 12, 1996

arm shall have a weather resistant steel fitting, welded in place. The fitting shall be shaped to lock on the shaft fitting by gravity and shall be secured by a minimum of one cap screw.

- (e) When twin luminaire arms are specified on the plans, they may be tapered, or two inch pipe arms 8 feet (2.45 meters) in length, conforming to ASTM Designation A 570, Grade A may be used. For tapered arms, the luminaire end shall consist of a welded two (2) inch (50 millimeters) schedule 40, 10-1/2 inch (268 millimeters) length pipe with a 7-1/2 inch (190 millimeters) exposed tenon, and the opposite end shall have a welded three bolt weather resistant steel fitting as called for on the Street Light Standard Drawing No. 314. The bolts shall be high strength conforming to ASTM Designation A 325 high strength bolts.
- (f) A four (4) inch (100 millimeters) by six and a half (6-1/2) inch (165 millimeters) handhole reinforced frame and slip-resistant indented type cover located eight (8) inches (200 millimeters) from the base plate shall be provided. The cover shall include a bar with one weather and vandal resistant 1/4 inch (6 millimeters) Hex socket head screw. The pole base cover shall be two or four piece ferrous metal, hot-dip galvanized; shall cover the base plate completely; and shall be firmly secured.
- (g) **Finish.** Pole assemblies and luminaire arms shall be hot-dip galvanized in conformance with ASTM Designation A 123.
- (h) **Tests.** The steel used in standards shall be tested in accordance with ASTM Designation A 370, paragraph 13.1. The supplier of the standards shall furnish certified notarized test reports showing the yield strength after fabrication of material used in the shaft and subsequent standards shall conform to this certification. At the discretion of the Engineer random samples may be selected of the finished product for testing purposes and tests shall be carried out and reports furnished at no additional cost.
- (i) **Tests, Deflection of Standards.** The standard, complete with modification, shall sustain a horizontal test load of 500 pounds (227 kilograms) applied eighteen (18) inches (450 millimeters) from the top of the shaft in any direction without failure of any component part, and with a deflection of not more than 7-1/2% of the pole shaft length measured from point of load application to the base plate.

This deflection includes a maximum allowance of 1/2 inch (13 millimeters) for testing and permanent set.

- (j) **Tests, Deflection, Luminaire Brackets or Mast Arms.** Luminaire brackets or mast arms and related pole attachment devices shall sustain a vertical load of 100 pounds (45 kilograms) applied within three (3) inches (75 millimeters) of the luminaire end of the support with the support attached to a rigid structure. The vertical deflection shall not exceed 5-1/2% of the bracket or mast arm length. The luminaire brackets or mast arms and related pole attachment devices shall sustain a transverse horizontal load of 50 pounds (22.7 kilograms) and a vertical load of 50 pounds (22.7 kilograms) applied within three (3) inches (75 millimeters) of the luminaire end of the support with the support attached to a rigid structure. The horizontal deflection shall not exceed 10% of the bracket or mast arm length, and the pole attached devices shall not develop any looseness within the specified loading range.
- (k) **Tests, Deflection of Davit Standards.** The davit standard, complete with modification shall sustain a horizontal test load of 500 pounds (227 kilograms) applied to the vertical shaft at the point at which the

davit portion becomes tangent. This load may be applied in any direction and the shaft shall sustain this load without failure of any component part, and with a deflection of not more than 7-1/2% of the length of the shaft measured from the point of load application to the base plate. This deflection includes a maximum allowance of 1/2 inch (13 millimeters) for testing methods and permanent set.

- (l) Standards and fittings shall be cleaned and finished as specified in Subsection 623 L.03.01. After erection, all outside surfaces shall be cleaned free from dust, dirt and oil, and all abraded and damaged areas shall be neatly refinished. Tie rods, nuts, washers, and other miscellaneous ferrous parts shall be galvanized before installation by the hot-dip process conforming to ASTM Designation A 153.
- (m) Posts, poles, standards, and cabinets shall not be erected until the foundation has set at least seventy-two hours, and shall be plumbed or raked, as ordered by the Engineer.

623 L.02.02 ANCHOR BOLTS: Anchor bolts shall conform to ASTM Designation A 576, Grade C-1035 for a minimum yield strength of 48,000 psi (331 MPa) and shall be provided with two nuts and two washers of 2-1/2 inch (63 millimeters) minimum O.D. Not less than twelve (12) inches (300 millimeters) of the upper end of the anchor rods and all nuts and washers shall be galvanized by the hot-dip process conforming to ASTM Designation A 153, or cadmium plated with type NS coating conforming to ASTM Designation A 165. After galvanizing or plating, the bolt threads shall accept galvanized or plated standard nuts without requiring tools or causing removal of protective coating.

Unless shown otherwise on the Drawings, anchor bolts for #7 gage standards and posts shall be 1-1/8 inch by 40 inches by 4 inches (3 by 1000 by 100 millimeters) and for standards and posts lighter than #7 gage shall be 1 inch by 36 inches by 4 inches (25 by 900 by 100 millimeters). The upper six (6) inches (150 millimeters) of anchor bolts shall be threaded. Plumbing of standards shall be accomplished by adjusting the nuts before the foundation is finished to one (1) inch (25 millimeters) minimum above final grade. Shims or other similar devices for plumbing or raking will not be permitted.

623 L.02.03 LIGHTING LUMINAIRES: The standard luminaire shall be of the high pressure sodium type, horizontal burning, cobra head style, in wattages specified in the plans. The luminaire shall consist of a precision diecast aluminum housing, globe ring and ballast module door. The lower portion of the luminaire shall be composed of two parts. One part shall contain the optical assembly and the other part shall be the ballast module door. The ballast module door shall contain all the major electrical components and shall be capable of being lowered after loosening one or two non-corrosive captive screws. The ballast shall be pre-wired to the lamp socket and terminal board. The ballast module door assembly shall be removable and replaceable by the use of quick disconnect plugs. The refractor holder shall have an automatic latch with a safety catch on the house side. The holder shall be forced upward at the streetside by spring pressure against the gasket seal when in the closed and latched position.

The luminaire housing and optical assemblies for 250 watt and 750 watt fixtures shall be the same size as is normally standard usage by the manufacturer for 400 watt fixtures. The slipfitter shall be capable of adapting to 1-1/4 inch (33 millimeters) through 2 inch (50 millimeters) pipe bracket without rearrangement of parts and be adjustable +5 degrees from horizontal.

The optical assembly shall consist of an aluminum reflector, prismatic acrylic refractor for 100 watt luminaires, and borosilicate prismatic glass refractor for 150 through 750 watt luminaires, or when specified shall be of polycarbonate resin vandal resistant material. The socket shall have a non-cantilevered, spring loaded contact, and

Rev. December 12, 1996

horizontal and vertical socket adjustment shall be provided within the reflector. The optical assembly latch shall be easily operated while wearing lineman's gloves, providing access to refractor-reflector and lamp. All ballast components shall be internally mounted on a down opening diecast ballast module door and easily removable and replaceable through the use of quick disconnect plugs. In 100 watt and 150 watt luminaires the starting aid shall be the plug-in type, removable without the use of tools. The ballast shall be pre-wired to the lamp socket and terminal board.

The ballast shall be capable of starting and operating a high pressure sodium lamp of the wattage specified in plans from a nominal 120 or 240 volt, 60 Hz power source, as indicated, within the limits specified by the lamp manufacturer. The ballast, including starting aid, must protect itself against normal lamp failure modes. The ballast shall be capable of operation with the lamp in an open or short circuit-condition for six months without significant loss of ballast life. 150 W Luminaires shall utilize 55 v. rated HPS lamps only.

The fixture manufacturer shall submit a statement to the effect that the ballast to be furnished is in full compliance with lamp-ballast specifications available to the fixture manufacturer from the lamp manufacturers at the time of bidding. Original manufacturer fixtures only are acceptable utilizing only new components. Rebuilt or remanufactured fixtures are not acceptable.

For nominal line voltage and nominal lamp voltage, the ballast design center will not vary more than 5% from rated lamp watts. At any lamp voltage, from nominal through life, lamp wattage regulation spread at that lamp voltage shall not exceed 18% for $\pm 10\%$ line voltage variation. The ballast shall be a regulator type.

The luminaire manufacturer shall supply ballast electrical data, and lamp operating volt-watt traces for nominal and $\pm 10\%$ rated line voltage to verify ballast performance and compliance with lamp specifications for the rated life of the lamp. The ballast must reliably start and operate the lamp in ambient temperatures down to -30°F for the rated life of the lamp. Ballast primary current during starting must not exceed normal operating current. The lamp current crest factor shall not exceed 1.8 for $\pm 10\%$ line voltage variation at any lamp voltage, from nominal through life. The power factor of the lamp-ballast system shall not drop below 0.90 for $\pm 10\%$ line voltage variations at any lamp voltage from nominal through life. The ballast design shall be such that the normal manufacturing tolerance for capacitors of $\pm 6\%$ will not cause more than a $\pm 8\%$ variation in regulation throughout rated lamp life for nominal line voltage.

When called for on the plans, a cut off luminaire shall be furnished for intersection and street lighting. This luminaire shall meet all of the above applicable specifications along with providing a true 90° cutoff and shielding with an Alzak aluminum reflector, a heat and impact resistant flat glass lens, a 2-position adjustable socket holder and a porcelain mogul screw shell socket with lamp grips. The optical system shall contain a filtering system to trap particulate contamination. Maximum candela at 80° shall be 9 and maximum candela at 90° shall be 0. The light distribution shall be ANSI/IES/MC/Type III.

Labels shall be in accordance with ANSI standards. All luminaires shall be approved by the Engineer. Luminaires shall be leveled and adjusted in accordance with instructions of the manufacturer or as directed by the Engineer.

Unless otherwise specified on the Plans, in the specifications or in the special provisions, all streetlighting luminaires shall be furnished complete with high pressure sodium high intensity discharge streetlighting lamps with the following characteristics:

Type/Watts	Description	ANSI Code	Lamp	Initial Lumens	Rated Life
HPS 750	LU750	S51WA-400	Clear	110,000	16,000 hours
HPS 400	LU400	S51WA-400	Clear	50,000	24,000 hours
HPS 250	LU250	S50VA-250	Clear	28,000	24,000 hours
HPS 200	LU200	S66MN-200	Clear	22,000	24,000 hours
HPS 150	LU150/55	S55SC-150	Clear	16,000	24,000 hours
HPS 100	LU100	S54SB-100	Clear	9,500	24,000 hours

The Contractor shall guarantee that all lamps which fail within one year under normal operating conditions shall be replaced at no cost to the Contracting Agency.

623 L.02.04 FUSEHOLDERS AND FUSES: (For multiple street lighting circuits) Fuseholders and fuses shall be installed in the bases of all lighting standards and shall be accessible through the handholes for the lighting standard bases. The fuseholders shall be single pole for 120 volts or double pole for 240 volts, waterproof type without the use of tape, with integral or separate conductor insulating boots, and must be certified by an independent nationally recognized testing facility. The single pole fuseholder shall consist of two sections, a line side section, and a load side section. When the line and load sections are mated per instructions from the manufacturer, the fuseholder body and terminals shall be vapor and waterproof. The design shall be such that if the fuseholder is reclosed under load, any arc will be confined within the body when a proper sized fuse is seated firmly in the terminals.

The double pole fuseholder shall contain two fuseholder chambers and consist of two sections, a line side section and a load side section. When the fuseholder is opened, both load side connections shall be simultaneously disconnected from the live side. The fuseholders shall be 30 amperes, 600 volt rating and accept 13/32 inch (10 millimeter) diameter by 1-1/2 inch (38 millimeter) fuses of the ampere rating specified in the contract. Glass, paper or indicating type fuses are not acceptable.

623 L.02.05 LOW VOLTAGE UNDERGROUND STREET LIGHTING SYSTEM: Unless otherwise specified on the plans, the low voltage lighting system shall be single phase, two wire, 240 volt multiple. The two wire system shall consist of two insulated 600 volt THW conductors of the specified gage and a green #8 THWN equipment bonding conductor as shown on the plans and shall bear the U.L. label. The service panel shall be 100 ampere, unless otherwise specified, and shall be wired for 120-240 volt with a full size neutral.

Pole and Arm Cable. Unless otherwise specified on the plans, the cable from the base of the lighting standard to the luminaire shall be two conductor No. 10 AWG plus ground, solid copper with insulation rated at 600 volts. The individual conductors shall be insulated with TW grade, and the outer jacket shall be PVC jacket type UF grade.

MISCELLANEOUS ELECTRICAL EQUIPMENT

623 L.02.06 PHOTO-ELECTRIC CONTROLS: Photo-electric controls shall be one of the types below, as shown on the plans or as specified in the Special Provisions. The photo-electric control shall be capable of

Rev. December 12, 1996

switching multiple lighting system directly or by a separate contactor as indicated on the plans.

For series lighting systems the photo-electric control shall be capable of switching series lighting systems through a high voltage controller.

Types of photo-electric controls shall be as follows:

- (a) **Type I.** Type I photo-electric control shall consist of a photo-electric unit and a contactor in a single weatherproof housing.
- (b) **Type II.** Type II photo-electric control shall consist of a photo-electric unit installed at the top of the first lighting standard from the service point, and controlling the lighting contactor in the pad mounted service and control cabinet. A by-pass switch shall be included to permit manual operation of the lighting system contactor. Unless otherwise specified in the plans, specifications, or in the Special Provisions, the photoelectric units shall be for 120 volt operation on two or three wire single phase multiple lighting systems.
- (c) **Equipment Details.** The photo-electric unit shall consist of a light sensitive element connected to a control relay. The light sensitive element shall have a spectral response such that it is especially sensitive to north sky illumination and shall have an "ON" level adjustable between minimum limits of 0.6 and 1.1 footcandles.

The unit shall be so designed that a failure of any electrical or electronic component will energize the lighting circuit. The photo-electric unit shall be mounted at the top of the standard designated on the plans and shall be oriented as directed by the Engineer.

- (d) **Contactor.** The contactor shall be constructed in accordance with NEMA standards for lighting contactors and shall have contacts rated to switch the specified lighting load. Contactor shall be the mechanical armature type. The mechanical type shall consist of an operating coil, a laminated core, a laminated armature, contacts and terminals. Contacts shall be silver alloy.
- (e) **Housing.** The contactor may be either integral with the photo-electric unit or may be located externally from it. When located externally, the contactor shall be housed in a suitable NEMA type 3 raintight enclosure with hasp for a padlock. The raintight enclosure shall be mounted on the same standard as the photo-electric unit at a height of approximately 28 feet (8.5 meters) above the base. All contactors housings shall be approved by the Engineer prior to installation.
- (f) **Wiring.** Conductors between the photo-electric unit and an external contactor shall be a minimum No. 12 AWG, and shall be installed inside the lighting standard.

623 L.02.07 PAINT: Unless otherwise specified in Subsection 623 L.02.01(g), all metal parts, fittings, signal heads, posts, pedestals, standards, cabinets, controller boxes, etc., shall be prepared and painted according to these specifications. Types of paints to be used shall be as specified in Section 714, "Paint and Pavement Markings."

CONSTRUCTION

623 L.03.01 GENERAL: The preparation and finishing of new equipment shall be as follows:

Galvanized and non-ferrous surfaces to be painted, shall be cleaned and coated with Vinyl Wash Primer, conforming to the requirements of Subsection 714.03.01(b). Ferrous metal surfaces shall be cleaned and immediately coated with the primer specified above.

If an approved primer coat has been applied by the manufacturer and is in good condition, additional primer application by the Contractor, other than for repairs, will not be required.

Factory enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer.

Existing equipment and material to be repainted whether remaining in place or to be relocated, shall be cleaned of all rust, scale, grease, dirt, and poorly bonded paint by any method satisfactory to the Engineer. Immediately after cleaning, all bare metal shall be primed as appropriate, or as specified for new material. A finish coat shall be then applied over newly primed areas followed by one or more finishing coats over the entire surface. Blast cleaning of galvanized metal surfaces in good condition, as determined by the Engineer, will not be permitted.

Paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators, except that no spraying shall be done at the jobsite. The work shall be done in a neat and workman like manner, and the Engineer reserves the right to require the use of brushes for the application of paint should the work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the Engineer.

The thickness of each paint coat shall be limited to that which will result in uniform drying throughout the film. Skips, holidays, thin areas, or other deficiencies in any one coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

The final coat shall present a smooth surface, uniform in color, free of runs, sags or excessive brush marks.

Flaws in the appearance of galvanized components (i.e., tiger- or zebra-striped) shall be cause for rejection by the owner.

623 L.03.02 BONDING AND GROUNDING: Metallic cable sheaths, steel conduit, metal poles, pedestals, pull boxes, and other metal enclosures shall be metallically joined together and made mechanically and electrically secure to form a continuous electrical conducting path and shall be effectively grounded as required by the National Electrical Code. All non-metallic conduit shall contain a green grounding conductor as specified herein, except if none is specified, this conductor shall be sized according to Article 250 of the National Electrical Code.

Bonding and grounding jumpers shall be copper wire or copper strap of the same cross-sectional area as No. 4 AWG for series and multiple lighting circuits. Bonding of standards and foundations shall be accomplished by means of a bare No. 4 copper wire attached to each anchor bolt and to a ½ inch (13 millimeters), or larger, brass, cadmium-plated or bronze bolt installed on the lower lip of the lighting standard handhole as shown on the Standard Drawings. The No. 8 green grounding conductor from the conduit and the No. 10 luminaire ground shall be connected to the No. 4 grounding conductor. Grounding of conduit and neutral at the service point shall comply with the applicable sections of Article 250 of the National Electrical Code.

623 L.03.03 TESTING: Prior to completion of the work, the Contractor shall cause the following tests to be made on all lighting circuits, in the presence of the Engineer:

- (a) Test for continuity of each circuit
- (b) Test for grounds in each circuit with a 500 volt megohmmeter with a minimum acceptable reading of 200 megohms

- (c) A functional test in which it is demonstrated that each and every part of the system functions as specified or intended herein
- (d) A high-pot test when specified
- (e) Before acceptance of the work and after adjusting the luminaire lamp sockets to produce the I.E.S. light distribution patterns specified in the plans, the Contractor shall provide the Engineer with footcandle readings showing average to minimum ratios in accordance with I.E.S. standards recommended for Average Maintained Horizontal Illumination for roadways shown in Standard Drawing No. 300.

Any fault in any material or in a part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until corrected.

METHOD OF MEASUREMENT

623.04.01 MEASUREMENT: The unit of measurement for "Traffic Signal Systems," "Street Lighting Systems," and "Traffic Signal and Street Lighting Systems," will be lump sum or unit price.

The quantity of "Conduit for Future Conductors," will be measured for payment by the linear foot (linear meter) of conduit complete and in place.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

623.05.01 PAYMENT: The lump sum price or unit prices paid for traffic signal systems, street lighting systems, sign illumination systems, modifying existing systems, or any combination thereof, shall be full compensation for doing all the work complete and in place as indicated in the contract documents, and as directed by the Engineer, including excavation and backfill, concrete foundations, restoring sidewalk, pavement, and appurtenances damaged or destroyed during construction, salvaging existing materials, and making all required tests.

Full compensation for all additional materials and labor, not shown on the plans or specified, which are necessary to complete the installations of the various systems, shall be considered as included in the prices paid for the systems, or units thereof, and no additional compensation will be allowed therefor.

The accepted quantities of "Conduit for Future Conductors," measured as provided in Subsection 623.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot (linear meter) for conduit.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

PAY ITEM	PAY UNIT
Traffic Signal Systems (may include sign lighting)	Lump Sum or Unit Price
Street Lighting Systems (may include sign lighting)	Lump Sum or Unit Price
Conduit for Future Conductors	Linear Foot (Linear Meter)

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SECTION 624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

DESCRIPTION

624.01.01 GENERAL: This work shall consist of providing for traffic by constructing detours or special detours, permitting traffic to pass through construction, and using flaggers or pilot cars and maintaining the base, or a combination of these methods as indicated in the contract documents or as directed in writing by the Engineer.

MATERIALS

624.02.01 GENERAL: The materials used for the construction and maintenance of facilities required for the free flow of public traffic and for protection of the work shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for such materials as set forth herein.

CONSTRUCTION

624.03.01 SPECIAL DETOURS: Special detours shall be constructed as shown on the plans or as specified. Detour locations indicated on the plans may be approximate only; the exact location shall be as staked by the Engineer.

Grading for special detours shall consist of motor grader work, supplemented where necessary by other mechanical equipment, to provide the specified roadbed width and a grade line free from breaks or rolls of sufficient magnitude to be hazardous to traffic. This work shall conform to the requirements of Section 107.21, "Dust Control."

When grading of special detours has been completed and approved by the Engineer and, if required on the plans or in the Special Provisions, the special detours shall receive surfacing materials of the kind and type specified, and they shall be placed and constructed in accordance with the requirements for the particular materials used.

Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.

Maintenance on special detours shall consist of performing any work necessary to maintain the detour satisfactorily, as ordered by the Engineer.

Eradication of special detours shall consist of blade grader and scraper work supplemented by other equipment if needed. Eradication will be performed to the extent that the ground will be restored as nearly as feasible to the original, and material disposed of, all as directed by the Engineer.

624.03.02 FLAGGERS: If, in the opinion of the Engineer, controlled traffic is necessary for protection of the work or for safety of public traffic, flaggers shall be employed by the Contractor.

Flaggers shall have completed an approved instructional course in flagging procedures. A prospective flagger shall possess a valid flagger card attesting satisfactory completion of said instructional course conducted by the Highway Department or some other approved course given by another entity of government within the State.

SECTION 625

CONSTRUCTION SIGNS

DESCRIPTION

625.01.01 GENERAL: This work shall consist of furnishing, erecting, maintaining, relocating and removing work zone traffic control devices, including signs, channelizing devices and lighting devices at locations set forth in the contract documents, or as directed by the Engineer, for the protection of the work, workers, and guidance and safety of the motoring and pedestrian public.

All work zone traffic control devices shall remain the property of the Contractor upon completion of the contract and shall be removed from the project by him.

All work zone traffic control devices shall conform to the requirements of the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), published by the U.S. Department of Transportation, Federal Highway Administration, as well as the current edition of the Nevada Traffic Control Handbook, published by the Nevada Department of Transportation, unless otherwise indicated on the plans or by the Special Provisions.

Regulatory signs shall be mounted so that the bottom of the sign will be a minimum of 5 feet above the ground surface or the pavement.

MATERIALS

625.02.01 GENERAL: It is expressly intended that a broad selection of material be granted the Contractor since work zone traffic control devices are in temporary use and new products become commercially available regularly. Sign panels may be constructed of steel, aluminum, wood, or other approved material and be of a sound, durable nature. The materials shall be of such quality to do the job for which they are intended and are subject to approval by the Engineer. Signs and channelizing devices which have become dull, have flaking or peeling paint, are dirty, discolored or are otherwise marred shall be repaired or replaced with acceptable units.

Reflective sheeting for all signs and channelizing devices shall conform to the requirements specified in the following section:

Sign Materials Section 716.03.01

625.02.02 SIGN DIMENSIONS: Sign dimensions shown in the MUTCD are minimum standard. Increases above this minimum are permissible and desirable where investigation has shown a larger sign is needed for adequate emphasis. In the enlarging of signs, standard shapes and colors shall be used, and standard proportions shall be retained so far as practicable.

CONSTRUCTION

625.03.01 GENERAL: Before any detour, temporary route or work zone is opened to traffic or imposed upon existing traffic, all necessary signs shall be in place. Signs required by road conditions or restrictions shall be

removed immediately when those conditions cease to exist or the restrictions are withdrawn. Guide signs directing traffic to and on temporary routes or detours shall be removed when no longer applicable.

Signs and barricades shall be maintained in first-class condition. Care shall be exercised to keep the sign faces free of dust and splashed mud. Any which may become scarred or damaged or destroyed shall be repaired immediately or replaced, at the Contractor's expense, as directed by the Engineer.

The responsibility for the protection of the work, workmen, and public traffic will rest with the Contractor and he shall be liable for damages and injury suffered by reason of the Contractor's operations or any circumstances, conditions, actions, or negligence in connection therewith.

625.03.02 SIGN PLACEMENT: Signs shall be placed in conformance with the latest edition of the Manual of Uniform Traffic Control Devices. All temporary stop signs shall be mounted on a post which is embedded in the ground a minimum of 18 inches (450 millimeters) or to a depth sufficient to prevent overturning by wind loadings and easy removal by vandals as approved by the Engineer with the following possible exceptions:

1. A flagperson is used to supplement temporary stop signs. The temporary stop signs must be post-mounted and embedded in the ground when no flagperson is present.
2. Temporary stop signs may be used with a moving construction operation with frequent lane shifts only when construction is in progress and the work force is present. When no construction is in progress or no work force is present, the temporary stop signs must be post-mounted and embedded in the ground.

625.03.03 SIGN SUPPORTS: Signs, posts, pole mountings, and their foundations shall be so constructed as to hold signs rigidly in a proper and permanent position, and prevent them from swaying in the wind, or from being turned or otherwise displaced by children or irresponsible persons.

A portable or removable type of mounting may be used for signs required intermittently or which are frequently moved. Such a mounting shall be heavy enough not to turn over in the wind, and its base shall not be appreciably wider than the sign.

A portable or removable type of mounting for temporary stop signs may only be used in a moving operation during the time when construction personnel are present. Such a mounting shall be heavy enough not to turn over in the wind. Temporary stop signs shall be post-mounted and embedded in the ground after working hours when no construction personnel are present.

625.03.04 CHANNELIZING DEVICES: Projects closed to traffic shall be protected by appropriate channelizing devices, as approved by the Engineer, in conjunction with appropriate work zone warning signs. If weighting of channelizing devices is necessary, sand bags may be used as long as a low center of gravity is maintained as approved by the Engineer.

METHOD OF MEASUREMENT

No direct measurement shall be made for work zone signs and channelizing devices unless otherwise specified.

BASIS OF PAYMENT

No direct payment shall be made for work zone signs and channelizing devices unless otherwise specified.

SECTION 626

FINAL CLEAN UP

DESCRIPTION

626.01.01 GENERAL: Before final acceptance, the Contractor shall remove or obliterate, insofar as feasible, all objects or disturbances of the ground which mar the landscape and were caused by his operations, whether or not part of the improvement. This shall be required on all areas used or occupied by the Contractor within or outside the right-of-way limits.

CONSTRUCTION

626.03.01 FINAL CLEAN UP: Rubbish, excess material, temporary structures, and discarded equipment shall be collected and disposed of as directed by the Engineer. Burning is prohibited. Pits or trenches for equipment setups or camp sites shall be filled and the ground restored, insofar as feasible, to its original conditions, within or outside of the right-of-way limits. Temporary haul roads within the right-of-way limits shall be scarified and bladed to blend with surroundings. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground. Waste shall be removed from the tops of banks and placed in the bottom of pit. Unless otherwise specified or directed by the Engineer, banks of pits shall be cut to not steeper than two to one (2:1) slopes to blend with the natural contours. Bottoms of pits shall be reasonably smooth. All other disturbances shall be removed or corrected as directed by the Engineer with particular attention to the abatement of any dust hazard.

Working areas and backslopes pertaining to the improvement shall be hand raked and loose objects including rocks and clods in excess of two inches (5 centimeters) in any dimension shall be removed from the site. Pavement, curb and gutter, sidewalks and driveways shall be swept or flushed and presented to the Contracting Agency in condition for maintenance without further work.

METHOD OF MEASUREMENT

626.04.01 MEASUREMENT: The unit of measure for "Final Clean Up" shall be lump sum.

BASIS OF PAYMENT

626.05.01 PAYMENT: The lump sum price paid for "Final Clean Up" shall be lump sum price bid for this item. All payments shall be made in accordance with Subsection 109.02, "Scope of Payment."
Payment will be made under:

PAY ITEM	PAY UNIT
Final Clean Up	Lump Sum

SECTION 627

PERMANENT SIGNS

DESCRIPTION

627.01.01 GENERAL: This work shall consist of furnishing, erecting, relocating and installing signs, sign supports and other materials required for highway signs in accordance with the current edition of the Nevada Traffic Control Manual, these specifications and as shown on the plans and as directed by the Engineer. This item does not include construction signs used for traffic control during construction.

The work shall generally consist of:

- (a) Overhead signs, including concrete foundations, steel sign posts and frames, and steel sign panels with porcelain enamel finish.
- (b) Ground mounted signs consisting of concrete foundations, steel sign posts, reflectorized aluminum sign panels, and appurtenances.

This item does not include sign illumination systems.

627.01.02 SHOP DRAWINGS: When overhead sign structures are to be furnished, the Contractor shall submit to the Engineer five sets of shop drawings for each overhead sign structure for approval. Fabrication of the overhead sign structures shall not commence until the shop drawings have been approved by the Contracting Agency.

Shop drawings for other than overhead signs will not be required, however, all signs shall conform to the plans and the current edition of the Nevada Traffic Control Manual. For signs which are shown on the Sign Summary Sheets and are not included in the current edition of the Nevada Traffic Control Manual, special sign design sheets shall be furnished by the Contracting Agency to the bidders of the project. The special design sheets shall include such information as letter heights, spacing between letters and words, borders, sign radii, etc. These signs shall conform to the special design sheets as well as the drawings noted in the plans.

MATERIALS

627.02.01 GENERAL: Materials shall conform to the following applicable requirements:

Sign Materials Section 716

627.02.02 REFLECTORIZATION: All signs, except overhead signs, shall be reflectorized. The types of reflective materials to be used shall be as follows:

- (1) Reflectorized green guide signs (excluding overhead guide signs) shall utilize Class 4 reflective sheeting

for sign background, letters, numerals, symbols, borders and accessories. All letters, numerals, symbols, borders and accessories shall be directly applied to the sign background.

- (2) All other reflectorized signs shall utilize Class 4 reflective sheeting.

627.02.03 OVERHEAD GUIDE SIGNS: All overhead guide signs shall be porcelain enamel.

627.02.04 CUT-OUT LETTERS, NUMERALS, SYMBOLS, AND ACCESSORIES FOR GUIDE POSTS: All names of places and highways on guide signs shall be composed of lower case letters with initial capital letters. The initial capital letters shall be one and one-third times the "loop" height of the lower case letters. Other legends on guide signs shall be in capital letters.

It is intended that the initial capital letters (and numerals) used shall be Series E, modified by widening the stroke-width to approximately one-fifth the letter (or numeral) height. Tables of recommended letter spacing can be obtained from the FHWA.

Arrows which are used for large directional guide shall be in direct proportion to the arrows shown in the MUTCD.

CONSTRUCTION

627.03.01 PANEL FASTENINGS: The panel sections shall be provided with suitable fastenings, as shown on the plans, to permit easy attachment to the supporting frames. These fastenings shall be so designed as to carry the full design load with a factor of safety of not less than 1.5. Panel sections shall be provided with closure strips at the joints.

Panel fastenings for use on sign panels covered with Class 4 reflective sheeting shall utilize nylon washers for contact between the reflective sheeting and the metal washer.

627.03.02 CLOSURE STRIPS: Closure strip shall be anchored by aluminum rivets as shown on the plans. Rivets shall be the same color as the sign face. Closure strips are required only on aluminum sign panels.

627.03.03 INSTALLATION: Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.

Signs and sign islands shall be constructed to the lines and grades given by the Engineer and in accordance with the design and locations shown on the plans.

All signs shall be erected as specified, before, during or immediately after the completion of bituminous plantmix surface operations.

The date of installation, consisting of month and year shall be permanently stamped on the back of each sign with metal dies and shall be visible only on close inspection. The stamp shall be placed on the lower right hand corner when facing the rear of the sign.

Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, and all undesirable material that is visible on the face of the sign shall be removed. The use of abrasives or other cleaning material that will scratch or otherwise deface shall not be permitted.

Sign islands shall be constructed as roadway embankment on conformity with Section 203, "Excavation and Embankment." Structure excavation and backfill shall conform to the requirements of Section 206, "Structure Excavation" and Section 207, "Backfill." Anchor bolts shall be set true to line and grade and posts shall be plumb.

Rev. May 8, 1997

Sign faces of all directional signs facing public traffic and directing such traffic to a portion of the project not yet open to public traffic, shall have the message covered.

Care shall be exercised at all times in the handling, storing, transporting, and erecting of the signs. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

Pipe sign posts may be field cut and drilled to adjust for local conditions when approved by the Engineer. Flame cutting will not be permitted. All field cuts and abraded areas on steel posts shall be thoroughly cleaned and given two coats of paint having a high-zinc dust content conforming to the requirements of Federal Specification MIL-P-21035.

Extending the lengths of sign posts to adjust for local conditions by splicing or welding will not be permitted.

627.03.04 TESTS: It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency. The Contractor shall furnish the Contracting Agency with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

627.03.05 RELOCATION: This work shall consist of temporary or permanent relocation of existing permanent sign panels, posts and footings as shown on the plans and as directed by the Engineer. Existing sign panels and posts that are removed for relocation shall be stockpiled on the jobsite at locations determined by the Engineer and shall remain the property of the administering entity. The Contractor shall remove and dispose of all concrete from sign posts prior to stockpiling as directed by the Engineer.

Temporary relocation of permanent sign panels for public bus or transit stops shall be as indicated on the plans or as directed by the Engineer. Temporary locations for public bus or transit stops shall conform to requirements of Subsection 107.07, "Traffic and Access."

The Contractor shall exercise care when removing and stockpiling signs for relocation. Signs which are damaged shall be repaired or replaced at the Contractor's expense.

METHOD OF MEASUREMENT

627.04.01 MEASUREMENT: Permanent signs, other than signs listed as "Overhead," shall be measured for payment by the number of square feet (square meter) of sign face surface. The square footage shall be determined from the dimensions of sign panels in the completed and accepted work.

The quantity of "Permanent Signs, Relocate" to be measured for payment shall be per each sign relocated, temporary or permanent.

Sign panels on permanent signs listed as "Overhead" signs shall be measured by the square foot (square meter) of sign panel in the completed and accepted work.

Sign supports for permanent signs listed as "Permanent Overhead Sign Support Structures" shall be measured on a Lump Sum basis.

All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

627.05.01 PAYMENT: Sign panels shall be paid for at the contract unit price bid per square foot (square meter) for "Permanent Signs (Ground Mounted)," which shall be full compensation for furnishing all labor, materials, tools, supplies, equipment and incidentals and for doing all the work involved in furnishing and erecting permanent

PERMANENT SIGNS

627

Rev. May 8, 1997

signs (other than signs listed as overhead) complete in place as shown on the plans and as herein specified, including but not limited to structure excavation and backfill, concrete foundations, supports, sign islands, and making all required tests.

Sign panels shall be paid for at the contract unit price bid per square foot (square meter) for "Permanent Sign Panels (Overhead)" which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment and incidentals and for doing all the work involved in furnishing and erecting permanent sign panels (for signs listed as overhead signs) complete in place as shown on the plans and herein specified.

Sign supports shall be paid for at the contract Lump Sum price bid for "Permanent Overhead Sign Support Structures" which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment and incidentals and for doing all the work involved in furnishing and erecting permanent sign supports (for all signs listed as overhead signs) complete in place as shown on the plans and as herein specified, including structure excavation and backfill, concrete foundations, cast-in-place concrete piles, structural steel posts and frame, sign islands, and making all required tests.

The contract unit price bid per each for "Permanent Signs, Relocate" shall be full compensation for removal of sign panels and posts, removal and disposal of sign footing, stockpiling of existing sign panels and posts, installing existing sign panel at temporary location, furnishing and installing posts and new footings and installing existing sign panels thereon and for furnishing all labor, materials, tools, supplies, equipment and incidentals necessary to complete the work as shown on the plans and as directed by the Engineer.

All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

Payment will be made under:

PAY ITEM

PAY UNIT

Permanent Signs (Ground Mounted)		Square Foot (Square Meter)
Permanent Sign Panels (Overhead)		Square Foot (Square Meter)
Permanent Overhead Sign Support Structures		Lump Sum
Permanent Signs, Relocate		Each

SECTION 628

PAINTING TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

DESCRIPTION

628.01.01 GENERAL: The Contractor shall apply all traffic striping, marking, and all other directional information on the surfaces of highways, streets, detour roads, parking lots, median strips and curbing only when required by the contract documents.

Should the Contractor elect to alter the existing traffic stripes and markings, or to divert the flow of traffic on construction projects for his own convenience and there are no specific pavement markings or lane delineations shown on the plans or in the Special Provisions, he shall with the approval of the Engineer provide the necessary temporary striping in accordance with the MUTCD at no expense to the Contracting Agency.

When not otherwise shown on the plans, detour transitional traffic line striping shall have a minimum taper of 20:1 for temporary striping and 30:1 for permanent striping. Temporary traffic lanes shall be at least 10 feet (3 meters) wide and no lane shall encroach within 5 feet (1.5 meters) of an open excavation or within 2 feet (600 millimeters) of a longitudinal curb.

This work shall also include the furnishing and placing of permanent pavement marking tapes as shown on the plans.

The specifications are for identity only, and approval of any specification by the Contracting Agency does not place any liability on the Contracting Agency or relieve the Contractor from warranty of the finished lines.

Prior to using any material, the Contractor shall provide the Engineer with a written "Certification of Compliance" from the manufacturer of the material. The certification shall include the manufacturer's name, business address and location of the manufacturing plant. It shall identify the specifications and include one copy. It shall show the quantity of materials supplied for each color, batch number and date of manufacture.

Manufacturer's lab test results must be supplied upon request of the Engineer.

Warranty

The Contractor shall warranty the applied markings for three year from the date of installation. If, for any reason, the markings fail to perform as specified, the Contractor, under this warranty, shall completely remove the old markings and apply new markings at his expense.

MATERIAL

628.02.01 PAINT FOR TRAFFIC STRIPING, PAVEMENT MARKING AND CURB MARKING: Paint for traffic striping and marking shall conform to the applicable requirements of Subsection 714.03.05.

628.02.02 All traffic stripes (except black stripes) shall be beaded on the final finish coat in accordance with Subsection 714.03.09.

The Contractor shall furnish all equipment, materials, labor and supervision necessary for painting traffic lanes, directional arrows, guide lines, curbs, parking lines, crosswalks and other designated markings in accordance with the contract plans, or for approved temporary detours essential for safe control of traffic through and around the construction site. The Contractor shall remove by wet sandblasting (or by other approved methods) all existing or temporary traffic markings and lines that are no longer needed. When temporary detour striping or markings are no longer required, they shall be removed prior to painting the new traffic stripes or markings.

628.02.03 RETROREFLECTIVE PREFORMED PAVEMENT MARKINGS: The retroreflective preformed pavement markings shall conform to the applicable requirements of Subsection 714.03.06. These retroreflective preformed pavement markings shall consist of film with pigments selected to conform to standard highway colors.

Type I Film: These retroreflective preformed pavement markings shall be used for stop bars, preformed words and symbols, and crosswalks within the limits of the project. Glass beads shall be incorporated into the film to provide immediate and continuing retroreflection.

Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the current edition of the "Manual on Uniform Traffic Control Devices for Streets and Highways."

Type II Film: These retroreflective preformed pavement markings shall be used for lane lines and edge lines within the limits identified in the plans. Ceramic beads shall be incorporated into the film to provide immediate and continuing retroreflection.

CONSTRUCTION

628.03.01 WEATHER CONDITIONS: Paint shall be applied only when the pavement surface is dry and clean, when the air temperature is above 40 degrees Fahrenheit (4 degrees Celsius), and when the weather is not windy, foggy, or humid.

628.03.02 EQUIPMENT: All equipment required to perform the work shall be approved in advance by the Engineer, and shall include such apparatus as brushes, brooms, compressors, air blowers to properly clean the pavement surface, a mechanical marking machine, a suitable device for heating the paint to the specified temperatures, a bead dispensing device, auxiliary hand spray painting equipment, paint rollers, or other equipment as may be necessary to satisfactorily complete the work.

The striping machine shall be an approved spray-type marking machine suitable for applying traffic paint at the temperatures specified in Subsection 714.03.06 or 714.03.07 for the particular paint or as recommended by the paint manufacturer. It shall have sufficient paint capacity for each color with adequate air pressure to perform the work satisfactorily without excessive stopping. The machine shall produce a uniform film thickness and cross section at the required coverage and shall produce markings with clean-cut edges without running or spattering. It must be capable of being guided within the straightness tolerances set forth in these specifications. The machine shall have suitable adjustments for painting the line with width specified and when required, shall be equipped with an automatic cycling device to produce intermittent (skip) lines. A standard skip-line pattern is normally a 24-foot (7.3 meters) cycle of which 9 feet (2.7 meters) are painted and 15 feet (4.6 meters) are unpainted. However, the machine shall be equipped to produce a variable skip pattern, including simultaneous painting of a broken line on one side and a solid line on the other side of the multiple strip. An acceptable tolerance in the skip pattern is plus

or minus 6 inches (150 millimeters).

The striping machine shall be capable of three-gun application consisting of one black and two yellow spray guns operating simultaneously or individually. The equipment shall also be capable of operating two white guns simultaneously.

The striping machine shall have a wheel base of sufficient length to produce a straight line to meet the straightness tolerance specified in Subsection 628.03.05. The machine must also be capable of producing curved lines without abrupt breaks, in accordance with approved layouts.

Provision shall be made for a dispenser capable of applying glass beads at the required rate.

Equipment for applying molten thermoplastic material shall readily extrude the material between 400 - 425 degrees Fahrenheit (204 - 218 degrees Celsius) to produce a continuous line 1/8 inch to 3/16 inch (3 to 5 millimeters) thick, of uniform cross section, and having clear sharp dimensions.

Thermoplastic material may also be applied by an approved machine that flame sprays the material onto clean road surfaces. This machine shall be capable of applying a coating 10 mils (0.3 millimeters) thick which will dry to "no pick up" in accordance with ASTM D 711. The equipment shall produce a smooth continuous line having clear sharp dimensions.

Word markings, letters, numerals, and symbols shall be applied using suitable spray equipment together with stencils and templates.

The Contractor shall provide a wet sandblasting machine with sufficient sand, water and air capacity to completely remove all existing or temporary traffic striping or unneeded traffic markings. This machine shall meet all requirements of the air pollution control district having jurisdiction. All sand used in wet sandblasting shall be removed from the pavement without delay as the sandblasting operation progresses. Removal of striping by high velocity water jet may be permitted when approved by the Engineer.

628.03.03 GEOMETRY, STRIPES, AND TRAFFIC LANES: Permanent and temporary striping and marking shall be in accordance with the MUTCD manual and the Nevada Traffic Control Manual.

628.03.04 PREPARATION OF EXISTING SURFACES: Existing markings and striping, either permanent or temporary, which are to be abandoned or obliterated shall be removed by wet sandblasting or other approved methods. Dry sandblasting may be used in selected areas only with the permission of the Engineer and with approval of the air pollution control authority having jurisdiction over the area in which the work will be performed. Alternate methods of paint removal require prior approval of the Engineer. Obliteration of traffic striping with black paint or light emulsion oil shall be done only with the prior approval of the Engineer.

Before applying paint, the existing pavement surface shall be cleaned by washing, sweeping, blowing, or vacuuming as necessary to remove moisture, dirt, grease, oils, acids, laitance or other foreign matter which would reduce the bond between the paint and the pavement. Areas which cannot otherwise be satisfactorily cleaned shall be scrubbed with a water solution of tri-sodium phosphate (10% Na_3PO_4 by weight) or other approved cleaning solution. After cleaning, the surface shall be rinsed with water and dried before painting.

628.03.05 LAYOUT, ALIGNMENT, AND SPOTTING: When necessary, the Engineer will furnish the needed control points for required pavement striping and markings. The Contractor shall establish pilot lining between these points by stringline or other method to provide striping that will vary less than 1/2 inch (13 millimeters) in 50 feet (15 meters) from the specified alignment.

The Contractor shall stripe or otherwise delineate the traffic lanes per the MUTCD manual in the new roadway or portion of roadway, or detour before opening it to traffic if it is required by the Contract Documents.

The Contractor shall provide an experienced technician to supervise the location, alignment, layout, dimensions, and application of the paint.

628.03.06 APPLICATION OF PAINT: Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved plans in the amounts required in Subsection 714.03.06 or 714.03.07 as applicable or as provided in the Special Provisions. Where temporary traffic striping and marking is required, it shall not be applied until the layouts, alignments, sequencing, and condition of the existing surface have been approved.

Paint shall be mixed in accordance with the manufacturer's instructions. It shall be mixed thoroughly and applied to the surface at the proper temperature, at its original consistency without the addition of any paint thinner. If the paint is applied in two coats, the first coat shall be thoroughly dry before the second coat is applied. Before applying thermoplastic paint on concrete surfaces, there shall be a prime coat consisting of either a two-component epoxy or a 10% solution of buna N rubber in methylethyl ketone applied one-half hour before application of the thermoplastic paint.

If the paint is applied in two coats, beads will be required only in the second coat. The first coat shall be thoroughly dry before the second coat is applied. On open graded surfaces, second coat shall follow no sooner than 14 calendar days after initial application.

Ten days shall elapse between the application of a bituminous seal coat and the permanent traffic marking. The paint shall not bleed, curl or discolor when applied to bituminous surfaces. If bleeding or discoloring occurs, the unsatisfactory areas shall be given an additional coat of paint.

Straight stripes deviating more than 1/2 inch in 50 feet (13 millimeters in 15 meters) shall be obliterated by sandblasting, and the markings corrected. The width of markings shall be as designed, within a tolerance of 4%. When existing striping and markings are to be repainted, they shall be repainted so as to completely cover the old markings within 1/4 inch (6 millimeters). Stripe repainting shall be retraced within a longitudinal tolerance of 6 inches (150 millimeters) plus or minus at the end of each stripe. Abrupt breaks in striping alignment will not be allowed. The striping shall be a continuous operation except where crossovers are required to complete painted medians.

Painting shall be performed by competent equipment operators and painters using proper equipment, tools, stencils, templates and shields in a workmanlike manner.

Difficulties experienced in cool weather shall be minimized by heating the traffic paint to provide for a uniform flow of material.

Reflective material shall be applied to traffic stripes and markings, in accordance with Subsection 714.03.09.

Temporary striping and marking shall be renewed when the stripes and markings have lost 50% of their original visual effectiveness.

Paint materials shall be tested before application to verify that they meet the specification requirements. The Engineer shall be notified upon delivery of the paint to permit inspection and sampling. When required by the Engineer, the Contractor shall furnish a notarized certificate signed by either an authorized employee of the manufacturer or testing laboratory stating that the paint conforms to the specified requirements. This certificate shall not be interpreted as final approval of the paint.

628.03.07 PROTECTION OF WORK, WORKMEN AND THE PUBLIC: The Contractor shall use proper and sufficient directional signs, warning devices, barricades, pedestals, lights, traffic cones, flagmen, or such other devices as necessary to protect the work, workmen, and the public.

Markings and striping shall be protected from injury and damage of any kind while the paint is drying.

628 **PAINTING TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS**
Rev. August 8, 1996

Adjacent surfaces shall be protected from disfiguration by spatter, splashes, spillage, and dripping of paint or other material.

In areas of high traffic volume, the Contractor shall schedule his work to paint traffic lines and markings in off-peak traffic hours.

628.03.08 DEFECTIVE WORKMANSHIP OR MATERIAL: Any work or materials not conforming to the plans and specifications shall be unacceptable and shall be redone, removed, replaced or made satisfactory to the Engineer at the sole expense of the Contractor.

628.03.09 INSTALLATION OF RETROREFLECTIVE PREFORMED PAVEMENT MARKINGS: The retroreflective pavement marking films shall not be applied within two weeks after laying and rolling asphalt concrete wearing courses. Both types of pavement marking films shall be capable of being adhered to asphalt concrete by a pre-coated pressure sensitive adhesive. A primer may be used to precondition the pavement surface. The preformed markings shall conform to the pavement contours by the action of traffic. After application the markings shall be immediately ready for traffic. The Contractor shall identify proper solvents and/or primers (where necessary) to be applied at the time of application, all equipment necessary for proper application, and recommendations for application that will assure effective performance.

The preformed retroreflective pavement markings shall be applied in accordance with the manufacturer's recommendations, a copy of which the Contractor shall supply the governing agency prior to installing the pavement marking film.

Joints in the initial installation of new pavement markings will be allowed only on lane lines and change of direction. The longitudinal bars in crosswalks, if used, shall be one piece.

Pavement marking failures shall be removed and replaced a minimum of 6 inches (150 millimeters) each side of the failure and the patch shall be a minimum of 24 inches (600 millimeters) in length.

MEASUREMENT

628.04.01 MEASUREMENT: The quantity of traffic striping and marking shall be measured by one or more of the following methods: lineal footage (lineal meters), the area in square feet (square meters), or one lump sum item complete in place, as shown on the plans or indicated in the Special Provisions.

The quantity of the Type I film for symbols and legends measured for payment shall be per each, complete and in place.

The quantity of the Type I film for crosswalks and stop bars measured for payment shall be the number of square feet (square meters), complete and in place.

The quantity of Type II film for longitudinal lines measured for payment shall be per linear foot (linear meter), complete and in place.

BASIS OF PAYMENT

628.05.01 BASIS OF PAYMENT: The lump sum or unit prices in the Proposal shall include full compensation for furnishing all labor, materials, tools and equipment and for doing all work involved in, or appurtenant to, the painting of all traffic striping or markings as shown on the plans or indicated in the Special Provisions.

All costs for temporary pavement painting for the convenience of the Contractor, including costs for sandblasting of existing lines and markings, shall be at his sole expense.

PAINTING TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

628

Rev. August 8, 1996

The contract unit bid price paid for Type I and Type II film shall be full compensation for furnishing all materials, as well as all labor, tools, equipment and incidentals necessary to complete the work.

Payment shall be made under:

PAY ITEM	PAY UNIT
Type I Film "ONLY"	Each
Type I Film (arrow)	Each
Type I Film for Crosswalks and Stop Bars	S.F. (SM)
Type II Film White 4" Marking	L.F. (LM)
Type II Film Yellow 4" Marking	L.F. (LM)

SECTION 629

WATER DISTRIBUTION FACILITIES

DESCRIPTION

629.01.01 GENERAL: The work to be done consists of furnishing and installing all necessary materials and equipment to complete distribution facilities, herein referred to as water mains, and/or to modify existing water facilities as shown on the plans and in accordance with the specifications.

Unless otherwise indicated on the plans and/or specified in the Special Provisions, the construction of water mains shall include excavation and backfill, the construction of concrete structures, anchors, thrust blocks, supports and encasements; the furnishing and placing of material and/or protective encasements; the furnishing, installing, testing and disinfecting of water pipelines, fittings, valves, blow-offs, air valves, services, fire hydrants and all appurtenances; the removal and/or restoration of existing improvements, and all work in accordance with the plans and specifications.

629.01.02 STANDARDS: Wherever the words "Standard Specifications" appear on the plans or in these specifications, they shall refer to the Standard Drawings and Specifications for Public Works Construction OffSite Improvements, Clark County Area, Nevada.

629.01.03 SHOP DRAWINGS:

- (a) Wherever called for in these specifications or on the drawings, or where required by the Engineer, the Contractor shall furnish to the Engineer for review two prints of each shop drawing. The term "shop drawing" as used herein shall be understood to include lists, graphs, operating instruction, etc. Unless otherwise required, said drawings shall be submitted at a time sufficiently early to allow review of same by the Engineer, and to accommodate the rate of construction progress required under the contract. Within 10 calendar days after receipt of said prints, the Engineer will return one print of each drawing to the Contractor with his comments noted thereon.
- (b) Fabrication of an item shall not be commenced before the Engineer has reviewed the pertinent shop drawings and returned copies to the Contractor without rejection. Revisions indicated on shop drawings shall be considered as changes necessary to meet the requirements of the contract drawings and specifications and shall not be taken as the basis of claims for extra work. The Contractor shall have no claim for damages or extension of time due to any delay resulting from making required revisions to shop drawings. The review of said drawings by the Engineer shall apply to general design only and shall in no way relieve the Contractor of responsibility for errors or omissions contained herein nor shall such review operate to waive or modify any provision or requirement contained in these contract specifications or on the contract drawings.

629.01.04 CONSTRUCTION LINES AND GRADES: Unless otherwise specified in the Special Provisions, all lines and grades required for proper execution of the work shall be furnished by the Contractor. The Contractor shall be responsible for the preservation of all bench marks and survey marks and shall be responsible

For convenience, specification times required for the pressure drop from 3.5 psig. to 2.5 psig. are tabulated on the following chart:

**SPECIFICATION TIME (MIN-SEC) REQUIRED
FOR PRESSURE DROP FROM 3.5 TO 2.5 PSIG
WHEN TESTING ONE PIPE DIAMETER ONLY
(PIPE DIAMETER, INCHES)**

	4	6	8	10	12	15	18	21	24	27	30	33	36	39	42
25	0:04	0:10	0:18	0:22	0:27	0:32	0:36	0:45	0:54	1:03	1:12	1:21	1:30	1:39	1:50
50	0:09	0:21	0:36	0:45	0:54	1:03	1:12	1:30	1:48	2:06	2:24	2:42	3:00	3:18	3:39
75	0:14	0:32	0:54	1:08	1:21	1:34	1:48	2:15	2:42	3:09	3:36	4:03	4:30	4:57	5:29
100	0:18	0:42	1:12	1:30	1:48	2:06	2:24	3:00	3:36	4:12	4:48	5:24	6:00	6:36	7:18
125	0:22	0:52	1:30	1:52	2:15	2:38	3:00	3:45	4:30	5:15	6:00	6:45	7:30	8:15	9:08
150	0:27	1:03	1:48	2:15	2:42	3:09	3:36	4:30	5:24	6:18	7:12	8:06	9:00	9:54	10:57
175	0:32	1:14	2:06	2:38	3:09	3:40	4:12	5:15	6:18	7:21	8:24	9:27	10:30	11:33	12:47
200	0:36	1:24	2:24	3:00	3:36	4:12	4:48	6:00	7:12	8:24	9:36	10:48	12:00	13:12	14:36
225	0:40	1:34	2:42	3:22	4:03	4:44	5:24	6:45	8:06	9:27	10:48	12:09	13:30	14:51	16:26
250	0:45	1:45	3:00	3:45	4:30	5:15	6:00	7:30	9:00	10:30	12:00	13:30	15:00	16:30	18:16
275	0:50	1:56	3:18	4:08	4:57	5:46	6:36	8:15	9:54	11:33	13:12	14:51	16:30	18:09	20:06
300	0:54	2:06	3:36	4:30	5:24	6:18	7:12	9:00	10:38	12:36	14:24	16:12	18:00	19:48	21:54
350	1:03	2:27	4:12	5:15	6:18	7:21	8:24	10:30	12:36	14:42	16:48	18:54	21:00	23:06	25:33
400	1:12	2:48	4:48	6:00	7:12	8:24	9:36	12:00	14:24	16:38	19:12	21:36	24:00	26:24	29:12
450	1:21	3:09	5:24	6:45	8:06	9:27	10:48	13:30	16:12	18:54	21:36	24:18	27:00	29:42	32:51
500	1:30	3:30	6:00	7:30	9:00	10:30	12:00	15:00	18:00	21:00	24:00	27:00	30:00	33:00	36:30

If the length to be tested is not calculated above, the following formula can be used to calculate the time required for the specified pressure drop.

TABLE 1 MINIMUM TEST TIME FOR VARIOUS PIPE SIZES

Nominal Pipe Size, in.	T(time), min/100 ft.	Nominal Pipe Size, in.	T(time), min/100 ft.
3	0.2	21	3.0
4	0.3	24	3.6
6	0.7	27	4.2
8	1.2	30	4.8
10	1.5	33	5.4
12	1.8	36	6.0
15	2.1	39	6.6
18	2.4	42	7.3

$$T = \frac{\text{Time in Table 1} \times L}{100}$$

WHERE

T = Time For Pressure to Drop from 3.5 Psig. to 2.5 Psig. in Minutes

L = Length of Line Between Manholes

If the pressure drop from 3.5 psig to 2.5 psig occurs in less time than the above tabulated or calculated values, the pipe shall be overhauled and, if necessary, replaced and relaid until the joints and pipe shall hold satisfactorily under this test.

If the section of line to be tested includes more than one pipe size, calculate the test for each size and add the test times to arrive at the total test time for the section.

At the end of air testing, all manholes shall be water tested to insure they are water tight per Subsection 603.03.14(a).

- d) **Test for Infiltration.** If, in the construction of a section of the sewer between structure, excessive groundwater is encountered, the test for leakage shall also be required as described in the Subsection on leakage test. For infiltration tests, the end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of groundwater, and pumping of groundwater shall be discontinued for at least three days after which the section shall be tested for infiltration. The infiltration shall not exceed 0.028 gallons per minute, per inch of diameter, per 1,000 (0.36 liters per minute, per centimeter of diameter, per 300 meters) of mainline sewer being tested and does not include the length of house laterals entering that section. Where any infiltration in excess of this amount is discovered before completion and acceptance of the sewer, the sewer shall be immediately uncovered at the expense of the Contractor and the amount of infiltration reduced to a quantity within the specified amount of infiltration before the sewer is accepted. Should, however, the infiltration be less than the specified amount, the Contractor shall stop any individual leaks that may be observed when ordered to do so by the Contracting Agency's Representative. The Contractor shall furnish all labor, materials, and calibrated flumes or "V" notch wiers and installation thereof for measuring infiltration and making the tests required at his own expense. All tests must be completed before street or trench is resurfaced, unless otherwise directed by the Contracting Agency's Representative.

630.03.15 TESTS FOR ALIGNMENT AND GRADE, AND DAMAGED OR DEFECTIVE PIPE IN PLACE:

After the pipe has been installed, tested for leakage, backfilled to existing grade and manholes raised, the sewer shall be "balled" from manhole to manhole with a sewer scrubbing ball of type and size to be approved by the Contracting Agency's Representative with the assistance of the Contractor's forces. All "balling" and "mirroring" shall be done in the presence of the Contracting Agency's Representative and shall constitute tests for alignment, grade, damage or defective pipe in place or any other type of faulty installation. Should "balling" or "mirroring" indicate any faulty installation of the pipe, repairs or replacements shall be made at the Contractor's expense as directed by the Contracting Agency's Representative. Full compensation for making these tests shall be included in the contract unit prices and no additional allowance will be made therefor. Where sewers are of sufficient size to permit hand cleaning "balling" may be omitted.

METHOD OF MEASUREMENT

630.04.01 MEASUREMENT: The method of measurement shall be as specified by the Contracting Agency.

BASIS OF PAYMENT

630.05.01 PAYMENT: Payment shall be as specified by the Contracting Agency.

SECTION 631

STREET NAME SIGNS

DESCRIPTION

631.01.01 GENERAL: The street name signs, mounting post, location, fabrication and installation shall conform to these specifications and any specifications referred to as part of this specification.

631.01.02 STREET NAME SIGN FACES: The legend shall include the name of the street with proper suffix, ordinal and block number as assigned by the responsible agency for that jurisdiction, all in accordance with the Standard Drawings.

MATERIALS

631.02.01 GENERAL: The finished face shall be applied to an aluminum sign blank conforming to the Standard Drawings.

631.02.02: The legend shall be made by one of the following two methods:

- (1) By reverse screening with green (blue for the City of North Las Vegas) transparent ink on a white wide-angle prismatic retroreflective sheeting which conforms to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6. When this method is used, the block number on the sign face may be two inch (2") (5 centimeters) numerals, die-cut from white conforming to the material specified in Subsection 716.03.01 "Reflective Sheeting," Class 6, White, using pressure-sensitive adhesive.
- (2) By applying white die-cut letters to green (blue for the City of North Las Vegas) wide-angle prismatic retroreflective sheeting which conforms to the material specified in Subsection 716.03.01 "Reflective Sheeting," Class 6. When this method is used, the letters and numerals shall be die-cut from white sheeting conforming to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6, White, and shall be applied using pressure-sensitive adhesive. The sign fabricator shall supply the Contracting Agency with a written guarantee of workmanship, stating that any such lettering which peels or loosens from the sign face within five (5) years will be repaired, or the sign replaced, free of charge.
- (3) By applying green (blue for the City of North Las Vegas) electronic cuttable transparent overlay film to white wide-angle prismatic retroreflective sheeting which conforms to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6.

CONSTRUCTION

631.03.01 STREET NAME SIGN INSTALLATION: The fabricated signs shall be installed using the hardware and piping as shown on the Standard Drawings.

The signs shall be installed on the corners of the intersection as indicated on an approved marked plat plan. Further, the signs shall be located on the P.C. line as indicated in the Standard Drawings.

631.03.02 EXCEPTIONS: No exceptions to the above specifications shall be allowed without prior written consent from the accepting agency.

METHOD OF MEASUREMENT

631.04.01 METHOD OF MEASUREMENT: The quantity of street signs measured for payment will be the number of complete signs in place.

BASIS OF PAYMENT

631.05.01 BASIS OF PAYMENT: Payment for street name signs shall be for each complete sign in place.

MATERIALS

701.02.01 GENERAL: Unless otherwise specified the type of cement used is to be at the Contractor's option based on availability, and no additional compensation will be allowed for substitution of any type of cement for another.

Portland cement concrete shall be subject to the requirements of Section 501, Table 1, except as herein noted.

Cement to be removed and replaced with fly ash shall be 13% to 20% of the weight of cement. Fly ash added at the mixer shall be in a proportion of 1.2 minimum to the weight of cement removed.

Class F fly ash conforming to the requirements of Section 729, "Fly Ash," shall be used.

PHYSICAL PROPERTIES AND TESTS

701.03.01 REQUIREMENTS: The cement, except Type I-P and Type II cements shall meet the requirements set out in the current Standard Specifications for Portland cement, AASHTO Designation M 85.

Type I-P cement shall conform to the specifications of ASTM Designation C 595.

Type II cement shall conform to the specifications of ASTM Designation C 150 with the following exceptions:

- (a) The cement shall not contain more than 0.60 percent by weight of alkalies calculated as Na_2O plus 0.658 K_2O when determined by flame photometry, using the direct intensity method in the specifications of ASTM Designation C 114.
- (b) The percentage of tricalcium silicate shall not be limited.

The percentage of soluble sulfates in the soil shall be determined by an analysis in conformance with California Test Method 417-B or equivalent. Upon approval of the Engineer, the concentrations of soluble sulfates in the soil may be determined from the results of two recent soils tests in the same general area as the location of the proposed off-site construction, or by an equivalent method.

SECTION 702

CONCRETE CURING MATERIALS AND ADMIXTURES

SCOPE

702.01.01 MATERIALS COVERED: This specification covers concrete curing materials, air-entraining admixtures, water retardants, fly ash, and hydrated lime. Attention is directed to Section 722, "Water" for mixing and curing.

PHYSICAL PROPERTIES AND TESTS

702.03.01 CURING MATERIALS: Curing materials shall conform to the requirements of the following tests:

Burlap Cloth made from Jute or Kenaf	AASHTO M 182
Waterproof Paper for Curing Concrete	AASHTO M 171
Liquid Membrane-Forming Compounds for Curing Concrete	ASTM C 309, Type 1D*
Plastic Sheeting	ASTM C 171
White Pigmented Curing Compound	ASTM C 309, Type 2, *&**
White Polyethylene Sheeting (film) for Curing Concrete	ASTM C 171

* *Except* the curing compound shall not react harmfully with the components of concrete or contain oils, waxes, or other materials which would prevent bonding of traffic marking paints. The film of curing compound shall be continuous, uniform, and free from pinholes, bubbles, or blisters.

** *Except the loss of water in the water retention test shall not exceed 0.40 kg/m² of surface.*

All curing compounds not previously approved shall be tested by a reputable testing laboratory, recognized by the Contracting Agency, who shall certify that the curing compound meets these specifications and requirements. The Contractor shall furnish the Contracting Agency with this certification prior to using the curing compound.

702.03.02 BLANK

702.03.03 AIR-ENTRAINING ADMIXTURES: Air-entraining admixtures shall conform to the requirements of ASTM C 260.

702.03.04 ADMIXTURE OTHER THAN AIR-ENTRAINING: These admixtures shall meet the requirements of ASTM Designation C 494 and shall be clearly marked as to Type A, B, C, D, E, F, or G.

702.03.05 HYDRATED LIME: Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

702.03.06 BLANK

702.03.07 WHITE PIGMENTED CURING COMPOUND - CHLORINATED RUBBER BASE: White Pigmented Curing Compound - Chlorinated Rubber Base shall conform to the current requirements of the State of Nevada Department of Transportation.

The Contractor shall furnish the Engineer with a certificate of compliance executed by the manufacturer of white pigmented curing compound - chlorinated rubber base. Such certificate shall attest that the curing compound as produced in the usual course of the manufacturer's trade, conforms to the requirements of these specifications.

702.03.08 FLY ASH: Fly Ash admixture shall conform to the requirements of Section 729, "Fly Ash".

SECTION 703

BITUMINOUS MATERIALS

SCOPE

703.01.01 MATERIALS COVERED: This specification covers the quality of asphalt cement, liquid asphalt, emulsified asphalt, cationic emulsion, and anionic emulsion.

REQUIREMENTS

703.02.01 CONTRACTOR'S RESPONSIBILITY: Bituminous material failing the requirements (including tolerances) of the tests hereinafter prescribed shall be subject to the provisions of Subsection 109.02, "Scope of Payment," and attention is directed thereto.

703.02.02 SHIPPING NOTICE: When shipments of materials arrive on the project after normal working hours, the Contractor shall notify the Engineer sufficiently in advance to make arrangements for an inspector to be present when the material is sampled.

Shipping notices shall be mailed upon making shipment and shall contain the following information:

- (a) Consignee and destination
- (b) Agency contract number
- (c) Delivery point
- (d) Date shipped
- (e) Car initials or number of truck transport delivery ticket number
- (f) Type and grade of material
- (g) Quantity loaded
- (h) Loading temperature
- (i) Net quantity
- (j) Signature of shipper or authorized representative

Three copies of the shipping notice shall be mailed to the Contracting Agency.

PHYSICAL PROPERTIES AND TESTS

703.03.01 REFINERY TEST REPORT: Refinery test reports shall be mailed to the Engineer as soon as tests have been completed, and the report shall contain the following data:

- (a) Date of shipment
- (b) Car initials or number of truck transport delivery ticket number
- (c) Destination and consignee
- (d) Contracting Agency contract number (or purchase order number, if applicable)
- (e) Type and grade of material

SECTION 704

BASE AGGREGATES

SCOPE

704.01.01 MATERIALS COVERED: This specification covers the quality and size of mineral materials used in base courses.

REQUIREMENTS

704.02.01 GENERAL: The mineral aggregate shall be the crushed and screened product from approved aggregate deposits, except that Type I aggregate base need not be crushed. The Engineer reserves the right to prohibit the use of aggregates from any source when:

- (a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.
- (b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the Contracting Agency.

The mineral aggregate shall be clean, hard, durable, free from any frozen lumps, deleterious matter, and harmful adherent coatings. Crushed portland cement concrete and asphaltic concrete pavement will be permitted, subject to the requirements of these specifications. No materials subject to regulation as hazardous wastes as defined in the Nevada Administrative Code 444.8565 shall be allowed.

704.02.02 DEFICIENCIES: If the product of a deposit is deficient in material passing the No. 16 sieve, filler from other approved deposits may be added at the crushing and screening plants. This is not to be construed as a waiver of any of the requirements contained herein.

704.02.03 PLASTIC LIMITS: When specified, aggregates shall conform to the applicable requirements of the following table:

TABLE 1

Percentage by Weight Passing 200 Sieve	Plasticity Index Maximum
0.1 to 3.0	15
3.1 to 4.0	12
4.1 to 5.0	9
5.1 to 8.0	6
8.1 to 11.0	4
11.1 to 15.0	3

Rev. June 9, 1994

PHYSICAL PROPERTIES AND TESTS**704.03.01 DRAIN BACKFILL:** This aggregate shall conform to one of the following grading requirement:

Sieve Sizes	Percentage by Dry Weight Passing Sieve		
	3 Inch Size	2 Inch Size	3/4 Inch Size
3 Inch.	100		
2 Inch.	90-100	100	
1-1/2 Inch.	70-100	95-100	
3/4 Inch.	0-50	50-100	100
1/2 Inch.			95-100
3/8 Inch.	0-10	0-55	70-100
No. 4		0-25	0-70
No. 8	0-5	0-15	
No. 200.	0-3	0-3	0-3

Unless otherwise specified in the contract documents the Contractor may use either the 3 inch size, 2 inch size, or 3/4 inch size.

	3 Inch Size	2 Inch Size	3/4 Inch Size
Source Requirement Test:			
Percentage of Wear (500 Rev.)			
ASTM C 131	45% Maximum	45% Maximum	45% Maximum

704.03.02 TYPE I AGGREGATE BASE: This aggregate shall conform to one of the following requirements:

Sieve Sizes	Percentage by Dry Weight Passing Sieve	
	3 Inch Size	2 Inch Size
3 Inch.	100	
2 Inch.	90-100	100
1-1/2 Inch.		95-100
1 Inch.	70-90	
No. 4	30-65	30-65
No. 16.	15-40	15-40
No. 200.	2-12	2-12

BASE AGGREGATES

704

Rev. October 12, 1995

Project Control Test	Test Method	Requirements
Sieve Analysis.	AASHTO T 27	Above
Sampling Aggregate	ASTM D 75	-----
Plasticity Index.	ASTM D 4318	Table 1
Liquid Limit	ASTM D 4318	35 Maximum
Resistance (R Value)	ASTM D 2844	60 Minimum
Percentage of Wear (500 Rev.) . . .	ASTM C 131	45 % Maximum

704.03.03 BLANK

704.03.04 TYPE II AGGREGATE BASE: This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Dry Weight Passing Sieve
1 Inch.	100
3/4 Inch	90-100
No. 4.	35-65
No. 16	15-40
No. 200.	2-10

Project Control Test	Test Method	Requirements
Sieve Analysis.	AASHTO	Above
Sampling Aggregate	ASTM D 75	-----
Fractured Faces.	Nev. T 230	50 % Minimum
Plasticity Index	ASTM D 4318	Table 1
Liquid Limit.	ASTM D 4318	35 Maximum
Resistance (R Value).	ASTM D 2844	78 Minimum
Percentage of Wear (500 Rev.) . . .	ASTM C 131	45 % Maximum

Type 2 Plantmix Aggregate as specified in Subsection 705.03.01 may be used in lieu of Type II Base Aggregate as specified above.

704.03.05 BLANK**704.03.06 BLANK****704.03.07 BLANK**

704.03.08 AGGREGATE FOR PORTLAND CEMENT TREATED BASE: This aggregate shall conform to the following requirements:

Sieve Sizes	Percentage by Dry Weight Passing Sieve	
3 Inch.	100	
2 Inch.	90-100	
No. 4	35-75	
No. 200	20	

Test	Test Method	Requirements
Sieve Analysis	AASHTO T 27	Above
Sampling Aggregate.	ASTM D 75	_____
Percentage of Wear (500 Rev.). . .	ASTM C 131	45 % Maximum

SECTION 705

AGGREGATES FOR BITUMINOUS COURSES

SCOPE

705.01.01 MATERIALS COVERED: This specification covers the quality and size of local mineral materials and commercial mineral fillers used in bituminous base and surface courses.

REQUIREMENTS

705.02.01 GENERAL: The mineral aggregate shall be the crushed and screened product of approved deposits. The Engineer reserves the right to prohibit the use of aggregates from any source when:

- (a) The character of the material is such, in the opinion of the Engineer, as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.
- (b) The character of the material is such, in the opinion of the Engineer, that undue additional costs may be accrued by the Contracting Agency.

The mineral aggregate shall be clean, hard, durable, free from frozen lumps, deleterious matter, and harmful adherent coatings.

When producing plantmix aggregate, all natural fines passing the No. 4 sieve shall be screened from the coarse aggregate and may be reintroduced into the mix at a rate not to exceed twenty (20) percent by dry weight of the combined aggregates.

The natural fines may be used only when all applicable mix design criteria have been met.

705.02.02 DEFICIENCIES: If the product of any deposit is deficient in the fraction passing the No. 50 sieve, additional filler from other approved deposits meeting the physical requirements may be added. The added material shall be fed to the drier in a uniform manner from a separate stockpile. If the added material is a commercial mineral filler, it shall be uniformly fed directly to the plant. This is not to be construed as a waiver of any of the requirements contained herein.

PHYSICAL PROPERTIES AND TESTS

705.03.01 PLANTMIX AND ROADMIX BITUMINOUS BASE AND SURFACE AGGREGATE, TYPES TWO FINE AND COARSE AND THREE: The aggregate shall conform to the following requirements:

Sieve Sizes	Percent By Weight Passing Sieve		
	Type 2 Coarse <u>Arterials</u>	Type 2 Fine <u>Residential/ Collector</u>	Type 3
1 Inch	100	100	—
3/4 Inch	84-97	90-100	—
1/2 Inch	66-82	78-94	100
3/8 Inch	56-72	68-84	90-100
No. 4	35-50	50-65	55-85
No. 8	23-38	30-49	32-67
No. 50	5-19	7-25	7-27
No. 200	2-7	2-9	2-10

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T 27	Above
Sampling Aggregate.	ASTM D 75	—
Fractured Faces	NEV. T 230	60% Minimum (2 fractures minimum) for Traffic Category I 35% Minimum (2 Fractures minimum) for Traffic Category II
Plasticity Index.	ASTM D 4318	6% Maximum
Liquid Limit.	ASTM D 4318	35% Maximum

Source Tests	Test Methods	Requirements
Percentage of Wear (500 REV.)	ASTM C 131	45% Maximum

705.03.03 PLANTMIX BITUMINOUS OPEN-GRADED SURFACE AGGREGATE: The aggregate shall conform to the following requirements:

Sieve Sizes	Percentage By Weight Passing Sieve	
	1/2 Inch	3/8 Inch
1/2 Inch.	100	—
3/8 Inch.	90-100	100
No. 4	35-55	20-45
No. 8	5-15	0-6
No. 200.	0-3	0-2

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T 27	Above
Sampling Aggregate.	ASTM D 75	—
Fractured Faces.	NEV. T 230	90% Minimum (2 fractures minimum)

Source Tests	Test Methods	Requirements
Percentage of Wear (500 REV.).	ASTM C 131	37% Maximum

705.03.04 COMMERCIAL MINERAL FILLER: Commercial mineral filler shall conform to the requirements of ASTM C977 for quicklime or to the requirements of ASTM C1097 for hydrated lime.

705.03.05 SCREENINGS: The screenings shall conform to the following requirements

Sieve Sizes	Percentage By Weight Passing Sieve	
	1/2 Inch	3/8 Inch
1/2 Inch.	100	—
3/8 Inch.	90-100	100
No. 4	15-35	20-45
No. 16.	0-4	0-6
No. 200	0-2	0-2

Project Tests	Test Methods	Requirements
Sieve Analysis	AASHTO T 27	Above
Sampling Aggregate	ASTM D 75	—
Fractured Faces	NEV. T 230	90% Minimum (2 fractures minimum)

AGGREGATES FOR BITUMINOUS COURSES

Source Tests	Test Methods	Requirements
Percentage of Wear (500 REV.).	ASTM C 131	37% Maximum

705.03.06 SAND BLOTTER: The sand shall conform to the following requirements:

Sieve Sizes	Percentage By Weight Passing Sieve	
1/2 Inch.	100	
No. 4	90-100	
No. 16.	30-75	
No. 200	0-12	

Project Tests	Test Methods	Requirements
Sieve Analysis.	AASHTO T 27	Above
Sampling Aggregate.	ASTM D 75	—
Organic Impurities.	ASTM C 40	—

SECTION 709

METAL AND THERMOPLASTIC PIPE

SCOPE

709.01.01 MATERIAL COVERED: This specification covers the quality of metal pipes, metal arch pipes, metal end sections, structural plate pipe, perforated metal pipe, and thermoplastic pipe used for culverts, drainage structures, conduits, underdrains, and cast iron soil pipe and cast iron water pipe.

PHYSICAL PROPERTIES AND TESTS

709.03.01 CORRUGATED METAL PIPE AND PIPE ARCHES: These conduits and the coupling bands shall conform to the requirements of AASHTO M 36 or AASHTO M 196 for the specified sectional dimensions and spelter coating. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Special Sections, such as elbows, tees and wyes for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to applicable requirements of AASHTO M 36.

When metal end sections are required, the following requirements shall pertain:

- (a) Metal end sections shall be of the gage shown on the plans.
- (b) The end of the pipe shall be furnished with annular corrugations to conform to metal end sections so that no leakage results from the connection; however, other designs may be used if approved by the Engineer.
- (c) Where connector sections are used the connector section shall be helical or annular as required to match the type of pipe used.

Gages of conduits shall conform to the requirements shown on the plans. Unless otherwise noted, the lightest gage listed for a specific diameter may be furnished.

Connecting bands may be two (2) gages lighter than that used for pipe but not more than twelve (12) gage or less than eighteen (18) gage. Unless otherwise approved by the Engineer, two-piece bands shall be required for pipe greater than forty-eight (48) inches (1.2 meters) in diameter.

Pipe thickness and coating shall be designed to withstand native soil corrosivity factors including, but not limited to pH and electrical resistivity of the soil, for a minimum life of seventy (70) years to first perforation.

The electrical resistivity of the soil shall be determined by California Test Method 643, "Method for Estimating the Service Life of Steel Culverts." For pipe coatings other than galvanized, the estimated service life shall be determined by applying appropriate correction factors to the value determined by California Test Method 643 as approved by the Engineer.

709.03.02 BITUMINOUS COATED CORRUGATED METAL PIPE AND PIPE ARCHES: These conduits and the coupling bands shall conform to the requirements of AASHTO M 36 for the specified sectional dimensions and gages, and to AASHTO M 190 for the type of bituminous coating. Coupling bands shall be fully coated with bituminous material. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

Rev. March 13, 1997

Special sections, such as elbows and flared end sections, for these conduits shall be of the same gage as the conduit to which they are joined, and shall conform to the applicable requirements of AASHTO M 190. Coating and invert paving shall be of the type specified.

When fiber bonded bituminous coating is specified, these requirements shall equally apply and in addition the special process of embedding fibers in the molten metallic bonding shall be used to bond the bituminous coating.

709.03.03 ALUMINIZED TYPE 2 COATED CORRUGATED STEEL PIPE: This pipe shall conform to the requirements of AASHTO M 36 and more specifically to the metallic coating specification AASHTO M 274. In addition, the use of Aluminized Type 2 Coated Corrugated Steel Pipe shall be limited by the following conditions:

- (a) Minimum Resistivity $R > 1500$ for $5 < \text{pH} < 9$
- (b) Minimum Resistivity $R > 1000$ for $6.1 < \text{pH} < 8.2$

A bituminous coating shall be applied to all aluminized pipe at each concrete interface.

709.03.04 CONCRETE LINED CORRUGATED STEEL PIPE: This pipe shall conform to the requirements of Section 709.03.03 for pipe and to ASTM A 849 except as modified by the following concrete lining specifications:

- (a) **Composition.** Concrete for the lining shall be composed of cement, fine aggregate and water that are well mixed and of such consistency as to produce a dense, homogeneous, non-segregated lining.

Mixture. The aggregates shall be sized, graded, proportioned and thoroughly mixed with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the design requirements of this specification. In no case, however, shall the concrete mixture be less than a six-sack mix in accordance with Section 701, "Portland Cement."

The lining shall have a minimum thickness of $1/8"$ (3.2 millimeters) above the crest of the corrugations and shall be applied so as to produce a homogeneous non-segregated lining throughout. The lining shall be applied in a two-course application, and shall be mechanically trowelled.

709.03.05 CORRUGATED ALUMINUM PIPE: This pipe shall conform to the requirements of AASHTO M 196.

709.03.06 CORRUGATED METAL PIPES FOR DOWNDRAINS: Downdrain flumes and pipe shall conform to the requirements of AASHTO M 36. Type III inlets shall conform to the requirements of AASHTO M 36. Type I and Type II inlets shall conform to the requirements of ASTM A 525 except 2.00 ounce (57 grams) coating shall be required. When specified, pipe, flumes, and inlets shall be bituminous coated conforming to the requirements of AASHTO M 190. All anchor assemblies, hardware and accessories shall conform to the requirements of ASTM A 153 and ASTM A 123.

709.03.07 CORRUGATED METAL PIPE FOR UNDERDRAINS: This pipe shall conform to the requirements of AASHTO M 36, Type III for the specified diameters. Unless otherwise specified, any one of the first three classes shown may be furnished.

709.03.08 BITUMINOUS COATED CORRUGATED METAL PIPE FOR UNDERDRAINS: This pipe shall conform to the requirements of AASHTO M 36 and shall be coated with the bituminous material to meet requirements of AASHTO M 190, Type A coating, except that minimum coating thickness shall be 0.03 inch (8 millimeters). Coupling bands shall be full coated. The specified minimum diameter for perforations shall apply after coating.

709.03.09 THERMOPLASTIC, PLASTIC PIPE CULVERTS AND DRAINS:

MATERIALS

- (a) **Corrugated Polyethylene Pipe, Type C** - Type C corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to AASHTO Designation M 294, unless otherwise specified herein or in the special provisions. Both the inside and outside surface of the pipe shall be corrugated.
- (b) **Corrugated Polyethylene Pipe, Type S** - Type S corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to AASHTO Designation M 294, unless otherwise specified herein or in the special provisions. Nominal sizes of 42 inches (1050 mm) and 48 inches (1200 mm) shall conform to AASHTO Designation MP6-95. The pipe wall shall be corrugated exterior construction with a smooth inner liner.
- (c) **Corrugated Polyethylene Pipe, Type D** - Type D corrugated polyethylene pipe shall be manufactured from high-density polyethylene (HDPE) virgin compounds and shall conform to AASHTO Designation MP6-95, unless otherwise specified herein or in the special provisions.

The pipe shall consist of an essentially smooth waterway braced circumferentially or spirally with projections or ribs joined to an essentially smooth outer wall. Both walls shall be fused to, or continuous with, the internal supports.

- (d) **Ribbed Profile Wall or Spiral Wound Polyethylene Pipe** - Ribbed wall polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds and shall conform to ASTM Designation F 894. The pipe wall shall be of either solid or hollow rib exterior construction with a smooth inner surface.
- (e) **Ribbed Profile Wall or Spiral Wound Polyvinyl Chloride Pipe** - Ribbed profile wall polyvinyl chloride pipe shall be manufactured from polyvinyl chloride (PVC) virgin compounds and shall conform to AASHTO Designation M 304, unless otherwise specified herein or in the special provisions. The pipe wall shall be of solid rib exterior construction with a smooth inner surface.
- (f) **Solid Wall Polyvinyl Chloride Pipe** - Solid wall polyvinyl chloride (PVC) pipe and fittings shall be type PSM Poly(vinyl chloride) pipe and fittings in accordance with ASTM D 3034, SDR 35, or Class P550 Polyvinyl Chloride Pipe and fittings conforming to the requirements of AASHTO M 278. Additives and fillers shall not exceed 10 parts by weight per 100 parts of PVC resin in the material compound.

Rev. March 13, 1997

- (g) **Special Fittings.** Special fittings such as elbows, tees and wyes for these conduits shall be of the same material as the conduits to which they are joined, and shall conform to applicable requirements for type of material being used.

When thermoplastic pipe end sections are required, the following requirements shall pertain:

- (1) End fittings shall be of the sizes shown on the plans.
- (2) The end of the pipe shall be furnished with corrugation to conform to the end fittings. However, other designs may be used if approved by the Engineer.
- (3) Where connector fittings are used, the connector fittings shall be helical or annular as required to match the type of pipe used.

High density polyethylene (HDPE) and polyvinyl chloride (PVC) compounds used in the manufacture of thermoplastic pipe culverts shall conform to the following provisions:

The Contractor shall provide the Engineer with a Certificate of Compliance from the manufacturer, for each type of thermoplastic pipe furnished, in accordance with the provisions of Subsection 106.05, "Certificates of Compliance," of these Specifications. Said certificate shall certify that the thermoplastic pipe complies with the requirements of the specifications, and shall include the resin material cell classification, unit weight of pipe, average pipe stiffness and the date of manufacture.

The cell classification for each individual property of HDPE compounds shall conform to ASTM Designation D 3350 and the following:

Property	Cell Classification
Density	3
Melt Index	2(*), 3 or 4
Modulus of Elasticity	4, 5 or 6
Tensile Strength	4, 5 or 6
Environmental Stress Crack Resistance	2 or 3
Hydrostatic Design Basis	0, 1, 2, 3, or 4
Ultraviolet-Stabilizer	C(**)

- (*) The Melt Index for cell classification 2 material used to manufacture pipe shall not be greater than 0.6. Rotationally molded couplings and end fittings may be produced from material compounds having a melt index cell classification of 1.

- (**) HDPE resin shall contain not less than $2\pm 1/2$ percent carbon black ultraviolet-stabilizer.

The cell classification for each individual property of PVC compounds shall conform to ASTM Designation D 1784 and the following:

Property	Cell Classification
Base Resin	1
Impact Strength (Izod)	2 through 6
Tensile Strength	3 or 4
Modulus of Elasticity	5 or 6
Deflection Temperature	4 or 5
Chemical Resistance	A, B, or C

709.03.10 CORRUGATED POLYETHYLENE PIPE FOR PERFORATED UNDERDRAINS: This pipe shall conform to the requirements of AASHTO M 252 or 294 for the specified diameters.

709.03.11 STRUCTURAL PLATE PIPE AND PIPE ARCHES: This pipe shall conform to the requirements of AASHTO M 167.

709.03.12 CAST IRON PIPE: This pipe shall conform to the requirements of ASTM 74, "Sewer Pipe" or AWWA 106, 108 "Water Pipe" as applicable.

709.03.13 STEEL WATER PIPE: This pipe shall conform to the requirements AWWA C 201, C 202.

SECTION 710

STRUCTURAL AND EYEBAR STEEL

SCOPE

710.01.01 MATERIAL COVERED: This specification covers the quality of structural and eyebar steel used in highway structures.

REQUIREMENTS

710.02.01 DEFECTS: Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish, and shall be straightened in the mill before shipment.

Material shall be free from loose mill scale, rust pits, or other defects affecting its strength or durability.

The Engineer reserves the right to reject material which he deems unsuitable for the purpose intended even though the material meets the requirements of the mill tolerances.

710.02.02 CHARPY V-NOTCH TEST: All steels used in and designated as main load carrying members subject to tensile stress, shall comply with all the requirements specified for Charpy V-notch test in the various AASHTO Designations for the steels involved. Sampling and testing procedures shall be in accordance with the requirements of the applicable AASHTO Designations.

PHYSICAL PROPERTIES AND TESTS

710.03.01 STANDARD STEEL: This steel shall conform to the requirements of AASHTO M 183.

710.03.02 HIGH STRENGTH-LOW ALLOY STRUCTURAL MANGANESE VANADIUM STEEL: This steel shall conform to the requirements of ASTM A 441.

710.03.03 HIGH TENSILE STRENGTH BOLTS: This steel shall conform to the requirements of ASTM A 325.

710.03.04 STAINLESS STEEL BOLTS: This steel shall conform to the requirements of ASTM A 276.

710.03.05 WELDED SEAMLESS STEEL PIPE: This steel shall conform to the requirements of ASTM A 53 (Grade B).

710.03.06 COLD-FORMED WELDED AND SEAMLESS CARBON STEEL STRUCTURAL TUBING IN ROUNDS AND SHAPES: This steel shall conform to the requirements of ASTM A 500 (Grade B) except the minimum tensile strength shall be 55,000 psi (379 MPa).

Testing Prestressing Reinforcement and Anchorages. All wire, strand, or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes. Anchorage assemblies to be shipped shall be likewise identified.

All samples submitted shall be representative of the lot to be furnished, and, in the case of wire or strand, shall be taken from the same master roll.

All of the materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.

The vendor shall furnish for testing the following samples selected from each lot. If ordered by the Engineer, the selection of samples shall be made at the manufacturer's plant by the inspector.

- (a) **Pretensioning Method.** For pretensioned strands, samples at least five (5) feet (1.5 meters) long shall be furnished of each strand size. A sample shall be taken from each end of every coil.
- (b) **Post-Tensioning Method.** The following lengths shall be furnished:
 - (1) For wires requiring heading - five (5) feet (1.5 meters).
 - (2) For wires not requiring heading - sufficient length to make up one parallel-lay cable five (5) feet (1.5 meters) long consisting of the same number of wires as the cable to be furnished.
 - (3) For strand to be furnished with fittings - five (5) feet (1.5 meters) between near ends of fittings.
 - (4) For bars to be furnished with threaded ends and nuts - five (5) feet (1.5 meters) between threads at ends.
- (c) **Anchorage Assemblies.** Two anchorage assemblies shall be furnished, complete with distribution plates of each size or type to be used if anchorage assemblies are not attached to reinforcement samples.

713.03.05 COLD-DRAWN STEEL WIRE FOR SPIRAL REINFORCEMENT: This steel shall conform to the requirements of ASTM A 82.

SECTION 714

PAINT AND PAVEMENT MARKINGS

SCOPE

714.01.01 MATERIALS COVERED: This specification covers the quality, color, and number of applications of paint in painting the various materials of construction. Attention is directed to Section 715, "Galvanizing," for galvanized coatings. The raw materials for use in the various paint formulas shall conform to the specifications designated by Federal or Military serial number or paint material code number under the various paint classifications hereinafter specified. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products. No "or equal" substitutions for any specified material shall be made without written consent of the Engineer. State specification numbers referred to are (California State Specifications) unless otherwise noted.

REQUIREMENTS

714.02.01 CERTIFICATES: The Contractor shall furnish the Engineer with written certification that all required tests have been satisfactorily completed and that the materials thereof comply with all of the requirements. Samples will be taken when required by the Engineer.

PHYSICAL PROPERTIES AND TESTS

714.03.01 IRON AND STEEL USE ITEMS:

- (a) **Zinc-rich Primer, Organic Vehicle Type (State Spec. 8010-61J-36).**

Description. This specification covers a one-package, thermoplastic organic zinc-rich primer whose mechanism of drying is that of solvent release. It is intended for use only on blast cleaned open steel structures exposed to the air.

This coating is intended for spray application. Limited application can be made by brushing.

- (b) **Pre-treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).**

Classification. This specification covers a wash primer formulated specifically for application prior to painting clean aluminum, galvanized surfaces or surfaces previously coated with an organic or inorganic zinc-rich primer. It is also used on blast cleaned steel when specified and is mandatory as an undercoat under vinyl paint systems.

- (c) **Vinyl Primer, Red Iron Oxide Type (State Spec. 8010-61J-23).**

Classification. This specification covers a ready-mixed vinyl-red oxide paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment Vinyl Wash Primer (State Spec. 8010-61J-27).

This paint should be applied alternately with Vinyl Primer, Red Iron Oxide - Titanium Dioxide Type (State Spec. 8010-61J-24) to provide a primer coating which may consist of one or more applications of each vinyl primer. Either State Specification 8010-61J-23 or 8010-61J-24 may be used for the initial application. This paint is formulated primarily for spray application.

(d) **Aluminum Vehicle (State Spec. 8010-91B-75).**

Classification. This specification covers an aluminum vehicle clear varnish and general all purpose phenolic base spar mixing varnish. This varnish should not be used on surfaces and in pigment combinations where yellowing will be objectionable.

(e) **Aluminum Paint, Finish Coat, (State Spec. 8010-61J-45).**

Classification. This specification covers a phenolic resin varnish base aluminum paint, suitable for use as a finish coat. It is formulated for use on structural steel and interior and underwater surfaces of steel water tanks and similar exposed surfaces.

This paint shall be furnished in 2-compartment containers and shall be mixed fresh each day.

(f) **Vinyl Paint, Aluminum Finish Coat (State Spec. 8010-61J-25).**

Classification. This specification covers a vinyl type aluminum paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27), or specified vinyl undercoats. This paint is primarily formulated for spray application.

This paint shall be furnished in 2-compartment containers and shall be mixed fresh each day.

(g) **Burnt Umber Tint Finish Coat (State Spec. 8010-61J-41).**

Classification. This specification covers a ready-mixed burnt umber tint paint suitable for use as a finish coat on properly prepared structural steel surfaces. This paint may be applied by spray or brush.

(h) **Burnt Sienna Finish Coat (State Spec. 8010-61J-53).**

Classification. This specification covers a ready-mixed burnt sienna paint suitable for use as a finish coat on properly prepared structural steel surfaces. This paint may be applied by spray or brush.

(i) **Green Finish Coat (State Spec. 8010-61J-47).**

Classification. This specification covers a ready-mixed green paint suitable for use as a finish coat on properly prepared structural steel surfaces. This paint may be applied by spray or brush.

(j) **Vinyl Green Finish Coat (State Spec. 8010-61J-40).**

Classification. This specification covers a ready-mixed green vinyl finish paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27), or specified vinyl undercoats. This paint is formulated primarily for spray application.

(k) **Vinyl Iridescent Green Finish Coat (State Spec. 8010-91B-43).**

Classification. This specification covers a ready-mixed iridescent green vinyl finish paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment, Vinyl Wash Primer (State

Rev. August 8, 1996

Spec. 8010-61J-27), or specified vinyl undercoats. This paint is formulated primarily for spray application.

(l) **Tan Finish Coat (State Spec. 8010-61J-51).**

Classification. This specification covers a ready-mixed tan paint suitable for use as a finish coat on properly prepared structural steel surfaces. This paint may be applied by spray or brush.

(m) **White Tint Base Finish Vinyl Coat (State Spec. 8010-71C-35).**

Classification. This specification covers a ready-mixed white tint base vinyl finish paint for use on properly prepared metal surfaces which have been treated with Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27). This paint is formulated primarily for spray application.

(n) **Enamel; Exterior White, Metal (State Spec. 8010-61J-09).**

Classification. This specification covers a fast drying exterior white enamel, primarily for use on metal, or for other exterior surfaces where gloss and durability are requisite.

This paint shall conform to the provisions of Military Specification MIL-E-1115A, and in addition, shall comply with all air pollution control rules and regulations in Clark County Nevada in effect at the time the paint is applied.

(o) **Enamel; Traffic Signal, Lusterless, Black (State Spec. 8010-61J-13).**

Classification. This specification covers a lusterless, black enamel for use in painting traffic signal hoods, shields, and other surfaces. When used on bare aluminum or zinc, Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27) shall be used first to insure proper bond.

(p) **Enamel; Traffic Signal, Dark Olive Green (State Spec. 8010-41B-A).**

Classification. This specification covers an enamel for use on signal poles and is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27).

(q) **Enamel; Traffic Signal, Yellow (School Bus Yellow).**

Classification. This specification covers high-gloss enamel for use on signal poles and is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27). School bus yellow shall conform to Federal Color No. 13432 as shown in Table V of Federal Standard No. 595a.

(r) **Enamel; Traffic Signal, Silver.**

Classification. This specification covers an enamel for use on signal poles and is formulated as a finishing coat to be used over Pre-Treatment, Vinyl Wash Primer (State Spec. 8010-61J-27). The silver shall conform to Federal Color No. 17178 as shown in Table IX of Federal Standard No. 595a.

714.03.02 TIMBER USE ITEMS:

(a) **Wood Primer Latex Base.**

Classification. This specification covers a ready-mixed priming paint for use on unpainted wood or

exterior wood work. It shall comply, in all respects, with Federal Specification TT-P001984, except that it shall dry hard in not more than 12 hours.

(b) **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 comply in all respects with Federal Specification TT-P96D.

Unpainted wood shall first be primed with Wood Primer conforming to the requirements in Subsection 714.03.02(a), "Wood Primer, Latex Base."

(c) **Enamel; Sign Post, Black (State Spec. 8010-61J-08).**

Classification. This specification covers a gloss black enamel for use on wood or metal.

714.03.03 CONCRETE USE ITEMS: Concrete end posts, (bridges), raised traffic bars, and miscellaneous concrete specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formulated or Specification
Finish	1	White	Water Thinned	Acrylic Resin or Synthetic Latex Alkyd Emulsion

714.03.04 ALUMINUM USE ITEM: Aluminum bridge railing and posts specified to receive paint shall be prepared for painting with a coat of Pre-Treatment, Vinyl Wash Primer conforming to the requirements of Subsection 714.03.01(b), (California State Spec. 8010-61J-27).

The Contractor may use any of the paint systems specified for use on iron or steel in Subsection 714.03.01 for painting aluminum, and shall submit to the Engineer for approval a letter indicating his choice of system as required for iron or steel.

714.03.05 PAINT FOR TRAFFIC STRIPING, PAVEMENT MARKING, AND CURB MARKING - GENERAL: These specifications are intended to cover ready-mixed paints of a consistency suitable for use on highway pavements and curbing, either asphaltic or Portland cement type.

Reference specifications and standards shall be Federal Specifications, latest revision, as herein noted, or Federal Test Method Standard No. 141, latest revision, as called for and amended in these specifications.

Paint shall be homogenous, free of contaminant and of a consistency suitable for use in the capacity for which it is specified. Finished paint shall be well ground and the pigment shall be properly dispersed in the vehicle according to the requirements of the paint. The dispersion shall be of such nature that the pigment does not settle badly, does not cake or thicken in the container, and does not become granular or curdled. Any settlement of pigment in the paint 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 smooth uniform product of the proper consistency. The manufacturer shall include in the paint the necessary additives for control of sagging, pigment settling, leveling, drying, drier absorption and skinning or other requisite qualities of a satisfactory working material. The paint shall possess satisfactory properties, in all respects which affect its application and curing.

The raw materials for use in the paint formula shall conform to the specifications designated by Federal Serial

Rev. August 8, 1996

Number or Paint Material Code Number hereinafter specified. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products. No "or equal" substitution for any specified material shall be made without written consent.

All manufactured paint shall be prepared at the factory ready for application. The addition of thinner or other material to the paint after the paint has been shipped will not be permitted unless otherwise specified in the contract Special Provisions.

The following characteristics shall be met:

- (a) **Abrasive Resistance:** Paints shall show an average wear index of between 0.1 and 0.3 when tested in accordance with Method 6192 of FTMS No. 141a and the following procedures.

Drawdown one even coat of each color to 3 Number 16 Morest chart panels to obtain a uniform dry-film thickness of 5-6 mils (0.15 millimeters). Allow to air dry 48 hours.

Determine Wear Index using 1,000-grams weights, CS-17 wheels and 1,000 cycles as the average for the three panels.

- (b) **Hiding Power:** The coating material when applied with 0.008 inch (0.20 millimeter) Bird Film applicator on a standard Morest Hiding chart, shall completely hide the color of black.
- (c) **Flexibility:** Coat vapor-degreased plane tin panels 3 inch x 8 inch (75 x 200 millimeters) conforming with FTM Standard 141 Method 2012.1, par 2.2 with one coat of the paint to a wet film thickness of 8 mils (0.2 millimeters). Dry in a horizontal position at room temperature for 18 hours.

Bend rapidly over 1/2-inch (13 millimeters) rod with the coated side uppermost. No cracking should be visible.

- (d) **Water Resistance:** Coat three clean glass plates 3 inch x 8 inch (75 x 200 millimeters) with one coat of each paint at 15 mils (0.4 millimeters) wet film thickness. Dry in a horizontal position at 25 degrees C. for 72 hours and immediately immerse one-half of the coated surface in color water for 48 hours, and boiling water for 15 minutes.

Remove and allow each panel to recover at 25 degrees C. and 55 percent RH for 40 minutes. Paint shall show no evidence whatever of embrittlement or loss or adhesion or disintegration excepting that a slight loss of gloss of the immersed portion is allowable.

- (e) The paint shall not exceed 80 ku viscosity at 72 degrees F. (22 degrees C.).
- (f) The paint shall weigh not less than 10.5 lbs. per gallon (1.26 kilograms per liter). Paint for traffic striping and markings shall conform to the requirements as shown in the following table:

PAINT FOR TRAFFIC STRIPING AND MARKING

Type of Paint	Reflective** Material	Pre-Treatment	Finish Coat
Thermoplastic	Federal Spec. TT-B-1325B) Added to the paint during manufacturer epoxy	Concrete pavement, 10% solution buna N rubber methyl ethyl ketone or approved two-component	See Subsection 714.03.06
Fast Dry	(Federal Spec. TT-B-1325B) May be added directly to paint during manufacture with Engineer's approval	See Subsection 628.03.04 Preparation of Existing Surfaces	See Subsection 714.03.07
Traffic Zones and Curb	(Federal Spec. TT-B-1325B)	See Subsection 628.03.04 Preparation of Existing Surfaces	State Specification Red (712.80.97) Green
Markings - *	May be added directly to paint during manufacture with Engineer's approval.		White, Same as red, substitute Yellow as red, substitute color pigment only

* Reflective material required only when specified

**See Subsection 714.03.09

714.03.06 THERMOPLASTIC PAINT AND PAVEMENT MARKINGS:

- (a) **Thermoplastic Paint (State Spec. 8010-71K-19).** Thermoplastic traffic line paint shall be reflectorized thermoplastic pavement striping material applied to the road surface in a molten state by mechanical means. It shall have a surface application of glass beads which, upon cooling to normal pavement temperatures, will produce an adherent reflectorized stripe of the specified thickness and width, and will be resistant to deformation by traffic. The material shall contain at least 20% by weight of glass beads in the white and yellow paints and at least 12% titanium dioxide in the white paint. The material, when applied at a temperature range of 400-425 degrees F. (204-218 degrees C.), and a thickness of 125 mils (1/8 inch) (3 millimeters) to 188 mils (3/16 inch) (5 millimeters) shall set to bear traffic is not more than two minutes when the temperature is 50 degrees F. (10 degrees C.) and not more than ten minutes when the air temperature is 90 degrees F. (32 degrees C.).

(b) Type I Film

Type I Film shall be a high durability retroreflective pavement marking film for preformed transverse, channelizing, and word/symbol markings subjected to high traffic volumes and severe wear conditions such as repeated shear action from crossover and encroachment on channelization lines, and stop, start, or turn movements. A retroreflective layer of glass beads and a layer of skid resistant particles shall be bonded to the top urethane wear surface. The urethane wear surface shall have a nominal thickness of 0.012 inches (0.31 millimeter).

Color

The daytime color of the white film shall provide a minimum initial luminance factor Y, of 80, and shall conform to the chromaticity requirements: $x = 0.290$, $y = 0.315$; $x = 0.310$, $y = 0.295$; $x = 0.330$, $y = 0.360$; $x = 0.350$, $y = 0.340$. Measurement shall be made in accordance with ASTM E 1349, using illuminant "C" and 0/45 (45/0) geometry. Calculations shall be in accordance with ASTM E 308 for the 2° standard observer.

Reflectance

The white film shall have the following initial minimum reflectance values as measured in accordance with ASTM D 4061. The photometric quantity to be measured shall be specific luminance (S_L), and shall be expressed as millicandelas per square foot per footcandle (mcd/ft²/fc). The metric equivalent shall be expressed as millicandelas per square meter per lux (mcd/m²/l). The test distance shall be 50 feet (15 meters) and the sample size shall be a 2.0 feet x 2.5 feet rectangle (0.61 x 0.76 meter).

Entrance Angle	86.0°	86.0°	86.5°
Observance Angle	0.2°	0.5°	1.0°
Specific Luminance S_L (mcd/ft ² /fc)	550	400	300

Skid Resistance

The surface of the retroreflective films shall provide an initial minimum average skid resistance value of 55 BPN when tested in accordance to ASTM E 303.

Retained Skid Resistance

The surface of the retroreflective film shall retain an average skid resistance value of 45 BPN, when tested in accordance with ASTM E 303, for a period of three years after installation. The 45 BPN minimum value shall be an average of several readings taken in both the wheel track and non-wheel track areas.

Tensile Strength and Elongation

The film shall have a minimum tensile strength of 400 pounds per square inch (28 kilograms per square centimeter) of cross-section when measured in the direction of the length of the roll and tested in accordance with ASTM D 638-76, except that a sample 6" x 1" (150 millimeters x 25 millimeters) shall be tested at a temperature between 70°F and 80°F (21°C and 26°C) using a jaw speed of 10 to 12 inches (250 millimeters to 300 millimeters) per minute. The sample shall not exceed 50% elongation at break when tested by this method.

Reflectivity Retention

To have a good, effective performance life, the skid resistance particles and glass beads must be strongly bonded and not removed by traffic wear.

The following test shall be employed to measure reflectivity retention:

Taber Abrasion Simulation Test

Using a Taber Abraser with an H-18 wheel and a 125 gram load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of particles and bead failure.

No more than 15% of the particles and beads shall be lost due to popout and the predominant mode of failure shall be "wear down" of the beads.

Glass Beads

The size, quality and refractive index of the glass beads shall be such that the performance requirements of the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

Glass Bead Retention

The film shall have glass bead retention qualities such that when a 2" x 6" (50 mm x 150 mm) samples bent over a 1/2" (13 mm) diameter mandrel, with the 2" (50 mm) dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.

Thickness

The film shall have a minimum thickness of 0.060 in. (1.52 mm).

Performance Requirements

The film, when applied according to the recommendations of the manufacturer, shall provide a neat,

Rev. August 8, 1996

durable marking that will not flow or distort due to the temperature if the pavement surface remains stable. The film shall be weather resistant and, through normal traffic wear, shall show no fading, lifting or shrinkage which will significantly impair the intended usage of the marking throughout its useful life and shall show no significant tearing, roll back or other signs of poor adhesion.

Installation and Warranty

The markings shall be applied in accordance with the manufacturer's instructions by installers who have been certified by the manufacturer for the installation of the material. The manufacturer shall provide governing agency with a written copy of installation instructions and a recommendation for the type of adhesive to be used prior to installation of materials.

The marking material and installation shall have a three (3) year warranty.

(c) **Type II Film**

Type II Film shall be a high durability retroreflective pliant pavement marking film for longitudinal markings subjected to high traffic volumes and severe wear conditions such as repeated shear action from crossover and encroachment on typical longitudinal configurations such as edge lines and lane lines.

Color

The preformed marking shall consist of white and yellow films with pigment selected and blended to conform to standard highway colors.

Reflectance

The white and yellow markings shall have the following initial expected retroreflectance values as measured in accordance with the testing procedures of ASTM D 4601. The photometric quantity to be measured shall be specific luminance (S_L), and shall be expressed as millicandelas per square foot per footcandle (mcd/ft²/fc). The metric equivalent shall be expressed as millicandelas per square meter per lux (mcd/m²/1). The test distance shall be 50 ft. (15 m) and the sample size shall be a 2.0 x 2.5 ft. rectangle (0.61 x 0.76 m).

	WHITE		YELLOW	
Entrance Angle	86.0°	86.5°*	86.0°	86.5°*
Observance Angle	0.2°	1.0°	0.2°	1.0°
Specific Luminance S_L (mcd/ft ² /fc)	1100	700	800	500

*These retroreflectance values are based on dark room photometric readings per ASTM D 4061. The "Ecolux™" retroreflectometer measures at this same approximate geometry. That is, 86.5° entrance angle and 1.0° observation angle.

Skid Resistance

The surface of the retroreflective films shall provide an initial minimum average skid resistance value of 45 BPN when tested in accordance to ASTM E 303.

Thickness

The pavement marking film without adhesive shall have a minimum caliper of 0.02 in. (0.51 mm) at the thinnest portion of the cross-section.

Beads

The size, quality and refractive index of the glass beads shall be such that the performance requirements of the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

Performance Requirements

The film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to the temperature if the pavement surface remains stable. The film shall be weather resistant and, through normal traffic wear, shall show no fading, lifting or shrinkage which will significantly impair the intended usage of the marking throughout its useful life and shall show no significant tearing, roll back or other signs of poor adhesion.

Installation and Warranty

The markings shall be applied in accordance with the manufacturer's instructions by installers who have been certified by the manufacturer for the installation of the material. The manufacturer shall provide governing agency with a written copy of installation instructions and a recommendation for the type of adhesive to be used prior to installation of materials.

The marking material and installation shall have a three (3) year warranty.

Qualified Products List

The Clark County Regional Transportation Commission (RTC) shall maintain a Qualified Products List (QPL) of all products available that satisfy the requirements of these specifications and have proven effective in field tests. All materials, equipment and labor necessary to install and field test a product shall be provided at the cost of the product's manufacturer. All field tests shall be evaluated with regards to the performance standards of these specifications for a period not less than one year. Upon satisfactorily completing the field tests, and after deemed acceptable by the RTC, the RTC shall amend the QPL to include the tested product.

Rev. August 8, 1996

714.03.07 FAST DRY TRAFFIC PAINT: Type I (Heatable) Fast Dry White, Type I (Heatable) Fast Dry Yellow, Type II Fast Dry White, and Type II Fast Dry Yellow shall comply with the requirements of any western state specification which is valid at the time of use in addition to meeting the requirements of Subsection 714.03.05.

Fast dry traffic paint shall be applied at the film thickness of 15 mils to 20 mils (0.4 to 0.5 millimeters) and shall dry to "no traffic pickup" within three (3) minutes.

The "no traffic pickup" time shall be determined by ASTM D 711.

714.03.07a ALL PURPOSE BLACK TRAFFIC PAINT - PAINT FORMULA 235: All purpose Black Traffic Paint - Paint Formula 235 shall comply with the requirements of any western state specification which is valid at the time of use.

714.03.08 READY-MIXED TRAFFIC STRIPE PAINTS: Where ready-mixed paints are specified, they shall be suitable for use on either asphalt concrete or Portland cement concrete.

714.03.09 REFLECTIVE MATERIAL: Reflective material shall consist of glass beads added to the surface of the final coat of paint prior to setting, so that the beads will have proper adhesion. Special care shall be taken with rapid dry paint and thermoplastic materials.

Glass beads shall conform to Federal Specification TT-B-1325B and shall be mechanically applied at a rate of 6 to 8 pounds of beads per gallon (0.7 to 1.0 kilograms per liter) of paint. Glass beads shall be applied to pavement markings, curbs and crosswalks by use of a dispensing device developed for this purpose or other methods approved by the Engineer.

The Engineer may authorize the use of paint containing pre-mixed glass beads. The type, gradation, quantity and quality of the pre-mixed glass beads shall be approved prior to the manufacture of the paint. In addition to the specified pre-mixed beads, 2 to 3 pounds of bead per gallon (0.25 to 0.35 kilograms per liter) of paint shall be mechanically applied when the paint is applied.

If thermoplastic paint is required, glass beads may be added directly to the combined pigment, filler and resin in accordance with Subsection 714.03.06. However, prior to setting, all thermoplastic paint surfaces shall receive an additional application of at least one pound of glass beads per gallon (0.12 kilograms per liter) of paint.

714.03.10 AIR POLLUTION: All paint shall meet the requirements of the appropriate Clark County Air Pollution Control Division.

714.03.11 TEST REPORTS AND CERTIFICATION: At the time of delivery of each shipment of material, the Contractor shall, upon request, deliver to the Engineer certified copies of the manufacturer's test report. The test report shall indicate the name of the manufacturer, type of material, date of manufacture, quantity, applicable State Specification Number and specification, manufacturer's lot or batch number, and results of the required tests. The test report shall be signed by an authorized representative of the manufacturer. The certified test reports and the testing required in connection therewith shall be at no cost to the Contracting Agency.

SECTION 715

GALVANIZING

SCOPE

715.01.01 MATERIALS COVERED: This specification covers the quality and thickness of galvanizing used on various material when called for on the plans or designed in the specifications.

PHYSICAL PROPERTIES AND TESTS

715.03.01 PRODUCTS ONE-EIGHTH (1/8) INCH (0.3 CENTIMETERS) THICK AND THICKER: Galvanizing of products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strip shall conform to the requirements of ASTM Designation A 123.

715.03.02 GUARDRAIL ELEMENTS: All rail elements shall be galvanized in accordance with AASHTO Designation M 180, Type 2.

715.03.03 HARDWARE: Bolts, nut, washers, and fastenings shall be galvanized in accordance with the requirements of ASTM Designation A 153.

SECTION 716

SIGN MATERIALS

SCOPE

716.01.01 MATERIALS COVERED: This specification covers the kind and quality of materials used in the construction and fabrication of "Work Zone Signs," "Temporary Signs" and "Permanent Signs."

REQUIREMENTS

716.02.01 GENERAL: The following materials shall conform to the requirements as noted:

Portland Cement Concrete		Section 501
Reinforcing Steel		Section 505

716.02.02 CERTIFICATES: It shall be the Contractor's responsibility to ascertain that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency. The Contractor shall furnish the Engineer with a written certification that all required tests have been satisfactorily completed and that materials and fabrication thereof comply with all the requirements.

PHYSICAL PROPERTIES AND TESTS

716.03.01 REFLECTIVE SHEETING: Sheeting shall be of the following class sets, as specified in the plans or the proposal, and unless otherwise specified or approved by the Engineer, shall be Class 4. The sheeting shall be a material approved by the Engineer, applied to approved sign substrate per manufacturer's instructions, and conform to the applicable requirements below.

Class 1 - Non-retroreflective plastic film (ScotchCal. or equal). Pressure sensitive adhesive coated plastic film for sign copy and borders shall be a material recommended by the retroreflective sheeting manufacturer as compatible with the background retroreflective sheeting, and shall meet the requirements for Type I, Class 1 of MIL-M-43719B, "Marking Materials and Markers, Adhesive, Elastomeric, Pigmented."

Life: 7 years

Class 2 - Enclosed Lens Retroreflective Sheeting (Engineer grade, or equal). Class 2 sheeting shall meet the requirements of USDOT FHWA Specification FP-96, Section 718, for Type I Sheeting.

Life: 7 years

Class 3 - Enclosed Lens Retroreflective Sheeting (Super Engineering grade, or equal). Class 3 sheeting shall meet the requirements of FP-96, Section 718, for Type II Sheeting.

Life: 10 years

Class 4 - Encapsulated Lens Retroreflective Sheeting (High Intensity grade, or equal). Class 4 sheeting shall meet the requirements of FP-96, Section 718, for Type III Sheeting and the following additional values for the minimum coefficients of retroreflection in units of candelas per footcandle per square foot (candelas per lux per square meter) for sheeting used in construction work zones:

Observation Angle (°)	Entrance Angle (°)	White	Yellow	Orange
0.2	+50	75	40	25
0.5	+50	35	20	10

Life: 10 years

Class 5 - Wide Angle Prismatic Retroreflective Sheeting (Diamond grade, or equal). Class 5 sheeting is a wide angle retroreflective sheeting with optimized performance at narrow observation angles and with extended entrance angle performance and shall have minimum coefficients of retroreflection, R' (determined in accordance with ASTM E 810, in units of candelas per footcandle per square foot (candelas per lux per square meter)), not less than the values shown below:

Observation Angle (°)	Entrance Angle (°) (0 degree orientation)	White	Red	Yellow	Blue	Green
0.2	-4	800	215	660	43	80
0.2	+30	400	100	340	20	35
0.2	+45	145	25	85	7.6	12
0.2	+60*	35	6.6	23	1.0	2.0
0.5	-4	200	45	160	9.8	20
0.5	+30	100	26	85	5.0	10
0.5	+45	75	18	60	2.8	6.0
0.5	+60*	30	6.4	20	2.0	2.0

* 60 degree angle shall be measured at a 90 degree orientation.

Observation Angle(°)	Entrance Angle(°) (90 degree orientation)	Fluorescent Orange
0.2	-4	200
0.2	+30	120
0.2	+50	50
0.5	-4	80
0.5	+30	50
0.5	+50	20

Life: 7 years

Class 6 - Wide Angle Prismatic Retroreflective Sheeting (Diamond grade VIP, or equal). Class 6 sheeting is a wide angle retroreflective sheeting with optimized performance over a broad range of observation angles and shall have minimum coefficients of retroreflection, R' (determined in accordance with ASTM E 810, in units of candelas per footcandle per square foot (candelas per lux per square meter)), not less than the values shown below:

Observation Angle (°)	Entrance Angle (°) (0 degree orientation)	White	Yellow	Red	Blue	Green
0.20	-4	430	350	110	20	45
0.20	+30	235	190	60	11	24
0.20	+40*	150	125	40	6	15
0.33	-4	300	250	75	15	33
0.33	+30	150	130	30	7	18
0.33	+40*	85	75	25	4	8
0.50	-4	250	200	60	10	25
0.50	+30	170	140	40	7	19
0.50	+40*	35	30	10	1.5	3.5
1.00	-4	80	65	20	4	10
1.00	+30	50	40	13	2.5	5
1.00	+40*	20	17	6	0.7	2.0

* 40 degree angle shall be measured at a 90 degree orientation.

Life: 7 years

Transparent colored ink reverse screening of white sheeting and overlaying of white sheeting with electronic cuttable colored transparent film must result in coefficients of retroreflection not less than 70% of the previously specified values for the corresponding colors for Class 2-4 sheeting. For Class 5 and 6 sheeting, the contrast ratio of the coefficient of retroreflection (R') for the white to the coefficient of retroreflection (R') for the color, when measured at 0.2° observation, -4° entrance, and 0° rotation shall be 5:1

to 15:1 for red, not less than 5:1 for blue and not less than 5:1 for green when processed in accordance with the recommendations of the sheeting manufacturer.

Field Performance Life Requirements. The supplier shall warranty that signs supplied shall have an effective reflective life of not less than that specified in the previous subsections. The retroreflective sign shall be considered unsatisfactory (and failing this life requirement) if it has deteriorated due to natural causes to the extent that:

- (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night conditions;

- (2) the values for the coefficients of retroreflection for Classes 2 - 4 are less than 50% of the required values for the same sign when new or for Classes 5 and 6, the contrast ratio is below the recommended values for the same sign when new, or
- (3) the sign material's integrity or adhesion to the sign substrate has substantially failed. Sheeting which fails this requirement within the specified required lifetime shall be replaced at no charge. Additionally, sheeting which fails this requirement within 3 years shall be replaced on the site at no cost to the using Agency for materials or labor. All finished signs shall be dated with the month and year of delivery in order to ascertain compliance with these lifetime requirements.

716.03.02 BLANK

716.03.03 ALUMINUM SIGN PANELS (FOR REFLECTIVE SHEETING): Sheet aluminum for sign panels shall be of 0.100 inch (2.5 millimeter) aluminum alloy Alclad 5052-H38 or 6061-T6 and shall conform to specifications for ASTM Designation B 209.

Sign panel sections shall be fabricated of standard width aluminum sheets not less than four (4) feet (1.2 meters) wide, except that not more than two (2) sheets for any one sign may be cut not less than eighteen (18) inches (460 millimeters) in width, so as to provide sign widths to nearest six (6) inch (150 millimeters) increments. Panel sections shall run from the top edge to the bottom edge of the sign without horizontal joints.

The aluminum shall be free of all corrosion, white rust, and dirt. All sign dimensions, metal gage, and bolt holes shall conform to the requirements set forth on the plans and in these specifications. Blanks shall be cleaned, degreased and chromated or otherwise properly prepared according to methods recommended by the sheeting manufacturer.

Metal shall not be handled, except by device or clean canvas gloves between all cleaning operations and the applications of the sign background material. There shall be no opportunity for the aluminum to come in contact with greases, oils, or other contaminants prior to the applications of the background material.

All fabrication, including cutting, shall be completed prior to the cleaning process. Metal panels shall be cut to size and shape and shall be free of defects resulting from fabrication. The surface of all sign panels shall be a plane surface.

716.03.04 BLANK

716.03.05 OVERHEAD SIGN STRUCTURES AND SIGN FRAMES: The materials used in the fabrication of overhead sign structures and footings shall conform to the following requirements:

- (1) **Sign frames.** Bars, plates, and shapes shall be structural steel conforming to the specifications of ASTM Designation A 36.
- (2) **Sign pipe posts.** Pipe posts shall be welded or seamless steel pipe conforming to the specifications of ASTM Designation A 53, Grade B. At the option of the Contractor, posts may be fabricated from structural steel conforming to the specifications of ASTM Designation A 36 or of ASTM Designation A 283, Grade D, except that plates more than one inch (25 millimeters) in thickness shall be structural steel conforming to the specifications of ASTM Designation A 373.

- (3) **Sign steel walkway gratings.** Steel walkway gratings shall be furnished and installed in accordance with details shown on the plans and the following provisions:
- (a) Gratings shall be the standard product of an established grating manufacturer.
 - (b) Material for gratings shall be structural steel conforming to the specifications of ASTM Designation A 36.
 - (c) For welded type gratings, each joint shall be full resistance welded under pressure to provide a sound, completely beaded joint.
 - (d) For mechanically locked gratings, the method of fabrication and interlocking of the members shall be approved by the Engineer, and the fabricated grating shall be equal in strength to the welded type.
 - (e) After fabrication, gratings shall be hot-dip galvanized.
 - (f) Gratings shall be free from warps, twists, or other defects affecting their appearance or serviceability. The tops of the bearing bars and cross members shall be in the same plane. Gratings distorted by the galvanizing process shall be straightened.
- (4) **Bolts and Nuts.** Bolts and nuts shall conform to the specifications of ASTM Designation A 307. Bolted connections shall conform to the provisions in Subsection 506.03.10, "Bolts and Bolted Connections."
- (5) Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A 36. Galvanizing shall conform to ASTM Designation A 123. All welding shall conform to the requirements set forth in Subsection 506.03.20, "Welding."
- (6) Anchor bolts, nuts and washers shall be of structural carbon-steel conforming to Section 710, "Structural and Eyebar Steel," and shall be galvanized in accordance with ASTM Designation A 153, or Cadmium plated in accordance with ASTM Designation A 165 Type TS. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least two (2) inches (50 millimeters) into concrete. Anchor bolts shall be of the size, shape and length as shown on the plans.
- (7) All bolts, nuts, clamps and metal washers not otherwise noted shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation A 165, minimum thickness as prescribed for grade Type TS and galvanizing shall conform to the requirements of ASTM Designation A 153.
- (8) Supporting frame shall be manufactured in accordance with the plans and requirements herein specified. All metal parts shall be galvanized after fabrication, in accordance with the provisions of Section 715. When permission is granted by the Engineer to zinc coat a surface by means other than hot-dip

galvanizing, the metalizing process shall be used to place the zinc. Metalizing shall be performed in accordance with the AWS Specifications and the thickness of the sprayed zinc coat shall be at least 5 mils (0.13 millimeters).

- (9) Truss frames shall be fabricated to the largest practical sections prior to galvanizing. Splice locations shall be submitted to the Engineer for approval and the Contractor shall not commence fabrication until such splice locations are approved.
- (10) All welding on the fabrication of the structure shall be done by welders qualified in accordance with AWS requirements using the inert-gas shielded-arc method. Welds shall be free from cracks, blow holes and other irregularities and shall be wire brushed or otherwise cleaned. No field welding on any part of the structural assembly will be permitted.

NOTE: Before fabrication is started, five (5) sets of shop drawings for each overhead sign structure shall be submitted to the Engineer for approval.

716.03.06 SIGN HARDWARE, POST, AND RELATED MATERIALS: Bearing plates and gusset or stiffener plates shall be of the sizes and dimensions shown on the plans and shall be galvanized after fabrication. Steel shall conform to ASTM Designation A 36. Galvanizing shall conform to ASTM Designation A 123. All welding shall conform to the requirements set forth in Subsection 506.03.20, "Welding."

Structural I-beam steel shall be galvanized in accordance with ASTM Designation A 153, or cadmium plated in accordance with ASTM Designation A 165 Type TS.

Anchor bolts, nuts and washers shall be of structural carbon-steel conforming to Section 710. The top portion of anchor bolts shall be galvanized or cadmium plated to such extent that the galvanized or cadmium plated portion will extend at least two (2) inches (50 millimeters) into the concrete. Anchor bolts shall be of the size, shape and length as shown on the plans.

Steel pipe for posts shall conform to the specifications of ASTM Designation A 120 and shall be galvanized. Galvanized steel pipe posts shall be of the diameter and length shown on the plans. The top of the posts shall be fitted with a cover. Posts showing damage shall be repaired or rejected.

Wood posts shall be constructed of Douglas Fir, West Coast Hemlock, or any other equivalent stress rated wood material, at the option of the Contractor. Said wood material shall be construction grade, free of heart center, minimum stress rating of 1200f, and shall be graded in accordance with the provisions contained in Section 718. Sweep shall not exceed 0.08 feet (24.4 millimeters) in 10 feet (3 meters).

Aluminum stiffeners, braces, and stringers used as horizontal supporting structural members shall be of aluminum alloy 6061-T6. These extrusions shall have a continuous inverted "T" slot. This inverted "T" shall accommodate positionable stainless steel clamping devices. These clamping devices shall provide complete freedom of alignment within this slot forming an interlocking clamp system for fastening the sign to the post. The sign support system described herein shall conform to AASHTO Standard Specifications for Highway Signs, Luminaires and Traffic Signals, latest revision, and be rated for minimum wind velocities of 80 mph. All bolts, nuts, clamps and metal washers in contact with this aluminum channel shall be Stainless Steel Type 304. The system shall be compatible with all I-beam, steel post and wood post systems.

All other bolts, nuts, clamps and metal washers in contact with other aluminum components shall be galvanized or cadmium plated. Cadmium plating shall conform to the specifications of ASTM Designation A 165, minimum

Rev. June 12, 1997

thickness as prescribed for grade Type TS and galvanizing shall conform to the requirements of ASTM Designation A 153.

Cantilever arm brackets shall be used when it is desired to offset the entire length of a sign to one side of a post or pole. Cantilever arm brackets shall consist of a stainless steel or aluminum head mounted to an extruded aluminum "TEE" section. This "TEE" section will have a continuous slot that will accept signs up to 1/8" (3.2 millimeters) thick. The heads shall be designed to accept 3/4" (19.1 mm) stainless steel banding. The "TEE"-shaped extrusions shall be made from 6061-T6 aluminum alloy. The cantilever arm brackets shall be used to support the entire length of the sign on both the top and the bottom. The sign shall be attached to the brackets using 1/8" (3.2 mm) rivets spaced according to the hole pattern pre-drilled on the extruded "TEE" section. These cantilever arm brackets shall be compatible with any size and shape of post or pole. This system shall be designed for use on signs up to 72 inches (1.83 meters) in length with a maximum surface area of 9.5 square feet (0.88 square meters). Signs with surface area greater than 2 square feet (0.19 square meters) shall be fastened to round posts or poles using 3/4" X .030 (19.1 mm X 0.76 mm) stainless steel banding. When mounting to square posts or flat surfaces, compatible stainless steel threaded studs or bolts can be used as well as 3/4" X .030 (19.1 mm X 0.76 mm) stainless steel banding. For signs less than 2 square feet (0.19 square meters) in surface area, 5/8" (15.9 mm) banding is acceptable.

INDEX OF SUBJECTS

(Released June 1997)

A

PAGE

Abandoned pipelines	202-1
Abbreviations	101-1
Abutments, backfill for	207-3
Abutting joints:	
Reinforced concrete pipe	603-2
Steel structures	506-7
Acceptance and final payment	105-8, 109-10
Accommodations for public traffic: (Also see maintenance of traffic)	624-1 - 624-3
Construction methods	624-1 - 624-2
Description	624-1
Equipment rental	624-2
Flaggers	624-1
Maintain base	624-2
Materials	624-1
Measurement	624-2
Payment	624-2 - 624-3
Pilot cars	624-2
Special detours	624-1
Work zone traffic control devices	625-1 - 625-2
Additives, fertilizers and	212-8
Adjustment: (Also see delays in completion of work: extension of contract time)	
For additional compensation	105-8 - 105-9
Admixtures:	
Air-entraining	702-1
Concrete curing materials and	702-1
Fly ash	702-2
Lightweight concrete	504-1
Other than air-entraining	702-1
Portland cement concrete	501-1 - 501-2
Advertisement, defined	101-2
Aggregates (Also see sections covering various items of work)	
Aggregate base courses:	
Compaction	302-2
Construction methods	302-1 - 302-2
Description	302-1
Materials	302-1
Measurement	302-2
Payment	302-2 - 302-3
Spreading	302-1

INDEX

	PAGE
Aggregate base courses-- <i>continued</i>	
Subgrade preparation	302-1
Tolerance for finished surface	302-2
Watering	302-2
Aggregates, base:	
Crushed portland cement concrete/asphalt concrete pavement	704-1
Deficiencies	704-1
General requirements	704-1
Grading requirements, tables	704-2 - 704-4
Drain backfill	704-2
Type I	704-2 - 704-3
Type II	704-3
Physical properties and tests	704-2 - 704-4
Plastic limits	704-1
Aggregates, bituminous courses:	
Bituminous pavement aggregate	705-2 - 705-4
Commercial mineral filler (Quicklime, Hydrated lime)	705-3
Deficiencies	705-1
General requirements	705-1
Materials covered	705-1 - 705-4
Physical properties and tests	705-2 - 705-4
Plantmix bituminous open-graded surface	705-3
Plantmix and roadmix bituminous base and surface	
Types 2 and 3	705-2
Sand blotter	705-4
Screenings	705-3 - 705-4
Aggregates, Portland cement products:	
Coarse, requirements for	706-2 - 706-3
Fine, requirements for	706-5 - 706-6
General requirements	706-1
Grout and mortar sand, requirements	706-6
Handling of	106-7
Lightweight, requirements tables	706-4
Lightweight, storage of	504-2
Stone for masonry and riprap	706-7
Aggregates, Portland cement treated base:	
Requirement tables	704-4
Sampling of base courses	106-4 - 106-6
Aggregate spreader, for surface treatment	408-1
Agreement:	
With owner of source materials	106-3
Supplemental	104-1 - 104-2
Air-entraining admixtures:	
Portland cement concrete	702-1
Alterations:	
Contract	104-1 - 104-2
Staging or sequence of operations	104-3

INDEX

PAGE

Altered quantities	104-1 - 104-2, 105-8 - 105-9
Aluminum alloy:	
Barbed wire	724-4
Bolts for signs	716-6 - 716-7
Bridge rail, used in	711-1
Fabrication and handling of	506-3
For pipe	711-1
For shims	711-1
For tubing	711-1
Aluminum sheets:	
Culvert markers and guide posts	721-1
Guardrail construction, reflector plates	720-1
Permanent signs	627-1
Sign panels	716-4
American Association of Nurserymen	101-1
American Association of State Highway Officials	101-1
American Concrete Institute	101-1
American Institute of Architects	101-1
American Institute of Steel Construction	101-1
American Railway Association	101-1
American Railway Engineering Association	101-1
American Society of Civil Engineers	101-1
American Society of Landscape Architects	101-1
American Society of Mechanical Engineers	101-1
American Society for Testing and Materials	101-1, 623-1
American Standards Association	101-1
American Water Works Association	101-1
American Welding Society	101-1
American Wire Gage	101-1, 623-1
American Wood Preservers Institute	101-1
Ammoniacal copper arsenite	615-1
Anchor assemblies:	
Concrete reinforcement	713-2
For downdrains	608-1 - 608-3
Anchor bolts:	
For rail posts	506-12
For signs	716-5, 716-6
Anchorage:	
And distribution plates, prestressed concrete members	495-2 - 495-3
Prestressing reinforcement and, testing	713-1 - 713-2
Angles, end connection	506-7
Anionic emulsified asphalts, specifications table	703-8
Annealing and stress relieving, steel structures	506-10
Annulment of award	103-2
Aprons, concrete	611-1 - 611-3
Archeological and paleontological objects, preservation of	107-7
Artifacts, preservation of	107-7

INDEX

	PAGE
Asbestos cement pipe (irrigation systems):	
Construction methods	213-6
Description	213-1
Materials	213-1
Measurement	213-8
Payment	213-8 - 213-9
Asbestos cement water pipe:	
Alternate lining and coating	629-3
Cast iron fittings for	629-2
Installation of asbestos cement piping	629-13 - 629-14
Materials	629-2
Mortar lining and coating	629-3
Steel fittings for	629-2 - 629-3
Asphalt cement:	
Average weights and volumes tables	109-4
Requirements	703-1 - 703-7
Road materials, specifications table	703-3
Asphalt emulsions:	
Anionic, specifications table for	703-8
Cationic, specifications table for	703-9
Measurement	109-3
For mulch	211-4
Asphalt for waterproofing and dampproofing	646-1
Assembly:	
Field, steel structures	506-12 - 506-13
Metal bin-type retaining walls	660-2
Shop, steel structures	506-6
Structural plate pipe	606-3
Assignees (See subcontractors)	
Assignment of contract	108-1
Associated General Contractors of America	101-1
Association of American Railroads	101-1
Authority and duties of:	
Engineer	105-1
Inspector	105-6
Automatic controllers, irrigation systems	213-2
Average weights and volumes tables:	
Asphalt cement	109-4
Asphaltic emulsion	109-4
Liquid asphalt	109-4
Award:	
Annulment of	103-2
Cancellation of	103-1
Of contract	103-1
Defined	101-2
And execution of contract	103-2
Notice of	103-1

INDEX

PAGE

B

Backfill:

Abutments	207-3
At culverts	207-3 - 207-4
Compaction	207-3 - 207-4
Construction methods	207-2 - 207-4
Crushed Rock	208-2
Defined	207-1
Description	207-1
Drain (See drain backfill)	
With excavated materials	202-1, 202-3, 206-2
Granular	207-1 - 207-2
Of holes	202-1
For irrigation systems	213-8
Materials	207-1 - 207-2
Payment	207-4
Pits	626-1
Placing and compacting:	
Abutments, piers, wingwalls and retaining walls	203-3
Bin-type retaining walls	203-4
Culverts	203-3 - 203-4
Sewer lines	630-9
Sand	208-1
Water for	722-1
Water mains	629-12
Backflow preventers, irrigation systems	213-3
Bar steel reinforcement for concrete	713-1 - 713-2
Barbed wire	616-1 - 616-2, 724-4
Barrel of cement, defined	109-3
Bars:	
Galvanizing of	715-1
High-tensile strength alloy	713-1 - 713-2
Lacing, for steel structures	506-7
Base courses, aggregates used in	106-4, 302-1 - 302-3, 704-2 - 704-4
Base of surface selected material (See selected material)	
Basements left by structure removal, backfill and compaction of	202-1 - 202-3
Bases (See sections for various items of work)	
Basis of payment clause (Also see sections for various items of work)	109-6
Batching plants for:	
Bituminous plantmix pavements	
(See bituminous mixing plant requirements)	401-5 - 401-9
Portland cement concrete pavement	409-4 - 409-7
Bearing devices, concrete structures	502-12 - 502-13
Bearing plates, steel structures:	506-12
Galvanizing of sign bearing plates	716-5

INDEX

	PAGE
Bearing surfaces, steel structures	506-6 - 506-7
Bearing value and penetration of piles	508-3 - 508-4
Bearing and anchorage, steel structures	506-12
Bedding, pipe	208-4 - 208-5
Beginning of work:	506-2
Steel mills	506-2
Bending reinforcing steel	505-2
Bidders:	
Award of contract (Also see award)	103-1
Bonds	103-2
Collusion among	102-4
Defined	101-2
Disqualification of	102-4
Examination of plans	102-2 - 102-3
Financial statement of	102-1
Licensing of	102-1
Material guarantee by	102-5
Notice to contractor	102-1
Preference	103-1
Prequalification of	102-1
Proposal (See proposal)	101-5
Bidding requirements and conditions	102-1 - 102-5
Bids: (Also see bidders; contractor; proposal)	
Irregular	102-3
Rejection of	102-4
Bituminous binders, pay quantities	109-3
Bituminous courses, aggregates for	705-1 - 705-4
Bituminous materials:	703-1 - 703-9
Asphalt cements	703-2 - 703-3
Contractor's responsibility for	703-1
Emulsified asphalt	703-2
Anionic emulsified asphalts	703-8
Cationic asphalt emulsions	703-9
Liquid asphalts	703-2, 703-5 - 703-7
Paving asphalts	703-3 - 703-4
Physical properties and tests	703-1 - 703-9
Polymerized asphalt	703-4
Preparation of	401-11
For prime coat	406-1
Refinery test report	703-1 - 703-2
For seal coat	407-1
Shipping notice	703-1
For surface treatment	408-1
For tack coat	405-1
Waterproofing and dampproofing, asphalt for	646-1
Bituminous mixing plant requirements:	401-5 - 401-9
For batching plants	401-6 - 401-8

INDEX

PAGE

Bituminous mixing plant requirements-- <i>continued</i>	
For dryer drum mixing plants	401-8 - 401-9
For recycling plants	404-1 - 404-5
Safety	401-6
Bituminous mixtures:	
Downdrains	608-2
Hauling equipment for	401-9
Job mix for	401-1 - 401-4
Bituminous open-graded plantmix surface:	
Aggregates for	705-3
Construction methods	403-2 - 403-3
Description	403-1
Joints	403-3
Materials	403-1 - 403-2
Measurements	403-3
Payment	403-3
Rollers	403-2
Surface tolerances	403-3
Weather limitations	401-10
Bituminous pavement:	
Removal of	202-1
Bituminous pavers	401-9 - 401-10
Bituminous plantmix base:	
Aggregates for	705-2
Construction methods	303-1
Description	303-1
Materials	303-1
Measurement	303-1
Payment	303-2
Rollers	303-1
Spreading and finishing	303-1
Surface tolerances	303-1
Weather limitations	401-10
Bituminous plantmix mixtures, composition of	401-1 - 401-4
Bituminous plantmix pavements (See pavements, plantmix bituminous)	
Bituminous plantmix surface:	
Aggregates for	705-1 - 705-4
Construction methods	402-1 - 402-2
Description	402-1
Materials	402-1
Measurement	402-2
Payment	402-2
Rollers	402-1
Spreading and finishing	402-1
Surface tolerances	402-1 - 402-2
Weather limitations	401-10

INDEX

	PAGE
Bituminous recycled aggregate surface:	
Aggregates for	404-2
Bituminous materials	404-2
Construction methods	404-4
Description	404-1
Materials	404-1 - 404-3
Measurement	404-4
Mixing	404-4
Mixing plants	404-4
Payment	404-5
Rollers	404-4
Softening agent	404-2 - 404-3
Spreading and finishing	404-4
Sub-base preparation	404-4
Surface tolerances	404-4
Weather limitations	401-10
Bituminous surface existing (See existing surfaces)	
Blasting for:	
Excavation	203-2 - 203-3
Blotter material (See sand blotter)	
Bolts and bolted connections, steel structures	506-5 - 506-6
High-tensile strength	710-1
Nuts, dowels and drift bolts	723-1
Nuts and washers, galvanizing of	723-1
Guardrail materials	720-1 - 720-2
For signs	716-6 - 716-7
Stainless steel	710-1
Structural plate pipe	606-1 - 606-4
Bolts and washers, timber structures	507-2
Bonded grout finish, concrete structures	502-17
Bonds, contract:	101-5
Guarantee bond	103-2
Labor and material	103-2
Surety	103-2
Borrow:	
Contract agreement for	203-5
Excavation and embankment	203-1 - 203-2, 203-5
Boxes, meter	629-6
Boxes, planter	212-3
Boxes, pull	623-3
Boxes, valve, irrigation systems	213-3
Braces for:	
Fence materials	724-1
Signs	716-5 - 716-6, 716-6 - 716-7
Timber structures	507-3
Brace wire, fence material	724-4

INDEX

PAGE

Bridge:

Defined	101-2
Length, defined	101-2
Railings, paint for	714-1 - 714-3, 714-4
Roadway width, defined	101-2
Bridges, concrete (Also see concrete structures)	
Extensions of existing	202-2
Load and speed restrictions on new	105-7 - 105-8
Placing Portland cement concrete in	502-1
Railing, aluminum for	711-1
Removal of	202-2
Steel (see steel structures)	
Timber (See timber structures)	
Bronze castings	712-1
Bronze disks for monuments	621-1
Brush, removal of	201-1 - 201-2
Buildings, removal and disposal of	202-1
Burning regulations	107-8

C

Calendar day, defined	101-2
Caps, timber structures	507-3
Carbon steel structural tubing	710-1
Cast aluminum alloy	711-1
Cast-in-place concrete piles	508-2, 508-7 - 508-8
Castings:	
Bronze	712-1
Gray iron	712-1
Iron and steel, painting of	614-2
Malleable	712-1
Steel	712-1
Catch basins, manholes and inlets:	
Adjusting of covers	609-2
Clean out	609-2
Construction methods	609-1 - 609-2
Covers, concrete	609-1
Description	609-1
Earthwork	609-2
Grates	609-1 - 609-2
Materials	609-1
Measurement	609-2
Payment	609-2 - 609-3
Pipe used in	609-1
Removal of	202-2
Cattle guards:	
Construction methods	617-1

INDEX

	PAGE
Cattle guards-- <i>continued</i>	
Description	617-1
Earthwork	617-1
Materials	617-1
Measurement	617-2
Paint for cattle guard wings	617-2
Painting	614-2
Payment	617-2
Wings	617-1
Cavities left by structure removal	202-1
Cement measurement	109-3
Cement, Portland	701-1 - 701-2
Cement, protecting and sampling	501-5
Cement treated base:	
Aggregates for	704-4
Compaction	304-3 - 304-4
Construction joints	304-4
Construction methods	304-1 - 304-6
Curing, protection and	304-5
Description	304-1
Finished surface	304-4
Materials	304-1
Mixing:	
Plantmix method	304-2 - 304-3
Roadmix method	304-1 - 304-2
Payment:	
Plantmix method	304-5 - 304-6
Roadmix method	304-5 - 304-6
Proportioning	304-1
Protection and curing	304-5
Requirements, Portland cement	701-2
Spreading	304-3
Time requirements	304-4
Tolerance for	304-4
Watering	304-5
Weathering limitations	304-5
Cement treated subgrade:	
Cement used in	701-1
Certificates:	
Of compliance	106-6, 701-1
Bituminous material	703-2
Cement	701-1
Elastomeric bearing pads	725-1
Epoxy	728-1
Fence materials	725-1
Gray iron castings	701-1
Guardrail materials	720-1

INDEX

PAGE

Certificates—*continued*

Object markers and guide posts	721-1
Paint	714-1
Permanent pavement marking tape	628-1
Pile shells	701-1
Roadside material	726-1 - 726-2
Sign materials	716-1
Steel piles	701-1
Structural steel	506-2
Timber	718-1
Vitrified clay sewer pipe	630-3
Chain-Link fencing:	
Drive gate for	616-3 - 616-4
Fabric	724-4
Change order	101-2, 104-1 - 104-2, 109-7 - 109-9
Changes in character of work	104-1 - 104-2
Channel, defined	101-2
Channel and slope protection (See riprap or wire mesh gabions)	
Channel excavation (See ditch and channel excavation)	
Character of workmen, method and equipment	108-3
Chief engineer (railroad), defined	107-3
Chipping, reaming and cutting	506-13
Cited specifications	106-6
Claims for adjustment and disputes	105-8 - 105-9
Classification and proportions:	
Lightweight concrete	504-2 - 504-3
Portland cement concrete	501-5 - 501-7
Clearance markers, railroad	107-4
Clearing and grubbing:	
Areas to be cleared	201-1
Construction methods	201-1 - 201-2
Disposal locations	201-2
Measurement	201-2 - 201-3
Payment	201-3
Scalping	201-2
Structure excavation material	206-1
Coarse aggregates for Portland cement concrete	501-1, 706-2 - 706-4
Cofferdams, concrete structures	502-5 - 502-6
Seal course of concrete under water	502-9
Structure excavation	206-1
Cold-formed carbon steel structural tubing	710-1
Collusion among bidders	102-4
Columns, concrete structures	502-8 - 502-9
Commencement of work	108-2
Preconstruction conference	108-4
Commercial mineral filler (Quicklime, Hydrated lime)	705-3

INDEX

	PAGE
Compaction: (Also see rollers and rolling)	
Aggregate base courses	302-2
Backfill	206-2 - 206-4
Basements and cavities left by structure removal	202-1
Concrete placed in concrete structures	502-7 - 502-8
Determined by:	
Nuclear method	111-1
Sand cone method	111-1
Dirt embankment	203-8
Embankment	203-8 - 203-9
Erosion control	211-2
Plantmix bituminous pavements, general	401-15
Portland cement concrete pavement	409-9 - 409-10
Portland cement treated base	304-3 - 304-4
Rock embankment	203-8 - 203-9
Selected material	301-1 - 301-2
Topsoil, erosion control	211-2
Trench backfill	208-5 - 208-6
Compactors, excavation and embankment (Also see rollers and rolling)	
Proof roller	203-9
Completion of work:	
Failure to complete on time	108-6
Termination of contractor's liability	108-6 - 108-7
Compliance, certificate of	106-6, 701-1
Concrete:	
Class of	501-6
Classification and proportions	501-5 - 501-7
Compaction of	502-7 - 502-8
Cutoff walls, slope paving	611-1
Deposited under water	502-9
End posts, paint for	714-4
Handling and placing	502-6 - 502-9
Making properties:	
Lightweight concrete	504-1 - 504-2
Portland cement concrete	501-3
Members, prestressed (See prestressed concrete members)	
Mixers	409-5 - 409-7, 501-9 - 501-12
Mixing	409-5 - 409-7, 501-9 - 501-13, 502-6
On-site mixed	501-10
Pavements:	
Portland cement (See pavements, portland cement concrete)	
Removal of	202-1 - 201-2
Piles:	
Cast-in-place	508-2, 508-7 - 508-8
Precast	508-6
Portland cement (See Portland cement concrete)	
Prestressed (See prestressed concrete members)	

INDEX

PAGE

<i>Concrete--continued</i>	
Properties and tests	409-1, 501-3
Ready-mixed	501-10 - 501-12
Reinforcement:	
Materials	713-1
Removal and disposal of	202-1 - 202-4
Sacked concrete for riprap	610-1 - 610-2, 610-7
Concrete curbs, gutters and sidewalks	613-1 - 613-7
Concrete curing material and admixtures:	
Admixtures other than air-entraining	702-1
Air-entraining admixtures	702-1
Fly ash	702-1
Hydrated lime	702-1
Water for	722-1
Concrete slope paving and aprons:	
Construction methods	611-1 - 611-2
Cutoff walls	611-1
Description	611-1
Earthwork	611-1 - 611-2
Expansion joints	611-2
Materials	611-1
Measurement	611-2
Payment	611-2 - 611-3
Concrete structures:	
Aprons (See concrete slope paving and aprons)	611-1 - 611-3
Bearing devices	502-12 - 502-13
Bonded grout finish	502-17
Catch basins (See catch basins, manholes and inlets)	609-1 - 609-3
Cofferdams and cribs	502-5 - 502-6
Compaction by mechanical vibration	502-7 - 502-8
Concrete deposited under water	502-9
Construction joints	502-9 - 502-10
Construction methods	502-1 - 502-18
Culverts (Also see culverts)	502-8
Curbs, gutters and sidewalks (See curbs, gutters and sidewalks)	613-1 - 613-7
Curing	502-13
Depth of footings	502-1
Description	502-1
Elastomeric bearing pads	502-13, 725-1 - 725-2
Expansion and fixed joints and bearings	502-11 - 502-13
Falsework:	
Centering of	502-5
Removal of	502-10 - 502-11
Filled joints	502-11
Fine surfaces	502-16 - 502-17
Finishing	502-13 - 502-17
Formed surfaces required finishing	502-16

INDEX

	PAGE
Concrete structures-- <i>continued</i>	
Form clamps or bolts	502-2 - 503-3
Forms:	502-1 - 502-5
Corrugated metal	502-3
Plywood	502-3
Removal of	502-10 - 501-11
In vicinity of railroads	502-2
Girders, slabs and columns	502-8 - 502-9
Handling and placing concrete	502-6 - 502-9
Horizontal surfaces, finish of	502-13 - 502-16
Joints	502-9 - 502-10, 502-11 - 502-12
Lightweight concrete (See lightweight concrete for structures)	
Live loads	502-17 - 502-18
Load restrictions	502-17 - 502-18
Materials	502-1
Measurement	502-18 - 502-20
Mixing concrete	502-6
Monuments (See monuments)	
Open joints	502-11
Ordinary surface finish	502-16
Patching	502-13
Payment	502-20
Piles	508-6 - 508-8
Placing concrete:	502-6 - 502-9
Culverts	502-8
Girders, slabs and columns	502-8 - 502-9
Pumping water	502-6
Reinforcement	502-5
Removal of falsework, forms and housing	502-10 - 502-11
Slope paving (See concrete slope paving and aprons)	611-1 - 611-3
Steel joints	502-11 - 502-12
Tremie or underwater bottom dump bucket	502-9
Vibrators, provisions for	502-7 - 502-8
Waterstops	502-12
Concrete surface, existing (See existing surfaces)	
Concrete surface finishing material	727-1
Concrete tests, properties and	409-1, 501-3
Concrete use items, paint for	714-4
Conditions of employment, wages and	110-1 - 110-2
Conduit:	
Electrical	623-2
Irrigation systems	212-5 - 212-7, 726-5 - 726-6
Perforated metal pipe for	709-1
PVC coated rigid steel	623-2 - 623-3, 623-9
Conference, preconstruction	108-4
Connection angles, steel structures	506-7

INDEX

PAGE

Construction:

Joints, bituminous pavement	401-16
Joints, cement treated base	304-4
Joints, concrete structures	502-9 - 502-12
Load and speed restrictions	105-7 - 105-8
Maintenance during	105-8
Signs (Also see signs, construction)	625-1 - 625-2
Stakes, lines and grades	105-5 - 105-6
Temporary stop signs	625-2

Contact joints, Portland cement concrete pavement	409-10

Contract:

Alterations	104-1 - 104-2
Assignment of	108-1
Award and execution of	103-1 - 103-2
Bond	103-2
Completion	105-8, 107-8 - 107-9, 108-6 - 108-7
Default and termination of	108-6 - 108-7
Defined	101-2 - 101-3
Execution and approval of	103-2
Failure to execute	103-2 - 103-3
Increased or decreased quantities	104-1 - 104-2
Intent of	104-1
Items, defined	101-3
Modification	105-8 - 105-9
Proposal forms for examination of	102-2 - 102-3
Subletting of	108-1
Termination of	108-7 - 108-8

Time:

Commencement of	108-2
Completion of	105-8
Defined	101-3
Determination and extension of	108-5 - 108-6
Failure to complete work on	108-6

Contracting agency, defined	101-3

Contracting agency furnished materials	106-7

Contractor:

Change in operations	104-3
Conformity of, with plans and specifications	105-1 - 105-2
Cooperation by:	
Between contractors	105-4 - 105-5
With utilities	105-3 - 105-4
Default and termination of contract	108-6 - 108-7
Defined	101-3
Delays in completion of work (See delays)	
Equipment	108-3
Failure to execute work	105-1, 108-6 - 108-7
Faithful performance bond	103-2

INDEX

	PAGE
<i>Contractor—continued</i>	
Financial statement of	102-1
Guarantee bond	103-2
Legal rights, no waiver of	107-10
Licensing of	102-4, 107-1
Limitation of operations	108-2 - 108-3
Material and labor bond	103-2
Methods	108-3
Notice	102-1
Notice to Proceed	101-4
Payments to:	
Acceptance and final	109-10 - 109-11
Extra and force account	109-7 - 109-9
Partial	109-9 - 109-10
Permits, licenses and taxes	108-5
Plans and working drawings of	105-1
Prequalification of	102-1
Prosecution and progress of contract	108-1 - 108-8
Public liability and property damage insurance	107-6
Railroad's insurance	107-5 - 107-6
Relations with railroad	107-3 - 107-5
Relief from maintenance and responsibility	107-8 - 107-9, 108-7
Responsibility for: (Also see legal relations and responsibility)	
Archaeological and paleontological objects, protection of	107-7
Artifacts, preservation of	107-7
Bituminous materials, quality of	703-1
Claims for materials, supplies and labor	107-6 - 107-7
Claims against subcontractor	107-7
Defective work	107-6 - 107-7
Entity furnished material	106-7
Explosives, use of	107-6
Hauling equipment, damage caused by	105-7 - 105-8
Landscape, protection and restoration of	107-7 - 107-8
Materials, supplies and labor	107-6 - 107-7, 107-9
Public convenience and safety	107-2 - 107-3
For sanitary conditions	107-2
Supplies	107-7
Surfaces opened by permit	107-1
During suspension of work	108-4
Termination of	108-7
Utility properties, protection and restoration of	107-1, 107-7, 107-9 - 107-10
Work and materials	107-6 - 107-7, 107-9
Supplemental agreement:	101-7, 104-1
Working drawings	101-7, 105-1
Workmen's compensation	107-6 - 107-7
Control of material	106-1 - 106-7

INDEX

PAGE

Control tubing, irrigation systems:	213-2
Installation of	213-5, 213-7
Materials requirements	213-2, 726-6
PVC	726-6
Control valves	213-3
Control of work	105-1 - 105-9
Conversion tables asphalt from gallons to weight	109-4
Conveyor scales	109-2 - 109-3
Coordination of plans, specifications, supplemental specifications and special provisions	105-2
Copyright	107-1
Corner posts	616-1 - 616-3
Corrugated metal pipe (See culverts)	
Covers, catch basins, manholes and inlets	609-1
Cribs, concrete structures	502-5 - 502-6
Culvert, defined	101-3
Culvert pipes (See culverts)	
Culverts:	
Asbestos cement pipe	635-1 - 635-3
Backfill	207-3 - 207-4
Clay pipe for	708-2
Closing of	202-2
Concrete and clay pipe and drains for	708-2
Concrete structures	502-8
Corrugated metal pipe and metal arch pipe:	
Construction methods	604-1 - 604-3
Description	604-1
Elliptical pipe	709-1
For downdrains	709-2
Laying culvert pipe	604-1
Materials	604-1
Measurement	604-3
Payment	604-3 - 604-4
Relay culvert pipes	604-3
Siphons	604-2
Slot pipe	604-2 - 604-3
For underdrains	709-2 - 709-3
Extensions of existing culverts:	202-2, 601-2 - 601-3
Removal of	202-2
Structural plate pipe and pipe arch culverts	606-4
Fiber-bonded bituminous coated pipe for	709-2
Laying culvert pipes:	601-2
Corrugated metal pipe and metal arch pipe	604-1
Reinforced concrete	603-2 - 603-3
Thermoplastic pipe	605-1
Non-reinforced concrete pipe for (Also see pipes)	602-1 - 602-2
Pipe culverts - general:	
Construction methods	601-1 - 601-3

INDEX

	PAGE
<i>Culverts--continued</i>	
Description	601-1
Earthwork	601-1 - 601-2
End sections	601-2
Extension of existing culverts	601-2 - 601-3
General requirements	601-1
Headwalls	601-2
Inspection of materials	601-1
Jacked pipes	601-2
Laying pipe	601-2
Materials	601-1
Measurement	601-3
Payment	601-3 - 601-4
Water encountered on site	601-4
Reinforced concrete pipe for (Also see pipes)	603-1 - 603-4
Relay culvert pipes	604-3
Removal of	202-1 - 202-2
Structural plate pipe and pipe arch culverts:	
Assembly	606-3
Bolts	606-1
Construction methods	606-2 - 606-4
Description	606-1
Earthwork	606-2 - 606-3
Extension of existing	606-4
Field inspection	606-2
Headwalls	606-4
Materials	606-1
Measurement	606-4
Payment	606-4 - 606-5
Plates	606-2
Quality requirements	709-5
Salvaged, reinstallation of	606-1
Strutting	606-3
Water encountered at site	606-5
Workmanship	606-3 - 606-4
Thermoplastic Pipe:	
Deflection Testing	605-2
Junctions	605-2
Measurement	605-2
Payment	605-2
Curbs, gutters, and sidewalks:	
Construction methods	613-1 - 613-6
Curb and gutter joints	613-4 - 613-5
Description	613-1
Earthwork	613-1
Forms	613-1 - 613-3
Materials	613-1

INDEX

PAGE

Curbs, gutters and sidewalks—*continued*

Measurement	613-6 - 613-7
Payment	613-7
Removal of	202-2
Sidewalk construction	613-5 - 613-6
Sidewalk expansion joints	613-4
Slip forms	613-2 - 613-3
Curing:	
Cement concrete, water for	722-1
Cement treated base	304-5
Formed concrete	501-14
Lime stabilized subgrade	306-4
Liquid asphalt materials	703-2
Materials and admixtures, concrete	702-1 - 702-2
Curing Portland cement concrete:	
Compound method	501-13 - 501-14
Form method	501-14
Pavement	409-11
Under water	502-9
Water method	501-13
Waterproof paper method	501-14
Curing prestressed concrete members	503-4 - 503-5
Cut-out letters, numerals, symbols and accessories:	
Permanent signs	627-2
Cuts, widening:	203-3
Measurement and payment for	203-12

D

Damage claims, contractor's responsibility for	107-6 - 107-7
Damages, liquidated	103-2 - 103-3, 108-6
Damage to work, contractor's responsibility for	107-9
Dampproofing	646-2
Day, calendar, defined	101-2
Decreased quantities, increased or	104-1 - 104-2
Default and termination of contract	108-6 - 108-7
Defective materials, contractor's responsibility for	107-9
Defective work, contractor's responsibility for	107-9
Definition and terms	101-1 - 101-8
Deflection Testing:	
Thermoplastic Pipe	605-2
Delays in completion of work:	
Due to cooperation with utilities	105-4
Due to preservation of artifacts and archeological and paleontological objects	107-7
Due to restoration of surfaces opened by permit	107-1
Due to weather	108-4
Right-of-way	108-7

INDEX

	PAGE
Detector loop sealant	623-26 - 623-28
Determination and extension of contract time	108-5 - 108-6
Detour, defined	101-3
Detour, special	624-1
Detours, arrangements for	104-3, 108-2 - 108-3, 625-1 - 625-2
Dewatering, structure excavation	206-1 - 206-2
Dirt embankment, compaction of	203-8
Disposal of materials: (Also see removal)	
Clearing and grubbing	201-1 - 201-2
Excavated	202-3
Non-perishable	202-1, 202-3
Outside highway right-of-way	107-8
Structure excavation materials	206-1 - 206-2
Structures	202-3
Disqualification of bidders	102-4 - 102-5
Distribution plates or assemblies, anchorage and	495-2 - 495-3
Testing prestressing anchorages	713-2
Distributors for bituminous materials	405-1
Ditch and channel excavation	203-1
Ditch and dike	203-1
Ditch and dike areas, roads in	107-8
Divided highway, defined	101-3
Downdrains:	
Anchor assembly	608-1
Bituminous mixtures and grouted riprap	608-2
Construction methods	608-1 - 608-2
Corrugated metal pipes for	608-1, 709-2
Description	608-1
Embankment protectors	608-1
Materials	608-1
Measurement	608-2
Metal	608-1
Payment	608-2 - 608-3
Riprap	608-2
Drain backfill:	
Aggregates for	704-2
Construction methods	209-1
Measurement	209-1
Payment	209-1 - 209-2
Around underdrains	209-1
Drain valves, irrigation systems	213-3 - 213-4
Drainage:	
Downdrains	608-1 - 608-3
Excavation	203-1
During roadway construction	203-4
Structures, metal pipe for	709-1 - 709-3, 709-5
Structures, removal of	202-1 - 202-4

INDEX

PAGE

Drains, concrete and clay pipe for	708-1 - 708-2
Metal pipe for	709-1 - 709-3, 709-5
Drawings, working:	101-7
Concrete form	502-1
Plan and	105-1
Signals and lighting	623-1 - 623-2
Steel structures	506-1 - 506-2
Driving of piles:	508-2 - 508-3
Bearing value and penetration	508-3 - 508-4
Equipment	508-2
Dust, control by watering	210-1
Nuisance	107-11
Dust palliative (See pollution control)	637-1 - 637-3

E

Earthwork:

Catch basins, manholes and inlets	609-2
Cattle guards	617-1
Concrete curbs, gutters and sidewalks	613-1
Concrete slope paving	611-1 - 611-2
Pipe culverts - general	601-1 - 601-2
Reinforced concrete pipe	603-1 - 603-2
Riprap and wire mesh gabions	610-6
Structural plate pipe	606-2 - 606-3
Underdrains	607-1 - 607-2
Edge planing, steel plates	506-6
Elastomeric bearing pads:	502-13, 506-12
Certificate of inspection	725-1
Material requirements	725-1
Physical properties and tests	725-1 - 725-2
Electronic Industries Association	101-1, 623-1
Eliminated items from contract	109-9
Elliptical:	
Concrete pipe, reinforced	603-1, 603-3
Embankment: (Also see excavation and embankment)	
Construction with excavated materials	202-2
Compaction:	
Construction methods	203-8 - 203-9
Dirt embankment	203-8
Equipment	203-8 - 203-9
Rock embankment	203-8 - 203-9
Testing by proof rolling	203-9
Testing for	111-1
Dirt, compaction for	203-8
Foundation for	203-5 - 203-6
Layer Thickness	203-6 - 203-8

INDEX

	PAGE
<i>Embankment--continued</i>	
Maintenance	203-9 - 203-10
Material	203-1 - 203-2
Pipe installation in new	601-1 - 601-2
Placing	203-6 - 203-8
Protectors, downdrains	608-1 - 608-3
Rock, compaction of	203-8 - 203-9
Against structures	207-3 - 207-4
Water for wetting of	722-1
Emergency vehicle priority control system:	
Matched system components	623-43
Optical detector	623-43, 623-44
Optical detector cable	623-43, 623-44
Optical emitter	623-43, 623-44
Priority control unit	623-43 - 623-44, 623-45
Reliability	623-45
System description	623-42
System component specification	623-44
System operations	623-43 - 623-44
Employee, defined (Also see workmen)	101-3
Employment, wages and conditions of	110-1 - 110-2
Emulsions, asphaltic:	703-2
Anionic specifications table	703-8
Average weights and volumes table	109-4
Cationic specifications table	703-9
Tack coat	405-1
Used in mulch	211-2
Enclosures for prestressing steel	503-1
End:	
Connection angles, steel structures	506-7
Corner and gate posts	616-3
Posts, concrete, paint for	714-4
Sections concrete pipe culverts	603-1
Sections, pipe culverts	601-2, 709-1, 709-4
Stiffeners, steel girders	506-10
Engineer:	
Authority of	105-1
Decisions of	105-1
Defined	101-3
Inspection by	105-6
Epoxy:	728-1 - 728-5
Binder (adhesive)	728-2, 728-4
Certificates	728-1
Directions for use	728-2
For bonding old concrete to new concrete	728-3
For inductive loops	728-5
Materials	728-1

INDEX

PAGE

Epoxy-- <i>continued</i>	
Packaging labeling and storage	728-1
Sampling and testing	728-1
Equipment: (Also see compactors, rollers, truck mixers, vibrators)	
Bituminous mixing plants	401-5 - 401-10
Concrete vibrators	502-7 - 502-8
Defined	101-4
Excavation and embankment	203-8 - 203-9
Equipment hours	104-3
Methods and	108-3
Pile driving	508-2 - 508-3
Portland cement concrete construction	501-3, 501-9 - 501-12
Recycle bituminous mixing plant	404-4
Rental	109-4, 624-2
Erection methods, steel structures	506-12 - 506-13
Erosion control: (Also see roadside materials)	
Compaction of top soil	211-2
Construction methods	211-2 - 211-5
Contractor's responsibility	107-8
Cultivation	211-2
Description	211-1
Dust palliative	637-2
Fertilizer	211-1
Firming	211-2
Jute matting	211-4 - 211-5
Materials	211-1 - 211-2, 726-1
Measurement	211-5
Mulch	211-1 - 211-2
Payment	211-5
Planting soil	211-1
Seed	211-1
Seeding and fertilizing	211-3
Excavation and backfilling of removed structures	203-1 - 203-3
Excavation and embankment:	203-1 - 203-12
Blasting	203-2 - 203-3
Borrow	203-1 - 203-2
Channel	203-1
Construction methods	203-2 - 203-10
Description	203-1
Drainage during construction of roadway	203-4
Drainage excavation materials	203-1
Maintenance	203-9 - 203-10
Measurement	203-10 - 203-12
Overbreak	203-3
Payment	203-12
Placing embankment	203-6 - 203-8
Roadway excavation	203-1

INDEX

	PAGE
Excavation and embankment-- <i>continued</i>	
Rock cuts	203-3
Rock materials	203-7
Selected material	203-4
Slides and slipouts	203-4
Slopes	203-3
Surplus material	203-3, 203-11
Tolerances, grading	203-1
Unsuitable material:	203-2
Removal of	203-2, 203-10
Widening Cuts	203-11
Excavation, structure	206-1 - 206-2
Excavation, adjacent to trees	213-5
Excavation and backfill, trench	208-1 - 208-8
Execution of contract, award and	103-1 - 103-3
Expansion and fixed joints and bearings	502-11 - 502-13
Expansion joints, sidewalk	613-4
Explosives, use of	107-6, 203-2 - 203-3
Extension:	
Of contract time:	107-7, 108-5 - 108-6, 108-7 - 108-8
Of existing culverts and bridges	202-2
Of structural plate pipe and pipe arch	606-4
Extra and force account work:	109-7 - 109-9
Equipment rental rates for	109-8
Idle time of equipment	109-5
Extra work:	
Defined	101-4
Eyebar steel	710-1 - 710-2
F	
Fabricated steel bar reinforcement	713-1
Facilities, utility (See utility property and services)	
Facing of bearing surfaces, steel structures	506-6 - 506-7
Failure:	
To carry on work in acceptable manner	108-6
To complete work on time	108-6
To execute contract	103-2 - 103-3
To maintain roadway or structure	105-8
Falsework, concrete structures	502-5
Drawings	502-5
Removal of	502-10 - 502-11
Falsework, steel structures	506-12
Fastenings, (hardware) galvanizing of	715-1
Fence materials	724-1 - 724-5
Fences:	
Partial payments on	109-9 - 109-10

INDEX

PAGE

Fences--continued

Removal and disposal of	202-1
Fencing: (Also see fence materials)	
Barbed wire and farm	616-1 - 616-2
Chain link	616-3
Construction methods	616-1 - 616-4
Corners	616-2
Description	616-1
Existing connections with new	616-1
Gates	616-3 - 616-4
Lines posts	616-2 - 616-3
Materials	616-1
Measurements	616-4
Metal posts	616-1 - 616-3
Partial payments on	109-9 - 109-10
Payment	616-4
Posts, wood	616-1 - 616-3
Quality requirements	724-1 - 724-5
Reconstructed	616-3
Standard	616-2
Wire, barbed and woven	616-2, 724-4
Fertilizers and additives, landscaping:	212-8
Commercial	211-1, 726-1, 726-2
Fertilizing, seeding and	211-3
Field assembling and riveting, steel structures	506-12 - 506-13
Field inspection, structural plate pipe	606-2
Field painting, steel structures	614-2 - 614-5
Filled joints, concrete structures	502-11
Fillers, commercial mineral (Quicklime, Hydrated lime)	705-3
Fillers, joint	707-1 - 707-3
Filter material:	610-3
Filter placement	610-6
Filter fabric	610-3
Final acceptance:	105-8
Cleanup	626-1
Inspection	105-8
Payment	109-10 - 109-11
Financial statement of bidders	102-1
Fine aggregates:	
For grout and mortar sand	706-6
Portland cement concrete	501-1, 501-7 - 501-9
Portland cement products	706-5 - 706-6
Finished surface, Portland cement treated base	304-4
Finishing:	
Aggregate base courses	302-1 - 302-2
Bearing and base plates	506-6 - 506-7
Bridge decks	502-14 - 502-16

INDEX

	PAGE
<i>Finishing--continued</i>	
Concrete structures:	502-13 - 502-17
Bonded grout surface	502-17
Fine surface	502-16 - 502-17
Formed surface	502-16
Horizontal surface	502-13 - 502-16
Ordinary surface	502-16
Lime stabilized subgrade	306-3 - 306-4
Plantmix bituminous base	303-1
Plantmix bituminous pavements - general	401-14 - 401-15
Plantmix bituminous surface	402-1
Portland cement treated base	304-4
Portland cement concrete pavements	409-9 - 409-10
Roadway excavation and embankment	203-1
<i>Fire:</i>	
Hydrants	107-10, 629-15
Prevention and control	107-8
Fittings, guardrail materials	720-1
Fixed joints and bearings, expansion and; concrete structures	502-11 - 502-13
Flagging protection, railroad	107-3
Flaggers	624-1
Flame cutting, steel or wrought iron	506-7
Flowable backfill	208-1 - 208-2, 208-6
Flume downdrains	608-1 - 608-3
Flushing and testing, irrigation systems	213-7
Fly Ash	702-2, 729-1
Footings, depth of, concrete structures	502-1
<i>Force account work: (Also see extra and force account work)</i>	
Claims for adjustment and disputes	105-8 - 105-9
Forfeiture of proposal guarantee	103-2
Forged steel products, galvanizing of	715-1
Form clamps or bolts, concrete structures	502-2 - 502-3
Formed concrete, curing of, concrete structures	501-14
<i>Forms:</i>	
Concrete structures	502-1 - 502-5
Corrugated metal	502-3
Curbs and gutters	613-1 - 613-3
Portland cement concrete pavement	409-7 - 409-8
Prestressed concrete members	503-1 - 503-2
Removal of	502-10 - 502-11
Over or in vicinity of railroads	502-2
Setting, concrete pavement	409-7 - 409-8
Slip	613-2 - 613-3
<i>Foundation:</i>	
Embankment	203-5 - 203-6
Watering of for embankment areas	203-8
Foundations, removal and disposal of	202-1

INDEX

	PAGE
Frames and grates, painting of	614-5
Frontage road or frontage street, defined	101-4

G

Gabions (See wire mesh gabions)	
Gage	109-1
Galvanized guardrail	715-1
Galvanizing:	
Hardware	715-1, 723-1
Materials	715-1
Products 1/8" and thicker	715-1
Rail elements	715-1
T-Section	724-4
Gaskets, rubber	707-1
Gates:	
Drive	724-4 - 724-5
Fencing	616-3 - 616-4, 724-4 - 724-5
Metal	724-4 - 724-5
Posts	724-3
Valves:	
Irrigation systems	213-2 - 213-4
Walk	724-5
Wire mesh	724-4
Gage, meaning of	109-1
Girders, slabs and columns:	
Concrete structures	502-8 - 502-9
Precast prestressed concrete	503-1 - 503-8
Grade separation, defined	107-3
Grades and lines, construction stakes	105-5 - 105-6
Grading operations:	
Roadway (See excavation and embankment)	203-1
Watering of, for dust control	210-1 - 210-2
Grading requirement tables:	
Base aggregates	704-2 - 704-4
Bituminous aggregates	705-2 - 705-4
Drain backfill	704-2
Granular backfill	207-1 - 207-2
Mortar sand	706-6
Portland cement aggregates	706-1 - 706-7
Sand blotter	705-4
Granular backfill	207-1 - 207-2
Grates, frames and, painting of	614-5
Gravel (See aggregates, base and surface)	702-1 - 706-7
Gray iron castings	712-1
Grout:	
Aggregate, requirements for	706-6

INDEX

	PAGE
Grout— <i>continued</i>	
Finish, concrete structures	502-17
Riprap	610-1
Grouted riprap downdrains	608-2
Grubbing, clearing and (Also see clearing and grubbing)	201-1 - 201-2
Guardrail materials:	720-1 - 720-2
Fittings	720-1
Paint	618-3 - 618-4
Posts	720-1
Rail members	720-1
Reflector plates	720-1
Guardrail:	
Construction methods	618-2 - 618-4
Description	618-1
Galvanized	715-1
Material requirements	720-1
Materials	618-1 - 618-2
Measurement	618-4
Painting	618-3 - 618-4
Payment	618-5
Posts	718-1
Reconstructed	618-4
Reflectors	618-1 - 618-2
Removal and disposal of:	202-1 - 202-4
For reuse	202-2
Guide posts, object markers and (Also see object markers and guideposts)	619-1 - 619-2
Gutter construction, curb and (Also see curbs, gutters and sidewalks)	613-1 - 613-6
Guying, staking and, landscaping	212-6

H

Handling materials	106-7
Hardware:	
Bolts, nuts, dowels, and drift bolts	723-1
Galvanizing of	723-1
Materials covered	723-1
For steel structures	506-5 - 506-6
For timber structures	507-2
Washers	723-1
Hauling equipment:	
For bituminous mixtures	401-9
Contractor's responsibility for damage caused by	105-7 - 105-8
Renting of	109-8
Hay or stray mulch materials	726-3
Headlight glare screen:	
Construction methods	632-4
Description	632-1

INDEX

PAGE

Headlight glare screen—*continued*

Materials	632-1 - 632-3
Measurement	632-4
Payment	632-4

Headwalls:

Pipe culvert	601-2
Placing concrete in	502-1
Structural plate pipe	606-4

High density polyethylene pipe, specifications for	709-3 - 709-5

High strength steel	710-1

High-tensile strength:

Alloy bars	713-1
Bolts	710-1
Seven-wire strand	713-1

Highway:

Defined	101-4
Opened by permit, restoration of	107-1
Signs (see signs)	

Holes:

For bolts, dowels, rods and lag screws, timber structures	507-2
Pin holes	506-11
Planting	212-4
Rivet	506-4
Subpunching of rivet	506-5

Holidays:

Defined	101-4
Limitation of operations on	108-2 - 108-3

Hose bibs, irrigation systems	213-4

Housing, removal of, concrete structures	502-10 - 502-11

Humus	726-1 - 726-3

Hydrated lime (See Lime)

I

Increased or decreased quantities and change in character of work	104-1 - 104-2, 105-8 - 105-9

Indirect tensile strength, plantmix bituminous pavement	401-2 - 401-3

Information available to bidders	102-1

Injury:

To persons, compensation for	107-6 - 107-7
To work, contractor's responsibility for	107-9

Inlets, catch basins, manholes and:	609-1 - 609-3

Removal of	202-2

Inspection:

By engineer	105-6
Final	105-8
Of materials	105-6
Pipe culverts	601-1

INDEX

	PAGE
<i>Inspection—continued</i>	
Plant	106-6
Of plant material, landscaping	212-2
Of prestressed beams	503-1
Of stored materials	106-7
Structural plate pipe	606-2
Structural steel	506-2 - 506-3
Timber	615-2, 718-1
Timber piles and piling	717-1
Of work:	
By utility corporations	105-6
Inspector, authority and duties of:	105-6
Defined	101-4
Installation:	
Irrigation systems	213-5 - 213-7
Of permanent signs	627-2 - 627-3
Of construction signs	625-1 - 625-2
Of temporary stop signs	625-2
Institute of Electrical and Electronics Engineers	101-1
Interpretation of plans and specifications by engineer	105-1
Iron:	
Gray iron castings	712-1
And steel use items, paint for	714-1 - 714-3
Wrought iron plates	712-1
Irregular, proposal	102-3
Irrigation systems:	
Adjusting	213-7 - 213-8
Automatic controllers	213-2
Backfill	213-8
Backflow preventers	213-3
Conduit	726-5 - 726-6
Construction methods	213-4 - 213-8
Control tubing:	
Installation of	213-5, 213-7
PVC	726-6
Control valves	213-3
Description	213-1
Drain valves	213-3 - 213-4
Excavation for:	213-5
Adjacent to trees	213-5
Flushing and testing	213-7
Gate valves	213-2
Hose bibs	213-4
Installation	213-5 - 213-7
Jointing	213-5
Materials	213-1 - 213-4
Measurement	213-8

INDEX

PAGE

Irrigation systems—*continued*

Payment	213-8 - 213-9
Pipe and fittings	213-1
Piping	213-5, 726-5 - 726-6
Quick-coupler valves	213-3
Sprinkler connections	213-6
Sprinkler heads	213-2
Testing, flushing and	213-7
Timber for minor irrigation structures	615-2
Vacuum breakers	213-4
Valve boxes	213-3
Watering	212-6 - 212-7

J

Jacked pipes, pipe culverts	601-2
Job mix formula for:	
Bituminous pavement	401-1 - 401-4
Portland cement concrete	501-7
Joint material	707-1 - 707-3
Jointing, irrigation systems	213-5
Joints:	
Concrete structures	502-9 - 502-10, 502-11 - 501-12
Corrugated metal pipe	604-1 - 604-3
Curbs, gutters and sidewalks	613-4 - 613-5
Mortar	603-2 - 603-3
Plantmix bituminous open-graded surface	403-3
Plantmix bituminous pavements	401-16
Portland cement concrete pavement	409-10 - 409-11
Portland cement treated base	304-4
Reinforced concrete pipe	603-2 - 603-3
Rubber gasketed	603-3
Steel structures	506-7
Jute matting:	
Material requirements	726-4
Placing of	211-4 - 211-5

L

Labor:	
And material bond	103-2
Requirements for employment for	110-1
Laboratory, defined	101-4
Lacing bars steel structures	506-7

INDEX

	PAGE
Landscaping: (Also see roadside materials)	
Construction methods	212-3 - 212-8
Description	212-1
Existing facilities	212-8
Fertilizers and additives	212-8
Handling and shipping	212-2
Inspection of plant material	212-2
Lumber	212-3
Materials	212-1 - 212-3
Measurement	212-9
Mulch, use of	212-3
Nomenclature	212-1
Payment	212-9 - 212-10
Planter boxes	212-3
Plant establishment work	212-8
Planting:	
Areas, preparation of	212-3 - 212-4
Beds	212-4
Holes	212-4
Layout of	212-3
Trenches	212-4
Plant materials, quality of	212-1 - 212-2, 726-1 - 726-2, 726-4
Pruning	212-6
Replacements	212-7 - 212-8
Staking and guying	212-6
Storage, temporary	212-3
Substitution of plants	212-2
Water for	722-1
Watering	212-6 - 212-7
Las Vegas Area Traffic System	623-36 - 623-41
Maintaining Interconnect Cable Requirements	623-5 - 623-7
Latex base paint	714-3 - 714-4
Laws to be observed: (Also see legal relations and responsibility)	
On wages and conditions of employment	110-1 - 110-2
Laying pipes:	
Culvert	603-2 - 603-3, 604-1
Corrugated metal and metal arch	604-1
Reinforced concrete	603-2 - 603-3
Sewer	630-10
Thermoplastic	605-1
Underdrains	607-2
Water	629-13 - 629-14
Legal relations and responsibility:	107-1 - 107-11
Dust control	107-11
Explosives, use of	107-6
Laws to be observed	107-1
Legal rights, no waiver of	107-10

INDEX

PAGE

Legal relations and responsibility--*continued*

Liability insurance	107-5 - 107-6
Liability for subcontractor	107-7
Materials, supplies and labor	107-6 - 107-7
Patents or copyright	107-1
Permits, licenses and taxes	107-1
Personal liability of public officials	107-6, 107-10
Property and landscape, protection and restoration of	107-7 - 107-8
Public convenience and safety	107-2 - 107-3
Railroads, relations with	107-3 - 107-5
Relief from maintenance and responsibility	107-8 - 107-9
Restoration of surfaces opened by permit	107-1
Sanitary provisions	107-2
Termination of contractor's responsibility	108-7
Utility properties	107-1, 107-7, 107-9 - 107-10
Workmen's Compensation Act	107-6 - 107-7
Length of bridge structure, defined	101-2
Liability insurance	107-5 - 107-6
Licenses, permits and taxes	107-1
Lighting (See signals and lighting)	623-46 - 623-54
Lightweight aggregates	706-4 - 706-5
Lightweight concrete for structure:	504-1 - 504-6
Admixtures	504-1
Aggregates, storage of	504-2
Classification and proportions	504-2 - 504-3
Concrete making properties	504-1 - 504-2
Construction methods	504-2 - 504-4
Description	504-1
Materials	504-1 - 504-2
Measurement	504-5 - 504-6
Mixing	504-3 - 504-4
Payment	504-6
Requirements and test methods for	504-1 - 504-2
Lime:	
For bituminous course aggregate purposes	705-3
For lime stabilized subgrade purposes	306-1 - 306-2
For masonry purposes	702-1
Lime stabilized subgrade:	306-1 - 306-5
Compaction	306-3 - 306-4
Description	306-1
Finishing and curing	306-4
Hydrated lime slurry sulfate chart (mellowing time)	306-1
Lime	306-1
Lime application	306-2
Measurement	306-4
Mixing	306-3
Payment	306-4 - 306-5

INDEX

	PAGE
Lime stabilized subgrade-- <i>continued</i>	
Proportioning	306-2
Subgrade material	306-1
Subgrade preparation	306-2
Water	306-2
Limitation of operations	108-2 - 108-3
Line posts:	616-2 - 616-3, 724-1
Certificates	724-1
Lines and grades, construction stakes	105-5 - 105-6
Liquid asphalts:	
Average weights and volumes table	109-4
Specifications for	703-2, 703-5 - 703-7
Temperature table	401-4
Live loads, concrete structures	502-17 - 502-18
Load:	
Restrictions on concrete structures	502-17 - 502-18
And speed restrictions	105-7 - 105-8
Testing, piling	508-5
Local materials:	
Arrangements with owners	106-2
Documents evidencing arrangements with property owners	106-3
Found in vicinity of work:	106-1
On work	104-3
Investigation of, by bidders or contractor	106-3
Owned by U.S. Government	106-3
Partial payments on	109-9 - 109-10
Possible sources	106-2 - 106-4
Samples and tests	106-4 - 106-6
Loose measurement	109-3
Lumber:	
For landscaping	212-3
Preservation treatments for	615-1 - 615-2
Quality requirements for	718-1 - 718-2

M

Maintain base:	624-2
Special detours and	624-1
Maintenance:	
During construction	105-8
Of embankment material	203-9 - 203-10
Of exiting and temporary electrical systems	625-4 - 625-5
Relief from	107-8 - 107-9
Of roadway or structure, failure to maintain	105-8
Of traffic: (Also see accommodations for traffic)	
During construction	104-2 - 104-3
During removal of structures	202-1

INDEX

PAGE

Maintenance--*continued*

During surface treatment	408-2
During suspension of work	104-2 - 104-3, 108-4
Major contract item, defined	101-4
Malleable castings	712-1
Manholes, inlets, catch basins, and	609-1 - 609-3
Removal of	202-1 - 202-2
Manual On Uniform Traffic Control Devices For Streets And Highways	101-1
Manufacturer's warranties or guaranties	106-1
Marker posts, metal	721-1
Markers:	
Culvert (See object markers and guide posts)	619-1 - 619-2
Metal posts	721-1
Object	619-1 - 619-2
Right-of-way (Also see right-of-way markers)	620-1
Timber, quality requirements	718-1 - 718-2
Marking and shipping, structural steel members	506-11
Masonry:	
Blocks, roadside materials	726-6
Removal and disposal of	202-1 - 202-3
Stone for	706-7
Materials:	
Accompanied by certificate of compliance	106-6
Contractor's responsibility of	107-9
Control of	106-1 - 106-7
Damaged	107-9
Defined	101-4
Details	701-1
Entity furnished	106-7
Excavated	202-3, 203-3 - 203-4
Found on work (See local materials)	
Guarantee on	102-5
Handling of	106-7
Inspections:	
Plant	106-6
Records of	106-1
Local (See local materials)	
Measurement of (See various sections covering items of work)	
Non-perishable, disposal of	202-1, 202-3
Outside highway right-of-way, disposal of	107-8
Rights in and use of materials found on the work	104-3
Roadside production of	108-1
Salvage of excavated	202-2 - 202-3
Samples and tests	106-4 - 106-6
Storage of	106-7, 107-3, 107-9, 212-3
Surplus, excavated	203-3
Unacceptable	106-7

INDEX

	PAGE
<i>Materials—continued</i>	
Unusable, perishable, disposal of	201-2
Matting jute; erosion control	211-4 - 211-5
Measured in the vehicle	109-3
Measurement and payment: (Also see section for various items of work)	
Bituminous tables, weights and volumes	109-4
Eliminated items	109-9
Extra and force account work	109-7 - 109-9
Partial payment	109-9 - 109-10
Quantities, measurement of	109-1 - 109-6
Scope of payment	109-6 - 109-7
Median, defined	101-4
Mesh, wire, fence materials:	724-4
Wire, reinforcing	713-1
Metal bin-type retaining walls (Also see retaining walls, metal bin-type)	660-1 - 660-2
Metal pipe and thermoplastic pipe:	709-1 - 709-5
Physical properties and tests	709-1 - 709-5
Scope	709-1
Metal posts:	
And braces	724-2 - 724-4
For chain link fence	616-3
For object markers and guide posts	721-1
For fence materials	724-2 - 724-4
Marker	721-1
Tubular	724-2
Metal, miscellaneous	712-1
Methods and equipment: (Also see equipment)	108-3
Substitute	108-3
Mineral aggregates:	
For base courses	704-2 - 704-4
Base and surfacing materials, watering	210-1 - 210-2
For bituminous courses	705-2 - 705-4
For Portland cement products	706-1 - 706-7
Mineral filler, commercial:	
For plantmix bituminous pavements	401-2 - 401-4, 401-12 - 401-14
Quicklime and hydrated lime	705-3
Miscellaneous:	
Aluminum, paint for	714-4
Concrete items, paint for	714-4
Iron, paint for	714-1 - 714-3
Metals	714-1 - 714-3, 714-4
Timber structures, paint for	507-4
Misfits, steel structures	506-13
Mixing methods for:	
Bituminous mixtures	401-5 - 401-9, 401-14, 404-4
Concrete pavement	409-2 - 409-7
Concrete structures	501-9 - 501-13, 502-6

INDEX

PAGE

Mixing methods for--*continued*

Lightweight concrete	504-3
Planmix bituminous pavement	401-5 - 401-9, 401-14
Portland cement treated base	304-1 - 304-3
Recycled bituminous pavement	404-4

Monuments:

Installation	621-1
Materials	621-1
Protection of by contractor	107-7

Mortar:

Aggregate requirements for	706-6
Bands of, for non-reinforced concrete and clay pipe	602-1
Class and proportion	501-16 - 501-17
Joint, for reinforced concrete pipe	603-2 - 603-3
Cement used in	701-1

Mulch:

Application of asphalt emulsion	211-4
Asphalt emulsion used in	211-2
Blowers	211-4
For erosion control	211-1 - 211-2
Hay or straw	211-1
For landscaping	212-3
Organic material	726-2 - 726-3
Quality requirements	726-3
Spreading	211-4
Wood cellulose fiber	726-3
Wood chips and shavings	726-3

N

Nails, fence materials	724-4
National Electric Code	623-1
National Electrical Safety Code	623-1
National Electrical Manufacturers Association	623-1
Neoprene, for elastomeric bearing pads	725-1 - 725-2
Nomenclature for plant names; landscaping	212-1
Non-perishable material, disposal of	202-1, 202-3
Notice to contractors:	102-1
Defined	101-4
Notice to proceed:	108-2
Defined	101-4
Nuisance, dust	107-11, 637-1 - 637-3
Nuts:	
Galvanizing of	715-1
For signs	716-6 - 716-7
For steel structures	506-1, 506-5

INDEX

PAGE

O

Object markers and guide posts:

Certificates	721-1
Construction methods	619-1
Description	619-1
Measurement	619-1
Payment	619-1 - 619-2
Reflectors	721-2 - 721-3
Removal and disposal of:	201-1
For reuse	202-2
Reset	619-1
Target members	721-1
Target plates	721-1 - 721-2
Obstructions (Also see removal of structures and obstructions)	202-1 - 202-4
On-site mixed concrete	501-10
One-way traffic	104-2
Open joints, concrete structures	502-11
Opening of proposals, public	102-4
Openings in the highway, restoration of	107-1
Operations (See Work)	
Order of preference, plans and specifications	105-2
Overbreak, excavation and embankment:	203-3
Measurement and payment for	203-10 - 203-11
Overhead structures, protection of	107-7

P

Pads, elastomeric bearing	502-13, 725-1 - 725-2
Painting:	
Application, general	614-2
Construction methods	614-2 - 614-5
Description	614-1
Field cleaning, structural steel	614-4
Frames and grates, structural steel	614-5
Guardrails	618-3- 618-4
Machine finished surfaces	614-5
Materials	614-1
Number of coats	614-1
Payment	614-5
Prepared paints	614-1
Raw materials	714-1
Steel structures	506-11, 506-13, 614-2 - 614-5
Steel surface preparation	614-2 - 614-4
Structural steel	614-4 - 614-5
Timber	614-5

INDEX

PAGE

Painting—continued

Weather conditions	614-2
Paint materials: (Also see galvanizing)	
Bridge railings	714-1 - 714-3, 714-4
Certificates for	714-1
For concrete use items	714-4
For guardrail	618-3 - 618-4, 714-1 - 714-3
For iron and steel use items	714-1 - 714-3
Materials covered	714-1
Miscellaneous iron	714-1 - 714-3
Miscellaneous timber structures	714-3 - 714-4
Physical properties and tests	714-1 - 714-6, 714-11
Right-of-way markers	714-1 - 714-3
Sign posts	714-1 - 714-3
Standard metal rail	714-1 - 714-3
Steel bridge railing	714-1 - 714-3
Target plates	721-2
For traffic striping, pavement marking and curb marking	714-4 - 714-6
For timber use items	714-3 - 714-4
Paleontological objects, preservation of	107-7
Palliative, dust (See pollution control)	637-1
Partial payments:	
Control of retention	109-9 - 109-10
Schedule for:	
Cattle guards	109-9 - 109-10
Fence	109-9 - 109-10
Guard and bridge rail	109-9 - 109-10
Irrigation systems	109-9 - 109-10
Signal and lighting systems	109-9 - 109-10
Watering	109-9 - 109-10
Patching, concrete structures	502-13
Patents	107-1
Pavements, bituminous plantmix:	
Aggregates	401-4
Breakdown rollers	401-15
Commercial mineral filler	401-4
Composition of mixtures	401-1 - 401-5
Construction methods	401-5 - 401-17
Description	401-1
Existing surface, preparation of	401-10 - 401-11
Finish rollers	401-15
Finishing, spreading and	401-14 - 401-15
Hauling equipment	401-9
Joints	401-16
Materials	401-1 - 401-5
Measurement	401-17
Mixing	401-14

INDEX

	PAGE
Pavements, bituminous plantmix-- <i>continued</i>	
Mixing plants	401-5 - 401-9
Pavers	401-9 - 401-10
Payment	401-17
Pneumatic-tired rollers	401-10, 401-15
Preparation of aggregates	401-11 - 401-14
Cold feed method	401-12
Marination method	401-12 - 401-13
Slurry method	401-13 - 401-14
Rollers	401-10
Rolling	401-15
Spreading and finishing	401-14 - 401-15
Surface tolerances	401-16
Surfacing miscellaneous areas	401-16 - 401-17
Weather limitations	401-10
Pavement markers:	
Construction Methods	633-3
Description	633-1
Materials	633-1 - 633-2
Measurement	633-3
Payment	633-3
Pavements, old, removal and disposal of	202-1 - 202-3
Pavements, Portland cement concrete:	
Aggregates, grading limits of combined	409-2
Batch plant and equipment	409-4 - 409-7
Classification and proportions	404-2 - 404-3
Compaction of	409-9 - 409-10
Concrete saw	409-10
Construction methods	409-2 - 409-12
Curing	409-11
Description	409-1
Equipment	409-4 - 409-8
Finishing	409-9 - 409-10
Forms	409-7 - 409-8
Gradation requirements	409-1
Grade, preparation of	409-1
Joints	409-10 - 409-11
Materials	409-1
Measurement	409-12
Mixers	409-5 - 409-7
Mixing	409-5 - 409-7
Payment	409-12 - 409-13
Placing	409-8 - 409-9
Properties and tests	409-1
Protection of pavement	409-11 - 409-12
Setting forms	409-7 - 409-8
Spreading, compacting and shaping	409-9 - 409-10

INDEX

PAGE

Pavements, Portland cement concrete—*continued*

Vibrators	409-8 - 409-9
Pavement, recycled bituminous aggregate:	
Aggregate preparation	404-4
Bituminous material	404-2
Bituminous mixing plant	404-4
Bituminous paving aggregate	404-2
Composition of mixtures	404-1 - 404-2
Removing existing bituminous pavement	404-2
Softening agent	404-2 - 404-3
Sub-base preparation	404-4
Pavers, bituminous	401-9 - 401-10
Paving asphalt, measurement of	109-3 - 109-4
Payment:	
Contract item, defined	101-3
Extra work (See extra work)	
Final acceptance and	109-10 - 109-11
Force account (See force account)	
Guarantee by contractor	107-7
Measurement and (Also see sections for various items of work)	109-1 - 109-11
Partial (See partial payment)	109-9 - 109-10
Schedule of partial payments (See partial payments, schedule for)	109-9 - 109-10
Scope of	109-6 - 109-7
Of taxes	107-1
For work or operations performed by railroad	107-4
Penetration of piles, bearing value and	508-3 - 508-4
Pentachlorophenol	615-1, 724-1
Permanent pavement marking tape:	
Beads - glass or ceramic	628-2, 714-8, 714-10
Certificates	628-1
Color	628-2, 714-7, 714-9
Glass bead retention	714-8
Installation	628-5, 714-9, 714-11
Performance requirements	714-8 - 714-9, 714-10
Qualified Products List	714-10
Reflectance	714-7, 714-9
Retained skid resistance	714-7
Reflectivity retention	714-8
Skid resistance	714-7, 714-10
Tensile strength	714-8
Type I film	628-2, 714-7 - 714-9
Type II film	628-2, 714-9 - 714-10
Warranty	628-1, 714-9, 714-10
Permanent signs (Also see signs permanent)	627-1 - 627-4, 716-1 - 716-7
Permit, restoration of surfaces opened by	107-1
Permits, licenses, and taxes	107-1
Personal liability of public officials	107-6, 107-10

INDEX

	PAGE
Persons, responsibility for injury to, by contractor	107-6 - 107-7
Piers, placing and compacting backfill at, ...	207-3
Piles:	
Preservative treatments for	615-1 - 615-2
Steel	712-1
Steel shell for	712-1
Timber	717-1
Treated	507-4, 508-5 - 508-6
Piling:	
Bearing value and penetration	508-3 - 508-4
Cast-in-place concrete	508-7 - 508-8
Construction methods	508-1 - 508-9
Cutoff and extensions	508-4 - 508-5
Description	508-1
Driving of	508-2 - 508-3
Equipment	508-2
Heads, treatment of	508-6
Lengths of	508-1
Load testing	508-5
Materials	508-1
Measurement	508-9
Payment	508-9 - 508-10
Precast concrete	508-6
Preservative treatment of	508-5 - 508-6, 615-1 - 615-2
Steel	508-9
Test:	508-1 - 508-2
Payment for	508-9 - 508-10
Timber	508-5 - 508-6
Timber caps	508-6
Pilot cars	624-2
Pins and rollers	710-1
Pins, rollers and pin holes	506-10 - 506-11
Pipe bedding	208-4 - 208-5
Pipe brackets, sign materials	716-6
Pipelines, abandoned, removal and disposal of	202-1 - 202-3
Pipe and pipe fittings:	
Irrigation systems	213-1, 213-5, 726-5 - 726-6
Material requirements	726-5 - 726-6
Pipe: (Also see culverts)	
Aluminum alloy for	711-1
Asbestos cement pipe	629-2, 635-1 - 635-3
Bituminous coated corrugated metal pipe and pipe arches	709-1 - 709-2
Bituminous coated corrugated metal pipe for underdrains	709-3
Catch basins, manholes and inlets; pipe or tile placed in masonry	609-2
Clay pipes:	
For underdrains	607-1
Concrete and clay pipe and drains	708-1 - 708-2

INDEX

PAGE

Pipe--continued

Corrugated aluminum pipe	709-2
Corrugated metal pipe and metal arch pipe	604-1 - 604-4
Corrugated steel pipe:	
Aluminized Type 2 Coating	709-2
Concrete lined	709-2
Culvert pipes (Also see culverts)	601-1 - 601-4
Installation of pipe:	
In new embankment	603-1 - 603-2
In underdrain outlets	607-2
Irrigation pipe	213-1
Metal and thermoplastic pipe	709-1 - 709-5
Thermoplastic pipe:	
Corrugated polyethylene	709-3
Ribbed profile wall or serial wound polyethylene	709-3
Ribbed profile wall or spiral wound polyvinyl chloride	709-3
Solid wall polyvinyl chloride	709-3
Non reinforced concrete and clay pipe:	602-1 - 602-2
Quality requirements	708-2
Perforated:	
Concrete pipe	708-2
Corrugated polyethylene	607-1
Metal pipe	709-5
Polyvinyl chloride irrigation pipe	726-5 - 726-6
Polyvinyl chloride sewer pipe	630-7 - 630-9
Reinforced concrete pipe:	603-1 - 603-4
Quality requirements	708-1 - 708-2
Reinforced concrete sewer pipe	630-5 - 630-7
Sewer (See sanitary sewers)	
Steel water pipe	629-3 - 629-4
Structural plate pipe and pipe arch culverts	606-1 - 606-5
Underdrains, pipes for (Also see underdrains)	607-1 - 607-3, 709-2 - 709-3, 709-5
Vitrified sewer pipe	630-2 - 630-5
Water (See water distribution facilities)	629-2 - 629-4
Welded seamless steel pipes	710-1
Piping	213-1, 213-5, 726-5 - 726-6
Pits:	
Backfilling	202-1
Protection of	626-1
Plans, defined	101-5
Plans and specifications:	
Change in by contractor	104-3
Conformity with	105-1 - 105-2
Contract modification	105-1
Coordination of	105-2
Examination of	102-2 - 102-3
Intent of	105-1

INDEX

	PAGE
Plans and specifications-- <i>continued</i>	
Interpretation of	105-1 - 105-2
Order of preference	105-2
And working drawings	105-1
Plant inspection	106-6
Planter boxes, landscaping	212-3
Planting areas, landscaping	212-3 - 212-4
Planting soil:	
Erosion control	211-1
For landscaping	212-3
Material requirements	726-2
Placement of	211-2
Planting trenches	212-3
Plantmix:	
Bituminous base (See bituminous plantmix base)	303-1 - 303-2, 705-2
Bituminous open-graded surface (Also see bituminous open-graded surface)	403-1 - 403-3, 705-3
Bituminous pavements (Also see pavements, bituminous plantmix)	401-1 - 401-17
Plant, landscaping: (Also see planting areas, roadside materials)	
Establishment of work	212-8
Handling and shipping	212-2
Inspection of	212-2
Nomenclature for names of	212-1
Pruning	212-6
Quality of	212-1- 212-2
Replacements	212-7 - 212-8
Staking and guying	212-6
Storage, temporary	212-3
Watering	212-6 - 212-7
Plates:	
Bearing	506-12
Galvanizing of	715-1, 716-5, 716-6
Steel	506-6 - 506-7
Stiffener, galvanizing of	716-5, 716-6
Web	506-7
Wrought iron	712-1
Platform scales	109-2
Plywood for forms, concrete structures	502-3
Pneumatic-tired compactors and rollers	203-9, 401-10
Pneumatically placed concrete mortar:	
Construction methods	612-1 - 612-2
Description	612-1
Finishing	612-2
Materials	612-1
Measurement	612-3
Payment	612-3
Placing	612-2
Preparation of foundation	612-1 - 612-2

INDEX

PAGE

Pole lines, protection of	107-7
Pollution control:	
Construction methods	637-1 - 637-2
Description	637-1
Materials	637-1
Measurement	637-2
Payment	637-3
Polymerized asphalt cement, specifications table	703-4
Polyvinyl chloride pipe (ribbed or spiral wound), specifications for	709-3
Polyvinyl chloride sewer pipe	630-7 - 630-9
Portland cement concrete: (Also see lightweight concrete)	
Admixtures	501-1 - 501-2
Aggregates:	
Grading limits of combined	409-2
Storage of	501-5
Cement, protecting and sampling	501-5
Cement used in	701-1
Classifications and proportions	501-5 - 501-7
Concrete making properties	501-3
Construction methods	501-3 - 501-17
Curing of	501-13 - 501-14
Damages, liquidated - table	502-19
Description	501-1
Equipment	501-3, 501-7 - 501-12
Gradation requirements	501-1
Hand mixing	501-13
Machine mixing	501-9 - 501-12
Materials	501-1 - 501-3
Materials details of portland cement	701-1 - 701-2
On-site mixed concrete	501-10
Pavements (See pavements, Portland cement concrete)	
Payment	501-17
Proportioning methods	501-7 - 501-9
Proportions, classifications and	501-5 - 501-7
Protecting and sampling cement	501-5
Ready-mixed concrete	501-10 - 501-12
Requirements and test methods	501-3
Retempering	501-13
Riprap, sacked concrete	610-1 - 610-2, 610-7
Structures (See concrete structures)	
Test methods, requirements and	501-3
Tricalcium silicate used in	701-2
Truck mixer or agitator	501-9 - 501-12
Weather limitation	501-14 - 501-16
Portland cement materials details	701-1 - 701-2
Portland cement products, aggregates for (Also see aggregates, Portland cement products)	706-1 - 706-7

INDEX

	PAGE
Portland cement treated base:	
Compaction	304-3 - 304-4
Construction joints	304-4
Finished surface	304-4
Mixing - plantmix	304-2 - 304-3
Mixing - roadmix	304-1 - 304-2
Proportioning	304-1
Protection and curing	304-5
Spreading	304-3
Time requirements	304-4
Weather limitations	304-5
Post clamps, sign materials	716-5 - 716-7
Post tensioning methods:	
Concrete reinforcement	713-1 - 713-2
Precast prestressed concrete members	503-1
Posts:	
Cattle guard	617-1
Concrete end, paint for	714-4
Construction sign	625-2
Fencing	617-1 - 617-3
Line	616-2 - 616-3
Metal fence materials	724-2 - 724-4
Object markers and guide	721-1
Removal of	202-1
Right-of-way markers	721-1
Steel pipe for	716-6
Timber	507-3, 718-1 - 718-2
Wood	720-1, 724-1
Precast:	
Concrete piles	508-6
Manholes	629-7, 630-2
Preconstruction conference	108-4
Prequalification of bidders and contractors	102-1
Preservative treatments for timber	615-1 - 615-2
Preservatives, timber	719-1
Pressed steel products, galvanizing of	715-1
Pressure:	
Conduits, concrete and clay pipe for	708-2
Pipe, reinforced concrete for	603-3
Prestressed concrete members:	
Anchorages and distribution	503-2
Construction methods	503-1 - 503-8
Curing	503-4 - 503-5
Description	503-1
Enclosures	503-2
Forms	503-1 - 503-2
Handling	503-5

INDEX

PAGE

Prestressed concrete members—*continued*

Materials	503-1
Measurement	503-8
Payment	503-8
Prestressing methods	503-1
Prestressing steel	503-2 - 503-4, 713-1 - 713-2
Pretensioning	503-2 - 503-4
Reinforcement and anchorages, testing of	713-2
Shipping	503-5
Prestressing cast-in-place concrete:	
Anchorage and distribution	495-2 - 495-3
Bonding and grouting	495-5 - 495-6
Construction methods	495-2 - 495-7
Description	495-1
Ducts	495-3
Materials	495-1 - 495-2
Measurement	495-7
Payment	495-7 - 495-8
Prestressing	495-4 - 495-5
Prime coat	406-1 - 406-3
Privilege taxes	107-1
Production sources, roadside	108-1
Profile grade, defined	101-5
Progress schedule	108-2
Progress of work, prosecution and	108-1 - 108-8
Project, defined	101-5
Proof rollers	203-9
Property marks, protection and restoration of	107-7
Proportioning methods for:	
Portland cement concrete	501-7 - 501-9
Portland cement concrete pavements	209-2 - 209-3
Proportions, classification and; portland cement concrete	501-5 - 501-7
Proposal:	
Change in staging or sequence of operations	104-3
Consideration of	103-1
Defined	101-5
Delivery of	102-4
Eliminated items from	102-3, 109-9
Form, contents of:	102-1 - 102-2
Defined	101-5
Signing of	102-3
Guarantee:	102-3 - 102-4
Defined	101-5
Forfeiture of	102-3 - 102-4
Return of	102-3
Irregular	102-3
Preparation of	102-3

INDEX

	PAGE
<i>Proposal—continued</i>	
Public opening of	102-4
Quantities, interpretation of	102-2
Rejection of	102-4
Requirements and conditions	102-3
Withdrawal or revision of	102-4
Prosecution and progress of work	109-1 - 109-11
Protection:	
Of archeological and paleontological objects and artifacts	107-7
And curing (See curing)	
Fire	107-8
Of poles	107-7
Portland cement	501-5
Of pavement	409-11 - 409-12
And restoration of property and landscape	107-7 - 107-8
Of trees and shrubs	107-7, 201-1
Pruning, landscaping	212-6
Public, convenience and safety: (Also see accommodations for public traffic)	107-2 - 107-3
Construction and temporary signs for safety of	625-1 - 625-2
Officials, personal liability of	107-6, 107-10
Pumping water	502-6
PVC coated rigid steel conduit	623-2 - 623-3, 623-9
PVC pipe:	
Irrigation systems	726-5 - 726-6
Sewer	630-7 - 630-9

Q

Qualification of bidders	102-1
Quality of materials and source of supply	106-1
Quantities, altered (See increased or decreased quantities):	
Interpretation of	102-2
Measurement of (Also see sections for various items of work)	109-1 - 109-6
Quick-coupler valves, irrigation systems:	213-3
Material requirements	726-6
Quicklime (See lime)	

R

Rail:	
Bridge, aluminum alloy used in	711-1
Elements, galvanizing of	715-1
Members, guardrail materials	720-1
Posts:	506-12
Finishing of	506-3
Standard metal, paint for	714-1 - 714-3

INDEX

PAGE

Railing:

Steel bridge, paint for	714-1 - 714-3
Timber bridge, paint for	714-3 - 714-4

Railroad crossing, defined	107-3

Railroads:

Clearance markers	107-4
Concrete forms over or in vicinity of	502-2
Employee's services	107-4
Flagging protection	107-3
Movement or adjustment of telephone, telegraph or signal facilities	107-4
Pay rates	107-4
Protective liability and property damage insurance	107-5 - 107-6
Rules and regulations with respect to highway contractors	107-3 - 107-4
Work or operations performed by	107-4

Ready-mixed concrete	501-10 - 501-12

Reaming, steel structures	506-5, 506-13

Reflector plates, guardrail	720-1

Reflectorization of:

Guardrails	720-1
Signs	625-1, 627-1 - 627-2

Reflectors, object markers and guide posts:	619-1

Guardrails	720-1

Reinforcement:

Bar steel	713-1
Concrete	502-5, 713-1 - 713-2
Fabricated steel bar or rod mats	713-1
Materials covered	713-1
Mesh	713-1
Physical properties and tests	713-1 - 713-2
Placement	505-2
Portland cement concrete pavement	409-8
Prestressing steel	713-1 - 713-2
Tieing	505-2
Welded steel wire fabric	713-1

Reinforcing steel (See reinforcement)	495-1 - 495-2, 503-1, 505-1 - 505-3

Relay culvert pipes	604-3

Relief from maintenance and responsibility	107-8 - 107-9

Removal of structures and obstructions: (Also see disposal of materials; types of structures and obstructions)

Abandoned pipelines	202-1 - 202-2
Bituminous pavement	202-1 - 202-4
Bridges	202-1 - 202-4
Brush	201-1 - 201-3
Buildings	201-1 - 201-4
Catch basins	202-2
Closing culverts	202-2
Construction methods	204-1 - 204-3
Culverts	202-1 - 202-3

INDEX

	PAGE
Removal of structures and obstructions— <i>continued</i>	
Curbs, gutters and sidewalks	202-2
Description	202-1
Drainage structures	202-1 - 202-3
Disposal of materials	202-3
Falsework, forms and housing	502-10 - 502-11
Fences:	202-1
For reuse	202-2
Foundation excavation	206-1 - 206-2
Foundations	202-1
Gates for reuse	202-2
Guardrail:	202-1
Designated for reuse	202-2
Guideposts:	202-1
Designation for reuse:	202-2
Manholes, catch basins and inlets	202-2
Measurement	202-3
Non-perishable material	202-1, 202-3
Objects or disturbances caused by contractor's operations	626-1
Object markers:	202-1
For reuse	202-2
Pavements	202-1 - 202-2
Payment	202-3 - 202-4
Perishable material	201-2
Roots	201-1 - 201-2
Rubbish	202-1, 626-1
Salvageable material	202-1, 202-2 - 202-3
Salvage from	202-2 - 202-3
Structural steel specified for salvage	202-2
Structure excavation material	206-1 - 206-2
Stumps	201-1 - 201-2
Substructures of existing structures	202-1
Timber or piling designated to be salvaged	202-3
Unacceptable and unauthorized work	105-6 - 105-7
Underground structures	202-1 - 202-2
Unsuitable material	203-2, 203-10, 626-1
Work zone traffic control devices	625-1
Rental of equipment:	
For accommodating traffic	624-2
Measurement and payment	109-4 - 109-6, 624-2 - 624-3
Rental rates	109-8
Reset object markers and guideposts	619-1
Restoration of property and landscape:	107-7 - 107-8
Surfaces opened by permit	107-1
Restrictions, load and speed	105-7 - 105-8
Retaining walls, metal bin-type:	660-1 - 660-2
Backfill for	660-1 - 660-2

INDEX

	PAGE
Retempering of Portland cement concrete	501-13
Return of proposal guarantee	103-1
Reuse of materials after removal of structures	202-2 - 202-3
Right-of-way:	
Defined	101-5
Delays	105-5, 108-7
Furnishing of	107-10
Right-of-way markers:	
Metal posts, requirements for	721-1
Rights in materials found on work	104-3
Riprap:	610-1, 610-2, 610-7, 610-9
Description	610-1
Construction	610-6, 610-7
Materials	610-1 - 610-2
Measurement	610-9
Payment	610-9
Riprap structures:	
Construction (Useable materials from old structures)	202-3
Downdrains	608-2
Rivet holes:	506-4
Subpunching of	506-5
Rivets	506-4 - 506-5
Road, defined	101-5
Roadbed, defined	101-5
Roads in ditch and dike areas	107-8
Roadside, defined:	101-6
Development, defined	101-6
Roadside materials: (Also see erosion control, irrigation systems, landscaping)	
Certificates and samples	726-1 - 726-2
Control tubing	726-6
Fertilizer, commercial	726-2
Gate valves	726-6
Humus (Organic material)	726-2 - 726-3
Irrigation materials	726-5 - 726-6
Jute matting	726-4
Masonry	726-6
Mulch	726-3
Pipe and pipe fittings	726-5 - 726-6
Plants	726-4
Quick-coupler valves	726-6
Requirements	726-1 - 726-2
Seeds	726-4
Top soil or planting soil	726-2
Tree ties	726-4
Roadway:	
Construction, drainage during	203-4
Defined	101-6

INDEX

	PAGE
Roadway-- <i>continued</i>	
Excavation and embankment	203-1 - 203-12
Finish tolerance	203-10
Grading	203-1
Width on bridge, defined	101-2
Rock cuts in excavation	203-3
Rock embankment compaction:	
Construction methods	203-8 - 203-9
Equipment	203-9
Testing	203-9
Rock embankment, placement	203-6 - 203-8
Rock materials, measurement for	203-10 - 203-11
Rod mats reinforcement, for concrete	713-1
Rolled material, straightening of:	506-3
Defects	710-1
Rolled steel products, galvanizing of	715-1
Rollers and rolling:	
Breakdown	401-15
Finish	401-15
Plantmix bituminous base	303-1
Plantmix bituminous open-graded surface	403-2
For plantmix bituminous pavements	401-10
Plantmix bituminous surface	402-1
Pneumatic-tired	203-9, 401-10, 401-15
Proof rolling	203-9
Steel wheel	401-10, 401-15
For surface treatment	408-1
Vibratory	401-10
Roots, removal of	201-1 - 201-2
Round timber piles	717-1
Rounded and transition slopes	204-1 - 204-2
Rubber gasketed joints, reinforced concrete pipe	603-3
Rubber gaskets	707-1
Rubbish, removal of	202-1, 626-1

S

Safety precautions, contractor's compliance with	107-2 - 107-3
Salvaging of materials:	
From removal of pavement, for reuse	202-2
From removal of structures	202-1 - 202-3
Structural of plate pipe and pipe arch culverts	606-1
Samples and tests	106-4 - 106-6
Sampling and protection of Portland cement concrete	501-5
Sand blotter:	
Aggregates for bituminous courses	705-4
For prime coat	406-1

INDEX

PAGE

Sand blotter— <i>continued</i>	
For seal coat	407-1
Sand, fine aggregate, concrete	706-5 - 706-6
Sand, fine aggregate, lightweight concrete	706-4 - 706-5
Sand for grout and mortar	706-6
Sanitary provisions	107-2
Scales, requirements of:	109-2 - 109-3
Bituminous material	401-6
Conveyor	109-2 - 109-3
Platform	109-2
Weigh box or hopper	401-7
Scalping for clearing and grubbing	201-2
Schedule, progress	108-2
Scope of payment	109-6 - 109-7
Screenings: (See surface treatment)	
Aggregates for	705-3 - 705-4
Seal coat	407-1 - 407-2
Seed beds, landscaping	212-4
Seeding and fertilizing, erosion control	211-3
Seeds, erosion control:	211-1
Quality requirements	726-4
Selected material, base or surface:	301-1 - 301-2
Selected material encountered in excavation	203-4
Measurement for	203-11
Sewers:	
Connections	630-11 - 630-12
Manholes	630-2
Pipe, PVC	630-7- 630-9
Pipe, reinforced concrete	630-5 - 630-7
Pipe, vitrified clay	630-2 - 630-5
Replacement	630-1
Tests for leakage and infiltration	630-13 - 630-16
Trenches	630-9
Shaping Portland cement concrete pavement	409-9 - 409-10
Shear connector studs	506-7 - 506-9
Sheet aluminum (See aluminum sheets)	
Shims, aluminum alloy:	711-1
Shop assembly, steel structures:	506-6
Painting	506-11
Riveting	506-4 - 506-5
Shoulder, defined	101-6
Sidewalk: (See curbs, gutters and sidewalks)	
Defined	101-6
Sign:	
Background	627-1, 716-1 - 716-4
Faces, preparation of	627-2, 716-4
Islands	627-2

INDEX

	PAGE
Sign materials	716-1 - 716-7
Sign posts (See posts)	625-2, 627-3, 716-6
Signals and lighting:	
Ballasts	623-49 - 623-50
Bonding and grounding	623-53
Conductor table (color)	623-4
Conductors	623-3, 623-8 - 623-9, 623-20
Conduit	623-2, 623-9 - 623-10
Controller; traffic signal	623-15 - 623-25
Controller construction specification	623-16 - 623-25
Controller diagrams	623-22 - 623-25
Cabinets	623-10 - 623-12
Cabinet equipment	623-12 - 623-15
Descriptions	623-1 - 623-2
Emergency vehicle priority control system	623-42 - 623-45
Equipment list and drawings	623-1 - 623-2
Excavating and backfilling	623-7 - 623-8
Expansion fittings	623-3
Field tests	623-16, 623-53 - 623-54
Flasher beacons	623-33
Flashers	623-33
Flashing operations	623-15
Foundations	623-8
Galvanizing	623-35, 623-36, 623-48, 623-49
Internally illuminated street name signs	623-31
Local communication interface unit	
Plug function table	623-37
Wiring diagram	623-38
Loop detectors	623-25 - 623-28
Luminaries, sodium vapor	623-49 - 623-51
Maintaining existing and temporary electrical systems	623-4 - 623-5
Malfunction management units	623-13 - 623-14
Mast arms	623-35, 623-47 - 623-48
Materials	623-2 - 623-4, 623-10 - 623-46, 623-46 - 623-52
Mounting brackets	623-30, 623-33, 623-48
Operating voltage	623-16, 623-51
Optical units	623-28 - 623-29
Painting	623-45 - 623-46, 623-52 - 623-53
Parts list, instruction sheets and	623-2
Pedestrian:	
Signal faces	623-31 - 623-33
Push buttons	623-42
Photoelectric controls	623-51 - 623-52
Pull boxes	623-2
Push button posts and guard posts	623-35
Regulations and code	623-1
Reinstalling salvaged electrical equipment	623-1

INDEX

PAGE

Signals and lighting--*continued*

Removing and replacing improvements	623-8
Safety precautions	623-7
Salvaging electrical equipment	623-1
Scheduling of work	623-7
Service locations and installations	623-10
Signal faces	623-28 - 623-31
Signal head mounting	623-30, 623-33
Standard drawings for	623-1
Standards, steel pedestals and posts	623-33 - 623-36, 623-46 - 623-49
Stockpiling salvaged electrical equipment	623-1
Traffic signal lamps	623-29
Video detection system	623-14 - 623-15
Wiring	623-8 - 623-10

Signs, construction:

Construction methods	625-1 - 625-2
Contractor's responsibility	625-2
Channelizing devices	625-2
Description	625-1
Foundations	625-2
Maintenance	625-2
Materials	625-1
Measurement	625-2
Mounting	625-2
Payment	625-2
Placement	625-2
Removal of	625-1
Temporary stop signs	625-2
Warning signs	625-2

Signs, permanent:

Aluminum sheet panels	716-4
Background	627-1
Construction methods	627-2 - 627-3
Cut-out letters, numerals symbols and accessories	627-2
Description	627-1
Frame supporting	716-5 - 716-6
Installation	627-2 - 627-3
Installation date	627-2
Islands	627-2
Materials	627-1 - 627-2
Measurement	627-3
Payment	627-3 - 627-4
Quality requirements	627-3
Reflectorization	627-1 - 627-2
Shop drawings	627-1
Sign faces	627-2
Sign islands	627-3

INDEX

	PAGE
Signs, permanent-- <i>continued</i>	
Tests	627-3
Sills, timber construction	507-2 - 507-3
Siphons, concrete and clay pipe:	708-2
Corrugated metal pipe and metal arch pipe	604-2
Reinforced concrete pipe	708-1 - 708-2
Site preparation, landscaping	212-3
Site of work, examination of	102-2 - 102-3
Slabs, concrete structures	502-8
Slides and slipouts, excavation and removal of:	203-4
Measurement for	203-11
Slip form curb, gutter and sidewalk	613-2 - 613-3
Slip joints, downdrains	608-1
Slopes:	
Cultivation of	211-2
Excavation and embankment	203-3
Paving, concrete	611-1 - 611-3
Rounded and transition	204-1 - 204-2
Slope and channel protection (See riprap and wire mesh gabions)	
Slot pipe	604-2 - 604-3
Society of Automotive Engineers	101-1
Soil (See planting soil)	726-1
Sources, of local material:	106-2 - 106-4
Of supply and quality requirements	106-4 - 106-6
Special detours, payment for	624-2
Special provisions:	
Coordination of plans, specifications, supplemental specifications, and	105-2
Defined	101-6
Specifications:	
Cited	106-6
Conformity with	105-1 - 105-2
Coordination of	105-2
Defined	101-6
Examination of	102-2 - 102-3
Interpretation of plans and	105-1 - 105-9
Preference, order of	105-2
Repetition of expressions, avoidance of	101-7 - 101-8
Supplemental	101-7
Specifications for:	
Aggregates for bituminous courses	705-1 - 705-4
Aggregates for Portland cement products	706-1 - 706-7
Base aggregates	704-1 - 704-4
Bituminous materials	703-1 - 703-9
Epoxies	728-1 - 728-5
Joint material	707-1 - 707-3
Paints and pavement markings	714-1 - 714-11

INDEX

PAGE

Specifications for--*continued*

Water	722-1
Speed restrictions, load and	105-7 - 105-8
Spikes, timber structures	507-3 - 507-4
Splices, reinforcing steel:	505-2
Steel structures	506-5
Spray nozzles, irrigation systems	213-7 - 213-8
Spreading and finishing: (Also see finishing)	
Aggregate base courses	302-1 - 302-2
Lime stabilized subgrade	306-3 - 306-4
Plantmix bituminous pavements	401-14 - 401-15
Plantmix bituminous surface	402-1
Portland cement treated base	304-3
Portland cement concrete pavement	409-9 - 409-10
Selected material base	301-1
Sprinklers:	
Connections	213-6
Heads	213-2
Irrigation systems, adjusting	213-7 - 213-8
Stainless steel bolts	710-1
Stakes, construction, lines and grades, preservation of	105-5 - 105-6
Staking and guying of plants	212-6
Standard steel	710-1
Standards:	
Fencing, metal gates for	724-4 - 724-5
Metal rail, paints for	714-1 - 714-3
United States of America Standards Institute	101-1
Staples, brace wire and nails	724-4
Steam cleaning, painting	614-3 - 614-4
Steel: (Also see structural and eyebar steel)	
Bridge railing, paint for	714-1 - 714-3
Guardrail materials	720-1
Joints, concrete structures	502-9 - 502-10, 502-11 - 502-12
Light standards, paint for	714-1 - 714-3
Paint for structural steel	614-4 - 614-5, 714-1 - 714-3
Piles	508-9, 712-1
Pipe for posts:	716-6
Tubular, fence material	724-2
Welded seamless	710-1
Plates, edge planing:	506-6
Surface finish	506-6 - 506-7
Prestressing	713-1 - 713-2
Reinforcing (See reinforcing steel)	713-1 - 713-2
Rolled material, straightening of	506-3
Sheets, for object markers, guide posts, guardrail reflector plates	721-1
Shells for piles	712-1

INDEX

	PAGE
Steel structures:	
Abutting joints	506-7
Annealing and stress relieving	506-10
Bearing and anchorage plates	506-12
Beginning of work, notice of	506-2
Bolts and bolted connections	506-5 - 506-6
Bolts and bolted connections, high-tensile strength	506-5 - 506-6
Bolts, nuts and washers, material requirements	506-1, 506-5
Construction methods	506-1 - 506-13
Description	506-1
Drawings, shop	506-1 - 506-2
Edge planing	506-6
Elastomeric bearing pads	506-12, 725-1 - 725-2
End connection angles	506-7
Erection methods and equipment	506-11 - 506-12
Facing of bearing surfaces	506-6 - 506-7
Falsework	506-12
Field assembling and riveting	506-12 - 506-13
Field painting	506-13
Flame cutting	506-7
Inspection and testing of	506-2 - 506-3
Lacing bars	506-7
Marking and shipping	506-11
Materials	506-1
Measurement	506-13 - 506-14
Misfits	506-13
Paint for iron and steel use items	714-1 - 714-3
Painting (Also see structural steel)	614-2 - 614-5
Payment	506-15
Pins, rollers and pin holes	506-10 - 506-11
Rail posts, erection:	506-12
Finishing	506-3
Rivet holes	506-4
Rivets	506-4
Rolled material, straightening of	506-3
Rollers	506-10
Shipping members	506-11
Shop assembly	506-6
Shop painting	506-11
Shot riveting	506-4 - 506-5
Stiffeners, fit of	506-10
Storage of structural material	506-3
Stress relieving, annealing and	506-10
Stud shear connectors	506-7 - 506-9
Subpunching, drilling and reaming	506-5
Web plates	506-7
Weights, calculated	506-14

INDEX

PAGE

Steel structures--*continued*

Welding	506-10
Stiffener plates, galvanizing of	716-5, 716-6
Stiffeners, fit of, steel structures	506-10

Stone:

For masonry and riprap	706-7
For riprap	610-2
For gabions	610-2 - 610-3

Storage of:

Agency furnished materials	107-9
Aggregates, lightweight concrete	504-2
Materials	106-7
Materials near railroad tracks	107-3
Plants, landscaping	212-3
Portland cement concrete aggregates	501-5
Structural steel materials	506-3
Timber and lumber	507-1

Storm drains, concrete and clay pipe for	708-1 - 708-2

Straightening, rolled structural steel materials	506-3

Straps, bars and braces for signs	716-6 - 716-7

Straw mulch materials	212-3, 726-3

Stream channels (See ditch and channel)

Street, defined	101-6

Street name signs	631-1 - 631-2

Stress relieving, steel structures	506-10

Stringers for signs:	716-6

For timber structures	507-3

Strip products, galvanizing of	715-1

Striping:

Application of paint	628-4
Bead application	628-3
Defective workmanship	628-5
Equipment required	628-2 - 628-3
Geometry	628-3
Installation of pavement markings	628-5, 714-9, 714-10
Layout	628-3 - 628-4
Measurement	628-5
Paint required	628-1, 714-4 - 714-6, 714-11
Payment	628-5 - 628-6
Preparation of surface	628-3
Protection of work, workmen, and public	628-4 - 628-5
Retroreflective preformed marking tape	628-2, 714-7 - 714-10
Warranty - marking tape	628-1, 714-9, 719-10
Weather requirements	628-2

Structural and eyebar steel:

Cold-formed welded and seamless carbon structural tubing in rounds and shapes	710-1
Defects	710-1

INDEX

	PAGE
Structural and eyebar steel-- <i>continued</i>	
High-strength, low-alloy structural manganese vanadium steel	710-1
High-tensile strength bolts	710-1
Physical properties and tests	710-1 - 710-2
Pins and rollers	710-2
Shear connector studs	710-2
Stainless steel bolts	710-1
Standard steel	710-1
Welded seamless steel pipe	710-1
Structural steel:	
Paint for	714-1 - 714-3
Painting	614-2, 614-4 - 614-5
Surface preparation	614-2 - 614-3
Tubing	710-1
Weights	506-14
Weight calculated	506-14
Structural timber, quality requirements for	718-1 - 718-2
Structures, concrete (See concrete structures)	
Structures, excavation for	206-1 - 206-2
Structures and obstructions, removal of (Also see removal of structures and obstructions)	202-1 - 202-4
Structures, steel (See steel structures)	
Structures, timber (See timber structure)	
Strutting, corrugated metal pipe	709-1
Strutting, structural plate pipe	606-3
Stud shear connectors, steel structures	506-7 - 506-9
Stumps, removal of	201-1 - 201-2
Subcontractor, contractor's liability for claims against	107-7, 108-1
Subcontractor, defined	101-6
Subgrade:	
Cement treated (See cement treated base)	304-1 - 304-6
Defined	101-6
Lime stabilized	306-1 - 306-5
Material, watering of	210-1 - 210-2
Preparation, aggregate base courses:	302-1
Selected material base or surface	301-1
Tolerances	302-2, 303-1, 304-4, 306-4
Subletting of contract	108-1
Subpunching, drilling and reaming	506-5
Substitute methods or types of equipment	108-3
Substitution of plants, landscaping	212-2
Substitution of reinforcing steel	505-2
Substructure, defined	101-6
Substructures of existing structures, removal and disposal of	202-1
Subsurface information	102-2
Sulfates in subgrade, stabilization	306-1
Superintendent, defined:	101-6
On the work	105-2 - 105-3

INDEX

	PAGE
Supplemental agreement:	104-1 - 104-2
Defined	101-7
When required	104-1
Supplemental specifications, defined	101-7
Supply of materials, source and quality	106-1
Surety, defined:	101-7
Responsibility of	108-7
Surface tolerances	401-16, 403-3, 404-4, 409-9
Surface treatment:	
Aggregate spreader	408-1
Application of bituminous material	408-2 - 408-3
Application of screenings	408-3
Distributors	405-1
Maintaining traffic	408-2
Materials	408-1
Preparation of surface	408-2
Rollers	408-1 - 408-2
Screenings	408-1
Weather limitations	408-2
Surfaces:	
Existing (See existing surfaces)	
Opened by permit, restoration of	107-1
Selected material for (See selected material base or surface)	
Treatment of (Also see surface treatment)	408-1 - 408-4
Surfacing:	
Bituminous plantmix surface	402-1 - 402-2
Bituminous recycled surface	404-1 - 404-5
Materials, watering of	210-1 - 210-2
Miscellaneous areas	401-16 - 401-17
Portland cement concrete pavement	409-1 - 409-13
Surplus excavated material:	203-3
Disposal of	203-3
Measurement and payment	203-10 - 203-12
Survey monuments	621-1
Suspension of work:	
Contractor's responsibility during	107-9
Temporary	108-4

T

Tack coat	405-1 - 405-2
Target members	619-1
Target plates:	
Base metal	721-1 - 721-2
Paint for	721-2
Taxes, permits, licenses and privilege	107-1

INDEX

	PAGE
Telltale, installation of	107-4
Temporary stop signs	625-2
Temporary suspension of work	108-4
Tensile strength requirements, plantmix bituminous pavements	401-2
Termination of contract and contractor's responsibility	108-7 - 108-8
Terms, definitions and	101-1 - 101-8
Test piles:	508-1 - 508-2
Payment for	508-9 - 508-10
Testing methods cited	106-6
Test methods for:	
Aggregates for bituminous courses	705-2 - 705-4
Aggregates for Portland cement products	706-4 - 706-7
Base aggregates	704-2 - 704-4
Bituminous materials	703-1 - 703-9
Compaction of rock embankment	203-8 - 203-9
Field density of soils and aggregates	111-1
Lightweight concrete	504-1 - 504-2
Load testing	508-5
Materials	106-4 - 106-6
Permanent signs	627-3
Portland cement concrete	501-3
Portland cement concrete pavement	409-1
Prestressing reinforcement and anchorages for concrete	495-1 - 495-3
Supply lines, irrigation systems	213-7
Studs	506-8
Timber:	
Certificates of inspection	718-1
Grades	718-1 - 718-2
Measurement	109-3
Merchantable	201-2
Paint for	714-3 - 714-4
Painting	614-5
Preservative treatments for (See preservative treatments for timber)	615-1 - 615-2
Preservatives	719-1
Quality requirements	718-1 - 718-2
Species	718-1
Timber piles:	508-5 - 508-6
Caps	508-6
Cushion caps	508-3
Heads of	508-6
Specifications of rounded piles	717-1
Treated	508-5 - 508-6
Treated caps	508-6
Timber posts:	
Guardrail posts	618-1
Preservatives	615-1 - 615-2
Quality requirements	718-1 - 718-2

INDEX

PAGE

Timber posts-- <i>continued</i>	
Sign posts, paint for	714-3 - 714-4
Wood posts	724-1
Timber structures:	
Bolts and washers	507-2
Bracing	507-3
Caps	507-3
Cattle guards (See cattle guards)	
Construction methods	507-1 - 507-4
Description	507-1
Framing	507-2 - 507-3
Guardrail (See guardrails)	
Holes for bolts, dowels, rods and lag screws	507-2
Inspection of timber, treated	615-2
Laminated floors	507-4
Materials	507-1
Measurement	507-4
Painting	507-4, 614-5
Paints	714-3 - 714-4
Payment	507-5
Piles (See timber piles)	508-5 - 508-6
Plank floors	507-3 - 507-4
Posts (See timber posts)	507-3
Preservative treatments for	615-1 - 615-2
Storage of materials	507-1
Stringers	507-3
Structural timber and lumber, quality requirements	718-1 - 718-2
Treated timber and piling	507-2
Trusses	507-4
Untreated timber	507-2
Workmanship	507-1
Timber use items, paint for	714-3 - 714-4
Time:	
Completion of contract	108-5 - 108-6
Extension of contract	107-7, 108-5 - 108-6
Failure to complete work on	108-6
Tolerances:	
Aggregates, type 2	302-2
Lime stabilized subgrade	306-4
Plantmix bituminous base	303-1
Plantmix bituminous surface	402-1 - 402-2
Plantmix open-graded surface	403-3
Portland cement treated base	304-4
Subgrade	203-10
Ton, meaning of	109-1
Traffic control:	
Construction signs	625-1 - 625-2

INDEX

	PAGE
Traffic control— <i>continued</i>	
Lane, defined	101-7
Maintenance (See maintenance of traffic)	
Manual On Uniform Traffic Control Devices	623-8, 625-1, 628-2
Nevada Traffic Control Manual	623-8, 625-1, 628-2
Permanent signs	627-1 - 627-4
Public convenience and safety	107-2 - 107-3
Temporary stop signs	625-2
Transition slopes, rounded and	204-1 - 204-2
Transverse expansion joints:	
Portland cement concrete pavements	409-10
Sidewalks	613-4 - 613-6
Traveled way, defined	101-7
Treated timber and piling	507-2
Tree ties:	
Landscaping	212-6
Materials requirements	726-4
Trees and shrubs:	
Excavation and adjacent to	213-5
Planting of	212-4 - 212-5
Protection of	107-7, 201-1
Removal of	201-1
Tremie for concrete deposited under water	502-9
Trenches, backfilling:	208-5 - 208-6, 629-12
Restoration of area	626-1
Underdrain outlets	607-2
Trench excavation and backfill	208-1 - 208-8
Tricalcium silicate used in Portland cement	701-2
Truck mixers or agitators, Portland cement concrete	501-9 - 501-12
Trusses, timber structures	507-4
Tubing:	
Aluminum alloy	711-1
Carbon steel structural	710-1
Control tubing, irrigation systems	726-6
Steel structure	710-1
U	
Unacceptable materials	106-7
Unacceptable and unauthorized work	105-6 - 105-7
Underdrains:	607-1 - 607-3
Backfill for	607-2
Materials for	607-1
Underwriters Laboratories, Inc.	101-1
United States of America Standards Institute	101-1
Unsuitable material:	
Excavation and embankment	203-2

INDEX

PAGE

Unsuitable material--*continued*

Measurement for payment	203-10
Perishable, destruction of	201-2
Removal of	107-4, 203-2, 626-1
Unsuitable weather, temporary suspension of work due to	108-4
Untreated timber	507-2
Utility Cut Patch Requirement	208-6 - 208-8
Utility property and services:	
Contractor's responsibility for	107-9 - 107-10
Cooperation of contractor with	105-3 - 105-4
Delays to contractor from removing and relocating of:	105-4
Compensation for	105-4
Inspection of work by	105-6
Restoration of surfaces opened by permit	107-1
Right-of-way delays	108-7
Underground facilities not known to entity	105-3

V

Vacuum breakers, irrigation systems	213-4
Valves:	
Abandoning of	629-15
Air release and air vacuum	213-4
Boxes and covers, water system	629-7
Boxes, irrigation systems	213-3
Butterfly	629-8
Gate	629-8 - 629-9
Installation of	629-13
Operators	629-8
Quick-coupler, irrigation systems	213-3
Vanadium steel	710-1
Vibrators for concrete structures	502-7 - 502-8
Vibrators for Portland cement concrete pavement	409-8 - 409-9
Volumetric measurements	109-3

W

Wages and conditions of employment	110-1 - 110-2
Waiver of legal rights	107-10
Walk gates, fence materials	724-5
Warning signs (Also see signs, construction)	107-2 - 107-3, 625-2
Warranties, manufacturer's	106-1
Washers:	
Cast	723-1
Flat malleable	723-1
Galvanizing of	723-1

INDEX

	PAGE
Washers-- <i>continued</i>	
For signs	716-6
For steel structures	506-1, 506-5, 716-5
For timber structures	507-2
Water:	
Lime stabilized subgrade	306-2
Meters	109-1
Pollution control	637-1
Pumping, concrete structures	502-6
Quality of	722-1
Retardants	702-1 - 702-2
Watering (Also see section covering various items of work)	210-1 - 210-2
Waterproofing and dampproofing:	646-1 - 646-2
Asphalt for	646-1
Construction methods	646-1 - 646-2
Description	646-1
Materials	646-1
Measurement	646-2
Payment	646-2
Waterstops:	
Concrete structures	502-12
Material requirements	502-12, 707-1 - 707-2
Weakened plane joints, Portland cement concrete pavements	409-10 - 409-11
Weather conditions, temporary suspension of work due to	108-4
Web plates, steel structures:	506-7
Stiffeners, welding of	506-10
Weighing of materials (Also see sections covering various items of work)	109-1 - 109-3
Weights of:	
Asphalt cement	109-4
Asphaltic emulsions	109-4
Liquid asphalt	109-4
Reinforcing steel	505-3
Structural steel	506-14
Weldability tests, stud shear connectors	506-8
Welded and seamless carbon steel structural tubing	710-1
Welded seamless steel pipe	710-1
Welded steel wire fabric reinforcement	713-1
Welded steel structures	506-10
Welding materials	712-1
Widening cuts, excavation:	203-3
Payment for	203-11
Wingwalls, placing and compacting backfill at	207-3
Wire:	
Barbed	616-1 - 616-2, 724-4
Brace	724-4
Fasteners	610-5 - 610-6
Internal connecting	610-5

INDEX

PAGE

Wire--continued

Lacing	610-5
Mesh	724-4
Prestressing high-tensile strength seven-wire strand	713-1
Prestressing high-tensile strength steel wire	713-1
Woven	616-2, 724-4
Wire mesh gabions:	610-1, 610-2 - 610-6, 610-7 - 610-9
Construction	610-7 - 610-9
Description	610-1
Fasteners	610-5 - 610-6
Internal connecting wires	610-5
Lacing wire	610-5
Materials	610-2 - 610-5
Measurement	610-9
Payment	610-9
Withdrawal or revision of proposals	102-4
Wood cellulose fiber mulch	726-3
Wood chips and shavings, mulch	726-3
Wood posts (Also see timber posts)	720-1, 724-1
Work:	
Character of workmen; methods and equipment	108-3
Change in character of work	104-1 - 104-2
Completion of portions of the work	107-8 - 107-9
Contractor's responsibility for	107-9
Control of	105-1 - 105-9
Day, defined	101-7
Default and termination of contract	108-6 - 108-7
Eliminated items	109-9
Examination of plans, specifications, contract documents, and site of work	102-2 - 102-3
Extra (See extra work)	
Failure to complete on time	108-6
Force account (See force account work)	
Increased or decreased quantities	104-1 - 104-2
Inspection of:	105-6, 106-6
By Engineer	105-8
Limitation of operations	108-2 - 108-3
Measurement and payment (Also see sections covering various items of work)	109-1 - 109-11
Notice to proceed	101-4, 108-2
Preconstruction conference	108-4
Prosecution and progress:	108-1 - 108-8
Schedule	108-2
Removal of unacceptable and unauthorized	105-6 - 105-7
Relief from maintenance and responsibility	107-8 - 107-9
Rights in and use of materials found on the work	104-3
Scope of	104-1 - 104-3
Subletting of contract	108-1
Superintendence of	105-2 - 105-3

INDEX

	PAGE
<i>Work--continued</i>	
Temporary signs	625-1 - 625-2
Temporary suspension of	108-4
Work zone traffic control devices	625-1 - 625-2
Working day, defined	101-7
Working drawings:	
Defined	101-7
Plans and	105-1
Workmen, character of	108-3
Woven wire	616-2, 724-4
Wrought iron plates	712-1