

Summary of Administrative Revisions to Standard Specifications 600 Series

Section	Description of Revision
ALL	<ul style="list-style-type: none"> • Formatting in accordance with CSI standards <ul style="list-style-type: none"> ○ All Paragraphs identified by a letter <ul style="list-style-type: none"> ▪ Sub-paragraphs identified by a number • Replace pronouns with appropriate noun references • Delete number word references and retain numeric number only • Modify grammar structure for clarity • Edit cross-references • Delete references to self (Uniform Standard Specifications) • Delete metric units • Delete references to design and procedural guidelines • Delete references to codes and standards that do not specifically relate to the section
628	<ul style="list-style-type: none"> • Subsections 628.01.01, 628.04.01, and 628.05.01 – Changed “Type I” to “Type 2” and “Type II” to “Type 1” to match the NDOT QPL for Pavement Markings
629	<ul style="list-style-type: none"> • Many of the references and product specifications in the section are outdated and superseded by UDACS <ul style="list-style-type: none"> ○ Subsection 629.01.02A – Modified to include UDACS as the standard ○ Subsection 629.02.01 thru 26 – deleted all material specifications already covered in UDACS ○ Subsection 629.03.11 – Deleted Asbestos Cement Pipe specifications ○ Subsection 629.03.12 – Deleted disinfection testing requirements already covered in UDACS ○ Subsection 629.03.15 – Deleted abandoning valves requirements already covered in UDACS.

SECTION 624**ACCOMMODATIONS FOR PUBLIC TRAFFIC****DESCRIPTION****624.01.01 GENERAL**

- A. This work shall consist of providing for traffic by constructing, maintaining, and removing 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**

- A. 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**

- A. 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.
- B. 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~~ Subsection 107.21, "Dust Control."
- C. 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 detours shall be placed and constructed in accordance with the requirements for the particular materials used.
- D. Water shall be applied to detours in amounts necessary to attain the compaction of graded sections and of surfacing materials.
- E. Maintenance on special detours shall consist of performing any work necessary to maintain the detour satisfactorily, as ordered by the Engineer.
- F. Eradication of special detours shall consist of blade grader and scraper work supplemented by other equipment if needed. Eradication ~~will~~shall 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

- A. 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.
- B. Flaggers shall have completed an approved instructional course in flagging procedures.

624

ACCOMMODATIONS FOR PUBLIC TRAFFIC

- C. A prospective flagger shall possess a valid flagger card attesting satisfactory completion of said instructional course conducted by the ~~Highway Department~~ Nevada Department of Transportation or some other approved course given by another ~~entity of government within the State~~ governmental agency.

624.03.03 PILOT CARS

- A. If, in the opinion of the Engineer, it is necessary to afford additional protection to the work, workers, or public traffic, a pilot car and driver shall be used as the Engineer directs. This provision shall be in effect even though the pilot car and driver are not indicated on the plans or provided for in these specifications.
- B. Pilot cars shall be suitable vehicles in good mechanical condition and shall carry a sign which shall comply with the design and mountings as shown on the standard drawings appended to the Special Provisions, or shown on the plans.

624.03.04 MAINTAIN BASE

- A. When the proposal contains an item of "Maintain Base," the provisions of Subsection 109.03, "Extra and Force Account Work," shall apply.

624.03.05 EQUIPMENT RENTAL

- A. When the proposal contains an item of equipment rental, the use of such equipment shall be as directed by the Engineer or as indicated on the plans.

METHOD OF MEASUREMENT

624.04.01 MEASUREMENT

- A. Measurement for the various items involved in accommodating traffic shall be paid for as ~~follows~~ specified below:
1. When the proposal contains an item ~~"Special Detours,"~~ measurement for payment will be made in accordance with the provisions of Subsection 109.03, "Extra and Force Account Work."
 2. When the proposal contains the item Flaggers, measurement for payment shall be the number of hours flaggers are used for the protection of the work or the safety of public traffic, as directed by the Engineer. If no separate item for flaggers is contained in the proposal, the cost of required flaggers shall not be measured or paid for directly but the cost thereof shall be considered as included in the payment for other items of work.
 3. When the proposal contains the item of ~~"Pilot Cars,"~~ the piloting as specified in the contract documents or ordered by the Engineer, will be measured by the number of hours that the pilot car and driver are actually used to lead traffic through the controlled areas.
 4. When the proposal contains an item ~~"Maintain Base,"~~ measurement for payment will be made in accordance with the provisions of Subsection 109.03, "Extra and Force Account Work."
 5. When equipment is used for constructing special detours or maintaining the base and such equipment is rented as indicated in the proposal, ~~it~~ the equipment shall be measured for payment by the number of hours actually used.

ACCOMMODATIONS FOR PUBLIC TRAFFIC

624

BASIS OF PAYMENT

624.05.01 PAYMENT

- A. Payment for ~~s~~Special ~~d~~Detours and ~~m~~Maintain ~~b~~Base, measured as specified in Subsection 624.04.01, "Measurement," will be paid for by "Force Account."
- B. Eradication of special detours shall be paid for as "Force Account" and shall be included in the bid item for "Special Detours."
- C. The accepted quantities of ~~p~~Pilot ~~e~~Car, measured as specified in Subsection 624.04.01, "Measurement," will be paid for at the contract bid price per hour for pilot car, which ~~price~~ shall be full compensation for the vehicle, an experienced driver, all operating costs, and depreciation.
- D. When the item pilot car does not appear in the proposal, and it is necessary to protect the traveling public, in the Engineer's opinion, pilot cars ~~will~~shall be furnished by the Contractor and payment ~~therefor~~ pilot cars will be made in accordance with Subsection 104.03, "Extra Work," except, however, when the Contractor constructs and maintains a detour at ~~his~~Contractor's expense as provided in Subsection 104.04, ~~subparagraph E.3(c), "Maintenance of Traffic."~~ subparagraph E.3.
- E. The accepted quantities of flaggers, when contained as a separate item in the proposal and measured as specified in Subsection 624.04.01, "Measurement," will be paid for at the contract bid price per hour per flagger, which ~~price~~ shall be full compensation for the flaggers, flagging, signs, and equipment.
- F. The accepted quantities of equipment rental measured as specified in Subsection 624.04.01, "Measurement," will be paid for at the contract unit price bid per hour for the particular items of equipment indicated in the proposal form. The contract unit price bid per hour shall include skilled operators for each piece of equipment, fuel, lubricants, repairs, depreciation, and all expenses incidental to the operation of the equipment.
- G. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- H. Payment will be made under:

PAY ITEM**PAY UNIT**

Special Detours	Force Account
Pilot Car	Hour
Flaggers	Hour
Maintain Base	Force Account
Rent Equipment (type)	Hour

SECTION 625

CONSTRUCTION SIGNS

DESCRIPTION

625.01.01 GENERAL

- A. 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.
- B. 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~~the Contractor.
- C. 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 Traffic Control Plans for Highway Work Zones for the Clark County Area, unless otherwise indicated on the plans or by the Special Provisions.
- D. 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

- A. 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.
 - 1. Sign panels may be constructed of steel, aluminum, wood, or other approved material and be of a sound, durable nature.
 - 2. The materials shall be of such quality to do the job for which they are intended and are subject to approval by the Engineer.
 - 3. Signs and channelizing devices ~~which~~that have become dull, have flaking or peeling paint, are dirty, ~~or~~or discolored, or are otherwise marred shall be repaired or replaced with acceptable units.
- B. Reflective sheeting for all signs and channelizing devices shall conform to ~~the requirements specified in the following section: Sign Materials—~~Subsection 716.03.01, "Sign Materials Reflective Sheeting."

625.02.02 SIGN DIMENSIONS

- A. Sign dimensions shown in the MUTCD are minimum standard.
 - 1. Increases above this minimum are permissible and desirable where investigation has shown a larger sign is needed for adequate emphasis.
 - 2. 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

- A. Before any detour, temporary route, or work zone is opened to traffic or imposed upon existing traffic, all necessary signs shall be in place.
- B. Signs required by road conditions or restrictions shall be removed immediately when those conditions cease to exist or the restrictions are withdrawn.
- C. Guide signs directing traffic to and on temporary routes or detours shall be removed when no longer applicable.
- D. Signs and barricades shall be maintained in ~~first-class~~operable condition.
 - 1. Care shall be exercised to keep the sign faces free of dust and splashed mud.
 - 2. Any signs and barricades that~~which may~~ become scarred, ~~or damaged,~~ or destroyed shall be repaired immediately or replaced, at ~~the Contractor's expense~~no additional cost to Contracting Agency and, as directed by the Engineer.
- E. The responsibility for the protection of the work, workmen, and public traffic will rest with the Contractor and the Contractor 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

- A. Signs shall be placed in conformance with the ~~latest edition of the Manual of Uniform Traffic Control Devices~~MUTCD.
- B. All temporary stop signs shall be mounted on a post ~~which~~that 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. ~~1.~~ A flagger is used to supplement temporary stop signs. The temporary stop signs ~~must~~shall be post-mounted and embedded in the ground when no flagger is present.
 - 2. ~~2.~~ Temporary stop signs may be used with a moving construction operation with frequent lane shifts only when construction is in progress and the flagger is present. When no construction is in progress and no flagger is present, the temporary stop signs ~~must~~shall be post-mounted and embedded in the ground.

625.03.03 SIGN SUPPORTS

- A. Signs, posts, pole mountings, and ~~their~~sign foundations shall be ~~so~~ constructed ~~as~~ to hold signs rigidly in a proper and permanent position, and prevent ~~them~~ signs from swaying in the wind, or from being turned or otherwise displaced ~~by children or irresponsible persons~~.
- B. A portable or removable type of mounting may be used for signs required intermittently or ~~which~~that are frequently moved. Such a mounting shall be heavy enough not to turn over in the wind, and ~~its~~the base shall not be appreciably wider than the sign.
- C. 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.
 - 1. Such a mounting shall be heavy enough not to turn over in the wind.

CONSTRUCTION SIGNS

625

2. Temporary stop signs shall be post-mounted and embedded in the ground after working hours when no flagger is present.

625.03.04 CHANNELIZING DEVICES

- A. Projects closed to traffic shall be protected by appropriate channelizing devices, as approved by the Engineer, in conjunction with appropriate work zone warning signs.
- B. 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

625.04.01 MEASUREMENT

- A. No direct measurement shall be made for work zone signs and channelizing devices unless otherwise specified.

BASIS OF PAYMENT

625.05.01 PAYMENT

- A. 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

- A. 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~~ Contractor's operations, whether or not part of the improvement.
- B. This shall be required on all areas used or occupied by the Contractor within or outside the right-of-way limits.

MATERIALS

626.02.01 BLANK

CONSTRUCTION

626.03.01 FINAL CLEAN-UP

- A. Rubbish, excess material, temporary structures, and discarded equipment shall be collected and disposed of as directed by the Engineer.
 - 1. Burning is prohibited.
 - 2. 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.
 - 3. Temporary haul roads within the right-of-way limits shall be scarified and bladed to blend with surroundings.
 - 4. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground.
 - 5. Waste shall be removed from the tops of banks and placed in the bottom of pit.
 - 6. 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.
 - 7. Bottoms of pits shall be reasonably smooth.
 - 8. All other disturbances shall be removed or corrected as directed by the Engineer with particular attention to the abatement of any dust hazard.
- B. Working areas and backslopes pertaining to the improvement shall be hand raked and loose objects including rocks and clods in excess of ~~two~~ 2 inches ~~(5-centimeters)~~ in any dimension shall be removed from the site.
- C. 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.

626

FINAL CLEAN UP

METHOD OF MEASUREMENT

626.04.01 MEASUREMENT

- A. The unit of measure for "Final Clean-~~U~~up" shall be lump sum.

BASIS OF PAYMENT

626.05.01 PAYMENT

- A. The lump sum price paid for "Final Clean-~~U~~up" shall be lump sum price bid for this item.
B. All payments shall be made in accordance with Subsection 109.02, "Scope of Payment."
C. Payment will be made under:

PAY ITEM

PAY UNIT

Final Clean-~~U~~upLump Sum

SECTION 627

PERMANENT SIGNS

DESCRIPTION

627.01.01 GENERAL

- A. 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 *Manual on Uniform Traffic Control Devices* (MUTCD), and these specifications, ~~and~~ as shown on the plans, and as directed by the Engineer.
- B. This item does not include street name signs or construction signs used for traffic control during construction.
- C. The work shall generally consist of:
 - 1. ~~(a)~~ Overhead signs, including concrete foundations, steel sign posts and frames, and aluminum sign panels with reflective sheeting.
 - 2. ~~(b)~~ Ground mounted signs consisting of concrete foundations, steel sign posts, aluminum sign panels with reflective sheeting, and appurtenances.
- D. This ~~item~~work does not include sign illumination systems.

627.01.02 SHOP DRAWINGS

- A. When overhead sign structures are to be furnished, the Contractor shall submit to the Engineer ~~five~~5 sets of shop drawings for each overhead sign structure for approval.
- B. Fabrication of the overhead sign structures shall not commence until the shop drawings have been approved by the Contracting Agency.
- C. 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 Manual on Uniform Traffic Control Devices~~MUTCD.
 - 1. For signs which are shown on the Sign Summary Sheets and are not included in the ~~current edition of the Manual on Uniform Traffic Control Devices~~MUTCD, special sign design sheets shall be furnished by the Contracting Agency to the bidders of the project.
 - 2. The special design sheets shall include such information as letter heights, spacing between letters and words, borders, sign radii, ~~etc~~and so forth.
 - 3. These signs shall conform to the special design sheets as well as the drawings noted in the plans.

MATERIALS

627.02.01 GENERAL

- A. Materials shall conform to ~~the following applicable requirements: Sign Materials~~ Section 716, "Sign Materials."

627.02.02 REFLECTORIZATION

- A. All signs shall utilize Class 6 retroreflective sheeting for sign background, letters, numerals, symbols, borders, and accessories.
- B. All letters, numerals, symbols, borders, and accessories shall be directly applied to the sign background.

627.02.03 LETTERS, NUMERALS, SYMBOLS, AND ACCESSORIES FOR GUIDE SIGNS

- A. All names of places and highways on guide signs shall be composed of lower case letters with initial capital letters.
 - 1. The initial capital letters shall be ~~one and one-third~~ $1\frac{1}{3}$ -times the "loop" height of the lower case letters.
 - 2. Other legends on guide signs shall be in capital letters.
- B. ~~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~~ $1\frac{1}{5}$ the letter (or numeral) height.
- C. Tables of recommended letter spacing can be obtained from the FHWA.
- D. Arrows ~~which~~ that are used for large directional guides shall be in direct proportion to the arrows shown in the MUTCD.

CONSTRUCTION**627.03.01 PANEL FASTENINGS**

- A. The panel sections shall be provided with suitable fastenings, as shown on the plans, to permit easy attachment to the supporting frames.
 - 1. ~~These~~ fastenings shall be so designed as to carry the full design load with a factor of safety of not less than 1.5.
 - 2. Panel sections shall be provided with closure strips at the joints.
- B. Panel fastenings for use on sign panels covered with Class 4 or Class 6 reflective sheeting shall utilize nylon washers for contact between the reflective sheeting and the metal washer.

627.03.02 CLOSURE STRIPS

- A. Closure strip shall be anchored by aluminum rivets as shown on the plans.
- B. Rivets shall be the same color as the sign face.
- C. Closure strips are required only on aluminum sign panels.

627.03.03 INSTALLATION

- A. Sign locations indicated on the plans are approximate only. Final determination of sign locations will be made in the field by the Engineer.
- B. 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.
- C. All signs shall be erected as specified, ~~before~~ before, during, or immediately after the completion of bituminous plantmix surface operations.

PERMANENT SIGNS

627

- D. 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.
- E. Each sign face shall be thoroughly cleaned according to the reflective material manufacturer's recommendations, ~~and~~
 - 1. ~~a~~All undesirable material that is visible on the face of the sign shall be removed.
 - 2. The use of abrasives or other cleaning material that will scratch or otherwise deface the sign shall not be permitted.
- F. Sign islands shall be constructed as roadway embankment ~~e~~in conformity with Section 203, "Excavation and Embankment."
 - 1. Structure excavation and backfill shall conform to ~~the requirements of~~ Section 206, "Structure Excavation," and Section 207, "Structure Backfill."
 - 2. Anchor bolts shall be set true to line and grade, ~~and~~
 - 3. ~~p~~Posts shall be plumb.
- G. 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.
- H. Care shall be exercised at all times in the handling, storing, transporting, and erecting of the signs. Signs ~~which~~that are damaged shall be repaired or replaced at ~~the Contractor's expense~~no additional cost to the Contracting Agency.
- I. Pipe sign posts may be field cut and drilled to adjust for local conditions when approved by the Engineer.
 - 1. Flame cutting will not be permitted.
 - 2. All field cuts and abraded areas on steel posts shall be thoroughly cleaned and given ~~two~~2 coats of paint having a high-zinc dust content conforming to ~~the requirements of~~ Federal Specification MIL-P-21035.
- J. Extending the lengths of sign posts to adjust for local conditions by splicing or welding will not be permitted.

627.03.04 TESTS

- A. ~~It shall be t~~The Contractor's ~~responsibility to ascertain~~shall verify that all required tests have been made by qualified testing laboratories as approved by the Contracting Agency.
- B. 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

- A. 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.
- B. 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~~Contracting Agency.
- C. The Contractor shall remove and dispose of all concrete from sign posts prior to stockpiling as directed by the Engineer.

627

PERMANENT SIGNS

- D. 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."
- E. The Contractor shall exercise care when removing and stockpiling signs for relocation. Signs ~~which~~that are damaged shall be repaired or replaced at ~~the Contractor's expense~~no additional cost to the Contracting Agency.

METHOD OF MEASUREMENT

627.04.01 MEASUREMENT

- A. 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.
- B. The quantity of "Permanent Signs, Relocate" to be measured for payment shall be ~~per~~the number of each sign relocated, temporary or permanent.
- C. 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.
- D. Measurement for payment of ~~S~~sign supports for permanent signs listed as "Permanent Overhead Sign Support Structures" shall be measured on a Lump Sum basis.
- E. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

627.05.01 PAYMENT

- A. 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 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.
- B. 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.
- C. 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.
- D. 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,

PERMANENT SIGNS

627

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, as specified, and as directed by the Engineer.

- E. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- F. 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**TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS****DESCRIPTION****628.01.01 GENERAL**

- A. The Contractor shall furnish and install all traffic striping, marking, and all other directional information on the surfaces of highways, streets, detour roads, medians, and curbing as shown on the plans and required by the contract documents.
- B. As defined in Section 714, "Paint and Pavement Markings," ~~of these specifications,~~ Type ~~1~~ 2 pavement marking materials shall be used for transverse markings such as crosswalks and stop bars as well as for symbols and legends.
- C. Type ~~H~~ 1 markings are defined as longitudinal markings such as lane lines and edge lines.

MATERIAL**628.02.01 MATERIALS FOR TRAFFIC STRIPING, PAVEMENT MARKING AND CURB MARKING**

- A. Materials for traffic striping and marking shall conform to ~~the applicable requirements of~~ Section 714, "Paint and Pavement Markings."
- B. All paint, epoxy, and polyurea paint traffic stripes (except black stripes) shall be beaded on the final finish coat in accordance with Subsection 714.03. ~~1209~~, "Reflective Material."
- C. The retroreflective preformed pavement markings shall conform to the applicable requirements of Subsection 714.03.06, "~~Thermoplastic Paint and~~ Pavement Markings."
 - 1. ~~These~~ retroreflective preformed pavement markings shall consist of plastic or thermoplastic material with pigments selected to conform to standard highway colors.
 - 2. Retroreflective beads shall be incorporated into the film to provide immediate and continuing retroreflection.
 - 3. 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~~ (MUTCD)."
- D. The Contractor shall furnish all equipment, materials, labor, and supervision necessary for installing 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.
- E. The Contractor shall warranty the applied markings for a minimum of ~~one (1)~~ year from the date of installation.
 - 1. If the manufacturer provides a longer warranty, the longer warranty shall apply.
 - 2. 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 ~~the Contractor's expense~~ no additional cost to the Contracting Agency.

TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS
CONSTRUCTION

628.03.01 WEATHER CONDITIONS

- A. Pavement marking materials shall be applied only when the pavement surface is dry and clean, when the surface temperature ~~shall be is~~ above ~~forty (40) degrees Fahrenheit (4 degrees Celsius)~~ and rising, and when the weather is not windy, foggy, or humid.
- B. Epoxy paint, Ppolyurea paint, and Preformed marking material, plastic or thermoplastic, shall only be applied if surface temperature is a minimum of ~~forty (40) degrees Fahrenheit (4 degrees Celsius)~~ and rising at the time of marking installation.
- C. If the manufacturer of the marking material requires a minimum surface temperature different than detailed above, the higher temperature shall be used.

628.03.02 EQUIPMENT

- A. All equipment ~~be~~ required to perform the work shall be approved in advance by the Engineer, and shall include, but not be limited to, 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.
- B. For traffic paint applications, the striping machine shall be an approved spray-type marking machine suitable for applying traffic paint in accordance with Section 714, "Paint and Pavement Markings," or as recommended by the paint manufacturer. The striping machine shall:
 - 1. ~~It shall h~~Have sufficient paint capacity for each color with adequate air pressure to perform the work satisfactorily without excessive stopping.
 - 2. ~~The machine shall p~~Produce a uniform film thickness and cross section at the required coverage.
 - 3. ~~and shall p~~Produce markings with clean-cut edges without running or spattering.
 - 4. ~~It must b~~Be capable of being guided within the straightness tolerances set forth in these specifications.
 - 5. ~~The machine shall h~~Have suitable adjustments for painting the line with width specified and when required.
 - 6. Be equipped with an automatic cycling device to produce intermittent (skip) lines.
 - 7. ~~The machine shall also b~~Be equipped to produce a variable skip pattern, including simultaneous painting of a broken line on ~~one 1~~ side and a solid line on the other side of the multiple strips. An acceptable tolerance in the skip pattern is plus or minus ~~six (6) inches (150 millimeters)~~.
 - 8. ~~The striping machine shall b~~Be capable of ~~three 3~~ gun application consisting of ~~one 1~~ black and ~~two 2~~ yellow spray guns operating simultaneously or individually.
 - 9. ~~The equipment shall also b~~Be capable of operating ~~two 2~~ white guns simultaneously.
 - 10. ~~The striping machine shall h~~Have a wheel base of sufficient length to produce a straight line to meet the straightness tolerance specified in Subsection 628.03.05, "Layout, Alignment, and Spotting."

TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

628

11. ~~The machine must also be~~ capable of producing curved lines without abrupt breaks, in accordance with approved layouts.
- C. For epoxy paint and polyurea paint applications, the striping equipment shall be a system capable of applying both yellow and white epoxy or polyurea paint to manufacturer's recommended proportions, producing striping of uniform dimension which comply with parameters for pavement markings set forth in Section 714, "Paint and Pavement Markings," ~~of these specifications.~~
 1. Equipment shall be capable of placing ~~two~~ 2 lines of traffic striping simultaneously with either line in a solid or intermittent pattern and applying retroreflective beads and or reflective elements at the rate recommended by the manufacturer.
 2. The equipment shall also have a metering device able to register the accumulated footage of markings installed per day for each spray gun.
 3. A technical expert in equipment operations and epoxy or polyurea applications shall be present at all times during the installation of epoxy or polyurea paint markings.
 - D. Equipment shall also be designed so that pressure gauges for each proportioning pump are constantly visible to the operator at all times during equipment operation so that any fluctuation and pressure difference can be monitored immediately. In addition, the striping equipment ~~must~~ shall have a minimum of one ~~twenty-four (24)~~ 2-inch long minimum static mixer unit for the proper mixing of the ~~two~~ 2 components of the epoxy paint material.
 - E. Provision shall be made for a dispenser capable of applying glass beads at the required rate.
 - F. Word markings, letters, numerals, and symbols shall be applied using suitable spray equipment together with stencils and templates.
 - G. Equipment for the application of preformed thermoplastic or plastic pavement marking material shall be as recommended by the manufacturer and as approved by the ~~governing entity~~ governing Engineer. Thermoplastic markings require the use of a propane torch as recommended by the manufacturer to fuse markings to asphalt and ~~p~~ Portland cement concrete pavements by means of heat.
 - H. 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.
 1. This machine shall meet all requirements of the air pollution control district having jurisdiction.
 2. All sand used in wet sandblasting shall be removed from the pavement without delay as the sandblasting operation progresses.
 3. Removal of striping by high velocity water jet may be permitted when approved by the Engineer.

628.03.03 GEOMETRY, STRIPES, AND TRAFFIC LANES

- A. Permanent and temporary striping and marking shall be in accordance with the MUTCD and Volume I of the ~~Uniform Standard Drawings for the Clark County Area.~~
- B. ~~If Should~~ the Contractor elects to alter the existing traffic stripes and markings, or to divert the flow of traffic on construction projects for ~~his~~ Contractor's own convenience, and there are no specific pavement markings or lane delineations shown on the plans or in the Special Provisions, ~~the~~ Contractor shall, with the approval of the Engineer, provide the

628 TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

necessary temporary striping in accordance with the MUTCD at no ~~expense~~additional cost to the Contracting Agency.

- C. 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.
- D. Temporary traffic lanes shall be at least ~~ten (10)~~ feet ~~(3 meters)~~ wide and no lane shall encroach within ~~five (5)~~ feet ~~(1.5 meters)~~ of an open excavation or within ~~two (2)~~ feet ~~(600 millimeters)~~ of a longitudinal curb.

628.03.04 PREPARATION OF EXISTING SURFACES

- A. Existing markings and striping, either permanent or temporary, ~~which~~that are to be abandoned or obliterated shall be removed by wet sandblasting or other approved methods.
 - 1. 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.
 - 2. Alternate methods of marking removal require prior approval of the Engineer.
 - 3. Obliteration of traffic striping with black paint or light emulsion oil shall be done only with the prior approval of the Engineer.
- B. Before applying pavement markings, the existing pavement surface shall be cleaned by washing, sweeping, blowing, vacuuming, or other methods recommended by the marking manufacturer, as necessary to remove moisture, dirt, grease, oils, acids, laitance, curing compound of pPortland cement concrete, or other foreign matter ~~which~~that would reduce the bond between the pavement marking material and the pavement.
- C. After cleaning, the surface shall be dried before applying pavement markings.

628.03.05 LAYOUT, ALIGNMENT, AND SPOTTING

- A. When necessary, the Engineer will furnish the needed control points for required pavement striping and markings.
- B. The Contractor shall establish pilot lining between these points by stringline or other method to provide striping that will vary less than ~~a half (1/2)~~ inch ~~(13 millimeters)~~ in ~~fifty (50)~~ feet ~~(15 meters)~~ from the specified alignment.
- C. The Contractor shall stripe or otherwise delineate the traffic lanes ~~per~~in accordance with the ~~Uniform~~ Standard Drawings and the MUTCD in the new roadway, portion of roadway, or detour before opening it to traffic if ~~it is~~so required by the Contract Documents.
- D. The Contractor shall provide an experienced technician to supervise the location, alignment, layout, dimensions, and application of the markings.

628.03.06 APPLICATION OF PAINT, EPOXY PAINT, AND POLYUREA PAINT

- A. Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved plans in accordance with ~~requirements of~~ this specification and Section 714, "Paint and Pavement Markings," or as provided in the Special Provisions.
- B. Where temporary traffic striping ~~and~~or marking is required, it shall not be applied until the layouts, alignments, sequencing, and condition of the existing surface have been approved.

TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

628

- C. Pavement marking material shall be mixed in accordance with the manufacturer's instructions. ~~#~~The material shall be mixed thoroughly and applied to the surface at the proper temperature, at its original consistency, and without the addition of ~~any~~ paint thinner or other materials.
- D. If traffic paint is applied in ~~two~~2 coats, comply with the following:~~the first coat shall be thoroughly dry before the second coat is applied.~~
 - 1. Retroreflective beads will be required only in the second coat.
 - 2. The first coat shall be thoroughly dry before the second coat is applied.
 - 3. On open-~~graded~~ surfaces, the second coat shall follow no sooner than ~~ten~~(10) calendar days after initial application.
- E. Application of retroreflective beads and or reflective elements shall be applied using the double drop method and ~~per~~in accordance with manufacturer's recommendations.
 - 1. Application rate of beads shall be as required by the manufacturer to meet retroreflectivity requirements specified in Subsection 714.03.06, "~~Thermoplastic Paint and Pavement Markings.~~"~~-of these specifications.~~
 - 2. In addition, retroreflective beads shall be applied to traffic markings in accordance with Subsection 714.03.~~1209~~, "Reflective Material."
- F. Ten days shall elapse between the application of a bituminous seal coat and the permanent traffic marking material.
 - 1. The traffic paint, epoxy paint, or polyurea paint shall not bleed, curl, or discolor when applied to bituminous surfaces.
 - 2. If bleeding or discoloring occurs, the unsatisfactory areas shall be corrected as directed by the ~~governing entity's~~ Engineer.
- G. Straight stripes deviating more than ~~a half~~(1/2) an inch in ~~fifty~~(50) feet ~~(13 millimeters in 15 meters)~~ shall be obliterated by sandblasting or other approved method and the markings corrected.
 - 1. The width of markings shall be as designed, within a tolerance of ~~four~~(4) percent.
 - 2. When existing striping and markings are to be repainted, they shall be repainted ~~so as to~~ completely cover the old markings within ~~a quarter~~(1/4) inch ~~(6 millimeters)~~.
 - 3. Stripe repainting shall be retraced within a longitudinal tolerance of ~~six~~(6) inches ~~(150 millimeters)~~ plus or minus at the end of each stripe.
 - 4. Abrupt breaks in striping alignment will not be allowed.
 - 5. The striping shall be a continuous operation except where crossovers are required to complete painted medians.
 - 6. Restriping operations involving epoxy paint and polyurea paint shall be performed in accordance with manufacturer's recommendations.
- H. The application of pavement markings and striping using traffic paint, epoxy paint, or polyurea paint shall be performed by competent equipment operators and painters using proper equipment, tools, stencils, templates, and shields in a workmanlike manner.
- I. Difficulties experienced in cool weather may be minimized by heating the pavement marking material in accordance with manufacturer's recommendations to provide for a uniform flow of material.

628 TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

- J. Temporary striping and marking shall be renewed when the stripes and markings have lost ~~fifty (50)~~ percent of their original visual effectiveness.
- K. The Contractor shall furnish a notarized certificate signed by either an authorized employee of the manufacturer or testing laboratory stating that the pavement marking material conforms to the specified requirements and is in accordance with Subsection 714.02.01, "Certificates."

628.03.07 PROTECTION OF WORK, WORKMEN, AND THE PUBLIC

- A. 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.
- B. Markings and striping shall be protected from injury and damage of any kind until the material is ready for traffic.
- C. Adjacent surfaces shall be protected from disfiguration by spatter, splashes, spillage, and dripping of paint, adhesives, primer, or other material.
- D. In areas of high traffic volume, the Contractor shall schedule ~~his~~ work to install traffic lines and markings in off-peak traffic hours.

628.03.08 DEFECTIVE WORKMANSHIP OR MATERIAL

- A. 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~~ no additional cost to the Contracting Agency.

628.03.09 INSTALLATION OF RETROREFLECTIVE PREFORMED PAVEMENT MARKINGS

- A. Traffic striping and marking shall be applied at locations and to the dimensions and spacing indicated on the approved plans in accordance with ~~requirements of~~ this specification and Section 714, "Paint and Pavement Markings," or as provided in the Special Provisions.
- B. The retroreflective preformed pavement marking materials shall not be applied within ~~two~~ 2 weeks after laying and rolling asphalt concrete wearing courses unless otherwise specified in the Special Provisions ~~of the contract~~.
- 1. The preformed markings shall conform to the pavement contours by the action of traffic.
 - 2. After application, the markings shall be immediately ready for traffic.
- C. 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 Contracting~~ a Agency prior to installing the pavement marking material.
- D. Joints in the initial installation of new pavement markings will be allowed only on lane lines and change of direction.
- E. The longitudinal bars in crosswalks, if used, shall be ~~one~~ 1 piece.
- F. Pavement marking failures shall be removed and replaced a minimum of ~~six (6)~~ inches ~~(150 millimeters)~~ each side of the failure and the patch shall be a minimum of ~~twenty-four (24)~~ inches ~~(600 millimeters)~~ in length.

TRAFFIC STRIPING, PAVEMENT MARKINGS, AND CURB MARKINGS

628

MEASUREMENT

628.04.01 MEASUREMENT

- A. The quantity of traffic striping and marking shall be measured by ~~one~~ 1 or more of the following methods: linear ~~footage~~ 1 ~~(lineal meters)~~, the area in square feet ~~(square meters)~~, or ~~one~~ 1 lump sum item complete in place, as shown on the plans or indicated in the Special Provisions.
- B. The quantity of ~~the~~ Type ~~1~~ 2 pavement marking materials for symbols and legends measured for payment shall be per each, complete and in place.
- C. The quantity of ~~the~~ Type ~~1~~ 2 pavement marking materials for crosswalks and stop bars measured for payment shall be the number of square feet ~~(square meters)~~, complete and in place.
- D. The quantity of Type ~~1~~ 1 pavement marking materials 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

- A. 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 installation of all traffic striping or markings, including removal of existing conflicting markings and preparation of surface for new markings, as shown on the plans or indicated in the Special Provisions.
- B. All costs for temporary pavement painting for the convenience of the Contractor, including costs for removal of existing lines and markings, shall be at no additional cost to the Contracting Agency ~~his sole expense~~.
- C. Payment shall be made under:

PAY ITEM**PAY UNIT**

Type 1 <u>2</u> "ONLY" Marking.....	Each
Type 1 <u>2</u> (a <u>A</u> Arrow) Marking	Each
Type 1 <u>2</u> Marking for Crosswalks and Stop Bars	Square <u>Foot</u> (SM)
Type 1 <u>1</u> White 4- inch <u>inch</u> Marking.....	Linear <u>Foot</u> (LM)
Type 1 <u>1</u> Yellow 4- inch <u>inch</u> Marking	Linear <u>Foot</u> (LM)

SECTION 629**WATER DISTRIBUTION FACILITIES****DESCRIPTION****629.01.01 GENERAL**

- A. 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.
- B. 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; and the removal and/or restoration of existing improvements; ~~and~~ all work in accordance with the plans and specifications.

629.01.02 STANDARDS

- A. ~~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 Off-Site Improvements, Clark County Area, Nevada~~ All work shall conform to these specifications and the latest edition of the "Uniform Design and Construction Standards For Potable Water Distribution Systems" (UDACS) prepared by the Las Vegas Valley Water District (LVVWD). Where conflicts may arise, the UDACS shall govern.

629.01.03 SHOP DRAWINGS

- A. ~~(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~~ 3 prints of each shop drawing.
 - 1. The term "shop drawing" as used herein shall be understood to include lists, graphs, operating instructions, ~~etc~~ and so forth.
 - 2. Unless otherwise required, ~~said~~ shop 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.
 - 3. Within 10 calendar days after receipt of ~~said~~ the prints, the Engineer will return ~~one~~ 1 print of each drawing to the Contractor with ~~his~~ the Engineer's comments noted thereon.
- B. ~~(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.
 - 1. 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.
 - 2. The Contractor shall have no claim for damages or extension of time due to any delay resulting from making required revisions to shop drawings.

3. The review of ~~said~~shop 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 therein 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

- A. Unless otherwise specified in the Special Provisions, all lines and grades required for proper execution of the work as shown in the Contract Documents shall be furnished by the Contractor.
- B. The Contractor shall be responsible for the preservation of all bench marks and survey marks and shall be responsible for the cost of ~~their~~ replacement.
- C. If a pipeline profile is shown on the drawings, cut sheets shall be prepared and made available to the Engineer upon request, at least 24 hours prior to excavation.

629.01.05 OPERATION OF VALVES

- A. Valves on public water mains shall be operated only by authorized personnel of the LVVWD, the governing agency, or under the direct supervision thereof.

629.01.06 JOINT USE TRENCHES

- A. Joint use trenches may be as shown in the Standard Drawings.
- B. Water mains shall be a minimum of 10 feet (~~3.05 meters~~) horizontally from sewers.

MATERIALS

629.02.01 GENERAL

- ~~A.~~ The Contractor shall furnish all materials, including appurtenances, necessary to complete all work as shown ~~or specified~~and in accordance with the specifications. Fabricated materials shall be new and of current manufacture.

~~629.02.02 ASBESTOS CEMENT PIPE~~

- ~~A.~~ Water mains shall be constructed of asbestos cement pipe Class 150, unless otherwise specified, and shall conform to the "Standard for Asbestos Cement Water Pipe" (AWWA C 400), provided, however, that joints shall be "Ring-Tite" as manufactured by Johns-Manville Corporation, "Fluid-Tite" as manufactured by Certainteed Products Corporation; or approved equal. Rubber rings shall conform to ASTM D 1869. The uncombined calcium hydroxide contained in the pipe and couplings shall not exceed 1% when tested in accordance with the Appendix to AWWA C 400.

~~629.02.03 CAST IRON FITTINGS~~

- ~~A.~~ Unless otherwise designated on the drawings, all fittings to be used with asbestos cement pipe shall be ~~cast ductile iron or gray iron~~ fittings conforming to the quality and wall thickness specified in the "American Standard for Cast Iron Fittings, 2 inches through 48 inches (5 through 122 centimeters), for Water and Other Liquids" (ASA A 21.10/AWWA C 110), provided, however, that the ends shall be designed for "Ring-Tite" joints as manufactured by JM Eagle, or "Fluid-Tite" joints as manufactured by Certainteed Products Corporation; or approved equal, specified in Subsection 629.02.02.

- ~~B. All cast ductile iron and gray iron fittings shall be mortar or asphalt lined as required by the Contracting Agency.~~
- ~~C. All buried flange joints shall be thoroughly cleaned and coated with not less than two 2 coats of EC 244 (or approved equal) and wrapped with two 2 layers of 6 mil thickness plastic wrap material.~~

629.02.04 STEEL FITTINGS

A. (a) General:

- ~~1. Where shown, fittings for use on asbestos cement pipe shall be fabricated steel fittings designed with minimum operating pressure equal to the maximum pipe ratings at a 4:1 safety factor.~~
- ~~2. Fittings for use on asbestos cement pipe shall have ends machined to receive the standard asbestos cement pipe coupling.~~
- ~~3. Fittings shall be manufactured in accordance with AWWA Standard C 201 or AWWA C 202 for fabricated welded steel pipe with dimensions as specified in AWWA Standard C 208, Table 1 or Table 2, except that side outlet and straight run dimensions may be reduced.~~
- ~~4. Flanges shall be compatible with the class rating of the fitting and shall conform to AWWA C 207, Tables 1, Table 2, or Table 3.~~
- ~~5. All welding shall be in accordance with AWWA Standard C 206 and requirements of the American Welding Society.~~
- ~~6. Fittings shall be as manufactured by Pipeline Accessories Company, or approved equal.~~
- ~~7. After fabrication, all steel fittings shall be lined and coated in accordance with Section 629.02.04, "Steel Fittings," paragraph (b) B or (c) C.~~

B. (b) Mortar Lining and Coating:

- ~~1. Steel fittings shall be lined and coated with cement mortar in accordance with the "Standard for Cement Mortar Protective Lining and Coating for Steel Water Pipe" (AWWA C 205), except the lining thickness shall be 3/4 inch (1.9 centimeters) for pipe over 16 inches (40.6 centimeters) in diameter, 1/2 inch (1.3 centimeters) for pipe of 14 inch and 16 inch (35.6 and 40.6 centimeters) diameter, and 5/16 inch (0.8 centimeters) for pipe of less than 14 inches (35.6 centimeters) in diameter.~~
- ~~2. Cement for lining may be either Type II or Type V.~~
- ~~3. Wherever practicable, steel fittings shall be lined centrifugally.~~
- ~~4. The cement mortar coating shall be 1-1/2 inches (3.8 centimeters) thick and shall be reinforced with spirally-wound 14 gauge steel wire spaced at one (1) inch (2.5 centimeters) centers positioned at approximately the center of the coating, or~~
- ~~5. in lieu of spirally-wound wire, the coating shall be reinforced with two (2) inch (5 centimeters) by four (4) inch (10 centimeters) No. 12 welded wire fabric crimped so as to hold the wire approximately at the center of the mortar coating.~~
- ~~6. Cement used for the mortar coating shall be Type V cement.~~
- ~~7. Immediately after curing the lining, ends of fittings shall be bulkheaded with heavy plastic to prevent the lining from drying out.~~
- ~~8. Bulkheads shall remain in place until the pipe and fittings are installed.~~

- ~~C. (c) **Alternate Lining and Coating:** As an alternate to cement mortar lining and coating, steel fittings may be coated and epoxy lined in accordance with Subsection 629.02.26, "Paintings and Coatings," paragraph B(b).~~

~~629.02.05 STEEL PIPES~~

~~A. (a) **General:**~~

- ~~1. The Contractor shall furnish all labor, materials, equipment and services for a complete installation of steel piping as shown on the drawings.~~
- ~~2. Pipe materials, method of manufacture, and shop testing of straight pipe shall conform to the requirements of the "Standard for Fabricated Electrically Welded Steel Water Pipe" (AWWA C 201).~~

~~B. (b) **Design:**~~

- ~~1. In no case shall the thickness be less than 3/16 of an inch (0.5 centimeters).~~
- ~~2. All outlets shall be designed with reinforcing for a water working pressure of 200 psi (1.38 MPa).~~

~~C. (c) **Joints:**~~

- ~~1. Welded steel pipe shall be provided with joints shown.~~
- ~~2. Field welds shall be made utilizing slip-bell joints or butt strap joints.~~

- ~~D. (d) **Fittings:** Steel welded fittings shall conform to the requirements of the "Specifications for Factory-Made Wrought Carbon Steel and Ferritic Alloy Steel Welding Fittings" (ASTM A 234).~~

~~E. (e) **Flanges:**~~

- ~~1. Materials, dimensions, and drilling of flanges for pipe and fittings shall be in accordance with the "Standard for Steel Pipe Flanges" Class D (AWWA C 207), or "Steel Pipe Flanges and Flanges Fittings" Class 150 (ASA ASME B 16.5), Class 150.~~
- ~~2. Flanges shall be furnished with flat faces.~~
- ~~3. Pipe flanges shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown.~~
- ~~4. Attachment of the flanges to the pipe shall conform to the applicable requirements of the above referenced AWWA Standard C 207.~~

~~F. (f) **Welding:**~~

- ~~1. All hand welding shall be done by welders certified in accordance with Appendix II of the "Code for Pressure Piping" (ASA ME B 31.1) or the "Standard for Field Welding of Steel Water Pipe Joints" (AWWA C 206).~~
- ~~2. Field welding shall conform to the requirements of the above referenced AWWA Standard C 206.~~

~~G. (g) **Shop Testing:**~~

- ~~1. Upon completion of the welding, but before lining, each steel plate special shall be bulkheaded and tested under a hydrostatic pressure of not less than 200 psi (1.38 MPa), provided,~~

- ~~2. h. However, that if straight pipe used in fabricating the specials has been previously tested in accordance with Subsection 629.02.05(a) herein AWWA C201, the circumferential welds may be tested by a dye penetrant process using Turco Dy-Chek, or approved equal, with no further hydrostatic test.~~
- ~~3. Any pin holes or porous welds which may be revealed by the test shall be chipped out and rewelded and the pipe or fitting retested.~~

~~H. (h) Lining:~~

- ~~1. Welded steel pipe and fittings shall be lined with cement mortar in accordance with the "Standard for Cement Mortar Protective Lining and Coating for Steel Water Pipe" (AWWA C-205).~~
- ~~2. Cement shall be Type V Portland cement.~~
- ~~3. Wherever practicable, plate specials shall be lined centrifugally.~~
- ~~4. Lining not applied by the centrifugal process shall be reinforced with two (2) inch by four (4) inch (5 by 10 centimeters) No. 12 gauge welded wire fabric crimped so as to hold the wire at approximately the center of the mortar lining.~~
- ~~5. Immediately after lining, ends of pipe and fittings shall be bulkheaded with heavy plastic to prevent the lining from drying out.~~
- ~~6. Bulkheads shall remain in place until the pipe and fittings are installed.~~

~~I. (i) Coating:~~

- ~~1. (1) All buried pipe and fittings or pipe encased in concrete shall receive 3/4 inch (1.9 centimeter) thick reinforced cement mortar coating.~~
 - ~~a. The coating shall be reinforced with spirally wound No. 14 gauge steel wire spaced at 1/2 inch centers or No. 12 gauge steel wire spaced at one (1) inch (2.5 centimeters) centers, positioned approximately at the center of the mortar coating; or~~
 - ~~b. In lieu of spirally wound wire, the coating shall be reinforced with two (2) inch by four (4) inch (5 by 10 centimeters) No. 12 gauge welded wire fabric crimped so as to hold the wire approximately at the center of the mortar coating.~~
 - ~~c. Cement, and sand and water shall be mixed in the proportions of 1 part of Type V cement to not more than 3 parts of sand.~~
 - ~~d. No more than 4 1/2 gallons (17 liters) of water shall be used per sack of cement.~~
 - ~~e. After the outside coating has been applied, the pipe shall be cured for 6 days under sprinklers.~~
- ~~2. (2) The exterior surfaces of welded steel pipe and fittings which that are located above ground or within structures shall be cleaned, primed, and finish painted as specified in Subsection 629.02.26, entitled "Painting and Coatings."~~

~~629.02.06 AIR-VACUUM AND AIR RELEASE VALVES~~

- ~~A. Unless otherwise specified, air vacuum and air release valves shall have screwed ends.~~
- ~~B. The bodies shall be of high strength cast iron or ductile iron and the float shall be of stainless steel.~~

- ~~C. All moving parts shall be bronze conforming to the requirements of the "Specifications for Leaded Red Brass and Leaded Semi-Red Brass Sand Castings" (ASTM B145 B584), Alloy A, or Type 18-8 stainless steel.~~
- ~~D. Seat washers and gaskets shall be of a material ensuring watertightness with a minimum of maintenance.~~
- ~~E. Valves shall be designed for normal operation at a water working pressure equal to the design pressure of the pipeline, and shall be tested under a hydrostatic pressure of at least 300 psi (2.07 MPa), and~~
- ~~F. Valves shall be Crispin Universal, Air Valve as manufactured by Multiplex Manufacturing Company, Berwick, Pennsylvania, or APCO "Heavy Duty" Combination Air Release Valve as manufactured by Valve and Primer Corporation, or approved equal.~~

629.02.07 PIPE CASING

- ~~A. (a) **General:** Unless otherwise specified or shown, the casing shall be steel or reinforced concrete pipe.~~
- ~~B. (b) **Steel Pipe Casing:**~~
 - ~~1. Steel pipe casing shall be fabricated from a minimum of 1/4-inch (0.6 centimeters) thick steel plates conforming to the requirements of ASTM A 283, Grades B, C, or D.~~
 - ~~2. All joints shall be welded.~~
 - ~~3. Interior joints shall be ground to a smooth finish.~~
 - ~~4. All welding shall be performed in accordance with AWWA C 201, "AWWA Standard for Fabricated Electrically Welded Steel Water Pipe."~~
- ~~C. (c) **Reinforced Concrete Pipe Casing:**~~
 - ~~1. Reinforced concrete pipe casing shall conform to the requirements of ASTM C 76, Class III.~~
 - ~~2. Joints shall be mortared on the inside and wiped smooth to provide a smooth interior along the full length of the casing.~~

629.02.08 PLASTIC SERVICE LATERALS

- ~~A. (a) **Plastic Piping:**~~
 - ~~1. Plastic piping shall be of a high density, ultra-high molecular weight polyethylene pipe compound, meeting the requirements of Type III, Grade P 33, Class C material as described in ASTM D 1248.~~
 - ~~2. Standard dimension ratio shall be SD R-7 for pipe size.~~
 - ~~3. The pipe shall be rated for 160 psi (1.10 MPa) working pressure at 73 degrees F. (23 degrees C.) for water and shall carry the National Sanitation Seal of Approval for drinking water.~~
 - ~~4. The pipe shall be pipe size as manufactured by Orangeburg, Carlon, Phillips 66 Drisco Pipe, Cresline, or approved equal.~~
 - ~~5. The plastic pipe shall be marked at intervals of not more than two feet (60 centimeters), and marking shall include the nominal size, manufacturer's name or trademarks, pressure rating at 73 degrees F. (23 degrees C.), 160 psi (1.10 MPa), ASTM material specification, PE 3306, standard dimension ratio.~~

~~B. (b) Fittings:~~

- ~~1. Fittings for pipe size shall be compression type fittings with stainless steel liner, the Mueller 110 compression connection, or as furnished by the Ford Meter Box C-36, or approved equal.~~
- ~~2. If minimum radius bends cannot be installed, fittings will be required.~~
- ~~3. No heating of pipe to accomplish bends or fittings will be accepted.~~

~~C. (c) Service Connection: Service connections shall include meter box, idler, and tail piece to be furnished and installed by the Contractor, as shown on the drawings or herein specified.~~~~629.02.09 RED BRASS PIPE AND FITTINGS~~

- ~~A. All brass pipe and bronze fittings shall conform to the requirements of the "Specification for Seamless Red Brass Pipe, Standard Sizes" (ASTM Designation B-43) and "Specification for Composition Bronze or Ounce Metal Casting" (ASTM Designation B-62).~~

~~629.02.10 COPPER SERVICE LATERALS~~

- ~~A. (a) Copper Tubing: Copper tubing shall comply with the requirements of ASTM Designation B-88, Type K seamless soft annealed and shall be delivered in 20-foot (6.1 meters) minimum straight lengths or coils.~~

~~B. (b) Pipe Fittings:~~

- ~~1. Pipe fittings shall be bronze flared gas tubing complying with ASAME B-16.26 or bronze compression type fittings.~~
- ~~2. Threads shall be as specified in AWWA C-800.~~

~~C. (c) Service Connections: Service connections shall include meter box, cast iron cover, idler, tail piece and meter, if required, all of which are to shall be furnished and installed by the Contractor.~~~~629.02.11 METER BOXES~~

- ~~A. Meter boxes shall be as manufactured by Brooks, or approved equal with cast iron lids.~~

~~629.02.12 SERVICE SADDLE~~

- ~~A. Service saddles for pipelines 6 inches (15 centimeters) and larger shall be double strap bronze service clamps, I.P. thread, Jones J-979, Smith-Blair 323, or approved equal.~~
- ~~B. Service saddles for pipelines smaller than 6 inches (15 centimeters) shall be single strap bronze service clamps with I.P. thread.~~

~~629.02.13 FLANGE GASKETS~~

- ~~A. Gaskets for flange joints shall be full-face gaskets, 1/8-inch (0.32 centimeters) thick cloth inserted rubber sheet, or 1/16-inch (0.16 centimeters) thick laminated asbestos fiber, Granite, or approved equal.~~

~~629.02.14 TAPPING SLEEVES~~

- ~~A. Tapping sleeves shall be:~~

1. ~~m~~Mechanical joint tapping sleeves, (unless caulk type are required.)
 2. ~~d~~Designed to withstand a working pressure of 200 psi (1379 KPa).
 3. ~~Tapping sleeves shall be Mueller H-615 or approved equal.~~
- B. ~~In addition to cast iron, steel fabricated tapping sleeves may be installed where the size of the tap is 75% percent or less of the size of the main being tapped.~~

629.02.15 BOLTS

- A. ~~Unless otherwise shown, bolts shall be a cadmium plated and shall conform with the "Specifications for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners," Grade B (ASTM Designation A 307, Grade B);, or "Specifications for Carbon Steel Bars Subject to Mechanical Property Requirements" (ASTM Designation A 306663;) or Threaded parts of ASTM Designation A 36, and shall meet the following additional requirements:~~
1. ~~(1) The nut materials shall be free-cutting steel;~~ and
 2. ~~(2) the nuts shall be capable of developing the full strength of the bolts.~~
- B. ~~Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.~~
- C. ~~All bolts shall have hexagon heads, and nuts shall be Heavy Hexagon Series.~~

629.02.16 MECHANICAL TYPE COUPLINGS

- A. ~~Mechanical type couplings shall be designed for a water working pressure equal to the design pressure for the pipe on which they couplings are to be installed, and shall be equipped with a Grade H rubber gasket for water service.~~
1. ~~Couplings shall be Gustin-Bacon or Victaulic, Style 44 or Style 77, or equal.~~
 2. ~~Buried couplings shall be epoxy-coated in accordance with Subsection 629.02.26, "Paintings and Coatings," paragraph B06(b).~~

629.02.17 SLEEVE-TYPE COUPLINGS

- A. ~~Sleeve-type couplings shall be:~~
1. ~~Smith-Blair Type 411, Dresser Style 38, or approved equal, and shall be~~
 2. ~~oOf steel without pipe stop,~~ and shall be
 3. ~~iIn sizes to fit the pipe and fittings shown.~~
- B. ~~The middle ring shall be not less than 1/4 inch" (0.64 centimeters) in thickness and may be either 5 inches or 7 inches (12.7 or 17.8 centimeters) long.~~
- C. ~~Buried sleeve-type couplings shall be provided with Type 304 stainless steel bolts, and all surfaces shall be epoxy-coated at the factory in accordance with Subsection 629.02.26, "Paintings and Coatings," paragraph B(b).~~

629.02.18 INSULATING FLANGE JOINTS

- A. ~~Insulating flange joints shall be provided as shown on the drawings.~~
- B. ~~Polyethylene stud sleeves, two 2 fabric-reinforced phenolic washers, and two 2 steel washers shall be provided with each stud.~~

WATER DISTRIBUTION FACILITIES

629

- ~~C. Gaskets shall be full face and gasket material shall be Johns-Manville No. 71 dielectric sheet packing.~~
- ~~D. Flanged joint insulating assemblies shall be as supplied by Central Plastics Distributing, or approved equal.~~

629.02.19 VALVE BOXES AND COVERS

- ~~A. Cast iron sliding type adjustable valve boxes with covers shall be provided for all buried valves.~~
- ~~B. Valve boxes shall consist of the top and bottom section with slide type extensions and large bottom base where required.~~
- ~~C. Drop type covers shall be marked "WATER." In paved areas, valve boxes shall be provided with a 6 inch (16 centimeters) thick collar, 24 inches (61 centimeters) square, at the ground surface.~~
- ~~D. Valve boxes and covers shall be Parkson-Buffalo type, Mueller A-10-364, Iowa F-2452, Tyler #6855, or approved equal.~~
- ~~E. Valve boxes shall be installed as shown.~~

629.02.20 PRECAST CONCRETE MANHOLES

- ~~A. Precast concrete rings used in making up manholes shall be manufactured by any process that will produce a dense, homogeneous concrete ring of first quality.~~
- ~~B. The grade rings shall have a minimum wall thickness of 4 inches (10 centimeters), if steel reinforced.~~
- ~~C. Manhole top sections shall be designed for an H-20 loading.~~
- ~~D. Manhole risers shall comply with meet the requirements of the "Standard for Precast Reinforced Concrete Manhole Sections" (ASTM Designation C-478).~~
- ~~E. Manhole grade rings, risers, and top sections shall be as manufactured by Associated Concrete Products, Costa Mesa, California; American Pipe and Construction Company, South Gate, California; Hydro-Conduit Corporation, Henderson, Nevada; or approved equal.~~
- ~~F. Cement used in concrete manholes shall be Type V Portland cement meeting the requirements of as specified in Section 701, "Hydraulic Cement."~~
- ~~G. Mortar for bonding the joints of the rings shall consist of one 1 part by volume of cement and 2-1/2 parts of volume of sand.~~

629.02.21 MANHOLE FRAMES AND COVERS

- ~~A. Except as otherwise shown, manhole frames and covers shall be designed for a clear opening of 30 inches (76 centimeters) and shall be Alhambra Foundry Style A-1310, or approved equal, and~~
- ~~B. the cover shall be marked "WATER."~~

629.02.22 CORPORATION STOPS AND ACCESSORIES

- ~~A. Corporation stops, and angle meter stops shall be as manufactured by the Mueller Company, H-1012, the James Jones Company, J-41, or approved equal.~~

~~B. Service clamps shall have double flat silicone bronze straps and bronze nuts.~~

~~629.02.23 VALVES~~

~~A. (a) General:~~

- ~~1. (1) The Contractor shall furnish and install all valves shown and specified.~~
- ~~2. (2) The flanges of valves may be raised or plain faces.~~
- ~~3. Unless otherwise noted, flanges of valves required to be flanged shall be faced and drilled to 125 pounds (0.86 MPa) American Standard dimensions.~~
- ~~4. (3) Unless otherwise specified, each valve body shall be tested under a test pressure equal to twice its design water working pressure.~~
- ~~5. (4) Unless otherwise specified, all interior bronze parts of valves, except gate valve stems, shall conform to the requirements of the "Specifications for Composition Bronze or Ounce Metal Castings" (ASTM B 62).~~
- ~~6. Gate valve stems shall be of bronze containing not more than 5 percent% of zinc nor more than 2 percent% of aluminum, and shall have a minimum tensile strength of 60,000 psi (413.8 MPa), a yield strength of 40,000 psi (275.8 MPa), and an elongation of at least 10 percent% in 2 inches (5 centimeters), as determined by a test coupon poured from the same ladle from which the valve stems to be furnished are poured.~~
- ~~7. (5) Shop drawings on valves shall be furnished in accordance with Subsection 629.01.03, "Shop Drawings."~~

~~B. (b) Butterfly Valves:~~

- ~~1. (1) Butterfly valves shall conform to the "AWWA Standard for Rubber-Seated Butterfly Valves" (AWWA C 504), subject to the following requirements:~~
 - ~~a. Valves shall be Class 150-B.~~
 - ~~b. Valves shall be furnished with flanges faced and drilled to 125_ pound (0.86 MPa) American Standard dimensions, and, unless otherwise shown, may be either short-bodied or long-bodied.~~
 - ~~c. Shaft seals shall be designed for use with standard split-V type packing.~~
 - ~~d. Valve discs shall be manufactured of any material listed in AWWA C504, Section 8.2_ of the above referenced AWWA standard except bronze.~~
 - ~~e. The metal surface seating against the rubber seat, or the surface in contact with the rubber disc edge, shall be tType 18-8 stainless steel.~~
 - ~~f. For valves 12 inches (30 centimeters) and larger, the rubber seat shall be attached to the valve body and not to the disc.~~
 - ~~g. For valves 10 inches (25 centimeters) and smaller, the rubber seat may be attached to the body or the disc.~~
 - ~~h. Valves 10 inches (25 centimeters) and smaller shall be "450" as manufactured by Dresser Industries, or approved equal.~~
 - ~~i. Valves 12 inches (30 centimeters) and larger shall be Series 650 as manufactured by BIF Industries, "Triton" as manufactured by Henry Pratt Company, or approved equal.~~

~~2. (2) Operators:~~

- ~~a. (a) Except as otherwise provided herein, valves shall be provided with watertight manual operators.~~
 - ~~1) The operating torque of each valve and operator shall be computed in accordance with Appendix A of AWWA Standard C 504, Appendix A, for the pressure as indicated and a velocity of 16 fps (4.9 meters per second).~~
 - ~~2) Operation shall be through totally enclosed, permanently lubricated, and sealed gear reducers which provide at least 40 revolutions of the operator input shaft to open or close valve.~~
 - ~~3) Gear reducers shall have self-locking worm gearing.~~
 - ~~4) Open and close stops shall be provided to limit valve disc travel.~~
 - ~~5) Traveling nut operators will not be permitted for valves 24 inches (61 centimeters) in diameter and larger.~~
- ~~b. (b) Unless otherwise specified, valves in vaults shall be provided with manual handwheels, and position indicators.~~
 - ~~1) The position of the handwheel will be specified at the time shop drawings are submitted.~~
 - ~~2) All valves shall be provided with a counterclockwise opening, 2-inch (5 centimeters) square operating nut with a horizontal valve shaft.~~

~~C. (c) Gate Valves:~~

- ~~1. Except as otherwise provided herein, gate valves shall conform to the "Standard for Gate Valves for Ordinary Water Works Service" (AWWA C 500).~~
- ~~2. Valves shall be of the iron bodied, bottom-wedging, double-disc type with non-rising stem, except as otherwise shown, with counterclockwise opening, and provided with a 2-inch (5 centimeters) square operating nut, or handwheel, as shown.~~
- ~~3. Valves with non-rising stems shall have O-ring seals.~~
- ~~4. Valves with outside screw and yoke shall be provided with stuffing boxes.~~
- ~~5. Unless otherwise specified, all interior parts of gate valves, including discs, shall be constructed of bronze conforming to the requirements contained in Subsection 629.02.23, "Valves," subparagraph A.5.(a)(4).~~
- ~~6. Gate valves shall be furnished with flanged ends, hub ends, or with "Ring-Tite" or approved equal ends as shown.~~
- ~~7. Gate valves 14 inches (36 centimeters) and larger in diameter shall be furnished with valved bypass.~~
- ~~8. Gate valves shall be as manufactured by Mueller, Iowa M & H, RichClow Valves, or approved equal.~~

~~D. (d) Angle Valves:~~ Angle valves shall be designed for a water working pressure equal to design pressure of the pipeline, shall be bronze trimmed, and Crane No. 353, Powell No. 308, or approved equal.~~E. (e) Miscellaneous Small Valves:~~

~~1. Miscellaneous small valves shall be as shown.~~

- ~~1. Where plug valves are indicated and where valves smaller than 4 inches (10 centimeters) are not specifically labeled or otherwise specified, the valves shall be iron-bodied, lever-operated, rubber faced, eccentric plug valves, Dezurik, Series 100 or approved equal.~~

629.02.02 CONCRETE

- A. All concrete shall be portland cement concrete conforming to ~~the requirements of~~ Section 501, "Portland Cement Concrete," ~~of the Standard Specifications.~~

629.02.03 REINFORCING STEEL

- ~~A. Reinforcing steel shall be deformed steel bars or cold-drawn steel wire, or fabricated forms of those materials, as required by the applicable drawings and specifications. Materials shall conform in quality to the requirements of "Reinforcement," Section 713, "Reinforcement," of the Standard Specifications.~~

629.02.26 PAINTINGS AND COATINGS

~~A. (a) General:~~

- ~~1. The Contractor shall furnish all labor, material and equipment necessary to complete the painting and to provide protective coatings as specified or required.~~
- ~~2. All coating thicknesses described herein refer to dry film thickness.~~

~~B. (b) Epoxy Coating:~~

- ~~1. (1) General: Where specified or shown, an epoxy coating shall be applied as specified herein.~~
- ~~2. (2) Material:~~
 - ~~a. Except as otherwise provided herein, the material used shall be 100 percent% powder epoxy and shall be 3-M Company "Scotchkotecoat," Michigan Chrome and Chemical Company "Micron 650 or 651," or approved equal.~~
 - ~~b. Where, in the Engineer's opinion, because of the nature of the item being coated, it would be impossible to use the powder epoxy method without causing damage to the item, the use of a liquid epoxy will be permitted.~~
 - ~~c. The Said liquid epoxy shall be 3-M Company No. Scotchkote 306, Keysite 740, or approved equal.~~
- ~~3. (3) Surface Preparation:~~
 - ~~a. The surface shall be blast-cleaned in accordance with SSPC-SP-5 (White Metal Blast Cleaning).~~
 - ~~b. The grit size used shall be as recommended by the epoxy manufacturer.~~
 - ~~c. All joints shall be ground smooth before blasting.~~
- ~~4. (4) Application:~~
 - ~~a. Application of the epoxy coating shall be in accordance with the manufacturer's instructions.~~

- b. ~~;~~ provided that ~~However,~~ if liquid epoxy is permitted, it shall be applied in not less than 3 spray coats to give the required total thickness.

5. ~~(5) Thickness of Coating:~~

- a. ~~The minimum dry coating thickness shall be 8 mils.~~
- b. ~~, provided, h~~ ~~However,~~ that the thickness of coating in the grooves or valves or fittings designed to receive a rubber gasket shall be approximately 5 mils.

6. ~~(6) Inspection:~~

- a. ~~Coating thickness shall be checked with a non-destructive magnetic type thickness gauge.~~
- b. ~~Coating integrity shall be tested with a sponge testing unit operating at approximately 60 volts.~~
- c. ~~All pinholes shall be marked, repaired, and retested.~~
- d. ~~No pinholes or other irregularities will be permitted in the final coating.~~

7. ~~(7) Field Repairs:~~

- a. ~~If small local repairs are necessary, they repairs shall be made using the same liquid epoxy with which the item was initially coated.~~
- b. ~~The surface must first be hand tool cleaned in accordance with SSPC-SP-2₁ (Hand Tool Cleaning).~~
- c. ~~The repair epoxy material shall be applied in accordance with the manufacturer's instructions.~~

C. ~~(c) Buried Galvanized Steel Pipe:~~

1. ~~Buried galvanized steel pipe and shall be cleaned and wrapped with PVC tape in accordance with these specifications.~~
2. ~~(1) Surface Preparation: Surfaces shall be cleaned in accordance with SSPC-SP-3₁ (Power Tool Company Cleaning).~~
3. ~~(2) Wrapping:~~
- a. ~~Prior to wrapping the pipe with PVC tape, the pipe shall be primed using a primer recommended by the PVC tape manufacturer.~~
- b. ~~After being primed, the pipe shall be wrapped with a 20₁ mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.~~
- c. ~~Application shall be in accordance with the tape manufacturer's instructions.~~

D. ~~(d) Buried Miscellaneous Ferrous Surfaces, Valves and Joints.~~

1. ~~(1) Surface Preparation: Surfaces shall be cleaned in accordance with SSPC-SP-3₁ (Power Tool Cleaning₁) or SSPC-SP-2₁ (Hand Tool Cleaning).~~
2. ~~(2) Coating:~~
- a. ~~Unless otherwise specified or shown, surfaces shall be field-coated with not less than 2 coats of 3-M Company's EC 244 or approved equal.~~
- b. ~~Application shall be in accordance with the manufacturer's instructions.~~

~~c. After drying, the coating shall not be less than 1/8 of an inch in thickness over all surfaces.~~

~~3. (3) Joints will shall be wrapped with two 2 layers of 6 mil thickness polyethylene film and tightly sealed.~~

~~E. (e) Exposed Ferrous Metal.~~

~~1. (1) Area of Application: All ferrous metal, not buried, (excluding stainless steel,) shall be painted or coated.~~

~~2. (2) Surface Preparation: Sandblasting perin accordance with SSPC-SP-6, (Commercial Blast Cleaning), except that SSPC-SP-3, (Power Tool Cleaning,) or SSPC-SP-2, (Hand Tool Cleaning,) will be permitted if the Engineer determines that sandblasting is inappropriate or will damage adjacent work.~~

~~3. (3) Coating.~~

~~a. (a) Amercoat Alternate:~~

~~1) Prime coat Amercoat 25 or Amercoat 38 (2 mils).~~

~~2) First finish coat Amercoat 52 (2 mils).~~

~~3) Second finish coat Amercoat 52 (2 mils).~~

~~4) Total thickness of system (6 mils).~~

~~5) Finish color will be selected by the Engineer.~~

~~b. (b) Engard Alternate:~~

~~1) Prime coat Engard 126 (3 mils).~~

~~2) First finish coat Engard 214 (1-1/2 mils).~~

~~3) Second coat Engard 214 (1-1/2 mils).~~

~~4) Total thickness of system (6 mils).~~

~~5) Finish color will be selected by the Engineer.~~

~~c. (c) Mobil Alternate:~~

~~1) Prime coat Mobil 13-Y-5 (2 mils).~~

~~2) First finish coat Mobil 12-F-17 (2 mils).~~

~~3) Second finish coat M 12-Series (2 mils).~~

~~4) Total thickness of the system (6 mils).~~

~~1) Finish color will be selected by the Engineer.~~

CONSTRUCTION

629.03.01 GENERAL

A. The Contractor shall perform all work required for construction of water mains and appurtenances as shown.

629.03.02 EXCAVATION

A. Excavation shall be as specified in Section 208, "Trench Excavation and Backfill."

629.03.03 PIPE BEDDING

- A. Pipe bedding shall be as specified in Section 208, "Trench Excavation and Backfill."

629.03.04 TRENCH BACKFILL

- A. Trench backfill shall be as specified in Section 208, "Trench Excavation and Backfill," ~~except that trenches shall be backfilled in at least two 2 lifts for pipe sizes of 12 inches (300 millimeters) and larger unless otherwise approved by the Engineer.~~

629.03.05 SOILS TEST

- A. Soils tests shall be as specified in Subsection 208.03.~~2004~~, "~~Soils-Testing~~."

629.03.06 CUTTING AND RESTORING STREET SURFACING

- A. Cutting and restoring street surfacing shall be as specified in Subsection 208.03.~~2105~~, "Cutting and Restoring Street Surfacing."

629.03.07 BACKFILL AROUND STRUCTURES

- A. Backfill around structures shall be as specified in Section 207, "Structure Backfill."

629.03.08 CONCRETE

- A. This work shall consist of furnishing and placing Portland cement concrete as specified in Section 502, "Concrete Structures."

629.03.09 CONNECTIONS TO EXISTING FACILITIES

- A. The Contractor shall make connections to existing pipelines as shown.
1. Dry connections to existing facilities shall be made at times ~~which~~that will cause the least inconvenience to the water consumers, and shall be planned ~~in such a manner~~so that the duration of any shutdown will be kept to a minimum.
 2. No additional compensation shall be paid for overtime which may be necessary in the making of connections to existing facilities.
- B. The Contractor shall notify the Engineer at least 3 days in advance of the date on which the Contractor proposes to begin to make connections to the existing facilities.
- ~~C. When a connection to an existing main is made, about 4 ounces of HTH shall be placed in the pipe at each point where the existing main is cut.~~
- ~~1. All new pipe and fittings at such connections shall be swabbed internally with an approved chlorine solution.~~
 - ~~2. All connections shall be made in the presence of the Engineer.~~
- C. After the new main is completed, the new main shall be tested and sterilized before the valve between the new main and the old main is opened.
- D. Time and duration of shutdown shall be as specified by the Contracting Agency.

629.03.10 INSTALLATION OF VALVES

- A. Unless otherwise noted, all buried gate valves shall be installed with the stems in a vertical position and all buried butterfly valves shall be installed with the shafts in a horizontal position.

~~B. Valve boxes shall be centered over the operating nuts and shall be set plumb.~~

~~629.03.11 INSTALLATION OF ASBESTOS CEMENT PIPING~~

~~A. (a) General.~~

- ~~1. (1) The Contractor shall install all pipe, fittings, valves, and appurtenances shown and specified herein including pipe supports, bolts, nuts, gaskets, couplings and jointing materials. All exposed piping shall be adequately supported with devices of appropriate design.~~
- ~~2. (2) Prior to commencing excavation for pipelines, the Contractor shall have materials, labor and equipment on the job site which are suitable for making emergency repairs to the existing water system, should the existing facilities be damaged by the Contractor's operations.~~
- ~~3. (3) The Contractor shall take all necessary precautions to prevent the pipe from floating due to water entering the trench from any source, and shall assume full responsibility for any damage due to this cause and shall at his own expense restore and replace the pipe to its specified condition and grade if it is displaced due to floating. The Contractor shall maintain the inside of the pipe free from foreign materials and in a clean and sanitary condition until its acceptance by the Contracting Agency.~~
- ~~4. (4) Trenches shall be in a reasonably dry condition when the pipe is laid. Necessary facilities shall be provided for lowering and properly placing the pipe sections in the trench without damage. The pipe shall be laid carefully to the lines and grades shown, or to the minimum depths indicated on the drawings, and the sections shall be closely jointed to form a smooth flow line. Exceptional care shall be taken in placing the pipe and making the field joints. Concrete thrust blocks shall be provided at the locations and of the sizes shown or indicated.~~

~~B. (b) Laying and Jointing Asbestos Cement Water Pipe.~~

- ~~1. (1) **General:** Asbestos cement pipe shall be installed in accordance with the "Standard for Installation of Asbestos Cement Water Pipe" (AWWA C 603), except as otherwise provided herein or shown.~~
- ~~2. (2) **Inspection:** Prior to installation in the trench, asbestos cement pipe and couplings and rubber rings shall be inspected for damage and defects in material and workmanship. Damaged or defective materials shall be rejected and removed from the job site.~~
- ~~3. (3) **Jointing to Cast Iron:** Unless otherwise shown, joints made between asbestos cement pipe and cast iron valves and fittings shall be "Ring-Tite" joints, or approved equal, sealed with a rubber ring gasket. After assembling the joint, the position of the rubber ring gasket shall be checked with a suitable gauge. Rubber ring gaskets shall be located an even distance from the face of the valve or fitting, for the full circumference of the pipe. Precaution shall be taken while jointing to prevent from entering the joint space.~~
- ~~1. (4) **Cover:** A minimum of 48 inches (122 centimeters) of cover shall be maintained over all asbestos cement pipe where there is not established street grade, unless otherwise shown on the drawings. A minimum of 36 inches (90 centimeters) of cover shall be maintained over pipe 12 inches (30 centimeters) in diameter and smaller, 42 inches (106 centimeters) of cover over pipe 14 inches (36 centimeters) and 16 inches (41 centimeters) in diameter where there is an established street grade, unless otherwise shown on the drawings.~~

629.03.11 HYDROSTATIC TESTING

- A. The Contractor shall test the pipeline in conformance with ~~AWWA C-603~~ the current UDACS and as specified by the Contracting Agency.

629.03.12 DISINFECTION

- ~~A. (a) **General:**~~ Disinfection shall be accomplished by chlorination in accordance with UDACS either at the same time or after the pipe has been tested, but the disinfection shall be completed before the pipe has been connected to the existing system.

~~B. (b) **Chlorination:**~~

- ~~1. The chlorine solution shall be applied in such a manner so that, as the pipeline is filled with water, the dosage applied to the water entering the pipe shall not exceed 50 ppm.~~
- ~~2. Care shall be taken to prevent the strong chlorine solution in the line being treated from flowing back into the line supplying the water.~~

~~C. (c) **Retention Period:**~~

- ~~1. Chlorinated water shall be retained in the pipeline long enough to destroy all nonsporeforming bacteria.~~
- ~~2. This period shall be at least 24 hours.~~
- ~~3. After the chlorine-treated water has been retained for the required time, the chlorine residual at the pipe extremities and at other representative points shall be at least 10 ppm.~~

- ~~D. (d) **Chlorinating Valves:** During the process of chlorinating the piping and pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with a heavily chlorinated water.~~

~~E. (e) **Final Flushing:**~~

- ~~1. Following chlorination, all treated water shall be thoroughly flushed from the piping and pipelines at their extremities.~~
- ~~2. Should the initial treatment fail to produce satisfactory disinfection of the piping and pipelines, as evidenced by the chlorine residual, the chlorination procedure shall be repeated until acceptable results are obtained.~~

- ~~F. (f) **Refilling With Water:** Following final flushing, the pipeline shall be filled with water and left full.~~

~~G. (g) **Bacteriological Tests:**~~

- ~~1. The Contractor shall be responsible for providing connections and apparatus necessary to obtain samples of water from the pipeline after final flushing is complete, but before the pipeline is placed into service.~~
- ~~2. Bacteriological analyses will be performed by the District Health Department.~~
- ~~1. Should the initial treatment fail to produce satisfactory disinfection of the pipeline as evidenced by the bacteriological tests, the chlorination procedure shall be repeated until acceptable results are obtained.~~

629.03.13 FIRE HYDRANT INSTALLATIONS

- A. Fire hydrants, assemblies, and the installation thereof, consisting of the hydrant, lateral, and valve at the main, shall consist of materials approved by the applicable Fire Department and shall be installed and painted in accordance with Fire Department specifications or requirements.
- ~~B. All fire hydrants shall be for use with "Fluid-Tite" or "Ring-Tite" asbestos cement pipe.~~
- B. They hydrants shall have 2-1/2-inch" NST nozzles higbee cut, ~~and one 4-inch" NST pumper nozzle, breakaway coupling at ground level, 4-inch" valve opening, and 6-inch" "Ring-Tite" inlet connection.~~
- C. All hydrants shall be of the compression type, 150 psi working pressure, and 300 psi test.
- D. ~~h~~Hydrants shall be able to deliver 250 gallons per minute from each 2-1/2-inch outlet with a pressure loss of not more than 1-3/4 pounds for two-way, 2-1/2 pounds for three-way.
- E. There shall be an O-ring between the hydrant barrel and bonnet.
- ~~G. Hydrants shall be bury type, with 1-1/8-inch pentagon operating nut, with counterclockwise opening, and painted in accordance with Fire Department specifications or requirements.~~

629.03.15 ABANDONING OF VALVES

- ~~A. Valves shown or specified to be abandoned, shall have the valve box removed a minimum of 12 inches (30 centimeters) below the surface, and backfilled with Asphaltic Concrete if in a paved area.~~
- ~~F. If not in a paved area, backfill may be native material.~~

629.03.14 INSTALLATION OF PIPE CASING

- A. ~~(a) General:~~ The Contractor shall furnish and install all pipe casing as specified herein and as shown on the drawings.
- B. The casing shall be laid true to grade and line with no bends or changes in grade or the full length of the casing.
- C. ~~(b)~~ The pipe shall be supported at each end of each joint with 4-inch" ~~*by~~ 4-inch" ~~*by~~ 3-inch" ~~(10 x 10 x 91 centimeters)~~ skids minimum.
 - 1. The annular space between the pipe and the casing shall be backfilled with sand.
 - 2. After installation of the pipe, and the casing shall be sealed at both ends with mortared brick or cement block.

METHOD OF MEASUREMENT**629.04.01 MEASUREMENT**

- A. The method of measurement shall be as specified by the Contracting Agency.

BASIS OF PAYMENT**629.05.01 PAYMENT**

- A. Payment shall be as specified by the Contracting Agency.

SECTION 630
SANITARY SEWERS
DESCRIPTION

630.01.01 WORK INVOLVED

- A. Unless otherwise indicated on the plans and/or specified in the Special Provisions, the construction of sanitary sewers shall include excavation and backfill, tunneling, jacking, the preparation of pipe subgrade, the construction of manholes or other structures, pipe cradle and encasement, the furnishing, placing, and testing of sewer pipe, the abandonment, removal, and/or restoration of existing improvements, the construction of appurtenances and connections, and all incidentals to sewerage construction in accordance with the plans and specifications.

630.01.02 CONFORMANCE WITH LINE AND GRADE

- A. Sanitary sewers and laterals shall be constructed to the sizes, lines, and grades as shown on the plans and/or specified in the Special Provisions.

630.01.03 EXISTING UNDERGROUND UTILITIES

- A. The sewer laterals and other underground utilities shown on the plans have been located with as much care as possible with the aid of the utility companies and office records.
- B. However, the Contracting Agency assumes no responsibility as to their exact location.

630.01.04 SEWER REPLACEMENT PROJECTS

A. Maintenance of Flow:

1. The sewer system shall be kept in continuous operation during construction.
2. Sewage flow shall be confined to closed conduits to avoid public nuisance and health hazard.

B. Bypassing Flow:

1. If the Contractor so elects, the Contractor may construct temporary pump or gravity sewer bypasses.
2. Bypasses shall be of sufficient capacity to handle peak flows without storage.
 - a. When temporary pumping is required, duplicate peak flow capacity pump units shall be provided by the Contractor to continuously handle sewage flow without interruption in the event of failure of either pump unit.
 - b. When temporary sewage suction sump or pit is constructed by the Contractor, such sump or pit shall be fully enclosed and properly vented as directed by the Engineer.

630.01.05 PROHIBITION OF DIVERSION

- A. Temporary diversion of sewage to storm drains or stream channels will not be permitted.

630.01.06 COMPENSATION FOR MAINTENANCE OF FLOW

- A. Because the method of temporary maintenance of flow during construction is at the option of the Contractor, within the limits specified above, full compensation for maintenance of flow shall be included in the prices bid in the contract proposal.

630.01.07 MECHANICAL COMPRESSION JOINT-VITRIFIED CLAY PIPE

- A. Unless otherwise indicated on the plans or in the Special Provisions, sanitary sewers constructed of vitrified clay pipe shall have mechanical compression type joints.
- B. Pipe and joint shall conform to ~~the provisions of Subsections~~ 630.02.03, "Vitrified Clay Pipe Sewers and Fittings." and Subsection 630.02.04, "Jointing Vitrified Clay Pipe."

630.01.08 CONCRETE PIPE

- A. Unless otherwise indicated on the plans ~~and/or~~ specified in the Special Provisions, concrete pipe for sewers shall be in accordance with ~~the provisions of Subsection~~ 630.02.06 ~~B,~~ "Reinforced Concrete Quality of Pipe," paragraph B(a) of these specifications.

630.01.09 JOINTS FOR REINFORCED CONCRETE PIPE

- A. Unless otherwise indicated on the plans or in the Special Provisions, joints for reinforced concrete pipe shall be in accordance with Subsection 630.02.06 ~~F,~~ "Reinforced Concrete Joining Reinforced Concrete Pipe," paragraph F(d).

630.01.10 PVC SEWER PIPE

- A. Unless otherwise indicated on the plans ~~and/or~~ specified in the Special Provisions, the requirements for PVC ~~S~~ewer ~~P~~ipe shall be in accordance with Subsection 630.02.07, "PVC Sewer Pipe."

MATERIALS**630.02.01 GENERAL**

- A. The following specifications set forth the requirements for materials used in the installation of ~~S~~anitary ~~S~~ewer ~~S~~ystems.

630.02.02 MANHOLES

- A. Unless otherwise shown on the drawings or specified in the Special Provisions, materials to be used for concrete manholes shall be in compliance with ASTM ~~C~~-478.
- B. Manholes shall be constructed of precast reinforced concrete risers and tops complying with ~~the requirements of~~ ASTM ~~C~~-478 and in accordance with the design and construction details shown on the drawings.
- C. The manhole rings and covers shall be in accordance with the Standard Drawings.
- D. All manhole bases shall be Type V concrete and ~~poured~~ placed in accordance with the Standard Drawings.

630.02.03 VITRIFIED CLAY PIPE SEWERS AND FITTINGS**A. General:**

1. The Contractor shall furnish and install extra strength vitrified clay pipe, fittings, and appurtenances of the dimensions and to the lines and grades as shown on the plans and herein specified.
2. The pipe to be installed at the various locations is identified by nominal diameter of pipe in inches followed by the ~~abbreviations~~ acronym: ~~V-C-P~~.

B. Quality of Pipe:

1. All vitrified clay pipe and fittings shall be of ~~one~~1 class designated extra strength, of the best quality, vitrified, homogeneous in structure, thoroughly burned throughout the entire thickness, sound, impervious to moisture, ~~sound~~, and free from cracks, checks, blisters, broken extremities, or other imperfections.
2. Pipe, ~~and must~~shall give a metallic ring when struck with a hammer.
3. Pipe shall be bell and spigot pipe unless otherwise ~~-~~specified.
4. Pipe ends shall be square with the longitudinal axis, ~~-and~~
5. ~~s~~Sockets shall be true, circular, and concentric with the barrel of the pipe.
6. The thickness of the shell, the depth of the socket, and the dimensions of the annular space shall be within the limits of permissible variation to dimension standards of the applicable provisions of ~~the~~ ASTM C-700 for the size of pipe indicated on the plans.

- C. **Certification:** A certificate from the manufacturer shall be furnished with each shipment of pipe attesting that the pipe meets the requirements of these specifications, including test reports for the hydrostatic pressure test and the loading test hereinafter specified.

D. Physical Tests for Pipe and Fittings:

1. Under the supervision of and when directed by the Contracting Agency, the ~~following~~ physical tests specified below shall be performed.
2. The cost of such supervision will be borne by the Contracting Agency and all other costs shall be borne by the Contractor.

E. Acceptance or Rejection on Results of Test:

1. If all the specimens tested meet the requirements of the test, all the pipe in the lot, shipment, or delivery corresponding to the sizes so tested shall be considered as complying with the test.
2. If, however, 10 percent% or more of the specimens tested fail to meet the requirements of the test, or if more than ~~one~~1 specimen fails to meet the requirements of the test, when the number to be tested is less than 10, then a second selection of specimens may be made for that test.
3. The number of pipes to be tested in the second selection of pipe shall be 5 for each specimen of the first selection that failed to meet the standards.
4. If 90 percent% or more of the pipe tested, including those first tested, meet the requirements of the test, the pipe in the lot, shipment, or delivery corresponding to the sizes so tested shall be considered as complying with that test; otherwise, all pipe of these sizes shall be rejected.

- F. **Identification Marks:** All pipe ~~or~~and fittings shall be clearly marked with the name of the manufacturer or with a trademark of a size and type ~~which has been~~ approved by and filed with the ~~Contracting Agency's Representative~~Engineer.

G. Tests:

1. The testing laboratory shall select at random for testing as herein specified up to 2 percent% of the number of pipe in each size of pipe furnished, except that in no case shall less than ~~five~~5 specimens be tested.

2. The specimens selected for testing purposes shall be sound pipe having dimensions consistent with these specifications. The lot or lots from which the test samples are taken shall be sufficient to fill the entire order for that size of pipe used in the work under the contract and, if they pass the tests, shall be so designated and marked.
 3. All pipe shall be subject to inspection at the factory, trench, or other point of delivery by the ~~Contracting Agency's Representative~~ Engineer. The purpose of the inspection shall be to cull and reject any pipe that, independent of the physical tests herein specified, fails to conform to ~~the requirements of~~ these specifications, or that may have been damaged during transportation ~~and/or~~ in subsequent handling.
- H. **Hydrostatic Tests:** In lieu of the standard ASTM absorption test, the following hydrostatic pressure test shall be substituted.
1. The hydrostatic pressure test shall precede the loading test by not less than ~~one~~ 1 hour nor more than ~~three~~ 3 hours and shall be applied to all the specimens received for testing in each size of pipe.
 2. When subjected to an internal hydrostatic pressure of ~~ten~~ 10 pounds per square inch (~~68.9 KPa~~) for the time specified ~~hereafter~~ below, the accumulated moisture on the exterior surface of the pipe shall not run down the sides in such quantity that it will exceed 10 milliliters per linear foot.

Thickness of Barrel	Testing Time
Up to and including 1 inch (2.5 centimeters)	7 minutes
Over 1" (2.5 centimeters) <u>inch</u> &and including 1-1/2" (3.8 centimeters) <u>inches</u>	9 minutes
Over 1-1/2" (3.8 centimeters) <u>inches</u> &and including 2" (5.0 centimeters) <u>inches</u>	12 minutes
Over 2" (5.0 centimeters) <u>inches</u> &and including 2-1/2" (6.4 centimeters) <u>inches</u>	15 minutes
Over 2-1/2" (6.4 centimeters) <u>inches</u> &and including 3" (7.6 centimeters) <u>inches</u>	18 minutes
Over 3 inches (7.6 centimeters)	21 minutes

I. **Loading Tests:**

1. The loading test shall be the ~~three~~ 3-edge bearing. ~~The loading test~~ shall conform to the applicable provisions of ASTM ~~C-301~~ C-301, and shall be applied to all specimens selected for testing, except that loading to test ultimate strength will not be required.
2. Pipe shall withstand the following loads:

Nominal Pipe Size In Inches	Minimum Test Loads Pounds Per Linear Foot
4 &and 6 (10 & 15 centimeters)	2,000 (29.763 kilograms per centimeter)
8 (20 centimeters)	2,200 (29.76 kilograms per centimeter)
10 (25 centimeters)	2,400 (35.71 kilograms per centimeter)
12 (30 centimeters)	2,600 (38.70 kilograms per centimeter)
15 (38 centimeters)	2,900 (43.15 kilograms per centimeter)
18 (46 centimeters)	3,300 (49.11 kilograms per centimeter)
21 (53 centimeters)	3,850 (57.29 kilograms per centimeter)
24 (61 centimeters)	4,400 (65.47 kilograms per centimeter)

Nominal Pipe Size In Inches	Minimum Test Loads Pounds Per Linear Foot
27 (69 centimeters)	4,700 (69.94 kilograms per centimeter)
30 (76 centimeters)	5,000 (74.41 kilograms per centimeter)
33 (84 centimeters)	5,500 (81.85 kilograms per centimeter)
36 (91 centimeters)	6,000 (89.29 kilograms per centimeter)
39 (99 centimeters)	6,600 (98.22 kilograms per centimeter)
42 (107 centimeters)	7,000 (104.17 kilograms per centimeter)

3. The net inside length of the pipe from the bottom of the socket to the spigot end of the pipe shall be used as the divisor to calculate the load per linear foot ~~(centimeter)~~.
- J. **Inspection Independent of Tests:** The following imperfections in a pipe or special fitting will be considered injurious and cause for rejection without consideration of the test results hereinabove specified:
1. There shall be no fractures or cracks passing through the barrel or socket, except that a single crack at the spigot end of the pipe not exceeding 75 percent of the depth of the socket, or a single fracture in the socket not exceeding 3 inches ~~(7.6 centimeters)~~ around the circumference nor 2 inches ~~(5.0 centimeters)~~ lengthwise may be permitted.
 2. Lumps, blisters, pits or flakes on the interior surface of a pipe or fitting.
 3. When the bore or socket of the pipe varies from a true circle more than 3 percent% of its nominal diameter.
 4. When a pipe or fitting, designated to be straight, deviates from a straight line more than 1/16 inch per linear foot ~~(0.52 centimeter per meter)~~. The deviation shall be measured from a straight edge at a point midway between the ends of the pipe.
 5. A piece broken from either the socket or spigot end.
 6. Tramp clays, gorge s, or other foreign matter ~~than have~~ fused permanently to the exterior or interior surface of the pipe or fitting.
 7. Pipes that ~~If~~, when placed in a vertical position, ~~the pipes~~ do not give a metallic ring when struck with a hammer.

630.02.04 JOINTING VITRIFIED CLAY PIPE

- A. Vitrified clay pipe and fittings shall be furnished with mechanical compression joints or compression couplings or approved equal.
- B. Materials for compression joints and couplings shall conform to ASTM C-425. ~~Materials for compression couplings shall conform to ASTM C 594.~~
- C. An approved lubricant shall be used in the assembling of the pipe and no further sealing element will be required.

630.02.05 STOPPERS

- A. Stoppers for sewage line shall be as approved by the pipe manufacturer.

630.02.06 REINFORCED CONCRETE PIPE

- A. The Contractor shall furnish and install reinforced concrete pipe, fittings s, and appurtenances of the dimensions and to the lines and grades as shown on the plans and herein specified.

The pipe to be installed at the various locations is identified by nominal diameter of pipe in inches ~~(centimeters)~~ followed by the ~~abbreviations~~acronym: R-C-P.

B. Quality of Pipe:

1. All reinforced concrete pipe and fittings shall be made by the centrifugal process conforming to ~~the requirements of~~ ASTM-C-76.
2. The pipe sections shall be manufactured with flared bell and spigot-type joints and incorporate O-ring rubber gaskets as their positive and flexible seal against internal or external hydrostatic pressures.
3. Pipe walls shall be designed and reinforced for 1350 D-load (Class III) according to ASTM-C-76.
4. Unless shown or specified otherwise, all R-C-P that is to carry sewage shall have not less than 2 inches ~~(5 centimeters)~~ of concrete between the inside of the pipe and the reinforcing, and not less than 1 inch ~~(2.5 centimeters)~~ clear between exterior of pipe and its reinforcing.

C. Identifications Marks: The following information shall be clearly marked on each pipe section:

1. Permissible D-load strength
2. Name or trademark of manufacturer
3. Date of manufacture
4. Letter "T" 6 inches ~~(15 centimeters)~~ or more from end of pipe to indicate the top of pipe for correct installation when elliptical reinforcement is used.
5. Markings shall be indicated on the pipe sections or painted thereon with waterproof paint.

D. Tests: Concrete pipe may be tested by the ~~Contracting Agency's Representative~~Engineer by one or more of the ~~following~~ tests specified below. The manufacturer shall furnish without charge all necessary equipment and samples for making the tests. All tests shall be made in accordance with ASTM-C-76.

1. **Absorption Test:** The absorption test may be made to determine the amount of moisture absorbed by the concrete.
2. **Three-Edge Bearing Strength Test:** The ~~three~~3-edge bearing test may be made to determine the strength of the pipe and the "D" load ~~which~~that the pipe will withstand.
3. **Core or Cylinder Test:** Cores may be cut from the concrete of the pipe or test cylinders case of the concrete as placed for the purpose of determining the strength of the concrete in the pipe.
4. **Visual Test and Inspections:**
 - a. Visual inspection may be made by the ~~Contracting Agency's Representative~~Engineer before and/or after the delivery of the pipe, for the purpose of determining the placement of the reinforcement, ~~the~~ size, shape, fractures, spalls, honeycomb, or other imperfections or damage.
 - b. The Contractor shall notify the ~~Contracting Agency's Representative~~Engineer not less than 24 hours in advance of beginning manufacture of the pipe.

SANITARY SEWERS

630

- c. The ~~Contracting Agency's Representative~~Engineer shall have access to all operations of the manufacture and may inspect and test any or all equipment, materials, and operations used in the manufacturing, handling, and curing of the pipe.
- E. **Cement:** Portland cement shall conform to ~~the requirements of~~ ASTM ~~C-150~~, Type ~~V~~ (high sulfate resistant).
- F. **Joining Reinforced Concrete Pipe:** Joints shall be made watertight and root-tight in an approved manner in accordance with ~~the requirements of~~ ASTM ~~C-443~~.
1. **Joint Design:**
- a. Pipe units shall be manufactured with flared bell and spigot-type joints.
- 1) The spigot end shall be provided with a gasket groove and the joint shall be sealed by ~~means of~~ a round rubber gasket in compression between the bell and spigot surfaces.
 - 2) The length of each gasket shall be volumetrically determined so that it will substantially fill the joint recess.
 - 3) The gasket shall be the sole element depended upon to make the joint watertight.
- b. The joints shall be self-centering and, upon proper closure of the joint, the rubber gasket shall be uniformly confined with the spigot groove and enclosed. In this condition, the gasket shall not support the weight of the pipe and shall function solely as the water seal element under all normal conditions of service, including expansion, contraction, and settlement.
- c. The joint shall be ~~so~~ designed ~~that it will~~to withstand, without cracking or fracturing, the forces caused by the compression of the gasket and the required hydrostatic pressure.
2. **Rubber for Gaskets:**
- a. The rubber-type compound used for manufacture of the solid continuous ring gaskets of circular cross section shall be neoprene.
- b. The compound shall contain no factice, reclaimed rubber, or any deleterious substance. All gaskets shall be extruded or molded and cured in such a manner that any cross section will be dense, homogeneous, and free from porosity, blisters, pitting, and other imperfections.
3. The neoprene shall meet the following physical requirements when tested in accordance with the applicable sections of Federal Test Method Standard No. ~~601~~ and appropriate ASTM test methods ~~of Test~~ as indicated.

Neoprene (by volume) min. %	50
Tensile strength, psi, min. ASTM D412	1800 (12.41 MPa)
Elongation at rupture, percentage, min. ASTM D412	425
Shore durometer, Type A (Center of range preferred)	
ASTM D676 <u>D2240</u> (the test shall be performed on the flat cross section of 1/2- <u>inch</u> [1.3 centimeters] length of gasket)	40±5

Compression set, percentage of original deflection, max. Method B (1/2-inch 1.3 centimeters long section of gasket, constant deflection; 22 hours at 158 degrees Fahrenheit (70 degrees Celsius) ASTM D395	20
Accelerated aging in air (70 hours at 212 degrees Fahrenheit (100 degrees Celsius) ASTM D-573 Tensile strength, percentage of original strength, min.	85
Hardness change, percentage, max.	+15
Water absorption, percent vol. change, max. 70 hours at 212 degrees Fahrenheit (100 degrees Celsius)	10
Ozone 6 ppm, 25 percent elongation, 2 hours at 100 degrees Fahrenheit (38 degrees Celsius) max.	No Cracking
Specific Gravity	1.30 to 1.45

4. After the joint is assembled, and if so directed by the ~~Contracting Agency's Representative~~ Engineer, a thin metal feeler gauge shall be inserted by the Contractor between the bell and the spigot and the position of the rubber gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position again checked, all at ~~the Contractor's expense~~ no additional cost to the Contracting Agency.

630.02.07 PVC SEWER PIPE

- A. **General:**—This ~~specification designates~~ subsection specifies general requirements for unplasticized polyvinyl chloride (PVC) ~~P~~lastic ~~G~~ravity ~~S~~ewer ~~P~~ipe with integral wall bell and spigot joints for the conveyance of domestic sewage.
- B. **Materials:** Pipe and fittings shall meet extra strength minimum of SDR-35 of ~~the requirements of~~ ASTM D-3034 ~~73~~.
- C. **Pipe:**
 1. All pipe shall be suitable for use as a gravity sewer conduit.
 2. Provisions ~~must~~ shall be made for contraction and expansion at each joint with a rubber ring.
 3. The bell shall consist of an integral wall section with a solid cross section rubber ring, factory assembled, and securely locked in place to prevent displacement.
 4. The rubber ring shall meet ~~the requirements of~~ ASTM D-1869 ~~72~~.
 5. Sizes and dimensions shall be as shown in this specification.
 6. Standard lengths shall be 20 feet and 12.5 feet ± 1 inch.
 7. At manufacturer's option, random lengths of not more than 15 percent ~~%~~ of total footage may be shipped in lieu of standard lengths.
- D. **Fittings:** All fittings and accessories shall be as manufactured and furnished by the pipe supplier or approved equal and have bell and/or spigot configurations identical to that of the pipe.
- E. **Physical and Chemical Requirements:** Pipe shall be designed to pass all tests at 73 degrees ~~Fahrenheit~~ (± 3 degrees ~~Fahrenheit~~).

SANITARY SEWERS

630

- F. **Pipe Stiffness:** Minimum "pipe stiffness" at 5 percent% deflection shall be 46 for all sizes when tested in accordance with ASTM -D-2412, ~~"External Loading Properties of Plastic Pipe by Parallel Plate Loading."~~
- G. **Joint Tightness:**
1. Assemble ~~two~~2 sections of pipe in accordance with the manufacturer's recommendation.
 2. Subject the joint to an internal hydrostatic pressure of 25 -psi for ~~one~~1 hour.
 3. Consider any leakage a failure of the test requirements.
- H. **Flattening:** There shall be no evidence of splitting, cracking, or breaking when the pipe is tested as follows:
1. Flatten 6-inch long specimen of pipe, ~~six inches long~~ between parallel plates in a suitable press until the distance between the plates is ~~forty~~40 percent of the outside diameter of the pipe.
 2. The rate of loading shall be uniform and such that the compression is completed within ~~two~~2 to ~~five~~5 minutes.
- I. **Drop Impact Test:**
1. Pipe (~~6-~~inch long section) shall be subjected to impact from a free falling tup (20 -pound Tup A-) in accordance with ASTM -D-2444.
 2. No shattering or splitting (denting is not a failure) shall be evident when the following impact energy is ~~impacted~~applied.
- | | | | | | |
|--------------|----------------|----------------|----------------|-----------------|-----------------|
| Nominal Size | <u>4"-inch</u> | <u>6"-inch</u> | <u>8"-inch</u> | <u>10"-inch</u> | <u>12"-inch</u> |
| Feet-Pounds | 140 | 210 | 210 | 220 | 220 |
- J. **Acetone Immersion Test:** After ~~two~~2 hours of immersion in a sealed container of anhydrous (99.5 percent% pure) acetone, a 1"-inch long sample ring shall show no sign of flaking on exterior or interior surfaces when tested in accordance with ASTM -D-2152.
- K. Manhole couplings manufactured by the pipe manufacturer shall be used at all manholes.
- L. A gauge plug furnished by the pipe manufacturer shall be pulled through the pipe from manhole to manhole to check the pipe for over-deflection. This check will be performed after the pipe is backfilled.

SIZES, DIMENSIONS, AND TOLERANCES

Nominal Size <u>(inch)</u>	Outside Diameter		Minimum Wall Thickness	Weight/Pounds <u>20'-foot</u> Length
Average	Tolerance			
4	4.215	±0.007	0.125	20.4
6	6.275	±0.009	0.18	43.9
8	8.4	±0.010	0.24	78.8
10	10.5	±0.013	0.3	123.4
12	12.5	±0.016	0.36	176.4

M. **Marking:**

1. Pipe in compliance with this standard shall be clearly marked as follows at intervals of ~~1.5-meters~~ (5 feet) or less:

- a. Manufacturer's name or trademark.
 - b. Nominal pipe size.
 - c. The legend "Type PSM SDR-35 PVC Sewer Pipe."
 - d. ASTM-D-3034.
2. Fittings in compliance with this standard shall be clearly marked as follows:
- a. Manufacturer's name or trademark.
 - b. Nominal size.
 - c. Material designation "PVC."
 - d. PSM.
 - e. ASTM-D-3034.

CONSTRUCTION

630.03.01 EXCAVATION AND BACKFILL

- A. Excavation and backfill shall be ~~done~~ in accordance with the Standard Drawings for excavation and backfill of sanitary sewers.

630.03.02 TRENCHES

- A. Trenches shall be ~~done~~ in accordance with Section 208, "Trench Excavation and Backfill."

630.03.03 PIPE BEDDING AND LAYING

A. Pipe Beddings:

1. Pipe bedding shall be ~~done~~ in accordance with Subsection 208.03.03~~12~~, "Pipe Bedding," and the Standard Drawings.
2. Place pipe that is to be bedded in a concrete cradle or encased in concrete in proper position on temporary supports consisting of concrete blocks or bricks. When necessary, rigidly anchor or weight the pipe to prevent flotation when the concrete is placed.
3. Place concrete for cradles, arches, ~~or~~and encasement uniformly on each side of the pipe and deposit at approximately its final position.
 - a. Do not move concrete more than 5 feet (~~1.5 meters~~) from its point of deposit.
 - b. Concrete placed beneath the pipe shall be sufficiently workable so that the entire space beneath the pipe can be filled without excessive vibration.

B. Pipe Laying:

1. Protect the pipe during handling against impact, shocks, and free fall. Do not permit hooks to come in contact with premolded joint surfaces.
2. Handle pipe ~~having~~with premolded joint rings or attached couplings so that no weight, including the weight of the pipe itself, will bear on or be supported by the jointing material.
3. Take care to avoid dragging the spigot ring on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.

SANITARY SEWERS

630

4. After delivery alongside the trench, carefully examine each piece of ~~vitrified-clay~~ pipe for soundness and specification compliance. Acceptable pipe may be marked with paint or other permanent marking material so that the marks are plainly visible after installation in the trench and before the pipe is covered.
5. Clean joint contact surfaces immediately prior to jointing.
6. Use lubricants, primers, or adhesives ~~as~~ recommended by the pipe or joint manufacturer.
7. Unless otherwise required, lay all pipe straight between changes in alignment and at uniform grade between changes in grade.
 - a. Excavate bell holes for each pipe joint.
 - b. When jointed in the trench, the pipe shall form a true and smooth line.
8. Divert surface water from the trench area to the greatest extent practicable without causing damage to the adjacent property. There shall be no free-standing water on the base upon which the pipe is laid.
9. Unless otherwise permitted by the Engineer, start pipe laying at the lowest point and install the pipe so that the spigot ends point in the direction of flow.
10. At times when the pipe laying is not in progress, the open end of the pipe shall be closed with a tight-fitting cap or plug to prevent the entrance of foreign matter into the pipe.
 - a. These provisions shall apply during the noon hour as well as overnight.
 - b. In no event shall water ~~which~~that has infiltrated into the trenches be allowed to enter into existing sewage flows.
 - c. The pipeline under construction may be used to remove water that has infiltrated into the trenches provided it is removed before entering the existing flows.

630.03.04 DEWATERING

- A. All water shall be removed so the top of base is dry for pipe laying.
- B. In no case shall water from the dewatering process be allowed into existing sewer lines.

630.03.05 JACKING

- A. **Equipment:** The jacking equipment used for this work shall be of ~~first-class~~serviceable quality and installed and operated in accordance with standard practice for this type of work and the approval of the Engineer.
- B. **Casing:**
 1. The jacked casing shall be large enough and so located that the sewer main can be jacked through and adjusted true to line and grade.
 2. The annular space between the sewer pipe and the casing shall be sand filled, and any voids outside the casing, ~~r~~ shall be completely filled by pressure grouting.
- C. **Flotation:** Sewer ~~P~~pipe shall be prevented from floating.

630.03.06 TUNNELING

- A. **Size:** The tunnel shall be large enough so that the sewer main can be jacked through true to line and grade.
- B. **Grouting:**
 - 1. The annular space between the sewer main and the tunnel wall shall be completely filled by pressure grouting.
 - 2. The sewer pipe shall be prevented from floating during the grouting operation.

630.03.07 SEWER LATERALS

- A. **General:**
 - 1. The term "sewer lateral" is defined as a branch sewer laid from main sewer to a point on the property line from which private sewer service can be obtained by proper extensions.
 - 2. Sewer laterals shall be constructed of the same type of sewer pipe and the same type of joint as is used in the trunk line sewer in accordance with the plans and all applicable provisions of these specifications.
- B. **Location Mark:** Where the curb is existing or is to be constructed as a part of the same job under which sewer laterals are installed, the location of the sewer lateral shall be plainly marked by stamping or chiseling the letter "S" in the face of the curb with a letter not less than 1_-inch ~~(2.5 centimeters)~~ high and 3/16_-inch ~~(0.48 centimeters)~~ deep.
- C. **Wye Connection:**
 - 1. A wye shall be installed in the main for each sewer lateral and lateral connection specified to be constructed.
 - 2. Not more than ~~one~~ 1 lateral shall be connected in ~~one~~ 1 length of sewer main pipe.
- D. **Lateral Connections:** Existing sewer laterals cut by construction of new sewers shall be connected to the new sewer main with pipe and fittings of the same diameter and material as that of the existing lateral.
- E. **Lateral Extension Connections:** Existing sewer laterals ~~which~~ that must be extended to reach new sewer mains, shall be disconnected at the existing sewer main, and shall be extended and connected to the new sewer main using pipe and fittings of the same diameter and material as that of the existing lateral.
- F. **Laterals Not Shown:**
 - 1. Laterals uncovered by the construction that are not shown on the plans shall be connected to the new sewer line.
 - 2. Such lateral connection work will be paid for at appropriate unit bid prices.

630.03.08 HOUSE CONNECTIONS

- A. **Definition:** House connections are those sewer laterals constructed on private property from the property line to a point of connection with the existing building (house) sewer. ~~and a cleanout shall be provided at the property line.~~
- B. **Plumbing Code:** All house connections shall conform to the provisions of the applicable Plumbing Code.

C. Conduct of Operations:

1. The Contractor shall conduct ~~his~~ operations ~~in such a manner that they will~~ to result in a minimum of interference to the existing improvements.
2. The Contractor shall restore the area to its original condition after constructing house connections.
3. Landscaping shall be carefully restored either by planting new plants of the same variety and size as those removed or by stockpiling and replacing the existing plants in a strong growing condition.

630.03.09 APPURTENANCES**A. Stubs and Plugs:**

1. Stubs in all sewer manholes shall consist of a short -length of vitrified clay extra strength pipe with mechanical compression joints, unless other~~wise~~ wise specified or shown.
2. All stubs shall be plugged.

B. Material:

1. Plugs for vitrified clay mechanical compression joint pipe, up to and including 12 inches ~~(30-centimeters)~~ in diameter, shall be furnished where required by the plans.
2. Plugs shall consist of vitrified clay disks with approved plastic joint component or shall consist of a resilient material plug of controlled design and dimensions for mating with the pipe to which it is to be applied.
3. A force-fit of joint shall be made between the plug and the pipe.

630.03.10 ABANDONMENT OF EXISTING SEWERS**A. Manholes to be Abandoned:** Manholes shall be abandoned as follows:

1. Concrete base shall be cracked or broken to provide drainage.
2. The manhole shall be removed from site. The remaining hole shall be backfilled and pavement shall be replaced as specified in Subsection 630.03.01, "Excavation and Backfill."
3. The manhole material shall be returned to the ~~owner~~ Contracting Agency unless otherwise specified ~~by the owner~~.

B. Sewer Mains to be Abandoned: Sewer mains shall be abandoned as follows:

1. Excavate and remove pipe.
2. Excavate and crush pipe in place.
3. Grout pipe with sand or grout and plug ends.
4. Method as approved by ~~entity~~ Engineer.

C. Plugs for Sewer Mains to be Abandoned: Plugs in sewer mains to be abandoned shall be Portland cement concrete a minimum of 12 -inches ~~(30-centimeters)~~ thick in 15 -inch ~~(38-centimeters)~~ mains and larger and a minimum of 6 -inches ~~(15-centimeters)~~ thick in sewer mains smaller than 15 -inches ~~(38-centimeters)~~.

630.03.11 VITRIFIED CLAY PIPE FITTINGS

- A. Vitrified clay pipe fittings shall include branches of every type and stoppers. Fittings shall be furnished and installed at the locations, to the grades, and of type and size shown on the plans and in conformance with these specifications.
- B. **Branches:**
1. Branches of type shown on the plans shall be furnished with connections of the sizes specified and shall be securely and completely fastened to the barrel of the pipe in the process of manufacture.
 2. Tee branches shall have their axis perpendicular to the longitudinal axis of the pipe. Wye branches shall have their axis approximately 45_-degrees (unless otherwise specified on the plans) to the longitudinal axis of the pipe, measured from the socket end. All branches shall terminate in sockets and the barrel of the branch shall be of sufficient length to permit making a proper joint when the connecting pipe is inserted in the branch socket.
 3. The quality of vitrified clay pipe fittings and the joints for fittings shall conform to the applicable provisions of these specifications.
- C. **Installation of Branches:**
1. Vitrified clay pipe wyes, tees, and other types of branches shall be furnished and installed along with vitrified clay pipe sewer.
 2. Wyes of size specified on the plans shall be installed for all sewer house connections and for future sewer house connections as shown on the plans, or specified in the detailed specifications.
 3. Tees shall be installed for chimneys shown on the plans.
 4. The longitudinal barrel of branch fittings to be placed in line and grade with the vitrified clay pipe sewer mains shall be of the same diameter, quality, and type as ~~said~~the sewer.
 5. Installation and bedding for branches shall conform to the applicable provisions set forth for vitrified clay sewer pipe.
 6. Unless otherwise specified, the branch of wye fittings shall be inclined upward at an angle not greater than 45_-degrees from a horizontal line.
 7. If so shown on the plans, tees with standard tee foundations shall be substituted for wye branches.
 8. No wye or tee for sewer house connection branch shall be placed closer than 5_-feet ~~(1.5 meters)~~, in the downstream side, to the centerline of any structure.

630.03.12 VITRIFIED CLAY PIPE AT MANHOLES OR STRUCTURES

- A. A 2_-foot ~~(0.6 meters)~~ vitrified clay pipe joint of the same inside diameter as the adjoining pipe shall be placed at the inlet and outlet to each manhole or structure as shown on the drawings.
- B. The pipe may be laid through the manhole to provide a smooth invert. In this event, the pipe will be broken out and the base grouted to create a smooth shelf.

630.03.13 BLANK

630.03.14 TEST FOR LEAKAGE AND INFILTRATION

- A. **General:** It is the intent of the plans and specifications that the completed sewer pipes of all types, along with manholes and other appurtenances, shall be watertight.
1. Each section of sewer between ~~two~~2 successive manholes shall be tested for leakage. Where excessive groundwater is encountered or dewatering procedures are required, an infiltration test shall also be made as set forth herein.
 2. If either the leakage ~~and~~/or infiltration rate as shown by the tests specified herein is greater than the amount specified, the pipe joints shall be repaired or, if necessary, the pipe shall be removed and relaid by the Contractor at ~~his expense~~no additional cost to the Contracting Agency. The sewer will not be considered acceptable until the leakage ~~and/or~~ infiltration ratess, as determined by test, ~~is~~are less than the allowable.
- B. **Leakage Test:**
1. **General:**
 - a. The Contractor shall water test for leakage all sections of pipe between structures.
 - b. Where groundwater is encountered, then both the infiltration test and leakage test shall be made.
 - c. Where the difference in elevation between the invert of the upper structure and the invert of the lower structure is more than 10-feet ~~(3.05 meters)~~, then the air test shall be made.
 2. **Water Test:**
 - a. Each section of sanitary sewer, between ~~two~~2 successive structures, shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper structure with plugs or stoppers and filling the pipe and structure with water to a point 4-feet ~~(1.22 meters)~~ above the invert of the open sewer in the upper structure.
 - b. The total leakage shall be the decrease in volume of water in the upper structure.
 - 1) The leakage shall not exceed 200-gallons per day per inch of nominal diameter of pipe per mile ~~(185 liters per centimeter of nominal diameter per kilometer)~~ of sewer pipe being tested.
 - 2) The length of house connections shall not be used in computing the length of sewer main being tested.
 - c. If leakage, as shown by the test, is greater than allowed, the pipe shall be overhauled and, if necessary, replaced and relaid until the joints and pipe ~~shall~~ hold satisfactorily under this test.
 - d. All tests ~~must~~shall be completed before the street or trench is resurfaced unless otherwise directed by the ~~Contracting~~Agency's RepresentativeEngineer.
 - e. The Contractor shall furnish all labor and materials for making the tests required at ~~his own expense~~no additional cost to the Contracting Agency.

3. **Air Test Procedure:**

- a. Each section of sewer between ~~two~~ 2 successive manholes shall be tested by plugging all pipe outlets with suitable test plugs.
- b. Air shall be slowly added until the internal pressure is raised to 4.0 psig.
- c. The compressor used to add air to the pipe shall have a blow-off valve set at 5 psig to ~~assure~~ ensure that at no time the internal pressure in the pipe exceeds 5 psig.
- d. The internal pressure of 4 psig shall be maintained for at least ~~two~~ 2 minutes to allow temperature to stabilize after which the air supply shall be disconnected and the pressure allowed to decrease to 3.5 psig.
- e. The time in seconds that is required for the internal air pressure to drop from 3.5 psig to 2.5 psig shall be measured and the results compared with the values as specified in ~~the latest edition of~~ ASTM C-828.
- f. 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

- g. 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

$T = \frac{\text{Time in Table 1} \times L}{100}$

100

WHERE

T = Time for pressure to drop from 3.5 psig to 2.5 psig in minutes

L = Length of line between manholes

- h. 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.
- i. 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.
- j. At the end of air testing, all manholes shall be water tested to ensure they are water tight ~~per~~ in accordance with Subsection 603.03.14 A.(a). "Test for Leakage and Infiltration General," paragraph A.

4. Test for Infiltration:

- a. If, in the construction of a section of the sewer between structures, excessive groundwater is encountered, the test for leakage shall also be required as described in the ~~S~~ subsection on leakage test.
- b. 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~~ 3 days, after which the section shall be tested for infiltration.
- c. The infiltration shall not exceed 0.028-gallons per minute, per inch of diameter, per 1,000 ~~feet~~ (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.
- d. Where any infiltration in excess of this amount is discovered before completion and acceptance of the sewer, the sewer shall be immediately uncovered at no additional cost to the Contracting Agency ~~the expense of~~ and the amount of infiltration reduced to a quantity within the specified amount of infiltration before the sewer is accepted.

630

SANITARY SEWERS

- e. 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~~Engineer.
- f. The Contractor shall furnish and install ~~all labor, materials, and~~ calibrated flumes, or "V" notch ~~we~~irs, ~~and installation thereof~~ for measuring infiltration and making the tests required at ~~his own expense~~no additional cost to the Contracting Agency.
- g. All tests ~~must~~shall be completed before street or trench is resurfaced, unless otherwise directed by the ~~Contracting Agency's Representative~~Engineer.

630.03.15 TESTS FOR ALIGNMENT AND GRADE, AND DAMAGED OR DEFECTIVE PIPE IN PLACE

- A. 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~~Engineer, with the assistance of the Contractor's forces.
- B. All "balling" and "mirroring" shall be done in the presence of the ~~Contracting Agency's Representative~~Engineer and shall constitute tests for alignment, grade, damaged or defective pipe in place, ~~or~~and any other type of faulty installation.
- C. Should "balling" or "mirroring" indicate any faulty installation of the pipe, repairs or replacements shall be made at ~~the Contractor's expense~~no additional cost to the Contracting Agency and as directed by the ~~Contracting Agency's Representative~~Engineer.
- D. Full compensation for making these tests shall be included in the contract unit prices and no additional allowance will be made therefor.
- E. Where sewers are of sufficient size to permit hand cleaning, "balling" may be omitted.

METHOD OF MEASUREMENT

630.04.01 MEASUREMENT

- A. The method of measurement shall be as specified by the Contracting Agency.

BASIS OF PAYMENT

630.05.01 PAYMENT

- A. Payment shall be as specified by the Contracting Agency.

SECTION 631**STREET NAME SIGNS****DESCRIPTION****631.01.01 GENERAL**

- A. 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

- A. 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**

- A. The finished face shall be applied to an aluminum sign blank conforming to the Standard Drawings.

631.02.02 SIGN LEGEND

- A. The legend shall be made by ~~one~~ 1 of the following ~~two~~ 3 methods:
1. ~~(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~~ that 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~~ 2-inch ~~(2") (5-centimeters)~~ numerals, die-cut from white conforming to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6, ~~W~~ white, using pressure-sensitive adhesive.
 2. ~~(2)~~ By applying white die-cut letters to green (blue for the City of North Las Vegas) wide-angle prismatic retroreflective sheeting ~~which~~ that conforms to the material specified in Subsection 716.03.01 "Reflective Sheeting," Class 6.
 - a. 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, ~~W~~ white, and shall be applied using pressure-sensitive adhesive.
 - b. The sign fabricator shall supply the Contracting Agency with a written guarantee of workmanship, stating that any ~~such~~ lettering ~~which~~ that peels or loosens from the sign face within ~~five~~ (5) years will be repaired, or the sign replaced, free of charge.
 3. ~~(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~~ that conforms to the material specified in Subsection 716.03.01, "Reflective Sheeting," Class 6.

631

STREET NAME SIGNS

CONSTRUCTION

631.03.01 STREET NAME SIGN INSTALLATION

- A. The fabricated signs shall be installed using the hardware and piping as shown on the Standard Drawings and as specified in Subsection 716.03.06, "Sign Hardware, Posts, and Related Materials."
- B. The signs shall be installed on the corners of the intersection as indicated on an approved plan. Further, the signs shall be located on the P.C. line as indicated in the Standard Drawings.

631.03.02 EXCEPTIONS

- A. No exceptions to the above specifications shall be allowed without prior written consent from the ~~accepting~~ Contracting agency.

METHOD OF MEASUREMENT

631.04.01 MEASUREMENT

- A. The quantity of street signs measured for payment will be the number of complete signs in place.
- B. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

631.05.01 PAYMENT

- A. Payment for street name signs shall be for each complete sign in place.
- B. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- C. Payment will be made under:

<u>PAY ITEM</u>	<u>PAY UNIT</u>
<u>Street Name Sign</u>	<u>Each</u>

SECTION 632

HEADLIGHT GLARE SCREEN

DESCRIPTION

632.01.01 GENERAL

- A. This work shall consist of furnishing and installing headlight glare screen at the locations and in accordance with the details shown on the plans and as specified herein.
- B. Headlight glare screen may consist of expanded steel or aluminum mesh panels mounted on galvanized steel posts and tied to a top and bottom tension wire or may be of other acceptable material specified in the plans.

MATERIALS

632.02.01 GENERAL

- A. The aluminum and steel materials for the headlight glare screen shall conform to the ~~following~~ provisions specified below:
- B. ~~(a)~~ **Expanded Mesh:**
 - 1. The expanded steel mesh panels shall be fabricated from 22 gauge ~~G~~galvanized ~~S~~sheet ~~C~~commercial ~~Q~~quality steel (~~D~~dry for continuous strip painting) conforming to ASTM A-525 with a 1.25-ounce ~~(35-grams)~~ commercial galvanized coat with minimum spangle. ~~or~~
 - 2. ~~(b)~~ The expanded aluminum mesh panels shall be fabricated of aluminum alloy 3105-H25.
 - 3. The expanded mesh panels shall have the following nominal dimensions:
 - a. Diamond Size:
 - 1) 1.33 inches ~~(3.38-centimeters)~~ short dimensions (center to center of bridges).
 - 2) 4.00 inches ~~(10.16-centimeters)~~ long dimension (center to center of bridges).
 - b. Strand Size:
 - 1) Aluminum: 0.050 inch ~~(0.127-centimeters)~~ thick.
 - 2) Steel: 0.034 inch ~~(0.086-centimeters)~~ thick.
 - 3) Aluminum or Steel: 0.250 inch ~~(0.635-centimeters)~~ in width.
 - c. Panel Size for Type A:
 - 1) 2'-0" ~~(0.62-meters)~~ long dimension of diamonds.
 - 2) 6'-8" ~~(2.03-meters)~~ or 12'-8" ~~(3.86-meters)~~ short dimension of diamonds.
 - d. Panel Size for Type B:
 - 1) 2'-0" ~~(0.61-meters)~~ long dimension of diamonds
 - 2) 5'-5" ~~(1.65-meters)~~ or 10'-5" ~~(3.17-meters)~~ short dimension of diamonds.

4. The weight of expanded aluminum mesh shall not be less than 0.21 pound per square foot ~~(1.02 kilograms per square meter)~~.
5. Steel mesh panels before fabrication shall be treated in power washing equipment with a chemical conversion coating conforming with ~~the requirements of~~ Federal Specification MIL-C-5541 and furnished with ~~two (2)~~ coats of protective paint on both sides, applied before fabrication.
6. Aluminum mesh panels before fabrication shall be treated in power washing equipment with a chemical conversion coating conforming with ~~the requirements of~~ Federal Specification MIL-C-5541 and finished with ~~one~~ 1 coat of high temperature baking enamel on both sides, applied before fabrication.

C. Finish of Mesh Panels:

1. The finish for the steel mesh panels shall be ~~one~~ 1 primer coat of zinc chromate containing epoxy followed by a finish coat of commercial quality, high temperature baking enamel, made with a combination of alkyd, vinyl, and amino resins, or equivalent materials formulated for roller coating application. Both coats shall be applied in ~~one~~ 1 continuous pass through the roller coating equipment.
2. The finish for the aluminum mesh panels shall be commercial quality, high temperature baking enamel, made with a combination of alkyd, vinyl, and amino resins, or equivalent materials, formulated for roller coating application. The finish shall be applied in ~~one~~ 1 continuous pass through the roller coating equipment.
3. The color of the enamel finish shall be Interstate Green unless otherwise specified. The baking enamel shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, ~~or~~ and other surface imperfections.
4. The composition of the baked dry film shall conform to the following requirements:
 - a. ~~1.—~~ **Thickness:** The dry film thickness shall not be less than 0.8 mil ~~(0.2 centimeters)~~ as determined by ASTM ~~Designation D-1400~~.
 - b. ~~2.—~~ **Gloss:** The gloss of the enamel shall be standard medium gloss (60 degrees specular gloss 70 minimum when tested in accordance with Federal Test Method Standard No. 141, Method 6101).
 - c. ~~3.—~~ **Color Uniformity:** The color uniformity of the enamel after baking shall be constant within commercial limits when checked visually in the MacBeth Daylight Booth.
 - d. ~~4.—~~ **Coating Adhesion:** There shall be no loss of adhesion of the coating to the base metal during or after fabrication of the expanded mesh panels.
- D. After fabrication, expanded mesh when installed on the barrier rail shall give a complete cut-off of all oncoming headlight beams at angles up to 20 degrees from the ~~if~~ straight-ahead direction of the headlight beams.
- E. Shearing shall be accomplished in a uniform and workmanlike manner with a minimum of burrs, edge spalling of enamel, sharp edges, and shear marks.
- F. ~~(e) —~~ **Posts, Caps and Hardware:**
 1. Posts on metal beam barrier rail shall be fabricated of structural steel conforming to ~~the specifications of~~ ASTM ~~Designation~~ A-36 shall be hot-dip galvanized after fabrication in accordance with ~~specifications of~~ ASTM ~~Designation~~ A-123. Hardware shall be commercial quality and shall be galvanized.

HEADLIGHT GLARE SCREEN

632

2. Posts on concrete barrier rail shall be standard weight black pipe conforming to ~~the requirements of~~ ASTM ~~Designation~~ A-53 or ASTM A-120 and shall be threaded to receive standard threaded pipe caps.
 - a. Posts and caps shall be hot-dip galvanized after fabrication.
 - b. Hardware shall be commercial quality and shall be galvanized.
- G. ~~(d)~~ **Tension Wires:** The top and bottom tension wires shall be 7-gauge and shall be galvanized coil spring steel wire of commercial quality.
- H. ~~(e)~~ **Wire Ties:**
 1. The bottom tension wire shall be tied to each post with 9-gauge (0.1483-inch-~~minimum-~~ ~~diameter-~~) ~~(.376-centimeter min. dia.)~~ steel wire ties or hog rings.
 2. The expanded mesh panels shall be tied to the top and bottom tension wires and to each post with 11-gauge (0.120-inch-~~minimum-~~ ~~diameter-~~) ~~(.305-centimeter min. dia.)~~ steel wire ties and hog rings ~~shall be commercial quality and shall be galvanized.~~
 3. Steel wire ties and hog rings shall be commercial quality and shall be galvanized.
 4. Aluminum wire ties or hog rings of the same minimum diameters as specified for steel may be substituted for steel wire ties or hog rings.
 5. The aluminum wire ties shall be aluminum alloy 1100-H18 conforming to ~~the specifications of~~ ASTM ~~Designation~~ B-211. Aluminum hog rings shall be fabricated from either aluminum alloy 6061-T94 or 5052-H38.
- I. ~~(f)~~ **Removable Expanded Mesh Panel:**
 1. Removable expanded mesh panels shall be installed as shown on the plans.
 2. The steel ~~"L"~~-shaped bolts with nuts and washers for supporting the removable panel and the sign fastening hardware shall be commercial quality and shall be galvanized.
 3. The sign shall conform to the provisions for target plates as provided in Section 619, "Object Markers and Guide Posts," and the plans.
 - a. The enamel finish coat shall comply with ~~the requirements of~~ Federal Specification TT-E-489 as required in Section 721, "Object Markers and Guide Posts." ~~of the Standard Specifications.~~
 - b. The color of the finished sign shall be white.
 - c. The letters on the sign shall be black.
 - d. The message on the panel shall read: "Emergency Panel."
 4. NOTE: ~~Without expense~~ At no additional cost to the Contracting Agency, ~~two~~ 2 certificates covering each order of material shall be furnished by the manufacturer, certifying that the product complies with the specifications.
 - a. One certificate shall be delivered to the Engineer in charge of the job site at the time of, or prior to, delivery of the order.
 - b. The other certificate shall be delivered to the Contracting Agency prior to acceptance of the material.

632

HEADLIGHT GLARE SCREEN

CONSTRUCTION

632.03.01 GENERAL

- A. Headlight glare screen shall be erected on steel posts, ~~and~~ tied to a top and bottom tension wire, and ~~shall be~~ mounted on the metal beam or concrete barrier rail at the location and in accordance with the details shown on the plans.
- B. The exact location of the removable expanded mesh Emergency Panel will be determined by the Engineer.

METHOD OF MEASUREMENT

632.04.01 MEASUREMENT

- A. The quantity of headlight glare screen to be paid for will be determined by the linear foot ~~(meter)~~ from actual measurement along the line of the completed headlight glare screen.
- B. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

632.05.01 PAYMENT

- A. The quantity of headlight glare screen measured as provided above, shall be paid for at the contract unit price bid per linear foot, ~~(meter) of "Headlight Glare Screen"~~ which ~~payment~~ shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing headlight glare screen, including the ~~E~~mergency ~~P~~anels and hardware, complete in place as shown on the plans and as specified.
- B. All payments will be made in accordance with Subsection 109.02 "Scope of Payment."
- C. Payment will be made under:

PAY ITEM**PAY UNIT**

Headlight Glare Screen (Type A)	Linear Foot (Meter)
Headlight Glare Screen (Type B)	Linear Foot (Meter)

SECTION 633**PAVEMENT MARKERS****DESCRIPTION****633.01.01 GENERAL**

- A. This work shall consist of furnishing and placing pavement markers at the locations shown on the plans or where directed by the Engineer.
- B. The markers shall have the shape, dimensions, and tolerances shown on the plans.
- C. Pavement markers will be of the type and color shown on the plans.

MATERIALS**633.02.01 NON-REFLECTIVE PAVEMENT MARKERS**

- A. Non-reflective pavement markers shall consist of a heat-fired, vitreous, ceramic base and a heat-fired, opaque, glazed surface to produce the properties required in these specifications.
 - 1. The markers shall be produced from any suitable combination of intimately mixed clays, shales, talcs, flints, feldspars, or other inorganic material ~~which~~that will meet the properties herein required.
 - 2. The markers shall be thoroughly and evenly matured and free from defects ~~which~~that affect appearance or serviceability.
- B. The top surface of the non-reflective marker shall be convex and the radius of curvature shall be between 3-1/2 inches ~~(8.9 centimeters)~~ and ~~six (6) inches (15 centimeters)~~, except that the radius of the ~~half (1/2)~~1/2 inch nearest the edge may be less.
 - 1. Any change in curvature shall be gradual.
 - 2. The top and sides shall be smooth and free of mold marks, pits, indentation, air bubbles, or other objectionable marks or discolorations.
 - 3. The bottom of the ceramic markers shall be free from gloss or glaze and shall have all areas of integrally formed protrusion projecting from the surface ~~which~~that will increase the effective bonding surface area of adhesive.
 - 4. The faces of the protrusions shall not deviate more than ~~five one-hundredths (0.05) inch (1.3 millimeters)~~ from a flat surface.
 - 5. The areas of protrusion shall have faces parallel to the bottom of the marker and shall project approximately ~~four one-hundredths (0.04) inch (1 millimeter)~~ from the bottom.
 - 6. The area of protrusions shall constitute a minimum of ~~thirty (30)~~ percent of the area of the bottom of the marker and shall increase the bonding surface area by a minimum of ~~twenty-four (24)~~ percent.
 - 7. To facilitate forming a mold release, the sides of the protruded area may be tapered.
 - 8. This taper shall not exceed ~~fifteen (15)~~ degrees from the perpendicular to the marker bottom.
- C. The non-reflective ceramic type markers shall conform to the following tests:

1. ~~(1)~~ Adhesive bond strength to bottom surface of the marker using epoxy adhesives specified in Subsection 633.02.03, "Pavement Marker Adhesive": 700 psi minimum. ~~(4.82 MPa)~~
2. ~~(2)~~ Glaze Thickness: 0.005 inch minimum. ~~(.013 centimeter)~~
3. ~~(3)~~ Moh Hardness: 6 minimum.
4. ~~(4)~~ Directional reflectance (white markers only):
 - a. ~~(a)~~ Glazed surface: 75 minimum.
 - b. ~~(b)~~ Body of marker: 70 minimum.
5. ~~(5)~~ Yellowness Index (white markers only):
 - a. ~~(a)~~ Glazed surface: 7 maximum.
 - b. ~~(b)~~ Body of marker: 16 maximum.
6. ~~(6)~~ Color (yellow markers only):
 - a. ~~(a)~~ Purity: 76 percent% to 96 percent%.
 - b. ~~(b)~~ Dominant wave length: 579 mu to 585 mu.
 - c. ~~(c)~~ Total luminous reflectance (Y value x 100): 41 minimum.
7. ~~(7)~~ Autoclave: Glaze shall not spall, crack or peel.
8. ~~(8)~~ Strength: 1,500 pounds minimum.
9. ~~(9)~~ Water absorption: 2.0 percent% maximum.

633.02.02 REFLECTIVE PAVEMENT MARKERS

- A. Reflective pavement markers shall be of the prismatic reflector type consisting of methyl methacrylate or suitable compounded acrylonitrile butadiene styrene (ABS) filled with a mixture of an inert thermosetting compound and filler material.
 1. The exterior surface of the shell shall be smooth and contain ~~one~~1 or ~~two~~2 methyl methacrylate, impact modified methacrylate, or polycarbonate prismatic reflector face(s) of the color specified.
 2. Reflective pavement markers shall be impact-resistant and abrasion-resistant.
- B. The base of the marker shall be flat (the deviation from a flat surface shall not exceed 0.05 inch ~~(1.3 millimeter)~~), rough textured, and free from gloss or substances ~~which~~that may reduce its bond to the adhesive.
 1. The angle between the face of the marker and the base shall be no greater than ~~forty five (45)~~ degrees.
 2. Marker dimensions are as set forth in the Standard Drawings.
- C. In accordance with ASTM D4280, the adhesive bond strength to the bottom surface of the marker shall not be less than ~~five hundred (500)~~ psi ~~(3.45 MPa)~~, when tested with epoxy adhesive.
 1. Markers with length and width both equal to ~~four (4)~~ inches ~~(10.2 millimeters)~~ shall undergo flexural strength testing and ~~must~~shall withstand a minimum ~~two thousand (2,000) lb pounds (909 kg)~~ without breakage or significant deformation.

PAVEMENT MARKERS

633

2. Markers with length less than ~~four (4) inches (10.2 millimeters)~~ shall undergo compressive strength testing and ~~must~~shall support a minimum load of ~~six thousand (6,000) lbpounds (2727 kg)~~ without breakage or significant deformation.
- D. The color of the reflector when illuminated by an automobile headlight shall be an approved clear, yellow, or red.
1. Off-color reflection shall constitute grounds for rejection.
 2. The reflective markers shall have initial minimum retroreflectance values specified as the product of Tables ~~1~~ and Table 2 when measured in accordance with ASTM E809.
 3. The photometric quantity to be measured is the coefficient of retroreflected luminous intensity (R_i), expressed as candelas per footcandle and millicandelas per lux (mcd/lx).
 4. One candela per lux equals 10.76 candelas per footcandle.

Table 1 - Minimum RI Values

Entrance angle $b_2 = (b_1 = 0^\circ)$	0°	$\pm 20^\circ$
Observation angle:	<u>0.2°</u>	<u>0.2°</u>
Minimum R_i (cd/ftcd)	3.0	1.2
Minimum R_i (mcd/lx)	279	112

Table 2 - Color Multiplying Factors

Color	White	Yellow/Amber	Red	Blue	Green
Multiplying Factor	1	0.6	0.25	0.1	0.33

- E. All reflective pavement markers shall meet ~~the requirements of~~ the minimum retroreflectance values specified as the product of Tables 1 and 2 shown above for the following tests:
1. Abrasion Resistance:
 - a. Entire lens surface of the marker shall be subjected to ~~one hundred (100)~~ rubs with a ~~one (1)-inch (25.4 millimeter)~~ diameter flat pad of No. 3 coarse steel wool conforming to Federal Specification FF-W-1825A.
 - b. A load of ~~fifty (50) ± 0.5 lbpounds (22 ± 0.2 kg)~~ is~~shall be~~ applied to steel wool pad during testing.
 2. Temperature Resistance: ~~The m~~Markers shall be conditioned for ~~twelve (12)~~ hours at ~~145 $^\circ$ degrees F $\pm 5^\circ$ degrees F (62.7 $^\circ$ C $\pm 2.5^\circ$ C).~~
 3. Testing:
 - a. Pavement markers shall be sampled and tested prior to use in accordance with Test Method Number 669 of the California ~~Division of Highways~~Department of Transportation.
 - b. ~~Lots of m~~Marker lots ~~which that~~ have been previously sampled and tested by the Contracting Agency and approved as conforming with these specifications may be used without further testing, if permitted by the Engineer.

633.02.03 PAVEMENT MARKER ADHESIVE

- A. The pavement marker adhesive shall be either a hot-melt bituminous adhesive or an epoxy adhesive ~~which~~that provides effective bonding of pavement markers to both asphalt and concrete pavement surfaces.
- B. The adhesive shall not permit excessive marker movement at hot summer temperatures and shall remain flexible at winter temperatures.
- C. The bituminous adhesive shall be an asphaltic material with a homogeneously mixed mineral filler ~~which~~that shall comply with ASTM D4280, ~~A1, "Specification for Bituminous Adhesive for Pavement Markers"~~.
- D. Epoxy adhesives shall comply with Subsection 728.03.10, "Epoxy Adhesives for Pavement Markers."
- E. The Contractor shall furnish the Engineer with certificates of compliance executed by the manufacturers of the markers and adhesive attesting that they conform to ~~the requirements of~~ these specifications.

CONSTRUCTION**633.03.01 INSTALLATION**

- A. The portion of the highway surface to which the markers are to be bonded by the adhesive shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint, and any other material ~~which~~that would adversely affect the bond of the adhesive.
- B. Cleaning shall be done by blast cleaning on all pavement surfaces; only air blast cleaning will be permitted on asphalt concrete surfaces.
- C. The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the marker in a quantity sufficient to result in complete coverage of the area of contact of the marker with no voids present and with a slight excess after the marker has been placed.
 - 1. Excess adhesive around the edge of the marker, excess adhesive on the pavement, and adhesive on the exposed surfaces of the markers shall be immediately removed.
 - 2. Soft rags moistened with mineral spirits conforming to Federal Specifications TT-T291 or kerosene may be used, if necessary, to remove adhesive from exposed faces of pavement markers.
 - 3. No other solvent shall be used.
 - 4. The markers shall be protected against impact until the adhesive has hardened to the degree designated by the Engineer.
- D. The adhesive shall not be used when either the pavement or the air temperature is less than ~~fifty (50) degrees Fahrenheit (10 degrees Centigrade)~~.
- E. No markers shall be installed if the relative humidity of the air is greater than ~~eighty (80)~~ percent or if the pavement is not surface dry.
- F. The adhesive shall be prepared and applied according to the manufacturer's requirements and specifications.
- G. The Engineer shall ~~be the judge as to~~ determine when the adhesive has set sufficiently to bear traffic.

PAVEMENT MARKERS

633

- H. All markers shall be applied in accordance with the manufacturer's recommendations.
1. Reflective markers shall be placed ~~in such manner~~so that the reflective face of the marker is perpendicular to a line parallel to the roadway centerline.
 2. No pavement markers shall be placed over longitudinal or transverse joints of the pavement surface.

METHOD OF MEASUREMENT

633.04.01 MEASUREMENT

- A. The quantity of each type of pavement marker to be measured for payment as units will be the number of each type determined by actual count complete in place.
- B. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

633.05.01 PAYMENT

- A. The accepted quantity of pavement markers measured as provided in Subsection 633.04.01, "Measurement," will be paid for at the contract unit prices bid per each for ~~"Non-Reflective Pavement Markers"~~ and Reflective Pavement Markers," which shall be full compensation for cleaning and preparing the pavement surface, for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and placing pavement markers, complete in place, including adhesives, as shown on the plans, as specified herein, and as directed by the Engineer.
- B. All payments will be made in accordance with Subsection 109.02 "Scope of Payment."
- C. Payment will be made under:

PAY ITEM**PAY UNIT**

Non-Reflective Pavement Markers	Each
Reflective Pavement Markers	Each

SECTION 634

TEMPORARY PAVEMENT STRIPING TAPE

DESCRIPTION

634.01.01 GENERAL

- A. This work shall consist of furnishing, locating, placing, maintaining, and removing temporary pavement striping tape and temporary pavement striping tape (pilot line).
- B. The underlined asterisk (*) as used in this section denotes the skip interval distance between striping tape segments as indicated in the Contract Documents.

MATERIALS

634.02.01 TEMPORARY PAVEMENT STRIPING TAPE

- A. Temporary striping tape shall be yellow or white or any combination thereof as directed by the Engineer and shall conform to the ~~following~~ requirements specified below:
- B. The striping material shall be reflectorized adhesive marking tape ~~which~~that will be readily visible when viewed with automobile headlights at night, ~~and~~ shall be composed of a conformable backing coated with a pressure sensitive adhesive, and shall be designed for marking of pavements.
- C. The tape shall be ~~four~~ 4 inches ~~(10 centimeters)~~ wide and not less than 20 mils ~~(.003 centimeter)~~ or more than 30 mils ~~(.007 centimeter)~~ thick with a minimum tensile strength of forty 40 pounds per inch ~~(7.1 kilograms per centimeter)~~ of width.
- D. The color shall closely match the color normally used by the Contracting Agency in pavement striping.
- E. The upper ~~of or~~ visible surface shall have a minimum apparent reflectance of ~~seventy-five (75)~~ percent as determined in accordance with ASTM ~~Designation~~ E-97.
- F. Beads shall be strongly adhered to the ~~four~~ 4-inch ~~(10 centimeter)~~ tape at the rate of at least 1.76 pounds but not more than 1.95 pounds per 100 linear feet ~~(.786 to .870 kilograms per 30 meters)~~.
- G. The striping material backing shall permit complete removal without requiring sandblasting, solvent, or grinding methods.
- H. Temporary pavement striping tape (pilot line) shall be 4-inch ~~x~~by 4-inch ~~(10 x 10 centimeters)~~ square and shall be placed on traffic lane lines at *-foot intervals. Lane lines ~~and at~~ *-foot intervals shall be located by the Contractor as approved by the Engineer.

CONSTRUCTION

634.03.01 INSTALLATION

- A. The Contractor shall furnish, apply, maintain, and remove all temporary pavement striping tape.
 - 1. Temporary pavement striping tape may be used on construction crossovers, detours, and temporary connections.

634

TEMPORARY PAVEMENT STRIPING TAPE

2. Temporary pavement striping tape (pilot line) may be placed on lane lines of permanent unmarked bituminous surfaces prior to allowing public traffic thereon, or, when approved by the Engineer, at the conclusion of paving operations on the day public traffic is first allowed on the unmarked bituminous surface.
- B. The surface to which the tape is applied shall be dry, and free of oil, grease, dust, or dirt.
- C. The tape shall be tamped down immediately after applications in order to obtain a proper bond, and shall be removed from final pavement surface and where necessary to reroute public traffic as directed by the Engineer.
- D. It should be considered normal and expected that portions of the temporary striping tape shall have to be replaced during the life of the contract. The locations and extent of these replacements shall be determined by the Engineer.

METHOD OF MEASUREMENT

634.04.01 MEASUREMENT

- A. Temporary pavement striping tape shall be measured for payment on a linear foot ~~(meter)~~ of tape basis.
- B. Temporary pavement striping tape (pilot line, * -foot) shall be measured for payment on a station basis, and each ~~one hundred (100)~~ feet ~~(30 meters)~~ shall constitute the unit of one station. Measurement shall be made on the initial application at the locations approved by the Engineer.
- C. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

BASIS OF PAYMENT

634.05.01 PAYMENT

- A. The contract unit price bid per linear foot ~~(meter)~~ of tape for "Temporary Pavement Striping Tape" and the contract unit price bid per station for "Temporary Pavement Striping Tape (pilot line, * -foot)" shall be considered full compensation for furnishing the tape as well as all labor, ~~materials~~, tools, equipment, and incidentals necessary to locate, install, and maintain the temporary pavement striping tape.
- B. Replacement of tape, as set forth above, shall not be measured or paid for directly but shall be considered as included in the contract unit price bid per linear foot ~~(meter)~~ for "Temporary Pavement Striping Tape" and the contract unit price bid per station for "Temporary Pavement Striping Tape (pilot line, * -foot)."
- C. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- D. Payment will be made under:

PAY ITEM

PAY UNIT

Temporary Pavement Striping Tape.....	Linear Foot (meter)
Temporary Pavement Striping Tape (pilot line, <u>* -foot</u>)	Station

SECTION 637**POLLUTION CONTROL****DESCRIPTION****637.01.01 GENERAL**

- A. This work shall consist of temporary pollution control measures ~~which~~that may be shown on the plans, specified in the Special Provisions, or ordered by the Engineer during the life of the contract. ~~and such~~
1. The work ~~must~~shall meet ~~State Health Board~~the applicable requirements of the Clark County Department of Air Quality and Environmental Management (DAQEM).
 2. ~~Said~~The work is intended to provide prevention, control, and abatement of water and air pollution within the limits of the project and to minimize damage to the work, adjacent property, and streams or other bodies of water.
- B. The Contractor shall, 7 days prior to the preconstruction conference, submit for acceptance ~~the~~is Contractor's proposed plans and schedules, in duplicate, for accomplishing the prevention of erosion and pollution that may occur due to ~~the~~is Contractor's operations. No work shall be started until ~~these~~ schedules and methods of operations have been accepted by the Engineer.
- C. ~~The~~is work shall include furnishing and applying a dust palliative to all completed excavation and embankment grading planes and other disturbed areas within the right-of-way except those areas ~~which~~that are to be paved under the terms of the contract and as directed by the Engineer. The dust palliative item does not include dust control measures required due to construction operations or carrying public traffic through construction or on detours.

MATERIALS**637.02.01 GENERAL**

- A. The binder for dust palliative shall be a resin emulsion that is miscible in water in the proportions hereinafter provided, is noncorrosive, and is effective as a dust palliative.
- B. Resin emulsion shall be composed of from 57 percent to 63 percent of semi-liquid petroleum resin and the remainder water to which a suitable emulsifying agent has been added.
1. The binder shall be mixed with additional water at the job site and at the appropriate rate of ~~four~~4 parts of water to ~~one~~1 part of binder.
 2. The exact rate of mixture ~~to~~shall be determined by the Engineer.
 3. The resin emulsion shall be readily miscible with water and when diluted with any hard water in proportions of ~~one~~1 part emulsion to ~~ten~~10 parts water shall show no signs of breakdown or separation of the petroleum resin base.
 4. Resin emulsion ~~which~~that has been stored in closed containers at temperatures above freezing for a period of up to ~~three~~3 months shall show no signs of separation.
 5. Any resin emulsion ~~which~~that has been stored for more than 3 months shall not be used until tested and approved.

CONSTRUCTION

637.03.01 GENERAL

- A. The temporary pollution control measures shall be as directed from time to time by the Engineer for the duration of the contract. The Engineer may revise and bring up to date any temporary control measures or instigate any new temporary pollution control measures found necessary as the work progresses.
- B. The temporary control measures to prevent pollution of streams or other bodies of water or of the air, and to minimize damage to the work, ~~and to adjacent property,~~ and to streams or other bodies of water, as directed by the Engineer and paid for on a force account basis, are in addition to any other measures provided for within the contract that are to be paid for as separate bid items.
- C. It is expected that compliance with these requirements will necessitate performance of certain items of work at a different time or in a different manner ~~that has been considered normal construction practice in the past and that~~ than originally planned, such causing revisions in scheduling of work ~~will~~ that may interfere with ~~said~~ normal construction practices.
- D. Unless otherwise approved by the Engineer, the total area of erodible earth material exposed by the Contractor's operation shall not exceed 750,000 square feet ~~(69,700 square meters)~~ before either temporary pollution control, or temporary or permanent erosion control measures are accomplished.
- E. Where erosion damage is probably due to the nature of the material or to the season of the year, the Contractor's operations shall be ~~so~~ scheduled so that pollution control features will be installed concurrently with or immediately following grading operations.
- F. Compliance with ~~the requirements of this~~ Ssection shall not relieve the Contractor from ~~his~~ Contractor's responsibility to comply with the other provisions of the contract, except that the Contractor will be required to replace, at ~~his expense~~ no additional cost to the Contracting Agency, any of the temporary pollution control work that is damaged by action of the elements.
- G. All erosion control work required elsewhere in the specifications or on the plans will be paid for under the provisions for the applicable contract items of work therefor.
- H. The Contractor shall coordinate ~~this~~ temporary pollution control work, as required by the Engineer, with ~~such~~ erosion control work ~~as may be~~ specified elsewhere in the contract to ~~as~~ ensure that effective and continuous pollution control is maintained during the construction of the project.
- I. The Contractor shall conduct ~~his~~ operations ~~in such a manner as~~ to minimize the effects of erosion and air pollution due to ~~the~~ Contractor's operations upon areas within the limits of the project, haul roads, material sites, disposal sites, and upon adjacent properties, streams, and other bodies of water.
- J. Mixing of the dust palliative material shall be accomplished by simultaneously placing the binder and water in the spreading equipment or by other mixing methods that will produce equivalent results.
 - 1. The resulting mixture shall be applied with pressure type water distributor trucks equipped with a spray system, or pressure type asphalt distributors conforming to ~~the requirements of Subsection 404.03.02~~ 405.03.01, "Equipment."

POLLUTION CONTROL

637

2. The mixture shall be applied at a total rate of approximately ~~one-half~~ 1/2 gallon per square yard ~~(2.3 liter per square meter)~~ in ~~two~~ 2 applications of ~~one-quarter~~ 1/4 gallon per square yard ~~(1.1 liter per square meter)~~.
3. The exact rate of application ~~to~~ will be determined by the Engineer.

METHOD OF MEASUREMENT

637.04.01 MEASUREMENT

- A. The required quantity of temporary pollution control work, except as set forth below, shall be measured for payment on a Force Account basis in accordance with Subsection 109.03, "Extra and Force Account Work."
- B. The required quantity of dust palliative will be measured by the ton ~~(metric ton)~~ prior to addition of water at the job site. ~~If in the event that~~ volumetric measurement is permitted by the Engineer, the dust palliative shall be measured as set forth in Subsection 109.01, "Measurement of Quantities," for asphaltic emulsion.
- C. The cost of furnishing materials and equipment and conditioning crushing, mixing, and processing plants and other equipment to comply with the DAQEM requirements ~~of NRS 445, especially the "Air Quality Regulations" adopted by the State Commission of Environmental Protection, January 18, 1972,~~ including watering for dust control, shall be considered as included in the contract price bid for other items of work and no further compensation will be allowed therefore.

BASIS OF PAYMENT

637.05.01 PAYMENT

- A. Payment for "Temporary Pollution Control" measured as provided above, will be paid for by Force Account.
- B. Dust palliative, measured as provided above, shall be paid for at the contract unit price bid per ton ~~(metric ton)~~ for "Dust -Palliative," which ~~price~~ shall be full compensation for furnishing the material, adding and mixing additional water at the job site, applying the mixture, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, complete and in place as indicated on the plans and as directed by the Engineer.
- C. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- D. Payment will be made under:

PAY ITEM**PAY UNIT**

Temporary Pollution Control.....	Force Account
Dust Palliative	Ton (Metric-Ton)

SECTION 646**WATERPROOFING AND DAMPPROOFING****DESCRIPTION****646.01.01 GENERAL**

- A. This work shall consist of furnishing and applying membrane waterproofing or dampproofing to the surface of the concrete as shown on the plans and as specified in these specifications.
 - 1. Membrane waterproofing consists of a coating of primer and a firmly bonded membrane composed of 2 layers of saturated glass fabric and 3 moppings of waterproofing asphalt.
 - 2. Dampproofing consists of a coating of primer and 2 moppings of waterproofing asphalt.

MATERIALS**646.02.01 GENERAL**

- A. Waterproofing asphalt shall conform to ~~the specifications of~~ ASTM ~~Designation~~ D-449, Type ~~A~~ for below ground and Type ~~B~~ for above ground, except that the ductility of Type ~~B~~ shall be 5 ~~minimum~~. The provisions in ~~said~~ ASTM D-449 relating to felt, asbestos felt, and cotton fabrics shall not apply.
- B. Primer for use with asphalt in waterproofing below and above ground level shall conform to ~~the specifications of~~ ASTM ~~Designation~~ D-41.
- C. Fabric shall conform to ~~the specifications of~~ ASTM ~~Designation~~ D-1668 for bituminous glass fabric treated with asphalt.

CONSTRUCTION**646.03.01 GENERAL**

- A. All concrete surfaces ~~which are~~ to be waterproofed shall be smooth and free from holes and projections ~~which~~ that might puncture the membrane. The surface to be waterproofed or dampproofed shall be dry and shall be thoroughly cleaned of dust and loose materials.
- B. No primer or asphalt shall be applied in wet weather, nor when the temperature is below 65 degrees ~~Fahrenheit (18 degrees Centigrade)~~, without authorization in writing from the Engineer.
- C. The primer shall be applied to the surface and allowed to dry before the first coat of asphalt is applied.
- D. The waterproofing asphalt shall be applied at a temperature of not less than 300 degrees ~~Fahrenheit (149 degrees Centigrade)~~ nor more than 350 degrees ~~Fahrenheit (177 degrees Centigrade)~~.

646.03.02 MEMBRANE WATERPROOFING

- A. Membrane waterproofing shall not be applied to any surface until the Contractor is prepared to follow ~~its~~ applications with the placing of ~~the~~ backfill within a sufficiently short time that the waterproofing will not be damaged as a result of exposure to weathering. Any waterproofing membrane ~~which~~ that loses its bond with the concrete shall be removed

646

WATERPROOFING AND DAMPPROOFING

and replaced with new membrane waterproofing by the Contractor at ~~his expense~~ no additional cost to the Contracting Agency.

- B. Beginning at the low point of the surface to be waterproofed, the waterproofing asphalt shall be thoroughly mopped onto the surface.
 1. A strip of fabric of half the width of the roll shall be rolled onto the hot asphalt immediately and carefully pressed into place ~~so as~~ to eliminate air bubbles and obtain close conformity with the surface.
 2. ~~The~~ is strip and an adjacent section of the surface, of a width equal to slightly more than ~~one-half~~ 1/2 the width of the fabric being used, shall then be mopped with hot asphalt and a full width of the fabric shall be rolled into this, completely covering the first strip, and shall be pressed into place as before.
 3. This second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip by not less than 2 inches ~~(5 centimeters)~~.
 4. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least 2 inches ~~(5 centimeters)~~ over the last strip but ~~one~~ 1.
 5. The entire surface shall then be mopped with hot asphalt.
 6. Special care shall be taken ~~at all laps to see~~ to ensure that ~~the~~ eachy lap is ~~are~~ thoroughly sealed down.
- C. The work shall be so regulated that at the close of the day's work the final mopping of asphalt shall have been applied to all the fabric in place.

646.03.03 DAMPPROOFING

- A. The waterproofing asphalt shall be thoroughly mopped on the surface to be dampproofed.
- B. When the first mopping of asphalt has set sufficiently, the entire surface shall ~~then~~ be mopped with the second coating of hot asphalt.
- C. Special care shall be taken to ~~see~~ ensure that there are no skips in the coatings and that all surfaces are thoroughly covered.

METHOD OF MEASUREMENT

646.04.01 MEASUREMENT

- A. The quantities of membrane waterproofing or dampproofing placed as shown on the plans or directed by the Engineer will be ~~determined~~ measured by the square yards ~~(square meters) from measurement of the~~ area covered by the membrane waterproofing or dampproofing.

BASIS OF PAYMENT

646.05.01 PAYMENT

- A. The quantity of membrane waterproofing or dampproofing measured as provided above, shall be paid for at the contract unit price bid per square yard ~~(square meter)~~ for "Membrane Waterproofing" or Dampproofing," which ~~payment~~ shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in

WATERPROOFING AND DAMPPROOFING

646

applying the waterproofing membrane or dampproofing, complete in place, as shown on the plans and as specified.

- B. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- C. Payment will be made under:

PAY ITEM**PAY UNIT**

Membrane Waterproofing	Square Yard	(Square Meter)
Dampproofing	Square Yard	(Square Meter)

SECTION 660**METAL BIN-TYPE RETAINING WALLS****DESCRIPTION****660.01.01 GENERAL**

- A. This work shall consist of furnishing and installing metal retaining walls of the bin type at the locations shown on the plans or designated by the Engineer and in conformity to the lines, grades, basic designs, and dimensions shown on the plans or established by the Engineer.
- B. The bin-type wall comprises prefabricated members with fittings and appurtenances for complete assembly in the field.
- C. The basic design of the wall refers to the length of wall spacers affecting depth of the wall.

MATERIALS**660.02.01 GENERAL**

- A. The galvanized sheets used in fabricating the several members shall conform to ~~the applicable requirements of AASHTO M 36 (Corrugated Metal Culvert Pipe)~~.
- B. Bolts, nuts, and miscellaneous hardware shall be galvanized.
- C. The various members shall be fabricated from specified metal of the respective gauges shown on the plans, but not lighter than 16 gauge. In the absence of given gauges or dimensions for any member, fitting, or appurtenance, the gauge of metal or dimensions thereof shall be as required to fully develop the strength of the members ~~where~~ for which gauges and dimensions are given and ~~which~~ that are used in structural combination.
- D. All members, fittings, and appurtenances shall be designed as integral units or parts of the whole assembly.

CONSTRUCTION**660.03.01 FABRICATION**

- A. Metal bin-type retaining walls shall consist of a plurality of pair of columns, one column of each pair being in the plane of the front and the other column being in the plane of the rear of the wall, with the pairs of columns spaced longitudinally with overlapping S-shaped tie members (spacers).
- B. The necessary bolts and appurtenances shall be furnished for complete assembly of the units into a continuous closed face wall of connected bins.
- C. All members shall be so fabricated that members of the same nominal size shall be fully interchangeable.
- D. The members shall be ~~so~~-fabricated and punched so that no drilling, punching, or drifting to correct defects in manufacture will be required during field assembly ~~ing, and any m~~.
- E. Members ~~having~~ with improperly punched holes will be rejected and shall be replaced with properly punched members.

660.03.02 EARTHWORK

- A. Rough excavation for the site of the wall shall be made to the elevation of the finished ground line at the face of the wall.
 - 1. Below this point, trenches ~~eighteen (18) inches (0.46 meters)~~ in width shall be excavated for the ~~four~~4 sides of the bin.
 - 2. The bearing of the base of the bin shall be firm and shall be approved by the Engineer before erection of the wall.
- B. Structure excavation and backfill for the interior of the bin and behind the wall shall conform to ~~the requirements of Subsection 206, "Structure Excavation"~~ and Section 207, "Structure Backfill."
- C. Backfilling behind the wall shall progress with the filling of the bins and shall not be carried ahead of the binfill.
 - 1. Existing slopes, ~~which~~ that are shaped ~~so as~~ to cause a wedge action in the backfill, shall be step-cut or benched before backfilling.
 - 2. The limiting dimensions of structure backfill behind the wall shall be the same as those prescribed in Subsection 207.03.01, "General." for walls and abutments, or as otherwise shown on the plans.

660.03.03 ASSEMBLY

- A. In the construction of a wall on a curve, the proper curvature for the face shall be obtained by the use of shorter stringers in the front or rear panels of retaining walls as designated in the plans or by the Engineer.
- B. The wall height and depth may be varied.
- C. Two or more designs of retaining walls may be incorporated in the same wall by the use of standard split columns to make the connection of the step-back.
- D. The units shall be erected as shown on the plans.
- E. Members shall be handled carefully. ~~and any which are damaged~~ damaged members shall be removed and new members substituted at ~~the Contractor's expense~~ no additional cost to the Contracting Agency.

METHOD OF MEASUREMENT**660.04.01 MEASUREMENT**

- A. The quantity of metal bin-type retaining wall measured for payment will be the number of square feet ~~(square meters)~~ shown on the plans for each design type of wall, complete and in place.
- B. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

METAL BIN-TYPE RETAINING WALLS

660

BASIS OF PAYMENT

660.05.01 PAYMENT

- A. The accepted quantities of metal bin-type retaining walls measured as provided in Subsection 660.04.01, "Measurement," shall be paid for at the contract unit price bid per square foot ~~(square meter)~~ for the type specified.
- B. Structure excavation and structure backfill will be paid for in accordance with Sections 206, "Structure Excavation," and Section 207, "Structure Backfill."
- C. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- D. Payment will be made under:

PAY ITEM**PAY UNIT**

Metal Bin-Type Retaining Wall (type) Square Foot ~~(Square Meter)~~

SECTION 680

FIBER OPTIC CABLE

~~01~~DESCRIPTION

680.01.01 GENERAL

- A. The work under this section shall consist of furnishing, installing, and testing all underground and outdoor fiber optic cables.
- B. All equipment and cable selection, mounting, and installation, as well as the cable management plan must be approved by the Freeway & Arterial System of Transportation (FAST) Director or designee, prior to installation.

~~02~~MATERIALS/EQUIPMENT

680.02.01 FIBER OPTIC CABLE

- A. All fiber optic cable shall be Single Mode Fiber Optic (SMFO) cable that is of loose tube construction, filled with a water-blocking material, and constructed by a certified International Organization ~~efor~~ Standardization (ISO) 9001 or 9002 manufacturer.
- B. Fiber optic cable shall be dielectric and comply with the requirements of Rural Utilities Service Standards ~~(RUS)~~ 1755.900 except as modified by these specifications.
- C. Fiber optic cable shall comply with the following requirements:
 - 1. ~~(1)~~Number of fibers: Minimum 72 strands, 6 tubes of 12 fibers each.
 - 2. ~~(2)~~Cladding diameter: $125 \pm 1.0 \mu\text{m}$.
 - 3. ~~(3)~~Core-to-cladding offset: $\leq 0.8 \mu\text{m}$.
 - 4. ~~(4)~~Cladding non-circularity: $\leq 1.0\%$.
 - 5. ~~(5)~~Maximum attenuation: $\leq 0.40 \text{ dB/km}$ at 1310 nm; ~~(6)~~ $\leq 0.30 \text{ dB/km}$ at 1550 nm.
 - 6. ~~(7)~~Microbend attenuation (1 turn, 32 mm diameter): ~~(8)~~ $\leq 0.05 \text{ dB}$ at 1550 nm.
 - 7. ~~(9)~~Microbend attenuation ~~(8)~~ (100 turns, 75 mm diameter): ~~(10)~~ $\leq 0.05 \text{ dB}$ at 1310 nm.
 - 8. ~~(11)~~Mode-field diameter ~~(12)~~ (matched cladding): $9.3 \pm 0.5 \mu\text{m}$ at 1310 nm; $10.5 \pm 1.0 \mu\text{m}$ ~~at~~ 1550 nm.
 - 9. ~~(13)~~Maximum chromatic dispersion: $\leq 3.2 \text{ ps}/(\text{nm} \times \text{km})$ from 1285 nm to 1330 nm and ~~(14)~~ $< 18 \text{ ps}/(\text{nm} \times \text{km})$ at 1550 nm.
 - 10. ~~(15)~~Fiber polarization mode dispersion: $0.5 \text{ ps}/(\text{km})^{1/2}$.
 - 11. ~~(16)~~Fiber coating: Dual layered, UV cured acrylate.
 - 12. ~~(17)~~Coating diameter: $245 \mu\text{m} \pm 10 \mu\text{m}$.
 - 13. ~~(18)~~Min storage temperature range: ~~-40°C to $+70^\circ \text{C}$~~ (-40°F to 158°F).
 - 14. ~~(19)~~Min operating temperature range: ~~-20°C to $+70^\circ \text{C}$~~ (-4°F to 158°F).
 - 15. ~~(20)~~Rated life: Certify a 20-year life expectancy when installed to manufacturer's specifications.

D. Buffer Tubes:

1. Each buffer tube shall be filled with a non-nutritive to fungus, electrically non-conductive, water-blocking material that is free from dirt and foreign matter.
2. The water-blocking material shall allow free movement of the fibers, without loss of performance, during installation and normal operation including expansion and contraction of the buffer tubes.
3. The water-blocking material shall be readily removable with conventional nontoxic solvents.
4. Buffer tubes shall be stranded around a central member using the reverse oscillation or "S-Z" stranding process.
5. The use of filler rods in the fiber optic cable when required to lend symmetry to the cable section is mandatory.

E. Central Strength Member: The fiber optic cable shall have a central strength member designed to prevent buckling of the cable.

F. Cable Core: The fiber optic cable shall utilize a dry water-blocking material to block the migration of moisture inside the cables.

G. Tensile Strength Members:

1. The fiber optic cable shall have tensile strength members designed to minimize cable elongation due to installation forces and temperature variation.
2. Underground fiber optic cable shall withstand a 2700N (600 lbf) tensile load where the change in attenuation does not exceed 0.2 dB during loading and 0.1 dB after loading.
3. The cable shall be rated for an installed tensile service load of 890N (200 lbf) or more.

H. Cable Jacket:

1. The fiber optic cable jacket shall be constructed of a ~~H~~high or ~~M~~medium ~~d~~Density ~~P~~polyethylene (HDPE/MDPE) jacket that has been applied directly over the tensile strength members and water-blocking material.
2. The jacket shall have at least 1 ripcord designed for easy sheath removal.
3. This cable will be rated for use in both underground and overhead installations.

I. Conductive Line Locating Material:

1. A ~~6~~-pair ~~P~~polyethylene (PE) 39, ~~No.~~ 22 AWG (American Wire Gauge) ~~AWG~~ interconnect cable shall be directly adjacent to the cable in every conduit containing fiber optic cables to aid in locating of the conduit once it is in place.
2. This is not required if an existing interconnect cable is in place.
3. Any other method of providing a conductive tracer wire must be approved ~~of~~ by the FAST Director or designee, prior to installation.

J. Environmental: The cable shall be capable of withstanding the following conditions without damage or decrease in function:

1. ~~(1)~~ Total immersion in water with natural mineral and salt contents.
2. ~~(2)~~ Salt spray or salt-water immersion for extended periods.

3. ~~(3)~~ Wasp and hornet spray.

03 CONSTRUCTION

680.03.01 INSTALLATION – GENERAL

- A. The cable shall not be installed in any pull box until the pull box has been approved for pulling by the ~~e~~C~~ontracting~~ ~~a~~A~~gency~~.
- B. Cabinets shall be installed prior to cable installation.
- C. Installation of fiber optic cable shall be ~~preformed~~performed by individuals who are experienced and certified by a nationally recognized fiber optic installation certification organization.
 1. Certifications ~~must~~shall be approved by the FAST Director or designee~~;~~ prior to construction.
 2. Installation of fiber optic cable shall be continuous and without splices unless approved by the FAST Director~~;~~ or designee.
 3. The Contractor shall perform all final length measurements and order cable accordingly.
- D. The Contractor shall handle fiber optic cable carefully taking care not to pull cable along the ground, over or around obstructions~~,~~ or through unnecessary curves or bends.
 1. The Contractor shall not exceed fiber optic cable bend radius at any time.
 2. Manufacturer approved pulling grips, cable guides, feeders, shoes, blowing devices, pulleys, and bushings shall be used to prevent damage to the cable during installation.
- E. Prior to installing any fiber optic cable, the Contractor shall furnish recommended procedures, maximum pulling tension, a list of the cable manufacturer's approved pulling lubricants, and the lubricant manufacturer's procedures for use. The Contractor shall adhere to the cable and lubricant manufacturer's installation procedures.
- F. The Contractor shall ensure that the tensile load on the cable does not exceed the allowed maximum manufacturer's specification by using a pulling load/tension system~~,~~ approved by the cable manufacturer, that ~~includes a means of alert~~sing the installer when the pulling or blowing tension approaches the limit and/or that displays the actual tension on the cable ~~(pulling load / tension system as approved by the cable manufacturer)~~.
 1. Contractor may supplement this procedure with a breakaway tension limiter set below the recommended tensile limit of the cable being pulled or blown.
 2. A device known as a "~~M~~mechanical ~~C~~cable ~~T~~tugger" may be used with appropriate tension limiter, and at no time shall any type of vehicle be used for pulling the fiber optic cable.
- G. When removing cable from the reel prior to installation, place it in a figure~~-eight~~-8 configuration to prevent kinking or twisting. Take care to relieve pressure on the cable at crossovers by placing cardboard shims (or equivalent method) or by creating additional figure~~-eight~~-8s.
- H. If cables are ~~to be~~ installed in conduit with existing cables or wires that shall remain, the Contractor shall not damage the existing cables or wires.

1. The Contractor shall disconnect, remove, reinstall, and reconnect the existing cables and wires if necessary to facilitate the installation of the new cable ~~without any~~ at no additional cost to the Contracting Agency.
 2. The Contractor shall be responsible for any damage to the existing cables or wires caused by this operation.
 3. New and existing conductors shall be terminated and the labeling shall be reconciled as part of this process.
 4. ~~2~~ Two weeks prior to disconnecting any existing cables, the Contractor shall submit a schedule, for approval by the FAST Director or designee, with the accurate time frames of when the existing cables are to be disconnected.
- I. In all locations where fiber enters a pull box, for each cable entering the pull box or vault, cable slack shall be loosely looped through in a figure-eight ~~8~~ or a loose loop with a minimum of 30 feet of slack in all pull boxes smaller than a Type 200 ~~V~~ vault, unless approved by the FAST Director or designee, prior to installation. The Contractor shall leave a minimum of 60 feet of slack per conduit entrance in all Type 200 ~~V~~ vaults or other pull boxes where fiber optic cable is to be spliced, allowing the splicing activities to take place outside the pull box above ground in a controlled environment.
- J. If the pull box has racks and hooks, the Contractor shall attach the cables to ~~them~~ racks or hooks with industry standard cable ties immediately upon entering the box.
1. In all cases each cable shall be labeled, ~~then-looped~~, and tied independently ~~of one another~~.
 2. The labeling on the fiber optic cable shall be approximately 2 feet from the entry point, and ~~must~~ shall note the direction of the cable along with its next point of entry (i.e., FAST FIBER North to XYZ -St. or FAST FIBER West to ABC -Blvd.).
 3. Cable ties ~~should~~ shall be tightened ~~so that they to~~ prevent cable slippage, but ~~do not deform or damage~~ the cable sheath shall not be deformed or damaged.
- K. The Contractor shall follow ~~the requirements of~~ local building codes and ~~the~~ National Electrical Code, ~~(NEC)~~ Article -770, inclusive of the Fine Print Notes (FPN), when installing indoor fiber optic cable.
- L. The Contractor shall furnish attachment hardware, installation guides, and other necessary equipment, not specifically listed herein, as necessary to install the fiber optic cable.

680.03.02 TESTING

- A. ~~(a)~~—Fiber optic cable shall meet the ~~following~~ test requirements specified below. All testing ~~is to~~ shall be performed by an experienced and certified tester of a nationally recognized certification organization.
1. ~~(1)~~ Factory Testing:
 - a. The Contractor shall submit factory test data and related documentation from the manufacturer to the Engineer and the FAST Director or designee, prior to installing the cable.
 - b. This includes the “index of refraction” of the cable to be installed.
 - c. This test shall demonstrate that the attenuation for each fiber string complies with the loss budgets required by these ~~S~~ specifications.
 - d. Test blue and slate fibers at 1,310 nm and 1,550 nm.

- e. Submit factory results for approval by the FAST Director or designee, prior to installing the cable.
- 2. ~~(2)~~ Pre-Installation Testing:
 - a. The Contractor shall test all cable prior to installation.
 - b. Any cable that is found to have visual cladding damage shall be rejected.
 - c. Test fibers at 1,310 nm and 1,550 nm.
 - d. Submit Optical Time Domain Reflectometer (OTDR) trace results for approval by the FAST Director or designee, prior to installing the cable.
 - e. OTDR results ~~must~~shall be approved by the FAST Director or designee, prior to installation.
- 3. ~~(3)~~ Post-Installation Testing:
 - a. Testing shall conform to the American National Standards for "Measurement of Optical Fiber Cabling Components Standard," latest revision.
 - b. After installation, the Contractor shall perform the following tests using the procedures of "Measurement of Optical Power Loss on Installed Single-Mode Fiber Cable Plant," latest revision, and all standards and procedures invoked therein, subject to the following clarification:
 - 1) OTDR Tests:
 - a) Conduct tests using an OTDR for each fiber.
 - b) Demonstrate that the attenuation for each fiber string comply with the loss budgets required by these Standards.
 - c) Test fibers at 1,310 nm and 1,550 nm.
 - d) Submit OTDR trace results for approval and acceptance by the FAST Director, or designee.
 - 2) Power meter readings are required from all fibers. Submit power meter results for approval and acceptance by the FAST Director, or designee.
- B. ~~(b)~~—The Contractor shall test all fibers on the cables, identify any unacceptable losses, and make corrective actions at no additional cost. The Contractor shall replace any cable in its entirety that is not compliant with these specifications at no additional cost.
- C. ~~(c)~~—Following completion of all testing, and approval by the FAST Director or designee, the Contractor shall compile and submit 1 one organized test notebook in hard copy format, as well as a single electronic copy in Microsoft® Excel that includes all required test results, summary tables, splice details, circuit diagrams, and OTDR traces and power meter results of each fiber by each cable tested. The test notebook and electronic copy shall also include the following:
 - 1. ~~(1)~~ Identification number and name as appropriate.
 - 2. ~~(2)~~ A summary sheet that clearly illustrates length and measured loss versus budgeted loss for each fiber or connected fiber string as appropriate; and
 - 3. ~~(3)~~ Calculations and notations for each fiber and wavelength that include total loss, measured dB/km loss, and any anomalies over 0.1 dB.

680

FIBER OPTIC CABLE

- D. ~~(d)~~—FAST ~~must~~shall have in its possession all pre- and post-testing data prior to final approval and acceptance.

~~04~~METHOD OF MEASUREMENT

680.04.01 MEASUREMENT

- A. The quantity of Fiber Optic Cable (72-strand) will be measured per linear foot installed, in place, complete and operational, and successfully tested.
1. The cable shall be measured by the marking on the exterior cable sheath.
 2. No separate measurement will be made for lubricant in this item.

~~05~~BASIS OF PAYMENT

680.05.01 PAYMENT

- A. The accepted quantity of Fiber Optic Cable (72-strand) will be paid for at the contract unit price bid per linear foot, which shall be full compensation for installing the cable and appurtenances, complete in place, and for providing labor, hardware, cable ties, single mode fiber optic cable, lubricant, conductive line locating material, water blocking material, and labeling, all as specified, as shown on the drawings, and as required by the Engineer.
1. All materials required to complete the system shall be incidental to the cable including the approval, furnishing, and installation of racks and hooks in pull boxes, for each type installed.
 2. Payment for the fiber optic cable installation shall also include the cost of all fiber optic termination strips, terminations, and labeling as incidental to the item requiring the work.
 3. Testing, warranty, documentation, and spare parts are considered incidental to the item requiring the work.
- B. All other components of the approved Communications Distribution Cable Assembly ~~(CDCA)~~ shall be specified and paid for under Section 681, "Fiber Optic Splice and Distribution Equipment." Testing, temporary connectors for testing, warranty, documentation, training, and spare parts are considered incidental to the item requiring the work.
- C. Payment will be made under:

PAY ITEM

PAY UNIT

Fiber Optic Cable (72-strand)Linear Foot

SECTION 681**FIBER OPTIC SPLICE AND DISTRIBUTION EQUIPMENT****DESCRIPTION****681.01.01 GENERAL**

- A. The equipment under this section shall consist of furnishing the fiber optic cable equipment or accessories including connectors, connector panels, splice trays, patch panels, jumper cables, cable troughs, underground splice closures, termination strips, branch cables, closet housings, pigtails, and Communications Distribution Cable Assembly (CDCA) for each splice location as determined by the drawings and specifications.
- B. All other equipment not used shall be delivered to the Freeway ~~&~~and Arterial System of Transportation (FAST) Traffic Management Center (TMC) prior to project acceptance
 - 1. No partial shipments will be accepted for deliveries to the TMC.
 - 2. All equipment supplied on this project will be delivered as part of a single delivery, and shall be labeled clearly with the project and location designation.
- C. All equipment shall be approved by the FAST Director or designee, prior to purchase.

MATERIALS/EQUIPMENT**681.02.01 UNDERGROUND SPLICE ENCLOSURES**

- A. Underground splice enclosures shall be cylindrical, butt-end style, corrosion resistant, gel sealed, and meet the requirements of GR-771-CORE.
 - 1. Underground splice enclosures shall gel seal, bond, anchor, and provide efficient routing, storage, organization, and protection for fiber optic cable and splices.
 - 2. The splice enclosure shall provide an internal configuration and single end cap with a minimum of 6 ports of 72-~~strand~~ backbone, trunk, and branch line cables. ~~A~~Provide a Tyco ~~Model #~~ Fiber Optic Splice Closure (~~FOSC~~) ~~Model No.~~ 450-B6-6-24-6-B3V~~;~~ or equivalent as approved by the FAST Director or designee.
- B. All splice trays, cable baskets, and related equipment shall be supplied with the underground splice enclosure.
- C. The enclosure shall have 6 stackable single fusion trays for 24 splices each to accommodate a total 144 splices, and each shall be designed specifically for housing 24 single-mode fusion splices protected by heat-shrink sleeves.
 - 1. The splice trays shall be easy to install and remove, and have provisions for a minimum entry of 4 buffer tubes.
 - 2. A storage basket for storing loose buffer tubes or single fiber shall be installed and delivered with the enclosure.
- D. Splice enclosures shall have a gel seal design with both the cable jackets and core tubes sealed, without the use of other water-blocking material. The splice enclosures shall be capable of being opened and completely resealed without loss of performance.

681.02.02 COMMUNICATIONS DISTRIBUTION CABLE ASSEMBLY

- A. The Contractor shall provide and install Single Mode Gator Patch ~~(CDCA)~~ Intelligent Transportation System (ITS) Drop Cable or equivalent which is factory terminated cable with epoxy filled patch panel with 12 fiber optic Straight Tip (ST) connectors as approved by the FAST Director or designee.
- B. The ~~(CDCA)~~ ~~is to~~ shall be used between the fiber optic trunk line and controller at lengths as shown on the plans, with the required slack or 20 feet to 25 feet in each splice vault and pull box, as well as the 20 feet slack neatly coiled in the controller cabinet.
- C. Drop cable shall be designed with an Optical Fiber Non-Conductive Riser (OFNR)-rated, all-dielectric cable that is ultraviolet-resistant and fully waterproof for outdoor applications. Cable shall have a single 3.0 mm buffer tube containing 12 color-coded fibers.

CONSTRUCTION**681.03.01 GENERAL**

- A. The Contractor shall provide all of the equipment for splices as noted on the drawings and in the quantities in the bid schedule.
- B. Additionally, the CDCA shall be installed in the conduit from the above ground facility to the splice vault, and ~~it~~ the CDCA shall be splice ready.
- C. Once the CDCA is installed and accepted following testing, all permanent splices of the CDCA, installed by the Contractor, to the trunk line will be performed in the communications vault.

681.03.02 LABELING

- A. The Contractor shall label all cables to allow effective splicing.
- B. Labeling shall be done in a neat, professional manner using permanent methods and products approved by the FAST Director or designee.
- C. The labels shall include all necessary information to properly identify the cable and ~~it's~~ mating connection.

681.03.03 TESTING

- A. Testing of the CDCA and related hardware in this section is included in the testing procedure in Section 680, "Fiber Optic Cable," ~~of the Standard Specification.~~

METHOD OF MEASUREMENT**681.04.01 MEASUREMENT**

- A. The quantity of Underground Splice Enclosures will be measured for payment per each supplied, complete and operational, and successfully tested.
- B. The quantity of CDCA will be measured for payment per each installed, in place, complete and operational, and successfully tested.
- C. Branch line cables, splice trays, warranty, documentation, training, and labeling are considered incidental to the item requiring the delivery of the needed equipment. The branch line cable shall adhere to the specifications described in Section 680, "Fiber Optic Cable," and will be paid for as specified in this section.

FIBER OPTIC SPLICE AND DISTRIBUTION EQUIPMENT

681

BASIS OF PAYMENT

681.05.01 PAYMENT

- A. The accepted quantity of Underground Splice Enclosures delivered complete and associated cable/hardware measured as provided above, will be paid for at the Contract unit price bid per each, which ~~price~~ shall be full compensation for the underground splice closures including gel, splice trays, cable baskets, single fusion trays, sleeves, and storage baskets.
- B. The accepted quantity of CDCA installed and tested positively will be paid for at the contract unit price bid per each, which ~~price~~ shall be full compensation for the cable assemblies including hardware, 12 ST connectors per each assembly, labor and tools for complete installation, testing, labeling, documentation, training, warranty, and splicing, all as accepted by the FAST Director or designee.
- C. Payment will be made under:

PAY ITEM**PAY UNIT**

Underground Splice Enclosures	Each
Communication Distribution Cable Assembly (CDCA) and Permanent Fiber Splicing	Each

SECTION 682**FIBER OPTIC TRANSCEIVER****DESCRIPTION****682.01.01 GENERAL**

- A. The ~~e~~C~~on~~tractor shall furnish a Fiber Optical Transceiver/Self-~~Healing~~ (OTR/SH) that interfaces the traffic controllers with the central control system using Single Mode Fiber Optic (SMFO) cable.
 - 1. This communications device shall contain a self-healing optical ring and perform remote control of master/slave functions.
 - 2. The OTR/SH provides an electrical signal interface for an Electronic Industry Association (EIA)-232/422/485 port and 4 SMFO interfaces (2 transmit and 2 receive) that support fault tolerant, optical counter rotating ring as well as add/drop/repeat capability allowing field controllers to be interconnected in a multi-dropped configuration.
 - 3. The device shall be an International Fiber Systems (~~IFS~~) Model #~~No.~~ D19130SHR, or equivalent, as approved by the Freeway ~~&and~~ Arterial System of Transportation (FAST) Director or designee.
- B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.
 - 1. The ~~agency-Project-Director~~Engineer shall be notified prior to the delivery to the TMC.
 - 2. No partial shipments will be accepted.
 - 3. All equipment supplied on this project will be delivered during a single delivery, and shall be labeled clearly with the project and location designation.
- C. All equipment selection shall be approved prior to purchase by the FAST Director or designee.

MATERIALS/EQUIPMENT**682.02.01 GENERAL**

- A. The OTR/SH shall require no user adjustments other than switch selection of the desired interface, anti-streaming time, and ~~M~~master/~~S~~slave operation.
- B. When the OTR/SH is installed in a rack-~~mounted~~ card cage, the unit shall be hot-swappable with no adverse ~~a~~effects to ~~itself~~the OTR/SH or other units in the cage.
- C. All equipment supplied shall have a full lifetime replacement/repair warranty.

682.02.02 MECHANICAL

- A. The OTR/SH shall be a surface mount device (field), or rack mount (hub) configurations, when specified.
 - 1. The field mounted Video Optical Transceiver (~~VOTR~~) shall be enclosed in corrosion resistant housing that protects the internal circuitry from the environment.

2. The housing shall be provided with suitable holes for mounting to a flat surface.
- B. When it is specified, the rack-mounted OTR/SH shall occupy no more than 4 ~~R~~ack ~~U~~units (RU; 7 inches of space), ~~and~~ be of the same manufacturer, and be compatible with the 19-inch rack-mountable card cage. The rack-mounted OTR/SH shall be able to obtain all necessary power from the card cage assembly without the use of external power cables.
- C. All OTR/SH shall have labeling as follows:
 1. ~~E~~external, silk screened, labeling consisting of: ~~T~~the device type, model number, part number, serial number, ~~L~~ight ~~E~~mitting ~~D~~iode (LED) status indicators, connector functions, and manufacturer on the front panel and/or the housing.
 2. Internal labeling shall be provided to clearly identify all dip switches and jumper positions.
- D. The OTR/SH shall have LED status indicators for the following signals:
 1. ~~(a)~~ A looped locked, Forward Direction.
 2. ~~(b)~~ A loop locked, Reverse Direction.
 3. ~~(c)~~ B looped locked, Forward Direction.
 4. ~~(d)~~ B loop locked, Reverse Direction.
 5. ~~(e)~~ Transmit Data A.
 6. ~~(f)~~ Receive Data A.
 7. ~~(g)~~ Transmit Data B.
 8. ~~(h)~~ Receive Data B.
 9. ~~(i)~~ Power (PWR).

682.02.03 OPTICAL

- A. ~~(a)~~—The OTR/SH shall have the following characteristics:
 1. ~~1)~~ Laser diodes operating at 1,310 nanometers.
 2. ~~2)~~ Link loss budget of 20 dB ~~(minimum)~~.
 3. ~~3)~~ Less than 2 μ sec optical repeating delay.
 4. ~~4)~~ Straight Tip (ST) connectors: 4.
 5. ~~5)~~ Minimum connection of ~~0.67 meters (2 feet)~~ of cable with no optical attenuation.
 6. ~~6)~~ Anti-~~S~~streaming ~~F~~unction.
- B. ~~(b)~~—The OTR/SH shall provide fault-tolerant self-healing data communication paths for the following scenarios:
 1. ~~1)~~ Scenario 1: A self-healing ring configuration is functioning, then a cable break occurs on the working ring between 2 OTR/SH's.
 2. ~~2)~~ Scenario 2: A self-healing ring configuration is functioning, then 2 cable breaks occur, 1 on the working ring and 1 on the protect ring between 2 OTR/SH's.
 3. ~~3)~~ Scenario 3: A self-healing ring configuration is functioning, then a single slave OTR/SH failure occurs.

682.02.04 ELECTRICAL SIGNAL INTERFACES:

- A. ~~(a)~~ Data:
1. ~~1)~~ Bi-directional data communication (simplex and full duplex operating modes).
 2. ~~2)~~ Switch selectable EIA-232, EIA-422, or EIA-485 multi-dropped interfaces.
 3. ~~3)~~ Data rates from DC to 100 kbps.
 4. ~~4)~~ Bit error rate of 10⁻¹¹.
 5. ~~5)~~ DB-25 connector with standard EIA 232 pinout.
 6. ~~6)~~ Switch selectable anti-streaming (4 - 64 seconds, or disabled).
- B. ~~(b)~~ The OTR/SH shall be designed ~~such that~~so there is no command ~~"echo"~~ of the original command received by the host computer. The OTR/SH master shall be capable of communication with at least 32 slave units on the self-healing ring.

682.02.05 CONTROL

- A. The OTR/SH shall operate in either the ~~"M"~~master mode or ~~"S"~~slave mode.
1. The OTR/SH master shall transmit digital signals from a hub location to a number of field (slave) OTR/SH locations.
 2. Both master and slave units shall be identical.
 3. The determination of master or slave shall be accomplished by either a manual switch on the OTR/SH or by remote contact closure.
 4. A ~~"closed"~~ remote contact closure would put the OTR/SH in the ~~M~~master mode.

682.02.06 POWER

- A. The OTR/SH shall operate to specification when supplied with 120 VAC ±15 VAC, 60 Hz ±3 Hz single-phase power.
- B. The use of transformers to reduce the 120 VAC prime power input to a lower level used by the OTR/SH is acceptable.

682.02.07 ENVIRONMENTAL

- A. The OTR/SH shall be designed to operate from ~~-40° C (-40° degrees F)~~ to ~~+74° C~~ {165° degrees F} with no cooling airflow, 0-95 percent relative humidity, non-condensing.
- B. The OTR/SH shall be compliant with National Electronics Manufacturers Association (NEMA) TS-~~1~~1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for shock, vibration, and voltage transient protection.

682.02.08 19-INCH RACK-MOUNTED CARD CAGE

- A. When required at a hub location, the OTR/SH shall be able to be installed in a 19-inch rack-mounted card cage.
1. The cage height shall not exceed 4-RU.
 2. The cage shall contain a fault tolerant power converter compatible with OTR/SH module power requirements.

682

FIBER OPTIC TRANSCEIVER

3. The cage shall include provisions for interconnecting cabling and be designed to accommodate a minimum of 12 OTR/SH modules that shall be easily mountable and removable from the cage.
- B. When installed in the cage, the OTR/SH modules shall be securable.
1. The module's maintenance indications shall not be distributed after being mounted in the drawer.
 2. A failure of ~~one~~ 1 OTR/SH module shall not impact the operation of other OTR/SH modules installed within rack-mounted cage.

682.02.09 FIBER OPTIC JUMPER CABLES

- A. ~~4~~ Four fiber optic jumper cables shall be delivered with each transceiver supplied, ~~and~~
- B. ~~The~~ fiber optic jumper cables shall meet the following requirements:
1. ~~(a)~~ 250 μ m buffering of each fiber.
 2. ~~(b)~~ 900 μ m buffering of each fiber applied after the initial 250 μ m buffering.
 3. ~~(c)~~ Maximum factory measured insertion loss of 0.5 dB ~~per~~ in accordance with EIA/Telecommunications Industry Association (TIA) 455-171.
 4. ~~(d)~~ Less than 0.2 dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg.
 5. ~~(e)~~ Aramid yarn strength member.
 6. ~~(f)~~ Rugged ~~3 millimeters~~ (0.12 inch) (approximate) Polyvinyl Chloride (PVC) sheathing.
 7. ~~(h)~~ Minimum bend radius of ~~320 millimeters~~ (12 inches) following installation, ~~640 millimeters~~ (25 inches) during installation.
 8. ~~(h)~~ Minimum tensile strength of 444N (100 ~~lbs~~ pounds).
 9. ~~(i)~~ ~~And~~ ST connectors that are factory terminated with strain relief.

CONSTRUCTION**682.03.01 INSTALLATION OF EQUIPMENT**

- A. Though no physical construction is part of this deliverable, the Contractor shall furnish all mounting hardware (i.e., machine screws, nuts, locking washers) to install the OTR/SH securely in the cabinet.
1. Mounting methods using tape, Velcro, and sticky back material will not be permitted.
 2. All necessary power adapters and cabling needed to obtain power from the power distribution assembly shall be provided.
- B. As noted above, the Contractor shall also supply the 4 simplex fiber optic jumper cables needed to be installed from the field termination panel (field mounted) or from the fiber optic patch panel (rack-mounted) to the 4 optical inputs of the OTR/SH.
1. Contractor shall also supply the data cables for the DB-25 data connector.
 2. This consists of a 60-inch DB-25 M-M connector to plug into the OTR/SH on ~~one~~ 1 end and the 2070N traffic signal controller on the other.

FIBER OPTIC TRANSCEIVER

682

- C. All OTR/SH shall be provided with protective covers on all optical connectors. The Contractor shall ensure that the protective covers remain on the optical connectors at all times when each connector is not being used.

METHOD OF MEASUREMENT

682.04.01 MEASUREMENT

- A. The quantity of Shelf Mount Fiber Optic Transceivers with Cables will be measured per each complete and successfully tested.
- B. The quantity of Rack Mount Fiber Optic Transceivers with Cables will be measured per each complete and successfully tested.
- C. The quantity of 19-inch Rack-Mounted Card Cage will be measured per each, complete and successfully tested.
- D. Each card cage or OTR/SH will be measured as a unit for furnishing each OTR/SH, complete in delivery, in accordance to the quantities on the Bid Schedule.
- E. Mounting hardware and power conversion hardware, if required are incidental to the OTR/SH bid item and will not be measured or paid separately.
- F. The equipment delivered will be tentatively accepted pending testing by the FAST Director or designee. Only after a series of bench tests of the devices will the final acceptance be made and documented.

BASIS OF PAYMENT

682.05.01 PAYMENT

- A. The accepted quantity of Shelf Mount Fiber Optic Transceivers with Cables will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under [Subsection 682.04.01, "Measurement,"](#) complete including warranty, delivery to FAST, optical transceiver(s), SMFO cable, hardware, housing, 4 fiber optic jumper cables per optical transceiver, data connectors, optical connector covers, and testing of the equipment; as specified and as shown on the drawings.
- B. The accepted quantity of Rack Mount Fiber Optic Transceivers with Cables will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under [Subsection 682.04.01, "Measurement,"](#) complete including warranty, delivery to FAST, optical transceiver(s), SMFO cable, hardware, 4 fiber optic jumper cables per optical transceiver, data connectors, optical connector covers, and testing of the equipment; as specified and as shown on the drawings.
- C. The accepted quantity of 19-inch Rack-Mounted Card Cage will be paid for at the contract unit price bid per each, which shall be full compensation for the equipment, measured as provided under [Subsection 682.04.01, "Measurement,"](#) complete including warranty, delivery to FAST, rack-mounted card cage, hardware, and testing of the equipment; as specified and as shown on the drawings.
- D. Payment will be made under:

682

FIBER OPTIC TRANSCEIVER

PAY ITEM:	PAY UNIT
Shelf Mount Fiber Optic Transceivers (OTR/SH) with Cables	Each
Rack Mount Fiber Optic Transceivers (OTR/SH) with Cables	Each
19-Inch Rack-Mounted Card Cage.....	Each

SECTION 683**VIDEO OPTICAL TRANSCEIVER WITH BI-DIRECTIONAL DATA CHANNEL****DESCRIPTION****683.01.01 GENERAL**

- A. The Contractor shall furnish the designated quantity of Video Optical Transceiver (VOTR) pairs that interface the Closed Circuit Television (CCTV) cameras with the central control system over Single Mode Fiber Optic (SMFO) cable.
 - 1. Each VOTR pair delivered shall provide 1 unidirectional National Television Standards Committee (NTSC) color video channel from the CCTV field location to another designated point and 1 bi-directional data channel between both locations.
 - 2. There ~~will~~shall be a designated video transmitter and a video receiver.
 - 3. The devices shall be International Fiber Systems (IFS) Model ~~#No.~~VT4930WDM and IFS Model ~~#No.~~VR4930WDM, or equivalent, as approved by the Freeway ~~&~~and Arterial System of Transportation (FAST) Director or designee.
- B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.
 - 1. No partial shipments will be accepted.
 - 2. All equipment supplied on this project ~~will~~shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.
- C. The VOTR ~~will~~shall be able to be connected to each end of ~~one~~1 single mode optical fiber with Straight Tip (ST) connections to establish a point-to-point communication topology for the locations shown on the drawings. VOTR's designed for mounting in card cages shall be hot swappable.
- D. All equipment selections shall be approved by the FAST Director or designee.

MATERIALS/EQUIPMENT**683.02.01 GENERAL**

- A. All equipment supplied ~~will~~shall have a full manufacturer's warranty.

683.02.02 MECHANICAL

- A. The VOTR shall be a surface mount device (field)~~;~~ or rack-mount (hub) configurations~~s~~, when specified.
 - 1. The field mounted VOTR shall be enclosed in corrosion resistant housing that protects the internal circuitry from the environment.
 - 2. The housing shall be provided with suitable holes for mounting to a flat surface.
- B. When it is specified, the rack-mounted VOTR shall occupy no more than 4 ~~R~~rack ~~U~~units (RU~~s~~) (7 inches) of space~~), and~~ be of the same manufacturer~~,~~ and be compatible with the 19-inch rack-mountable card cage. The rack-mounted VOTR's shall obtain all necessary power from the card cage assembly without the use of external power cables.
- C. All VOTR's shall have labeling as follows:

683 VIDEO OPTICAL TRANSCEIVER WITH BI-DIRECTIONAL DATA CHANNEL

1. ~~e~~External, silk screened, labeling consisting of: -the device type, model number, part number, serial number, ~~L~~ight ~~E~~mitting ~~D~~iode (LED) status indicators, connector functions, and manufacturer on the front panel and/or the housing.
 2. Internal labeling shall be provided to clearly identify all dip_switches and jumper positions.
- D. The VOTR shall have LED status indicators for presence of video carrier, input power, and data transmission.

683.02.03 OPTICAL

- A. The optical component shall have the following features:
1. ~~(a)~~ Laser both directions (wavelength 1310/1550 nm) over 1 single mode fiber.
 2. ~~(b)~~ Link loss budget of 23_dB ~~(minimum)~~.
 3. ~~(c)~~ ST ~~C~~connectors only.
 4. ~~(d)~~ Minimum connection of ~~0.67-meters~~ (2 feet) of cable with no optical attenuation.

683.02.04 DATA

- A. The data component shall have the following features:
1. ~~(a)~~ Bi-directional data communications (simplex and full duplex operating modes).
 2. ~~(b)~~ Selectable Electronic Industry Association (EIA)-232, EIA-422, or 2-wire EIA-485 interfaces.
 3. ~~(c)~~ Data rates from DC to 100_kbps.
 4. ~~(d)~~ Bit error rate of 10⁻⁹.
 5. ~~(e)~~ Data receiver output (EIA-232/422) defaults to a "low" state in the event of a fiber break or failed data transmitter.

683.02.05 VIDEO

- A. The video component shall have the following features:
1. ~~(a)~~ NTSC Color, compliant with ~~EIA~~EIA/TIA-250-C for Medium-Haul Transmission and EIA-170 Video Standards.
 2. ~~(b)~~ Bandwidth range of 5_Hz to 6.5_MHz.
 3. ~~(c)~~ Signal-to-Noise Ratio > 60 dB.
 4. ~~(d)~~ Differential Gain < 3 percent.
 5. ~~(e)~~ Differential Phase < 3 degrees.
 6. ~~(f)~~ Tilt < 1 percent.
 7. ~~(g)~~ BNC Connection.

683.02.06 POWER

- A. The VOTR shall operate to specification when supplied with 120_VAC ~~±~~15_VAC, 60_Hz ~~±~~3_Hz single-phase power.

- B. The use of transformers to reduce the 120 VAC prime power input to a lower level used by the VOTR is acceptable. This transformer shall be supplied if necessary.

683.02.07 ENVIRONMENTAL

- A. The VOTR shall be designed to operate from ~~minus-40°C (-40° degrees -F)~~ to ~~+74°C~~ ~~(165° degrees -F)~~ with no cooling airflow, 0-95 percent relative humidity, non-condensing.
- B. The VOTR shall be compliant with National Electronics Manufacturers Association ~~(NEMA)~~-TS-1/TS-2 and Caltrans Traffic Signal Control Equipment Specifications for shock, vibration, and voltage transient protection.

683.02.08 19-INCH RACK MOUNTED CARD CAGE

- A. When required at a hub location, the VOTR shall be able to be installed in a 19-inch rack mounted card cage.
1. The cage height shall not exceed 4 RU.
 2. The cage shall contain a fault tolerant power converter compatible with VOTR module power requirements.
 3. The cage shall include provisions for interconnecting cabling and be designed to accommodate a minimum of ~~seven~~ 7 VOTR modules that shall be easily mountable and removable from the cage.
- B. When installed in the cage, the VOTR modules shall be securable.
1. The module's maintenance indications shall not be distributed after being mounted in the drawer.
 2. A failure of 1 VOTR module shall not impact the operation of other VOTR modules installed within rack-mounted cage.

683.02.09 FIBER OPTIC JUMPER CABLES

- A. ~~4~~ Four fiber optic jumper cables shall be delivered with each transceiver supplied ~~and~~
- B. ~~t~~ The fiber optic jumper cables shall meet the following requirements:
1. ~~(a)~~ 250 µm buffering of each fiber.
 2. ~~(b)~~ 900 µm buffering of each fiber applied after the initial 250 µm buffering.
 3. ~~(c)~~ Maximum factory measured insertion loss of 0.5 dB ~~per~~ in accordance with EIA/Telecommunications Industry Association (TIA) ~~-455--171~~.
 4. ~~(d)~~ Less than 0.2 dB loss when subjected to EIA/TIA-455-1B, 300 cycles, 0.5 kg.
 5. ~~(e)~~ Aramid yarn strength member.
 6. ~~(f)~~ Rugged ~~3 millimeters~~ ~~(0.12 inch)~~ (approximate) Polyvinyl Chloride (PVC) sheathing.
 7. ~~(g)~~ Minimum bend radius of ~~320 millimeters~~ ~~(12 inches)~~ following installation, ~~640 millimeters~~ ~~(25 inches)~~ during installation.
 8. ~~(h)~~ Minimum tensile strength of 444-N (100 ~~lbs~~ pounds).
 9. ~~(i)~~ ~~And~~ ST connectors that are factory terminated with strain relief.

683

VIDEO OPTICAL TRANSCEIVER WITH BI-DIRECTIONAL DATA CHANNEL

CONSTRUCTION

683.03.01 GENERAL

- A. Though no physical construction is part of this deliverable, the Contractor shall furnish all mounting hardware (i.e., machine screws, nuts, locking washers) to install the VOTR's securely in the cabinet.
 - 1. Mounting methods using tape, Velcro, and sticky back material will not be permitted.
 - 2. All necessary power adapters and cabling needed to obtain power from the power distribution assembly shall be provided and secured.
- B. As noted above, the Contractor shall also supply the 1 simplex fiber optic jumper cable needed to be installed from the field termination panel (field mounted) or from the fiber optic patch panel (rack mounted) to the single optical inputs of the VOTR.
- C. All VOTR's shall be provided with protective covers on all optical connectors. The Contractor shall ensure that the protective covers remain on the optical connectors at all times when each connector is not being used.

METHOD OF MEASUREMENT

683.04.01 MEASUREMENT

- A. The quantity of Sshelf Mmounted VOTR's with Ccable will be measured for payment per each delivered, complete and operational, and successfully tested.
- B. The quantity of rack mounted VOTR's with cable will be measured for payment per each delivered, complete and operational, and successfully tested.
- C. The quantity of 19-inch rack mounted card cage will be measured for payment per each delivered, complete and operational, and successfully tested.
- D. Mounting hardware, power conversion hardware (if required), and the VOTR rack mountable card cage in the hub is incidental to the VOTR bid item and will not be measured or paid separately.
- E. The equipment delivered will be tentatively accepted pending testing by the FAST Director or designee. Only after a series of bench tests of the devices will the final acceptance be made and documented.

BASIS OF PAYMENT

683.05.01 PAYMENT

- A. The accepted quantity of Sshelf Mmounted VOTR's with cable delivered complete will be paid for at the contract unit price bid per each, which ~~price~~ shall be full compensation for the VOTR(s), SMFO cable, housing(s), 4 fiber optic jumper cables per video transceiver, hardware, 1 simplex fiber optic jumper cable per video transceiver, warranty, and delivery to the FAST Director or designee.
- B. The accepted quantity of rack mounted VOTR's with cable delivered complete will be paid for at the contract unit price bid per each, which ~~price~~ shall be full compensation for the VOTR(s), SMFO cable, 4 fiber optic jumper cables per video transceiver, hardware, 1 simplex fiber optic jumper cable per video transceiver, warranty, and delivery to the FAST Director or designee.

VIDEO OPTICAL TRANSCEIVER WITH BI-DIRECTIONAL DATA CHANNEL

683

- C. The accepted quantity of 19-inch rack mounted card cage delivered complete will be paid for at the contract unit price bid per each, which ~~price~~ shall be full compensation for the rack mounted card cage, hardware, warranty, and delivery to the FAST Director or designee.
- D. Payment will be made under:

PAY ITEM	PAY UNIT
Shelf Mounted Video Optical Transceivers with Cable	Each
Rack Mounted Video Optical Transceivers with Cable	Each
19-Inch Rack Mounted Card Cage	Each

SECTION 684**LAYER 2 FIELD-HARDENED ETHERNET SWITCH****01DESCRIPTION****684.01.01 GENERAL**

- A. This specification describes the functional, performance, environmental, submittal, documentation, and warranty requirements, as well as the method of measurement and basis of payment, for a Layer 2 Field-Hardened Ethernet Switch, herein called the field switch.
- B. The Field Switch shall comply with ~~the requirements stated within~~ this specification ~~so as~~ to operate within the Freeway and Arterial System of Transportation (FAST) Arterial Management System ~~(AMS)~~ and Freeway Management System ~~(FMS)~~.
- C. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.
 - 1. The ~~agency Project Manager~~ Engineer shall be notified prior to the delivery to the TMC.
 - 2. No partial shipments will be accepted.
 - 3. All equipment supplied on this project ~~will~~ shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.
- D. All equipment shall be approved prior to purchase by the FAST Director or designee.

02MATERIALS/EQUIPMENT**684.02.01 FUNCTIONAL REQUIREMENTS**

- A. The field switch shall comply with the following standards:
 - 1. ~~(a)~~ Institute of Electrical and Electronic Engineers (IEEE) 802.IQ: Local and Metropolitan Area Networks, ~~—Virtual Bridged Local Area Networks~~.
 - 2. ~~(b)~~ IEEE 802.1P: Traffic Class Expediting and Dynamic Multicast Filtering, —Draft 8.
 - 3. ~~(c)~~ IEEE 802.3X: IEEE Standards for Local and Metropolitan Area Networks; Specifications for 802.3 Full Duplex Operation.
 - 4. ~~(d)~~ IEEE 802.1W: IEEE Standards for Local and Metropolitan Area Networks, —Common Specifications, ~~—Part 3; Media Access Control (MAC) Bridges~~, ~~—Amendment 2~~, Rapid Configuration.
 - 5. ~~(e)~~ Federal Communications Commission ~~(FCC)~~ Rules and Regulations, Vol. II; Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (~~P~~ product electromagnetic compatibility is required).
 - 6. ~~(f)~~ National Electronics Manufacturers Association (NEMA) TS-1, Section 2, ~~—Traffic Control System~~. The following clauses apply:
 - a. ~~(1)~~ 2.1.2: Voltage.
 - b. ~~(2)~~ 2.1.3: Frequency Range.
 - c. ~~(3)~~ 2.1.4: Power Interruption.

- d. ~~(4)~~—2.1.5: Temperature and Humidity, as modified herein.
 - e. ~~(5)~~—2.1.6: Transients, Power Service.
 - f. ~~(6)~~—2.1.7: Transients, Input-~~e~~Output terminals.
 - g. ~~(7)~~—2.1.8: Non-~~D~~estruct Transient Immunity.
 - h. ~~(8)~~—2.1.12: Vibration.
 - i. ~~(9)~~—2.1.13: Shock.
7. ~~(g)~~Underwriters Laboratories, Inc.~~y~~ (UL) 60950: Safety Requirements for Information Technology (IT) Equipment (applicable to equipment safety).
8. ~~(g)~~Military Handbook MIL-HDBK-217F-2: ~~Military Handbook for~~ "Reliability Prediction of Electronic Equipment," Notice 2.
- B. Detailed Requirements:
- 1. ~~(i)~~The field switch shall:
 - a. ~~(1)~~—Be 6-port (minimum) 10/100 Base TX RJ-45.
 - b. ~~(2)~~—Have a minimum of ~~2~~two 100 Base FX fiber optical ports.
 - c. ~~(3)~~—Operate non-blocking, at full wire speed.
 - d. ~~(4)~~—Support remote reset and remote management.
 - e. ~~(5)~~—Support IGMP snooping.
 - f. ~~(6)~~—Support IP Multicast filtering.
 - g. ~~(7)~~—Support remote turn on/off Base TX ports.
 - 2. ~~(j)~~The field switch shall also meet the following functionality and performance requirements:
 - a. Each ~~(1)~~—10/100 Base TX port shall connect via RJ-45 connector.
 - 1) The ports shall operate as half-duplex or full-duplex (IEEE 802.3x) over 100_m segment lengths~~_-and~~
 - 2) The ports shall provide auto-negotiation and Medium Dependent Interface/Medium Dependent Interface, Crossover (MDI/MDIX) capability.
 - b. ~~(2)~~—Each 100 Base FX (Fiber Transmission~~-(FX)~~) port shall connect via~~l~~ fiber connectors and 9/125_μm single-mode fiber.
 - 1) Fiber connectors shall be available as Straight Tip (ST).
 - 2) The ports shall operate as full~~_-~~duplex (IEEE 802.3x) over 15 km segment lengths.
 - 3) The minimum link loss budget (OPB = ~~R~~X* (min) – LED aging) shall be greater than or equal to 15 dB.
 - c. ~~(3)~~—The field switch shall provide the following advanced Layer 2 functions:
 - 1) IEEE 802.1Q VLAN with support for a minimum of 128 Virtual Local Area Networks (VLAN)~~_-f~~
 - 2) IEEE 802.1P priority queuing~~_-f~~
 - 3) IEEE 802.1W rapid spanning tree (required)~~_-f~~

LAYER 2 FIELD-HARDENED ETHERNET SWITCH

684

- 4) IEEE 802.3X flow control greater than or equal to 1,028.
- 5) ~~s~~Support automatic address learning of a minimum 4,096 Medium Access Control (MAC) addresses and greater than or equal to 1,028 static MAC address.
- d. ~~(4)~~—The field switch shall provide the following port security functions:
 - 1) ~~a~~Ability to configure static MAC addresses.
 - 2) ~~a~~Ability to disable automatic address learning per ports; known hereafter as secure port.
 - 3) ~~s~~Secure ports only forward statically configured MAC addresses.
 - 4) ~~t~~Trap and alarm upon any unauthorized MAC address and shutdown for programmable duration.
 - 5) Port shutdown requires administrator to manually reset the port before communications are allowed.
 - 6) ~~a~~All the above activities are done remotely.
- e. ~~(5)~~—The field switch shall provide the following network management functions:
 - 1) SNMPv3 (RFC 2273).
 - 2) RMON (RFC 1757).
 - 3) Port Mirroring (RFC 1757).
 - 4) Spanning Tree (IEEE 802.1D).
 - 5) Rapid Spanning Tree (IEEE 802.1W).
- f. ~~(6)~~—The field switch shall support:
 - 1) ~~t~~Telnet.
 - 2) Trivial File Transfer Protocol (TFTP) or File Transfer Protocol (FTP).
 - 3) Command Line Interface ~~(CLI)~~ and
 - 4) Simple Network Management Protocol (SNMP).
3. ~~(k)~~—The field switch shall have an integrated web interface.
 - a. Reset/Reboot and firmware shall be supported via all methods listed above.
 - b. All parameters and settings (network management, security, Layer 2 features, ~~etc~~and so forth) shall be user configurable through the maintenance port, web interface, Telnet, and all other supported remote management tools.
4. ~~(l)~~—The field switch shall allow for stand-alone shelf mounting unit and DIN rail mounting.
5. ~~(m)~~—The field switch shall ~~support~~have the following characteristics:
 - a. ~~(1)~~—Power: Nominal 120 VAC, 60 Hz.
 - b. The unit shall be provided with all power conversion and regulation necessary to support electronics operation.

- c. The power input circuitry shall be designed to protect the electronics from damage by a power surge or under-voltage condition.
- d. Power consumption shall not exceed 20 ~~W~~Watts.
- 6. ~~(n)~~ The field switch shall include a power status indicator.
- 7. ~~(e)~~ Physical Characteristics:
 - a. ~~(1)~~ 6-Port.
 - b. ~~(2)~~ The field switch shall not exceed 3 inches" high ~~*by~~ 17.25 inches" wide ~~or by~~ 10 inches" ~~deep (3" x 17.25" x 10")~~.
 - c. ~~(3)~~ The weight shall not exceed 6 ~~lb~~pounds.
- 8. ~~(p)~~ Environmental: The field switch shall conform to functional and performance specifications as defined herein when operated in the following environment.
 - a. ~~(1)~~ Temperature: ~~-20°C~~ -4 degrees F to ~~74°C~~ 165 degrees F.
 - b. ~~(2)~~ Humidity: 5 to 95 percent relative humidity, non-condensing.
- 9. ~~(q)~~ Cooling shall be by convection with case acting as heat sink. No cooling fan shall be used.
- 10. ~~(r)~~ The field switch shall have the following minimum indicators:
 - a. ~~(1)~~ Power: On, Off.
 - b. ~~(2)~~ Network status per port: Transmit, receive, link, speed.
- 11. ~~(s)~~ Status indicators shall be Light ~~E~~mitting ~~D~~iode (LED).
- 12. ~~(t)~~ All connectors, indicators and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list. The external markings shall include the product function name, model number, serial number and manufacturer's name.
- 13. ~~(u)~~ The field switch shall have a minimum Mean Time Between Failures (MTBF) of 40,000 hours.
- 14. ~~(v)~~ Each unit shall have a unique MAC address. MAC address shall be derived from an address space of 10,000 sequential addresses.
- 15. ~~(w)~~ Documentation: Upon delivery, the following minimum documentation shall be provided by the vendor with each field switch provided:
 - a. ~~(1)~~ Initial configuration: ~~(This document shall provide both hardware and software settings).~~
 - b. ~~(2)~~ Setup and configuration manual.
 - c. ~~(3)~~ Users manual.
- 16. ~~(x)~~ Warranty:
 - a. The field switch shall be warranted for a minimum of 3 years.
 - b. The warranty shall guarantee the field switch to be free from defects from assembly, fabrication and materials.
 - c. The warranty ~~will~~shall begin upon acceptance by the ~~e~~Contracting ~~a~~Agency.

LAYER 2 FIELD-HARDENED ETHERNET SWITCH

684

~~03~~CONSTRUCTION**684.03.01 BLANK**~~04~~METHOD OF MEASUREMENT**684.04.01 MEASUREMENT**

- A. The Layer 2 Field-Hardened Ethernet Switch shall be measured per each. The mounting hardware and cabling and network management software are considered incidental to the unit and will not be measured or paid for separately ~~to the unit~~.

~~05~~BASIS OF PAYMENT**684.05.01 PAYMENT**

- A. The accepted quantity of Layer 2 Field-Hardened Ethernet Switch ~~(s)~~ will be paid for at the contract unit price per each, which shall be full compensation for, ~~The unit will include~~ furnishing and ~~configuration~~ configuring the unit, and for all labor, material, and equipment required ~~f~~or ~~facilitate~~ ing an operational field switch.
- B. Payment will be made under:

PAY ITEM**PAY UNIT**

Layer 2 Field-Hardened Ethernet Switch..... Each

SECTION 685**VIDEO ENCODER****DESCRIPTION****685.01.01 GENERAL**

- A. This specification describes the functional, performance, environmental, submittal, documentation, and warranty requirements, as well as the method of measurement and basis of payment, for a rugged field deployable and user selectable Moving Picture Experts Group (MPEG)-2 and MPEG-4 video encoder.
1. This video encoder will transmit data via RS-232/422 and accept standard National Television Standards Committee (NTSC) composite video signal as input, digitally compress it, and transmit it over the Freeway and Arterial System of Transportation (FAST) communication network.
 2. The video encoder shall comply with ~~the requirements stated within this specification so as to~~ operate within the FAST Arterial Management System (AMS) and Freeway Management System (FMS).
- B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.
1. The ~~agency Project Manager~~ Engineer shall be notified prior to the delivery to the TMC.
 2. No partial shipments will be accepted.
 3. All equipment supplied on this project ~~will~~ shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.
- C. All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS**685.02.01 FUNCTIONAL REQUIREMENTS**

- A. The video encoder shall comply with the following standards:
1. ~~(1)~~ National Electronics Manufacturers Association (NEMA) TS ~~1~~ Section 2 - Traffic Control System. The following clauses apply:
 - a. ~~a)~~ 2.1.2: Voltage.
 - b. ~~b)~~ 2.1.3: Frequency Range.
 - c. ~~c)~~ 2.1.4.1: Power Interruption.
 - d. ~~d)~~ 2.1.5: Temperature and Humidity, as modified herein.
 - e. ~~e)~~ 2.1.6: Transients, Power Service.
 - f. ~~f)~~ 2.1.7: Transients, Input-~~e~~ Output terminals.
 - g. ~~g)~~ 2.1.8: Non-~~d~~ Destruct Transient Immunity.
 - h. ~~h)~~ 2.1.12: Vibration.
 - i. ~~i)~~ 2.1.13: Shock.

2. ~~(2)~~International Organization for Standardization: (ISO) 9001: Quality Assurance, MPEG-2, ISO/13818-2 Video Compression.
3. ~~(3)~~Institute of Electrical and Electronic Engineers (IEEE) 802.3: Part 3, CSMA/CD Access Method and Physical Layer Specifications.
4. ~~(4)~~Federal Communications Commission ~~(FCC)~~Rules and Regulations, Vol. II: Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (~~P~~product electromagnetic compatibility is required).
5. ~~(5)~~Underwriters Laboratories, Inc. (UL) 60950: Safety Requirements for IT Equipment (~~A~~applicable to equipment safety).
6. ~~(6)~~Military Handbook MIL-HDBK-217F-2: ~~Military Handbook for~~ "Reliability Prediction of Electronic Equipment," Notice 2.

B. Detailed Requirements:

1. ~~(a)~~The video encoder shall support the following video features:
 - a. ~~(1)~~Signal format: 30 fps, NTSC color.
 - b. ~~(2)~~Resolution: 720 x 480 (full ~~R~~resolution).
 - c. ~~(3)~~Video Settings: Contrast, saturation, brightness, and hue.
2. ~~(b)~~The video encoder shall support bi-directional serial communications over ~~e~~Ethernet via the following methods:
 - a. ~~(1)~~Encoder serial port to decoder serial port data stream.
 - b. ~~(2)~~Internet Protocol (IP) socket to encoder serial port.
3. ~~(3)~~The video encoder shall support full-duplex~~ed~~ serial interface and data rates up to 57.6 kbps.
 - a. The baud rate, stop bits, data bits, and flow control shall be user configurable.
 - b. The serial interface shall be transparent to the device (i.e., no additional or special protocols shall be required to communicate between the ~~C~~closed ~~C~~circuit ~~T~~television (CCTV) control interface and the encoder).
4. ~~(e)~~The video encoder shall support the following:
 - a. ~~(1)~~Encoding Formats: The unit shall be capable of being soft configured to perform MPEG-2 ISO/13818-2 video compression and MPEG-4 ISO/14496 video compression.
 - b. ~~(2)~~The encoder shall be capable of being soft configured to produce elementary, or transport stream.
 - c. ~~(3)~~Bandwidth:
 - 1) 1.5 Mbps ~~to~~ 10 Mbps for MPEG-2 and 64 Kbps to 5 Mbps for MPEG-4.
 - 2) ~~(The data rate shall be defined as the maximum committed bandwidth to be utilized, which includes bursting).~~
 - 3) The default bandwidth for the video encoder shall be set to 5 Mbps for MPEG-2 and 1 Mbps for MPEG-4.

VIDEO ENCODER

685

- d. ~~(4)~~—Latency: The end-to-end latency between the video encoder and the video decoders shall be no more than 250 ms while operating at a rate of 5 Mbps.
- 5. ~~(e)~~ The video encoder shall support the following network features:
 - a. ~~(1)~~—Ethernet Interface: 10/100 Mbps, Full-Duplex, Auto Negotiate (802.3), (RJ-45).
 - b. ~~(2)~~—Static IP Addressing: (Class A, B, and C).
 - c. ~~(3)~~—SNMP (MIB2).
 - d. ~~(4)~~—Unicast and Multicast (IGMP V2).
 - e. ~~(5)~~—Gateway Configuration.
 - f. ~~(6)~~—Adjustable Packet Payload Size.
- 6. ~~(e)~~ The video encoder shall support:
 - a. ~~(1)~~—Command Line Interface ~~(CLI)~~.
 - b. ~~(2)~~—Telnet.
 - c. ~~(3)~~—Trivial File Transfer Protocol (TFTP) or FTP (new firmware download).
 - d. ~~(4)~~—The video encoder shall have an integrated web interface, ~~which~~ that provides remote configuration.
 - e. ~~(5)~~—Reset/Reboot and firmware upload shall be supported via all methods listed above.
 - f. ~~(6)~~—All video (i.e., resolution, contrast, ~~etc.~~ and so forth), data (i.e., baud rate, parity, ~~etc.~~ and so forth), encoder (i.e., bandwidth, ~~etc.~~ and so forth), and network (i.e., IP, subnet mask, gateway, ~~etc.~~ and so forth) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet, and all other supported remote management tools.
 - g. ~~(7)~~—All configurations and settings shall be downloadable/exportable in ~~a~~ document form. As a minimum, the exported settings shall include video, network, and data settings.
- C. Failure and Reset Recovery: The recovery time of a hard or soft reset shall be less than 45 seconds.
- D. Electrical: ~~(a)~~—The video encoder shall ~~support~~ have the following characteristics:
 - 1. ~~(1)~~Power:
 - a. Nominal input voltage of 120 VAC 60 Hz.
 - b. The unit shall contain all power conversion and regulation necessary to support electronics operation.
 - 2. ~~(2)~~Power consumption: Shall not exceed 70 ~~W~~ Watts.
 - 3. ~~(3)~~All supplied video encoders shall have the same power connectors.
 - a. Each unit shall be provided with a power cable that is at least 5 feet ~~(1.5 meters)~~ in length.
 - b. ~~and~~ Power cable shall be terminated with a male, 3-prong UL-listed power connector for interface with the previously stated power system.

E. Ports: ~~(a)~~—The video encoder shall have the following ports:

1. ~~(1)~~ Network: 10/100 Mbps RJ-45.
2. ~~(2)~~ Video: Composite Bayonet Neill-Concelman (BNC) and S-Video.
3. ~~(3)~~ Data:
 - a. Two Electronics Industry Association (EIA)-RS232/422/485, DB-9* (Female):
 - 1) These ports shall provide data pass-through for serial control (i.e., PTZ camera control).
 - 2) If EIA RS422 is not provided natively by the port, an EIA RS232-to-422 converter meeting all encoder environmental requirements shall be supplied.
 - 3) RJ-45 may be provided in place of DB 9. For each RJ-45 port, an RJ-45-to-DB-9 converter shall be supplied.
 - b. ~~(4) Data: 1~~ One EIA-232 DB-9* (Female):
 - 1) This port shall provide maintenance interface for local configuration.
 - 2) *RJ-45 may be provided in place of DB-9. For each RJ-45 port, an RJ-45-to-DB-9 converter shall be supplied.

F. Status Indicators:

1. ~~(a)~~ The video encoder shall have the following minimum indicators:
 - a. ~~(1)~~ Activity.
 - b. ~~(2)~~ Power.
 - c. ~~(3)~~ Video Loss.
 - d. ~~(4)~~ Transmit.
 - e. ~~(5)~~ Receive.
2. ~~(b)~~ Status indicators shall be LED.

G. Physical Characteristics:

1. ~~(a)~~ The video encoder shall not exceed 2-1/2 inches-1/2" high ~~*by~~ 12 inches" wide ~~*by~~ 13 inches "deep ~~(2-1/2" x 12" x 13").~~
2. ~~(b)~~ The weight shall not exceed 10-lb pounds.

H. External Markings:

1. All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list.
2. The external markings shall include the product function name, model number, serial number, and manufacturer's name.

I. Environmental:

1. ~~(a)~~ The video encoder shall conform to the performance specification when operated in the following environment:
 - a. ~~(1)~~ Temperature: ~~-20°C to +70°C (-4° degrees -F to 165 degrees °F.)~~
 - b. ~~(2)~~ Humidity: 5 to 95 percent relative humidity, non-condensing.

VIDEO ENCODER

685

- c. ~~(3)~~—The video encoder shall be conformal coated to prevent damage from blowing sand and dust.
 - 2. ~~(b)~~ The video encoder shall have a minimum Mean Time Between Failures (MTBF) of 60,000 hours.
- J. MAC Address:
 - 1. Each unit shall have a unique MAC address.
 - 2. MAC address shall be derived from an address space of 10,000 sequential addresses.
- K. Network Management Software: All custom Management Information Base's (MIB's) required for network management shall be provided for use with third party network management software.
- L. IP Addressing: Each unit shall support and be delivered with 2 user settable IP addresses, 1 for command and control, and 1 for video multicasting.

685.02.02 SUBMITTALS

- A. The following shall be submitted by the ~~Vender~~ Contractor to the ~~e~~ Contracting ~~a~~ Agency:
 - 1. ~~(a)~~ Acceptance Test Procedures, ~~(stand-alone and operational)~~.
 - 2. ~~(b)~~ Training Syllabus.
 - 3. ~~(c)~~ Users Manual.
 - 4. ~~(d)~~ Parts List.
 - 5. ~~(e)~~ Description of MAC addresses scheme/space.
 - 6. ~~(f)~~ Certifications/Statements ~~of~~:
 - a. Provide certification of ~~C~~ Conformance to all standards listed in this section ~~of the Uniform Standard Specifications~~.
 - b. Testing for compliance will be performed by an independent party.

CONSTRUCTION ~~TESTING~~**685.03.01 TESTING**

- A. Prior to acceptance by the ~~e~~ Contracting ~~a~~ Agency, the video encoder shall require testing as described below.
- B. The ~~supplier~~ Contractor shall absorb all costs associated with the testing including and not limited to shipping and handling, all material and equipment, and any labor required from the bidder.
- C. Prior to acceptance of any video encoder, the following tests shall be performed:
 - 1. ~~(a)~~ Stand-Alone Acceptance Test (SAT):
 - a. Using the ~~FAST~~ FAST-approved vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST.
 - b. A vendor representative may be present during the SAT.
 - c. The Contractor will provide the ~~V~~ Vendor ~~will be provided~~ with a schedule of the test, including time and place.

2. ~~(b)~~ The SAT will be performed as follows:
 - a. ~~(1)~~ The video encoder will be assembled and connected to power in a stand-alone configuration.
 - b. ~~(2)~~ The video encoder will be powered up and allowed to initialize, boot, and run self-diagnostic tests as defined in the ~~FAST~~ FAST-approved test procedures.
 - c. ~~(3)~~ After the video encoder has started and initialized, any additional test procedures will be executed.
 - d. ~~(4)~~ After the test procedures have been executed, the video encoder will be allowed to run, uninterrupted, for a burn-in period of 72 hours.
 - e. ~~(5)~~ At the end of the burn-in period, the unit will be restarted and configuration verified.
 - f. ~~(6)~~ Upon completion of all test procedures, the ~~Vendor~~ Contractor will be notified of SAT acceptance or failure.
3. ~~(c)~~ Operational Test:
 - a. After successful completion of the SAT, FAST will configure and connect the video encoder to the FAST test network.
 - b. A ~~FAST~~ FAST-provided CCTV assembly will be connected (video and data) to the video encoder.
 - c. Along with the video encoder, the network will also have a video decoder unit with a video monitor, and a ~~P~~ersonal ~~C~~omputer (~~PC~~) operating the video decoder software and camera control application provided by the County Contracting Agency.
 - d. The following tests will be performed by FAST:
 - 1) ~~(1)~~ Video Image (subjective quality acceptable to FAST).
 - 2) ~~(2)~~ Serial Data Channel both point-to-point (encoder to decoder), and IP.
 - 3) ~~(3)~~ User programmable parameters and functions.
 - 4) ~~(4)~~ Network management.
4. ~~(d)~~ While connected to the network, the video encoder shall not, in any way compromise the function or functions or any other connected network device(s).
5. ~~(e)~~ Upon completion of all the tests, the ~~Vendor~~ Contractor will be notified of operational test acceptance or failure. If the unit fails the test, the ~~Vendor~~ Contractor shall supply a new unit and the test shall be restarted.

685.03.02 WARRANTY

- A. The video encoder shall be warranted by the vendor for a minimum of 3 years.
 1. The warranty shall be provided by the Contractor and shall guarantee the video encoder to be free from defect from assembly, fabrication, and materials.
 2. The FAST and Contracting Agency may exercise the option of purchasing an extended warranty for an additional 2 years utilizing the video encoder extended 2 -year warranty item as indicated in Section 685.075.01, "Payment."

VIDEO ENCODER

685

- B. The warranty shall be provided in writing. If the normal manufacturer's warranty extends for a longer period, the video encoder shall be warranted for that period.
- C. The warranty shall be measured from the date of receipt by the eContracting aAgency.
 - 1. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract.
 - 2. A report shall be submitted to FAST annually which details the status of equipment warranties.
- D. Video encoders found to be defective during the warranty period shall be replaced free of charge by the manufacturer. The vendor shall be responsible for all shipping and handling costs for equipment under warranty.
- E. The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:
 - 1. (a) Software and firmware upgrades.
 - 2. (b) Software patches.

METHOD OF MEASUREMENT

685.04.01 MEASUREMENT

- A. The video encoder shall be measured per each. ~~The unit will include furnishing all material required for facilitating an operational video encoder including all necessary jumpers.~~
- B. The video encoder ~~extended 2-~~year warranty shall be measured by lump sum.

BASIS OF PAYMENT

685.05.01 PAYMENT

- A. The accepted quantity of video encoder will be paid at the contract unit price per each, which shall be full compensation for, ~~The unit will include~~ furnishing and configuration the unit, and for all labor, material, and equipment, including all necessary jumpers, required ~~for~~ to facilitating an operational video encoder.
- B. The lump sum price for the video encoder ~~extended 2-~~year warranty shall be full compensation for the extended warranty.
- C. Payment will be made under:

PAY ITEM

PAY UNIT

Video Encoder	Each
Video Encoder extended 2-year warranty	Lump sum

SECTION 686**VIDEO DECODER****DESCRIPTION****686.01.01 GENERAL**

- A. This specification describes the functional, performance, environmental, submittal, documentation, and warranty requirements, as well as the method of measurement and basis of payment, for a rugged field deployable and user selectable Moving Picture Experts Group (MPEG)-2 and MPEG-4 video decoder.
1. This video decoder will accept serial data signal and the digitally compressed video over the Freeway and Arterial System of Transportation (FAST) Communication Network Ethernet (TCP/IP) network from a video encoder, and output the decoded video as a standard National Television Standards Committee (NTSC) composite video signal and the serial data as RS-232/422.
 2. The video decoder shall be of the same manufacturer and fully compatible with the video encoder provided under ~~Specification~~ Section 685, "Video Encoder".
 3. The video decoder shall comply with ~~the requirements stated within this specification so as to~~ operate within the FAST Arterial Management System ~~(AMS)~~ and Freeway Management System ~~(FMS)~~.
- B. This specification is for equipment only, no installation, to be delivered to the FAST Traffic Management Center (TMC) for testing and approval prior to final acceptance.
1. The ~~agency Project Manager~~ Engineer shall be notified prior to the delivery to the TMC.
 2. No partial shipments will be accepted.
 3. All equipment supplied on this project ~~will~~ shall be delivered during a single delivery, and shall be labeled clearly with the project and location designation.
- C. All equipment shall be approved prior to purchase by the FAST Director or designee.

MATERIALS/EQUIPMENT**686.02.01 FUNCTIONAL REQUIREMENTS**

- A. The video decoder shall comply with the following standards:
1. ~~(a)~~ International Organization for Standardization: (ISO) 9001: Quality Assurance, MPEG-2 ISO/13818-2 Video Compression and MPEG-4 ISO/14496 Video Compression.
 2. ~~(b)~~ Institute of Electrical and Electronic Engineers (IEEE) 802.3: Part 3: CSMA/CD Access Method and Physical Layer Specifications.
 3. ~~(c)~~ Federal Communications Commission ~~(FCC)~~ Rules and Regulations, Vol. II: Part 15 for Class A Equipment Electronic Compatibility and Susceptibility (~~P~~ product electromagnetic compatibility is required).
 4. ~~(d)~~ Underwriters Laboratories, Inc. (UL) 60960: Safety Requirements for IT Equipment (a Applicable to equipment safety).

5. ~~(e)~~ Military Handbook MIL-HDBK-217F-2: ~~Military Handbook for~~ "Reliability Prediction of Electronic Equipment", Notice 2.
- B. Detailed Requirements:
1. ~~(a)~~ The video decoder shall inter-operate with the video encoders, as defined in Section 685, "Video Encoder."
 2. ~~(b)~~ The video decoder shall support the following video features:
 - a. ~~(1)~~ The unit shall be capable of being soft-configured to perform MPEG-2 ISO/13818-2 video decoding and MPEG-4 ISO/14496 video decoding.
 - b. ~~(2)~~ The unit shall be capable of being soft-configured to produce elementary or transport stream.
 - c. ~~(3)~~ Video stream of up to 10 Mbps, auto-detecting.
 - d. ~~(4)~~ Video frame rate up to 30 fps and resolution of 720 x 480 pixels.
 - e. ~~(5)~~ 30 fps NTSC color video output.
 - f. ~~(6)~~ The end-to-end latency between the video encoder and the video decoders shall be no more than 250 ms while operating at a rate of 5 Mbps.
 3. ~~(c)~~ The video decoder shall support the following network features:
 - a. ~~(1)~~ Ethernet Interface: 10/100 Mbps, Half/Full-Duplex, Auto Negotiate (802.3), (RJ-45).
 - b. ~~(2)~~ Static Internet Protocol (IP) Addressing: (Class A, B, and C).
 - c. ~~(3)~~ Simple Network Management Protocol (SNMP) (~~M1B1~~ MIB1, MIB2).
 - d. ~~(4)~~ Unicast and Multicast (IGMP V2).
 - e. ~~(5)~~ Gateway Configuration.
 4. ~~(d)~~ The video decoder shall support:
 - a. ~~(1)~~ Command Line Interface (~~CLI~~).
 - b. ~~(2)~~ Telnet.
 - c. ~~(3)~~ Trivial File Transfer Protocol (TFTP) or FTP (new firmware download).
 - d. ~~(4)~~ The video decoder shall have an integrated web interface, ~~which~~ that provides remote configuration and management features.
 - e. ~~(5)~~ Reset/Reboot and firmware upload shall be supported via all methods listed above.
 - f. ~~(6)~~ All video (i.e., resolution, contrast, ~~etc~~ and so forth), data (i.e., baud rate, parity, ~~etc~~ and so forth), encoder (i.e., bandwidth, ~~etc~~ and so forth), and network (i.e., IP, subnet mask, gateway, ~~etc~~ and so forth) parameters and settings shall be user configurable through the maintenance port, web interface, Telnet, and all other supported remote management tools.
 - g. ~~(7)~~ All configurations and settings shall be downloadable/exportable in ~~a~~ document form. As a minimum, the exported settings shall include video, network, and data settings.
- C. Failure and Reset Recovery: The recovery time of a hard or soft reset shall be less than 45 seconds.

VIDEO DECODER

686

D. Electrical: ~~(a)~~—The video decoder shall ~~support~~have the following characteristics:

1. ~~(1)~~Power:
 - a. Nominal input voltage of 120 VAC 60 Hz.
 - b. The unit shall contain all power conversion and regulation necessary to support electronics operation.
2. ~~(2)~~Power consumption: Shall not exceed 70 ~~W~~watts.
3. ~~(3)~~All supplied video decoders shall have the same power connectors.
 - a. Each unit shall be provided with a power cable that is at least 5 feet ~~(4.5 meters)~~in length, ~~and~~
 - b. Power cable shall be terminated with a male, ~~three~~3-prong, UL-listed power connector for interface with the previously stated power system.

E. Ports:

1. ~~(a)~~The video decoder shall have the following ports:
 - a. ~~(1)~~—Network: 10/100 Mbps RJ-45.
 - b. ~~(2)~~—Video: Composite Bayonet Neill-Concelman (BNC) and S-Video.
 - c. ~~(3)~~—Data:
 - 1) ~~2~~Two Electronics Industry Association (EIA)-RS232/422/485, DB-9* (Female), ~~(supporting up to 57.6 kbps)~~:-
 - a) These ports shall provide data pass-through for serial control (i.e., PTZ camera control).
 - b) RJ-45 may be provided in place of DB 9. For each RJ-45 port, an RJ-45- to- DB 9 converter shall be supplied.
 - 2) ~~(4)~~—~~Data:~~ ~~1~~One EIA-232 DB-9* (Female):-
 - a) This port shall provide maintenance interface for local configuration.
 - b) RJ-45 may be provided in place of DB 9. For each RJ-45 port, an RJ-45- to- DB 9 converter shall be supplied.

~~*RJ-45 may be provided in place of DB-9. For each RJ-45 port, a RJ-45 to DB-9 converter shall be supplied.~~

F. Status Indicators:

1. ~~(a)~~The video decoder shall have the following minimum indicators:
 - a. ~~(1)~~—Activity.
 - b. ~~(2)~~—Power.
 - c. ~~(3)~~—Video Loss.
 - d. ~~(4)~~—Transmit.
 - e. ~~(5)~~—Receive.
2. ~~(b)~~Status indicators shall be Light Emitting Diode (LED).

G. Physical Characteristics:

1. ~~(a)~~The video decoder shall not exceed 2-1/2-~~1/2~~" inches high ~~*by~~ 12 inches" wide ~~*by~~ 13 inches" deep ~~(2 1/2" x 12" x 13")~~.

686

VIDEO DECODER

2. ~~(b)~~ The weight shall not exceed 10_ pounds.
- H. External Markings:
1. All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list.
 2. The external markings shall include the product function name, model number, serial number_ and manufacturer's name.
- I. Environmental:
1. ~~(a)~~ The video decoder shall conform to the performance specification when operated in the following environment:
 - a. ~~(1)~~ Temperature: 0°C ~~(+32~~ degrees °F) to ~~(+40°)~~ C ~~(104~~ degrees °F).
 - b. ~~(2)~~ Humidity: 5 to 95_ percent relative humidity, non-condensing.
 2. ~~(b)~~ The video decoder shall have a minimum Mean Time Between Failures (MTBF) of 60,000_ hours.
- J. MAC Address:
1. Each unit shall have a unique MAC address.
 2. MAC address shall be derived from an address space of 10,000_ sequential addresses.
- K. Network Management Software: All custom Management Information Base (MIB's) required for network management shall be provided for use with third party network management software.
- L. IP Addressing: Each unit shall support and be delivered with 2_ user settable IP addresses, 1_ for command and control, and 1_ for video multicasting.

686.02.02 SUBMITTALS

- A. The following shall be submitted by the ~~Vender~~ Contractor to the ~~e~~ Contracting ~~a~~ Agency:
1. ~~(a)~~ Acceptance Test Procedures_ ~~(stand-alone and operational)~~.
 2. ~~(b)~~ Training Syllabus.
 3. ~~(c)~~ Users Manual.
 4. ~~(d)~~ Parts List.
 5. ~~(e)~~ Description ~~(s)~~ of MAC address scheme/space.
 6. ~~(f)~~ Certifications/Statements_:
 - a. Provide certification of: ~~C~~ conformance to all standards listed in this section.
 - b. Testing for compliance will be performed by an independent party.

CONSTRUCTION

686.03.01 TESTING

- A. Prior to acceptance by the ~~e~~ Contracting ~~a~~ Agency, the video decoder shall require testing as described below.

VIDEO DECODER

686

- B. The ~~vendor~~ Contractor shall absorb all costs associated with the testing including and not limited to shipping and handling, all material and equipment and any labor.
- C. Prior to acceptance of any video decoder the following tests shall be performed:
1. ~~(a)~~ Stand-Alone Acceptance Test (SAT):
 - a. Using the FAST-~~approved~~ vendor-supplied test procedures, FAST will perform the SAT in a test area provided by FAST.
 - b. A vendor representative may be present during the SAT.
 - c. The Contractor shall provide the Vendor ~~will be provided~~ with a schedule of the test, including time and place.
 2. ~~(b)~~ The SAT will be performed as follows:
 - a. ~~(1)~~ The video decoder will be assembled and connected to power in a stand-alone configuration.
 - b. ~~(2)~~ The video decoder will be powered up and allowed to initialize, boot, and run self-diagnostic tests as defined in the FAST-approved test procedures.
 - c. ~~(3)~~ After the video decoder has started and initialized, any additional test procedures will be executed.
 - d. ~~(4)~~ After the test procedures have been executed, the video decoder will be allowed to run, uninterrupted, for a burn-in period of 72 hours.
 - e. ~~(5)~~ At the end of the burn-in period, the unit will be restarted and configuration verified.
 - f. ~~(6)~~ Upon completion of all test procedures, the ~~Vendor~~ Contractor will be notified of SAT acceptance or failure. If the unit fails the test, the ~~Vendor~~ Contractor shall supply a new unit and the test shall restart.
 3. ~~(c)~~ Operational Test:
 - a. After successful completion of the SAT, FAST will configure and connect the video decoder to the FAST Test Network.
 - b. Along with the video decoder, the network will also have a video encoder unit as specified in Section 685, "Video Encoder," and a ~~P~~ersonal ~~C~~omputer (~~PC~~) operating the video decoder software, as specified by FAST, and the camera control application provided by FAST.
 4. ~~(d)~~ The following tests will be performed by FAST:
 - a. ~~(1)~~ Video Image (subjective quality acceptable to FAST).
 - b. ~~(2)~~ Serial Data Channel both point-to-point (encoder to decoder), and IP.
 - c. ~~(3)~~ User programmable parameters and functions.
 - d. ~~(4)~~ Network management.
 5. ~~(e)~~ While connected to the network, the video decoder shall not, in any way compromise the function or functions or any other connected network device~~(s)~~.
 6. ~~(f)~~ Upon completion of all the tests, the ~~Vendor~~ Contractor will be notified of operational test acceptance or failure. If the unit fails the test, the ~~Vendor~~ Contractor shall ~~be disqualified and the Agency will proceed with the next low qualified bidder~~ supply a new unit and the test shall be restarted.

686.03.02 WARRANTY

- A. The video decoder shall be warranted by the vendor for a minimum of 3 years.
1. The warranty shall be provided by the Contractor and shall guarantee the video decoder to be free from defect from assembly, fabrication, and materials.
 2. The FAST and eContracting aAgency may exercise the option of purchasing an extended warranty for an additional 2 years utilizing the item number as indicated in Subsection 686.075.01, "Payment."
- B. The warranty shall be provided in writing. If the normal manufacturer's warranty extends for a longer period, the video decoder shall be warranted for that period.
- C. The warranty shall be measured from the date of receipt by the eContracting aAgency.
1. The manufacturer shall be responsible for maintaining a list of equipment supplied and warranty information during the period of the warranty contract.
 2. A report shall be submitted to FAST annually which details the status of equipment warranties.
- D. Video decoders found to be defective during the warranty period shall be replaced free of charge by the manufacturer. The vendor shall be responsible for all shipping and handling costs for equipment under warranty.
- E. The manufacturer shall also provide technical support coverage for all equipment and software furnished. This support shall as a minimum include the following:
1. (a) Software and firmware upgrades.
 2. (b) Software patches.

METHOD OF MEASUREMENT**686.04.01 MEASUREMENT**

- A. The video decoder shall be measured per each. ~~The unit will include furnishing all material required for facilitating an operational video encoder including all necessary jumpers.~~
- B. The video decoder, extended 2-year warranty shall be measured by lump sum.

BASIS OF PAYMENT**686.05.01 PAYMENT**

- A. The accepted quantity of video decoder will be paid for at the contract unit price per each, ~~which shall be full compensation for The unit will include~~ furnishing and ~~configuration~~ configuration the unit, and for all labor, material, and equipment, including all necessary jumpers, required ~~for~~ to facilitate ~~ing~~ an operational video decoder.
- B. The lump sum price for video decoder extended 2-year warranty shall be full compensation for the extended warranty.
- C. Payment will be made under:

PAY ITEM**PAY UNIT**

Video Decoder	Each
Video Decoder extended 2-year warranty	Lump sum

SECTION 687**CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT****DESCRIPTION****687.01.01 GENERAL**

- A. This specification shall govern the furnishing and installation of Closed Circuit Television (CCTV) field equipment of a CCTV microprocessor unit at designated field locations and equipment cabinets as shown on the plans.
- B. This equipment will be installed by the Contractor at designated sites, and all hardware, software, and assorted components needed for the proper operation of the units shall be supplied.
- C. All materials furnished, assembled, fabricated, and-or installed under this item shall be new, corrosion-resistant, and in strict accordance with the specifications.
- D. The equipment design and construction shall utilize the latest techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonalty.
 - 1. The equipment shall be designed for ease of maintenance.
 - 2. All component parts shall be readily accessible for inspection and maintenance.

MATERIALS/EQUIPMENT**687.02.01 FUNCTIONAL REQUIREMENTS**

- A. The CCTV Field Equipment together with the CCTV central equipment in the Traffic Management Center (TMC) will form a complete CCTV system ~~which~~that shall meet the following requirements.
- B. The video camera positioning system shall provide dual-~~mode~~, day (color) and night (monochrome) video camera with optical zoom lens and a high speed positioning system.
 - 1. The lens shall haves a focal length of 3.4 mm to 119 mm (35:1) with auto/manual focus.
 - 2. ~~A~~The digital zoom shall provide a range of up to 12X ~~provides with~~ an effective zoom ratio of 350:1.
 - 3. The effective focal length ~~is~~shall be 3.4 mm to 1,190 mm.
 - 4. The video camera shall have a~~The~~ 1/4-inch¹⁴" format Progressive Scan CCD image sensor and lens combination ~~results in capable of providing~~ an effective horizontal angle of view of 55.8 ~~degrees~~[°] wide angle to 17 ~~degrees~~[°] max-imum telephoto.
 - 5. The camera shall provide Wide Dynamic Range (WDR) by use of dual-~~shutter~~ exposure technique.
- C. ~~In addition, t~~The camera shall be provided with electronic stabilization using the 2 motion-frequency selectable stabilization method.
 - 1. The pan function shall provide 360 ~~degrees~~[°] of continuous rotation, with a variable speed from 0.1 ~~degree~~[°] per second to 160 ~~degrees~~[°] per second.

687

CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

2. The tilt function shall provide 180 degrees° of movement 0 degree° to +90 degrees° to -90 degrees°, with a variable speed from 0.1 degree° per second to 40 degrees° per second.
3. Up to 64 presets shall be available for storing and recalling zoom, pan, and tilt positions.
4. The positioner shall be capable of 8 point or 16 point compass annotations with primary direction spelled out, ~~and~~ intermediate directions abbreviated with 2 letters, and a tour sequence defined using up to 64 preset positions.
5. All camera functions and pan ~~&and~~ tilt functions ~~are~~ shall be operable via RS-422 serial communications.
6. Communications protocol command set shall be the Freeway and Arterial System of Transportation (FAST) protocol.

D. Features:

1. ~~(a)~~ 1/4-inch^{1/4"} Progressive Scan Color Sensor.
2. ~~(b)~~ Horizontal Resolution of ~~540~~ 520 TV Lines.
3. ~~(c)~~ 35:1 (3.4 mm to 119 mm) optical zoom lens.
4. ~~(d)~~ Continuous digital zoom with selectable range from OFF to ~~10X~~ 12X.
5. ~~(e)~~ Effective overall focal length of 3.4 mm to 1,190 mm.
6. ~~(f)~~ Electronic Image Stabilization.
7. ~~(g)~~ Auto/Manual Focus.
8. ~~(h)~~ Selectable long-term integration to 1/2 second with frame store video output.
9. ~~(i)~~ Selectable shutter speeds from 1/2 second to 1/30,000 second.
10. ~~(j)~~ Composite video output; NTSC format.
11. ~~(k)~~ Adjustable color balance.
12. ~~(l)~~ Crystal or Internal phase adjust line-lock, software adjustable.
13. ~~(m)~~ Programmable on -screen character generator.
14. ~~(n)~~ ~~Wide Dynamic Range (WDR)~~ by use of dual -shutter exposure technique.
15. ~~(o)~~ RS-422 serial control protocol command set to FAST protocol.
16. ~~(p)~~ Camera Addressing via serial control.
17. ~~(q)~~ 8 point or 16 point compass annotation.
18. ~~(r)~~ 3 1/2-inch ^{1/2"} diameter ~~S~~ ssealed enclosure ~~P~~ pressurized with dry nitrogen.
19. ~~(s)~~ Continuous rotation capability in either direction.
20. ~~(t)~~ Variable pan speed from 0.1 degree per °/second to greater than >160 degrees per °/second (~~P~~ preset ~~M~~ mode).
21. ~~(u)~~ Variable tilt speed from 0.1 degree per °/second to 40 degrees per °/second.
22. ~~(v)~~ 64 zoom, focus, pan ~~&and~~ tilt preset positions, each with a unique user programmable Preset ID.

E. Camera Specifications:

1. ~~(a)~~—Imager: Interline Transfer Progressive Scan CCD with mosaic-type color compensating filter.
2. ~~(b)~~—Image Area: 1/4-inch^{1/4}" Format 3.6 mm horizontal(H) ~~by~~ 2.7 mm vertical(V).
3. ~~(c)~~—Resolution: 520 horizontal; 350 vertical.
4. ~~(d)~~—Picture Elements (total): 811 horizontal(H) ~~by~~ 508 vertical(V).
5. ~~(e)~~—Video Output: NTSC, 1 V p-p @ at 75 ohms, unbalanced.
6. ~~(f)~~—Maximum Lens Aperture: f/1.4 (wide) angle to f/4.2 ~~(tele)~~ photo.
7. ~~(g)~~—Optical Zoom Range: 35X35:1, 3.4 mm to 119 mm.
8. ~~(h)~~—Digital Zoom Range: 1X (Off) through 12X, Smooth transition from Optical to Digital Zoom.
9. ~~(i)~~—Effective Digital Focal Length: 119 mm to 1,190 mm.
10. ~~(j)~~—Optical Zoom Speed: 2-speeds, from approximately 2.9 seconds to 5.8 seconds full range.
11. ~~(k)~~—Horizontal Angle of View: Optical: 55.8 degrees° to 1.7 degrees°; At 10X-12X Digital: 55.8 degrees° to 0.17 degree°.
12. ~~(l)~~—Minimum Focus Distance: 40 inches" in telephoto, 0.4"0.4 inch in wide angle.
13. ~~(m)~~—Electronic Stabilization: 2 motion-frequency selectable stabilization method.
14. ~~(n)~~—Digital Compass: 8-point or 16-point compass annotation with primary direction spelled out and intermediate directions abbreviated with two2-letters.
15. ~~(o)~~—Auto Focus: Selectable Auto/Manual. ~~(1)~~—Minimum Sscene illumination for Reliable Auto Focus, 30 percent% video.
16. ~~(p)~~—Manual Focus Speed: One1 speed, approximately 2.0 seconds to full range.
17. ~~(q)~~—Zoom &and Focus Presets: 64 preset positions; focus ishall be auto; and, if programmed, shall display the Preset ID.
18. ~~(r)~~—Flash Memory: Update firmware and new features via serial communication.
19. ~~(s)~~—Long Term Integration Range: (Short Shutter);
 - a. ~~(t)~~—Shall Provides manual selection of integration duration for enhanced sensitivity.
 - b. Integration times areshall be 1/2 second, 1/4 second, 1/8 second, 1/15 second, and 1/30 second.
 - c. Frame sStore video output shall provides continuous video output, updated at the integration rate.
20. ~~(u)~~—Manual Shutter: ~~(1)~~—Selectable shutter speeds of 1/60; 1/120; 1/180; 1/250; 1/500; 1/1,000; 1/2,000; 1/4,000; 1/10,000; and 1/30,000 second.
21. ~~(v)~~—Auto Iris: ~~(1)~~—Iris shall automatically adjust s to compensate for changes in scene illumination toand maintain constant video level output within sensitivity specifications.

22. ~~(w)~~ Manual Iris: ~~(1) Changing the video level shall do the effect of open iris/close iris.~~
- ~~To give the effect of open iris, a~~ decrease in the video level value shall give the effect of open iris. ~~change and to give the effect of close iris a~~
 - An increase in the video level shall give the effect of close iris ~~change.~~
23. ~~(x)~~ Gamma: 0.45.
24. ~~(y)~~ AGC: 028 dB.
25. ~~(z)~~ Color Balance: Auto Tracking Color Balance/Manual with adjustable Red and Blue Levels.
26. ~~(a1)~~ Signal to Noise Ratio: >Greater than 50 dB.
27. ~~(b1)~~ Synchronization: Crystal or Phase-Adjust Line Lock on 60_Hz.
28. ~~(c1)~~ Sensitivity: (3,200K): Scene Illumination @at F1.4, Wide Angle:

0.5- Lux <u>@</u> at 1/60_Sec.	F1.4 Shutter	Color I.R. Cut On
0.05- Lux <u>@</u> at 1/2_Sec.	F1.4 Shutter	Color I.R. Cut On
0.2- Lux <u>@</u> at 1/60_Sec.	F1.4 Shutter	Monochrome mode I.R. Cut Off
0.01 Lux <u>@</u> at 1/4_Sec.	F1.4 Shutter	Monochrome mode I.R. Cut Off

F. Camera Housing:

- ~~The~~ Each camera housing shall be a corrosion-resistant, ~~and~~ tamperproof-sealed, and pressurized ~~housing~~ with ~~five pounds psi~~ 5 psi of dry nitrogen ~~with~~ and shall include a Schrader purge fitting and 20-psi relief valve ~~for each camera~~. The size of the housing shall be 3-1/2-inch diameter or smaller.
- The camera housing shall include a loss of pressure sensor that will trigger an alarm message that will be inserted in the video output signal.
- The enclosure shall be constructed from 6061-T6 standard aluminum tubing with a wall thickness of 0.25 inches ~~+/-~~ ±0.03 inches.
 - Internal components shall be mounted to a rail assembly.
 - A copper-plated spring-steel ring shall be used to ensure electrical bonding of the rail assembly and components to the camera housing.
 - The housing exterior shall be finished by pre-treatment with conversion coating and baked enamel paint.
 - The camera enclosure shall be designed to withstand the effects of sand, dust, and hose-directed water.
- The internal humidity of the housing shall be less than 10 percent, when sealed and pressurized.
 - Desiccant packs shall be securely placed inside the housing to absorb any residual moisture and maintain internal humidity at 10 percent or less.
 - A sun shield shall be provided to shield the entire housing from direct sunlight.

G. Mechanical Specifications (DSP Camera Assembly):

- ~~(a)~~ Weight: 4.2 ~~lb~~ pounds.
- ~~(b)~~ Dimensions:

CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

687

- a. ~~(1)~~ Length (less connectors): 12.0" inches.
 - b. ~~(2)~~ Housing Diameter: 3.5" inches.
 - c. ~~(3)~~ Height (~~i~~ncluding mounting base): 5.13" inches.
 3. ~~(e)~~ Mounting: 4 mounting nuts on bottom of base.
- H. Character Generator Specifications:
1. ~~(a)~~ ID ~~C~~characters ~~are~~shall be ~~W~~white with a ~~B~~black border.
 2. ~~(b)~~ A maximum of 6 lines of user-~~programmable~~ alphanumeric text ~~can~~shall be displayed, plus 2 fixed lines for low-pressure indicator and ~~P~~privacy ~~Z~~ones.
 3. ~~(c)~~ Text ~~can~~shall only be displayed in uppercase characters.
 4. ~~(d)~~ Camera ID:
 - a. Up to 2 lines, each up to 24 characters long.
 - b. If both lines are programmed, Line 1 of Camera ID shall always appear above Line 2 of Camera ID regardless of top or bottom selection.
 5. ~~(e)~~ Preset ID:
 - a. 1 line, up to 24 characters long, user-~~programmable~~ for each of the 64 ~~pres~~et positions.
 - b. When a preset position is recalled, the corresponding preset ID ~~i~~shall be displayed.
 - c. The preset ID shall remain displayed until a pan, tilt, zoom, manual focus, auto focus select, or another preset command is received.
 6. ~~(f)~~ Compass Annotation:
 - a. 8-point or 16-point compass annotation shall be settable for a true north position.
 - b. Display shall include North, NE, East, SE, South, SW, West, and NW.
 - c. Position shall be able to be grouped with the site location or separate from site location. ~~and~~
 - d. Position shall be user-~~selectable~~ for a 3-second time out or permanent display and ~~for user-enabled~~d/disabled.
 7. ~~(g)~~ Azimuth and Elevation:
 - a. Position shall be displayed in 0 degree to ~~—359~~-degrees for AZ position, ~~and~~ +95 to -95 in ~~EL~~-elevation (EL) ~~and~~
 - b. Position shall be user-~~selectable~~ for 3-second time out or permanent display and ~~for user-enabled~~d/disabled.
 8. ~~(h)~~ Low Pressure Indicator:
 - a. ~~1~~-line, "Low Pressure"; messages ~~can~~shall be displayed in "blinking" or "non-blinking" mode ~~and be displayed~~ when activated by low internal pressure.
 - b. Adjustable set points by altitude shall be provided via the serial port to activate low-pressure.
 - c. Message shall be user-enabled/~~or~~ disabled.

- d. In maintenance mode, readings of the internal pressure of the camera housing shall be displayed from 5 psi down to 1 psi, in 0.1 psi increments.
- 9. ~~(i)~~ Internal Temperature Indicator:
 - a. 1 line, in degrees C, numeric messages ~~can~~shall be displayed in “blinking” or “non-blinking” mode.
 - b. Message shall be user-enabled/~~or~~ disabled.
 - c. In maintenance mode, ~~camera~~ readings of the internal temperature of the camera housing shall be in 1 degree increments.
- 10. ~~(j)~~ Sector Message:
 - a. Up to 16 sectors in 360 degrees ~~may~~shall be able to be defined with up to 24 characters long.
 - b. Message shall be programmable via the RS-422 serial communications.
- I. Message Positioning:
 - 1. ~~(a)~~ Right side positioning ~~is~~shall be accomplished by padding left side of message with spaces.
 - 2. ~~(b)~~ Messages ~~can~~shall be capable of being positioned at either the top or the bottom of display.
 - 3. ~~(c)~~ Blank lines ~~are~~shall not displayed.
 - 4. Any programmed line being displayed shall fill in toward the top if top positioning is selected, or toward the bottom if bottom position is selected.
- J. Privacy Zones:
 - 1. Video blanked out for up to 8 privacy zones shall be provided.
 - ~~2. The video shall be blanked out for privacy.~~
 - 2. 1-line and numeric messages ~~can~~shall be displayed.
 - 3. Message shall be displayed in “blinking” or “non-blinking” mode and be user-enabled/~~or~~ disabled.
 - 4. Privacy ~~Z~~zones shall be programmed via the RS-422 serial communications.
- K. Communication and Camera Addressing Protocol:
 - 1. ~~(a)~~ Control and addressing shall be via RS-422/RS-232 optically isolated serial communications.
 - a. Additional protocols shall consist of Cohu, American Dynamics, Javelin, Philips/Bosch, Vicon, and Pelco-D.
 - b. The National Transportation Communications for ITS Protocol (NTCIP) 1205 protocol communications protocol shall be included as an option.
 - 1) Refer to NTCIP 1205 protocol for detailed description.
 - 2) This allows for migration to the NTCIP standard while maintaining operation of existing CCTV system protocols.
 - 2. ~~(b)~~ Upon receipt of any given command, the Camera Positioning System shall not take longer than 1.0 second to respond.

CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

687

3. ~~(e)~~ All programmable functions shall be stored in non-volatile memory and shall not be lost if a power failure occurs.
 4. System configurations such as video privacy zones, preset text, and sector ID shall be able to be stored in a computer file, ~~and~~
 5. ~~a~~ A camera personality ~~can~~ shall be able to be cloned or uploaded into a camera in the event that a camera replacement is necessary.
- L. Pan and Tilt Positioning Specifications:
1. ~~(a)~~ Continuous rotation capability in either direction.
 2. ~~(b)~~ 180 degrees° of tilt movement, +90 degrees° to -90 degrees° unobstructed.
 3. ~~(c)~~ Pan Speed (Operator Control): Variable from 0.1 degree per °/second to 80 degrees per °/second.
 4. ~~(d)~~ Pan Speed (Preset Control): >Greater than 160 degrees per °/second.
 5. ~~(e)~~ Tilt Speed (Operator Control): Variable from 0.1 degree per °/second to 40 degrees per °/second.
 6. ~~(f)~~ Tilt Speed (Preset Control): 40 degrees per °/second.
 7. ~~(g)~~ 64 Pan and Tilt preset positions with repeatability within ± 0.5 degree°.
 8. ~~(h)~~ The positioning system shall be invertible for mounting to a ceiling.
- M. Tour Specifications:
1. ~~(a)~~ 8-tour sequence ~~can~~ shall be able to be defined.
 2. ~~(b)~~ The tour ~~is~~ shall be programmed by selecting the preset position by number, and then selecting a dwell time.
 - a. The presets ~~can~~ shall be able to be used in any order, ~~and~~
 - b. ~~t~~ The same preset ~~may~~ shall be able to be used more than once as long as the total number of preset positions used does not exceed 32.
 3. ~~(c)~~ The dwell time shall defines the length of time paused at each preset position. ~~It can~~ shall be from 1 second to 60 seconds, and shall be. ~~The dwell time can~~ capable of being changed individually for all stops on the tour.
 4. ~~(d)~~ If the appropriate preset ID is programmed, it shall be displayed for each preset position used on the tour.
 5. ~~(e)~~ The tour shall stop upon receipt of a pan command.
 6. ~~(f)~~ All programmable functions shall be stored in non-volatile memory.
- N. Power Requirements:
1. ~~(a)~~ Operating Voltage: 89 VAC to 135 VAC, 120 VAC Nominal, 50/60 Hz, ~~(± 3.0 Hz, and)~~ in accordance with National Electrical Manufacturers Association (NEMA) standard NEMA TS-2, Section 2.1.2, (1998) for "Traffic Control System 2.1.2."
 2. The line variation specifications shall be tested to meet these specifications by an outside agency, other than the camera manufacturer. The tests shall be provided upon request.
 3. ~~(b)~~ Primary Input Power Interruption: ~~This is defined in~~ Comply with NEMA TS-2, Section 2.1.4, "Power Interruption," NEMA standard TS-2 (1998).

4. Transients Power Service:
 - a. The CCTV field equipment shall ~~meet the requirements of~~ comply with NEMA TS-2, sSection 2.1.6, ~~“t~~Transients, ~~p~~Power ~~s~~Service.” ~~of the NEMA standard TS-2 (1998).~~
 - b. The surge specifications shall be tested to meet these specifications by an outside agency; other than the camera manufacturer.
 - c. The tests shall be provided upon request.
 5. ~~(e)~~Power consumption shall not exceed a total of 30 ~~W~~watts for camera/receiver/P&T driver (pan and tilt in motion).
- O. Environmental Specifications:
1. ~~(a)~~Ambient Temperature Limits (Operating): ~~-34°C to +74°C (-30 degrees °F to 165 degrees °F)~~, NEMA ~~2.1.5.1 Standard TS-2, Section 2.1.5.1 (1998).~~
 2. ~~(b)~~Ambient Temperature Limits (Storage): ~~-45°C to +85° C (-50 degrees °F to 185 degrees °F)~~, NEMA ~~2.1.5.1 Standard TS-2, Section 2.1.5.1 (1998).~~
 3. ~~(c)~~The environmental specifications of the camera shall be tested to meet these specifications by an outside agency; other than the camera manufacturer. The tests shall be provided upon request.
 4. ~~(d)~~Humidity: Up to 100 percent% relative humidity ~~(per in accordance with MIL-E-5400T, paragraph 3.2.24.4), IP 67 R~~rating.
 5. ~~(e)~~Other: Withstand exposure to sand, dust, fungus, and salt atmospheres s per in accordance with MIL-E-5400T, paragraph 3.2.24.7, paragraph 3.2.24.8, and paragraph 3.2.24.9.
 6. ~~(f)~~Shock: Up to 10 ~~G~~g's, 11_ms, in any axis under non-operating conditions, in accordance with MIL-E-5400T, paragraph 3.2.24.6.
 7. ~~(g)~~Vibration: Sine vibration from 5 to 30 Hz, 1/2_g, 3_-axis, 1 hour without damage.
 8. ~~(h)~~Wind Loading: 150 mph ~~W~~wind load survivability, operability to 70 mph.
- P. Mechanical Specifications:
1. ~~(a)~~Weight: ~~S~~s shall not exceed 19 ~~lb~~pounds.
 2. ~~(b)~~Dimensions: 11 inches high by ~~(h) ×~~ 13.3 inches wide ~~(w).~~
- Q. Mounting Configurations: The Camera Positioning System shall include 5 possible mounting configurations: ~~7~~ a-wall mount, pole mount, parapet mount, corner mount, and ~~or~~-pedestal mount versionss.
- R. Main Interface Connector: The main interface connector shall be equivalent to an Amphenol 206036-3 with back shell 206070-1 and mating connector equivalent to an Amphenol 206037-11 with clamp 206070-1.

687.02.02 LOCAL INTERSECTION CAMERA CONTROL UNIT

- A. The control unit shall provide convenient on-site camera control of camera positioning systems.
 1. The unit shall offer system protocol from most major CCTV camera manufacturers.

CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

687

2. The unit shall withstand the harsh operating environment associated with roadside installations.
 3. Local control functions ~~are~~shall be accomplished using front panel switches that include ~~pan~~ and tilt, lens zoom, focus and iris.
 4. Focus and iris shall include an auto/manual toggle with LED indication of the current state.
 5. ~~Also included is a~~shall be included local/remote switch that transfers control from the central system to the control unit.
 6. This function shall ~~have~~ a built-in ~~five~~5-minute timer that automatically transfers control back to the remote mode if left unintentionally in the local mode.
- B. A front panel RS-232 port shall be provided ~~that~~connects to a laptop PC for programming advanced camera site settings, and that allows extended camera control functions.
1. 2 rear panel DB9 connectors shall provide both RS-422 and RS-232 formats for control system data connections.
 2. The unit shall support most CCTV camera manufacturer's communications protocols.
- C. Electrical:
1. Operating voltage - 89 VAC to 135 VAC, 47 to 63 Hz, NEMA TS-2, ~~Section~~2.1.2.
 2. Mounting: - EIA standard 19-~~inch~~RU cabinet, 1 RU.
- D. Front Panel Controls:
1. Pan: - 3-~~position~~position momentary switch (pan right, stop, pan left).
 2. Tilt: - 3-~~position~~position momentary switch (tilt down, stop, tilt up).
 3. Zoom: - 3-~~position~~position momentary switch (tele, stop, wide).
 4. Focus Mode: - 2-~~position~~position momentary switch (auto-manual) with LED indication of manual mode.
 5. Focus control: - 3-~~position~~position momentary switch (near, stop, far).
- E. Rear Panel Connectors: Camera - single multi-pin AMP for camera video, RS-422 data, and 20 VAC power.

687.02.03 WARRANTY

- A. The camera shall include a 2-~~year~~year warranty that includes parts and labor.
- B. The 2-year period shall begin at the time of acceptance of the project.

CONSTRUCTION**687.03.01 CABLE HARNESS**

- A. The cables used for CCTV control, video, and 120 VAC power shall be installed as an integrated unit.
- B. Cohu, ~~M~~Model ~~CA~~Number CA295H wiring harness or approved equal shall be used.
- C. The wiring shall be installed from the CCTV unit to the ~~in~~in-~~C~~cabinet ~~c~~Control unit.

687

CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

1. The ~~e~~C~~o~~ntractor shall be responsible for determining the length needed, and order the correct size accordingly.
2. Connectors at both ends of the cable are required.

687.03.02 DOCUMENTATION

- A. Complete documentation of the system, as it is built, shall be provided by the Contractor.
 1. ~~(a)~~—A minimum of 2 copies of descriptive manuals and brochures for each type of electronic equipment and apparatus proposed for this project shall be supplied.
 2. ~~(b)~~—These documents shall contain sufficient technical data for complete evaluation. The quality, function, and capability of each deliverable item shall be described.
 3. ~~(c)~~—Manuals or brochures shall be originals or copies equal to originals.

687.03.03 OPERATIONAL TESTING

- A. ~~(a)~~—Upon completion of the system integration testing, the CCTV ~~F~~field ~~E~~equipment shall be required to complete a 30-day period of acceptable operation.
 1. ~~1)~~—The system operational test shall fully and successfully demonstrate all system functions using live data and controlling all system activities.
 2. ~~2)~~—Failure in any hardware item during the test period, with the exception of expendable items such as fuses and minor equipment as determined by the Engineer, shall necessitate restarting the 30-day test period for its full 30-day duration upon repair.
 3. ~~3)~~—Any failure of system software, ~~or~~ discovery of a software deficiency that causes a system malfunction, or discovery of software operation ~~which~~that is not in compliance with the specifications, shall cause the 30-day test to be restarted in its entirety after correction of the software problem.
 4. ~~4)~~—No intermittent hardware, software, communication, or control operation; ~~or other~~ malfunctions not related to a specific hardware; or software malfunction shall be permitted to persist during the test period. Diagnostic testing ~~which~~that does not result in changes to system hardware or software shall result only in the loss of acceptable test time.

METHOD OF MEASUREMENT

687.04.01 MEASUREMENT

- A. The quantity of CCTV field equipment shall be measured per each. ~~This item shall include the video camera, zoom lens, pan/tilt drive, camera housing, pole mount, receiver/driver, surge protection devices, and all cables, connections and hardware. All pre-assembly of any CCTV equipment shall be considered incidental to CCTV field equipment.~~

BASIS OF PAYMENT

687.05.01 PAYMENT

- A. The accepted quantity of CCTV field equipment will be paid at the Contract unit price bid per each which shall be full compensation for the video camera, zoom lens, pan/tilt drive, camera housing, pole mount, receiver/driver, surge protection devices, and all cables,

CLOSED CIRCUIT TELEVISION (CCTV) FIELD EQUIPMENT

687

connections and hardware~~equipment~~, measured as provided under Subsection 687.04.01.
"Measurement," complete including warranty, ~~delivery to FAST~~installation, and testing of
the equipment as specified and shown on the drawings.

B. Pre-assembly of CCTV equipment and components shall be considered incidental to
CCTV field equipment.

C. Payment will be made under:

PAY ITEM

PAY UNIT

CCTV Field Equipment.....Each

SECTION 688

REMOTE DATA RADIO COMMUNICATION SYSTEM

DESCRIPTION

688.01.01 GENERAL

- A. The data radio unit for installation at remote intersection traffic signal control shall be of solid state design.
1. ~~The~~ data radio unit shall provide the capability of receiving digital signal transmissions from a master station data radio unit and returning transmissions to the master station data radio unit as required by the Freeway and Arterial System of Transportation (FAST) data radio system.
 2. The remote station data radio unit shall be Microwave Data System (MDS) Model – MDS-9710A ~~(or approved equal)~~ and shall meet the ~~following~~ requirements below.
- B. The remote data radio unit shall be configurable as a master station or remote radio.
1. ~~The~~ unit shall be capable of operating as a half-duplex or simplex radio and shall support all splits in duplex frequencies.
 2. Full network diagnosis shall be available when operating as a master station.
 3. The ~~units~~ shall provide high system performance and data integrity through digital signal processing.
 4. The data radio ~~units~~ shall have the ability to communicate with any asynchronous protocol without extra software or programming.

MATERIALS / EQUIPMENT

688.02.01 FUNCTIONAL REQUIREMENTS

- A. The remote data radio units shall conform to the following general requirements:
1. ~~(a)~~ Supply Voltage: 10.5 VDC to 16.5 VDC.
 2. ~~(b)~~ Tx Current: 2 amps typical at 5 watts.
 3. ~~(c)~~ Rx Current: Less than 125 milliamps.
 4. ~~(d)~~ Sleep Mode: 15 milliamps nominal ~~Humidity~~, 95 percent at ~~40~~ 104 degrees ° ~~°F~~, non-condensing.
 5. ~~(e)~~ Temperature Range: ~~-30~~ -22 degrees F to ~~+60°~~ 140 degrees F.
 6. ~~(f)~~ Data Rate: 9,600 bps (rf).
 7. ~~(g)~~ Port Speed: 300 bps to 9,600 bps (rf and data) at 12.5 kHz ~~C~~ channel spacing.
 8. ~~(h)~~ Bit error rate: BER x .000001.
 9. ~~(i)~~ Casing: Die cast aluminum.
 10. ~~(j)~~ Dimensions: 2-inch" by 6-inch" by 8-inch" maximum.
 11. ~~(k)~~ Weight: 2.5 ~~lb~~ pounds, maximum.
 12. ~~(l)~~ Operational Modes: Asynchronous; ~~—S~~ simplex, half-duplex.

13. ~~(m)~~ Data Interface: RS-232, DB-25 Female connector supports: TXD, RXD, RTS, CTS, DCD, RUS, AUX 14. ~~(n)~~ POWER, DSR, and GND.
 14. ~~(n)~~ Synthesizer Range: 400 kHz sliding window, manually tunable.
 15. ~~(e)~~ Current Consumption:
 - a. ~~(1)~~ RF Unit Rx/Standby: 70 milliamps maximum.
 - b. ~~(2)~~ RF Unit Tx: 1.6 amps nominal.
 16. ~~(p)~~ TX to RX Transition Time: 3 milliseconds RSSI Squelch.
- B. Modem/Diagnostics: The remote data radio units shall conform to the following:
1. ~~(a)~~ Modulation: Digital/CPFSK.
 2. ~~(b)~~ CTS Delay: 0 to 255 millisecond, programmable in 1 millisecond increments.
 3. ~~(c)~~ PTT Delay: 0 to 255 millisecond, programmable in 1 millisecond increments.
- C. Radio Receiver: The radio receiver shall conform to the following:
1. ~~(a)~~ Type: Double conversion superheterodyne.
 2. ~~(b)~~ Frequency Stability: ± 0.00015 percent (1.5 ppm).
 3. ~~(c)~~ Adjacent Channel: 60 dB nominal.
 4. ~~(d)~~ Sensitivity 12 dB Sinad: -117 dBm nominal.
 5. ~~(e)~~ Spurious Rejection: 80 dB.
 6. ~~(f)~~ Desensitization: 65 dB at 12.5 kHz and 70 dB at 25 kHz nominal.
 7. ~~(g)~~ IF Selectivity: 100 dB at adjacent channel.
 8. ~~(h)~~ Electronic Industry Association (EIA) Inter-modulation: 65 dB.
 9. ~~(i)~~ RSSI: Negative -112 dBm to -54 dBm.
 10. ~~(j)~~ Squelch Opening Time: 1.5 milliseconds.
 11. ~~(k)~~ Audio Outputs:
 - a. ~~(1)~~ Filtered: -10 dB, 600 ohm unbalanced, adjustable.
 - b. ~~(2)~~ Unfiltered: 40 mV RMS at 2 kHz Dev.
 12. ~~(l)~~ Harmonic Distortion: 3 percent maximum.
- D. Radio Transmitter: The radio transmitter shall conform to the following:
1. ~~(a)~~ RF Power: Adjustable between 0.5 w and 5 w at 13.6 VDC.
 2. ~~(b)~~ Duty Cycle: Continuous.
 3. ~~(c)~~ Time Out Timer: Programmable between 1 second and 255 seconds, or OFF.
 4. ~~(d)~~ Spurious and Harmonics: -55 dBc maximum.
 5. ~~(e)~~ Hum and Noise: -40 dB between 300 Hz and 3,000 Hz.
 6. ~~(f)~~ Audio Inputs:
 - a. ~~(1)~~ Filtered: -10 dBm, 600 ohms unbalanced, adjusted, at 2 kHz Dev.
 - b. ~~(2)~~ Unfiltered: 245 mV RMS at 2.5 kHz Dev.
 7. ~~(g)~~ Audio Response:

REMOTE DATA RADIO COMMUNICATION SYSTEM

688

- a. ~~(1)~~ Filtered: Between 1 dB and -3 dB from 5 Hz to 3,000 Hz.
- b. ~~(2)~~ Unfiltered: 1 dB and -3 dB from 5 Hz to 4,000 Hz.
- 8. ~~(h)~~ Frequency Stability: ± 0.00015 percent (1.5 ppm).
- 9. ~~(i)~~ Transmitter Attack Time: Less than 1 millisecond to within 100 Hz.
- 10. ~~(j)~~ Carrier Power: Programmable from 0.1 watts to 5 watts.
- 11. ~~(k)~~ Carrier Power Accuracy: Normal plus or minus 1.5 dB.
- 12. ~~(l)~~ Output Impedance: 50 ohms.
- E. Connectors and Harnesses:
 - 1. All connectors and harnesses shall be furnished with each data radio unit. It is the supplier's responsibility to contact FAST to determine the type of connectors required.
 - 2. The remote data radio unit is for use with the FAST system.
- F. Power Requirements: The remote data radio units shall meet all specified requirements when the input power is 120 VAC plus or minus 10 VAC, and 55 Hz plus or minus 5 Hz.
- G. Antennae Requirements:
 - 1. A Yagi-type antennae with 9 dB gain shall be provided with each unit.
 - 2. The antennae shall be capable of operation within the 940 MHz to 960 MHz bandwidth.
- H. Software Requirements: All software necessary for the units to be fully functional shall be downloaded into the devices at the factory before shipment.
- I. Compliance to FAST: All equipment supplied shall conform to the requirements of FAST.

CONSTRUCTION**688.03.01 INSTALLATION**

- A. The radio unit shall be installed as shown on the Drawings.

METHOD OF MEASUREMENT

688.04.01 MEASUREMENT

- A. The quantity of Remote Data Radio uUnit shall be measured per each. ~~This item shall include providing and installing the radio unit as shown on the plans.~~

BASIS OF PAYMENT

688.05.01 PAYMENT

- A. The accepted quantity of Remote Data Radio uUnit(s) will be paid for at the contract unit price bid per each which shall be full compensation for ~~the equipment~~ providing and installing the radio unit and appurtenant equipment, measured as provided under Subsection 688.043.01 "Measurements." as specified, and shown on the drawings.
- B. Payment will be made under:

PAY ITEM:**PAY UNIT**

Remote Data Radio Unit..... Each