#4

TOYOTA ARIZONA PROVING GROUND

CONSTRUCTION SPECIFICATIONS

Registered Professional Engineer (Civil)
CERTIFICATE NO.
11426
R. DOUGLAS
PETERS, P.E.
Date Signed 10-18-91
ARIZONA, U.S.A.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
19942
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Date Signed 10-18-91
ARIZONA, U.S.A.

October 18, 1991

21456-C-12/13
Specifications

CONSTRUCTION SPECIFICATIONS

TOYOTA ARIZONA PROVING GROUNDS

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SECTION 101 SUMMARY OF THE WORK

101-1 General:

The work is situated on the Toyota Arizona Proving Grounds in Maricopa County. The project site is approximately 45 miles northwest of the City of Phoenix and 15 miles west of U.S. Route 60 and 89 along Patton and Peak View Roads.

101-2 Project Description:

The subcontractor shall furnish materials, products, labor, superintendence and transportation to construct the following roads and facilities. Also the work includes, but is not limited to clearing and grubbing of the project site, earthwork for all roads, and paving. The subcontractor shall also provide and construct the complete drainage system which includes pipe culverts, box culverts and underpasses, pump station with suction and discharge pipes, headwalls, wingwalls and cutoff walls, and diversion channels.

The subcontractor shall construct the power distribution system.

The subcontractor shall furnish all materials and construct steep grade road system which includes, earthwork, paving, catch basins, drains and pump station including all electrical and controls.

101-2.01 Major Road:

The following are the major work items of the project.

A. Oval Track

The purpose of this facility is to enable vehicles to be driven safely at high-speed to obtain testing data such as fuel economy, component durability, and overall vehicle performance in a warm-weather environment. The test track shall be oval in configuration with a length of 10 miles. It shall have level straighways, and shall lie in a uniform plane which will generally slope to conform with the existing ground topography. Test track shall consist of three lanes: high-speed lane, medium-speed lane, and low-speed lane. The design speed of each lane shall be 160 mph, 110 mph, and 60 mph, respectively. The sectional shape of the bank shall consist of three order parabola. The track has been designed and shall be constructed so that there would be no lateral acceleration to the test vehicle when it is traveling at the design speed.

B. Loop Road "A"

The purpose of this facility is to provide a bypass for ride and vibration surface and braking test lane.

C. Ride and Vibration Surfaces

The purpose of this facility is to evaluate riding comfort, including noise and vibration analysis. Road surfaces representative of North America shall be provided for the ride and vibration surface section (special surfaces are also provided in the cornering course).

D. Ramp Ways

This facility is to connect the high-speed track with access roads, consequently shall be sufficiently aligned to ensure safety of vehicle transit.

Ramp Way A is provided for merging and Ramp Way B is for exiting.

E. Cornering Course

The purpose of this facility is to evaluate handling characteristics including stability and controllability.

F. Dirt Track

This facility aims at evaluating durability of the vehicle running on unpaved roads.

G. Steep Grade

This facility aims at evaluating vehicle climbing ability and brake performance, and shall consist of three types of grade (14°, 20% and 30%) that shall be paved with concrete.

H. Access Roads

Access roads shall be provided between the main gate and garage and office building and between each test course and each facility.

I. Drainage

The drainage system consists of reinforced concrete box culverts, pipe culverts and storm drains. The pipe culverts and storm drains include reinforced concrete pipe, corrugated metal pipe, slotted drains, high density polyethylene pipe,

catch basins and flap gates. There are pump stations complete with wet well, pumps with associated cables and controls, piping, valves, connections to inlet and outlet pipes and other appurtenances.

J. Underpasses

There are underpasses to provide crossing of the high speed track.

K. Power Distribution System

The power distribution system consists of the main 12.47KV overhead and underground lines. This starts from the APS substation at site boundary. There are transformers at specified locations at the site.

L. Rain Catchment Units

These are to provide water to small wild life.

101-3 Codes, Standards and References:

Arizona Department of Transportation, ADOT Highways Division, Standard Specifications for Road and Bridge Construction, 1990 Edition.

Arizona Department of Transportation, Highways Division, Standard Drawings for Construction, January, 1991.

Arizona Department of Transportation, Highways Division, Standard Drawings for Signing and Marking (S&M Standards), November, 1988.

Arizona Department of Transportation, Structures Section, Standard Drawings, 1988

Arizona Department of Transportation Traffic Control Manual for Highway Construction and Maintenance, January, 1989.

Manual on Uniform Traffic Control Devices for Streets and Highways, 1988 and amendments.

Subsurface information is available in the Geotechnical Investigation Report For The Arizona Proving Ground Project, May 30, 1991 prepared by Sergent, Hauskins & Beckwith, hereinafter referred to as "The Geotechnical Report".

Some of the sections have been developed with the aid of above mentioned ADOT standard specifications.

101-4 Payment Provisions:

Any and all payments will be in accordance with the Subcontract Price in Exhibit "C" and the payment provisions in Exhibit "A" and "B" of this Contract. Any payment provisions that may be in the documents listed below will not apply to this subcontract.

SECTION 103 404 PERMIT RESTRICTIONS:

The U.S. Army Corps of Engineers has designated certain washes as falling under their jurisdiction. Certain rules and regulations apply to any work performed in and around these washes. The filling and dredging of certain washes at the Proving Grounds site is controlled by an existing U.S. Corps of Engineers, 404 Permit. Any construction (grading, filling, etc.) in these washes is not allowed without prior approval of the Contractor. The Subcontractor shall submit the temporary road plans, laydown areas, waste sites, etc. to the Contractor prior to the start of construction.

With respect to work conducted in and around said jurisdictional washes, the SUBCONTRACTOR shall comply with and adhere to the Rules and Regulations published in the Federal Register, Vol. 51, No. 219 Part 330 - Nationwide Permits, contained in Appendix E, particularly Parts 330.5(a)(26), 330.5(b) and 330.6 and the jurisdictional washes given in the figure.

SECTION 105 SUBMITTALS

105-1 Description:

The work under this section specifies the requirements for the submittal of documents to the document control manager, which are defined in these specifications. It also describes the procedures for "Supplemental" submittals.

105-2 General Requirements:

105-2.01 Initial Submittals:

A. Submittal Schedule - The Subcontractor shall identify the submittals which will be required and determine the date on which each submittal will be required in conformance with the project schedule. Submit list of submittals to the document control manager within twenty (20) calendar days after Notice to Proceed and update monthly.

B. Title Block - show the following information:

(1) Date and revision dates.

(2) Contract title and number.

(3) The names of the Subcontractor, second tier Subcontractor, supplier, manufacturer, and, when applicable, the seal and signature of an Engineer registered in the State of Arizona for the involved discipline.

(4) Identification of product either by description, model number, style number, serial number, or lot number.

(5) Subject identification by Contract Drawing or Specification reference.

C. Action Block - The Subcontractor shall include a blank space, three (3) inches by four (4) inches, in the lower right corner, just above the title block in which the Engineer may indicate the action taken.

D. Make submissions sufficiently in advance so that the Engineer can review and accept them not less than twenty (20) working days before work represented by those submittals is scheduled to be performed. Unless otherwise specified, submit six (6) copies of each document.

E. Allow a minimum of ten (10) working days for review of each submittal by the Engineer.

Accompany submittals with a Subcontractor transmittal form containing the following information:

(A) Subcontractor's name, address and telephone number.

(B) Submittal number and date.

(C) Contract title and number.

(D) Supplier's, manufacturer's or Subcontractor's name, address and telephone number.

(E) Subject identification, including contract drawing and specification reference.

(F) Identification of deviations from contract documents.

(G) Subcontractor's stamp and signature certifying his review.

Changes in accepted submittals will not be permitted unless those changes have been accepted in writing by the Engineer.

105-2.02 Supplemental Submittals:

Supplemental submittals initiated by the Subcontractor for consideration of corrective procedures shall contain sufficient data for review. Make supplemental submittals in the same manner as initial submittals.

105-3 Submittal Review:

105-3.01 Subcontractor's Review:

The Subcontractor shall review submittals, stamp and sign as reviewed and approved, prior to submission to the Documents Control Manager.

105-3.02 Engineer's Review:

Submittals will be reviewed by the Engineer for conformance to requirements of the contract drawings and specifications. Review of a separate item will not constitute review of an assembly in which the item functions. Review and acceptance will not relieve Subcontractor from his responsibility for accuracy of submittals, for conformity of submittals to requirements of contract drawings and specifications, for compatibility of described product with contiguous products and the rest of the system, or for protection

and completion of the contract in accordance with the contract drawings and specifications.

The Engineer will review the submittals for general conformance with the contract documents and mark, sign and date the review stamp.

The marks have the following meanings:

STATUS 1

Information delineated on the document has been reviewed by Taisei/Bechtel without comment and may be used by Supplier. The document requires no changes and can be handled by correspondence. The document must meet project record retention requirements, including reproduction.

STATUS 2

Information delineated on the document is in basic accord with the specifications and purchase order. Minor deviations have been noted, some aspects of the subject matter are incompletely defined, or other minor technical changes are required to make the item usable.

STATUS 3

Information delineated on the document is not to be used by the Supplier because it:

- does not conform to project criteria;
- is of design that is technically unusable without significant changes;
- does not meet Bechtel requirements (for example, orientation of equipment, nozzles, conduit connections); or
- does not conform to the procurement requirements.

JOB NO.

SUPPLIER DOCUMENT STATUS

1. ☐ WORK MAY PROCEED
2. ☐ REVISE AND RESUBMIT. WORK MAY PROCEED SUBJECT TO RESOLUTION OF INDICATED COMMENTS
3. ☐ REVISE AND RESUBMIT. WORK MAY NOT PROCEED.
4. ☐ REVIEW NOT REQUIRED. WORK MAY PROCEED.

PERMISSION TO PROCEED DOES NOT CONSTITUTE ACCEPTANCE OR APPROVAL OF DESIGN DETAILS, CALCULATIONS, ANALYSES, TEST METHODS OR MATERIALS DEVELOPED OR SELECTED BY THE SUPPLIER AND DOES NOT RELIEVE SUPPLIER FROM FULL COMPLIANCE WITH CONTRACTURAL OBLIGATIONS.

REVIEWED	A	C	E	J	M	PD	

G-321
DOCUMENT CATEGORY _____

RESPONSIBLE ENGINEER _____ DATE _____

STATUS 4

Information delineated on the document need not be reviewed prior to its use by the Supplier. This STATUS is given to those documents which depict supplier standard products, shop details not requiring Bechtel review, etc.

Where marked as in three (3) above, a new ten (10) working day Engineering review period shall start from the day of resubmittal to the document control manager.

105-3.03 Subcontractor Responsibilities:

The Subcontractor shall coordinate each submittal with the requirements of the work and place particular emphasis upon ensuring that each submittal of one trade is compatible with other submittals of that trade and submittals of other trades.

Subcontractor's responsibility for errors and omissions in submittals and associated calculations is not relieved by the Engineer's review, correction and acceptance of submittals.

Subcontractor's liability to the Engineer in case of deviations in the submittals from the requirements of the contract documents is not relieved by the Engineer's review and acceptance of submittals containing deviations unless the Engineer expressly approves the deviation through the issuance of a change notice.

The Subcontractor shall maintain a file of all approved submittal documents at the work site.

105-3.04 Certificates:

A. General:

The contractor shall submit to the Engineer an original and two copies of either a Certificate of Compliance or a Certificate of Analysis, as required, prior to the use of any materials for which these specifications require that such a certificate be furnished. Submissions shall be made in accordance with the requirements of the ADOT Materials Testing Manual.

B. Certificate of Compliance:

The Engineer may permit the use of certain materials or manufactured assemblies prior to sampling and testing if accompanied by a Certificate of Compliance, as herein specified:

The Certificate of Compliance shall contain the following information:

(1) Project number to which the material is consigned.

(2) Name of contractor to whom the material is supplied.

(3) Kind of the material supplied.

(4) Quantity of material represented, such as lot, batch, etc.

(5) Means of material identification, such as label, lot number, marking.

(6) Statement that the material complies in all respects with the specific requirements of the cited specifications.

(7) The original signature of a person having legal authority to bind the manufacturer or supplier of the material. A reproduction is not acceptable. The signature shall be notarized.

The person signing the certificate shall be in one (1) of the following categories:

a. An officer of a corporation.

b. A partner in a business partnership or an owner.

c. A general manager.

d. Any person having been given the authority by one (1) of the above. This must accompany the certificate of compliance in writing.

Each of the first six (6) items specified above, shall be provided by the firm or organization that is certifying the material prior to the signing as defined in item seven (7), and all of the first six (6) shall be in one type style or handwriting. No certificate will be accepted that has been altered, added to, or changed in any way after the authorized original signature or the person that has legal authority to bind the firm or organization has been affixed to the original certificate. Materials or assemblies will not be incorporated into the project without a valid certificate of compliance or proper testing. Materials of assemblies used on the basis of a Certificate of Compliance may be sampled and tested at any time and if found not in conformity with the requirements of the plans and the specifications will be subject to rejection whether in place or not.

The Engineer reserves the right to refuse to permit the use of material on the basis of a Certificate of Compliance.

C. Certificate of Analysis:

The Certificate of Analysis shall include all the information required in a Certificate of Compliance and, in addition, shall include the results of all tests required by the specifications, such as mill test reports for certain types of structural steel.

105-3.05 Inspection of the Plant:

The Engineer may undertake the inspection of materials at the source. In the event plant inspection is undertaken, the Engineer shall have the cooperation and assistance of the Subcontractor and the producer with whom the Subcontractor has contracted for materials, and the Engineer shall have full entry at all times to such parts of the plant as may be involved in the manufacture or production of the materials being furnished. Adequate safety measures shall be provided and maintained.

The Engineer reserves the right to retest all materials which have been tested and accepted at the source of supply after the same have been delivered and prior to incorporation into the work and to reject all materials which, when retested, do not meet the requirements of the specifications.

105-4 Method of Measurement:

The work of this section will not be separately measured for payment.

SECTION 106 QUALITY CONTROL REQUIREMENTS

106-1 Description:

This section identifies the Quality Control (QC) activities to be performed by the Subcontractor during all phases of the contract. The types and frequency of testing and measurements as a minimum shall satisfy ADOTTM-XII-TWO-D Materials Testing Manual and Appendix A of these specifications. Omissions and misdescriptions shall not relieve the Subcontractor of his responsibility to perform all tests/inspections required within the scope of this contract. All QC responsibilities lie with the Subcontractor, with the exception of those tests or inspections specifically identified as being performed by others.

106-1.01 General Requirements:

The Subcontractor shall be responsible for the development, implementation and maintenance of a Quality Control Program consistent with the requirements of this section, that assures equipment and material conformance to the applicable requirements of every section of the specification. The Subcontractor's Quality Control Program (SQCP) shall assure the maintenance of adequate quality throughout all applicable areas of contract performance such as: design, inspection, testing, handling, storage and site construction activities. The SQCP shall provide a mode of operation that emphasizes the identification, correction and prevention of deficiencies and discrepancies. Documentation shall include plans, procedures, detailed work instructions and records. Procedures to implement the SQCP shall be developed, specific responsibilities assigned and individual job authorities clearly delineated. Procedures shall be established to systematically verify compliance with the requirements of this section and any other requirements of the specification necessary to show conformance to the contract.

The Subcontractor's Quality Control Program (SQCP) shall be subject to evaluation by the Engineer or Owner to determine that the SQCP meets contractual requirements. Preplanned audits of Subcontractor, second tier Subcontractor and supplier activities will be performed by the Engineer or Owner to verify compliance with the specifications and all referenced standards. Audits will be performed on a systematic basis or as warranted by general quality trends.

Whenever a reference is made in the contract documents to a standard specification, manual or national consensus standard, such as ASTM, AASHTO, ACI or codes and standard issued by any other recognized State of Arizona and/or national organization, and the number or other identification representing the year of adoption or latest revision is omitted, it shall mean the standard

specification, manual or national consensus standard in effect on the date of the Letter of Invitation to Bid.

106-5 Submittals:

Refer to Section 105, Submittals and Section 110, Shop Drawings, Product Data and Samples, for detailed procedures.

The Subcontractor shall submit six (6) copies of his Quality Control Plan (QCP) to the Construction Manager within thirty (30) days after Notice to Proceed. Existing, in-place QC programs are acceptable and the requirements herein shall form the basis of review and modification thereof. No work covered by the QCP shall start until the Engineer's approval has been obtained. The QCP shall contain a comprehensive account of the Subcontractor's QC procedures that shall be applied throughout the project. It shall include, but not be limited to, the following:

(1) Organization chart identifying the manager of the QC Department, showing that this position is outside the construction staff, with clear lines of authority for QC, reporting directly to the Subcontractor's corporate management. The QC Manager or his designated substitute, acceptable to the Engineer, shall be present at the work site at all times that any work is in progress and at any time that any employee or second tier Subcontractor is present at the work site. References hereinafter to Subcontractor Quality Control or SQC shall mean inspection or testing by qualified personnel identified on the approved Quality Control Organization Chart.

(2) A procedure development plan for the preparation of detailed inspection and test procedures required to implement the inspection and test plan and demonstrate compliance with the contract specifications and drawings. The procedure development plan shall also include an index of all quality control procedures and instructions that will be required to implement the quality control program.

Before starting work, the Subcontractor shall designate in writing the name, qualification and experience of the manager of quality control who, on approval of the Engineer, shall have full authority to represent and act for the Subcontractor on all quality-related matters. The Subcontractor shall notify the Engineer in writing in the event the Subcontractor desires to change his QC manager or other key personnel identified on the organization chart, and shall provide information specified above for the Engineer's approval of the new QC manager. No Subcontractor QC personnel shall be removed from the work without prior written approval of the Engineer.

The Subcontractor's Quality Control Program shall include detailed procedures for compliance with the minimum testing requirements as noted in Section 106-1 of this specification. The testing noted in this Appendix Section shall be considered as a minimum to guide the Subcontractor in development of his Quality Control Program.

Before starting work, the Subcontractor shall implement the QCP and instruct, in accordance with the QCP, the workmen, second tier Subcontractors, material suppliers, and others who perform Quality Control tasks. The instructions shall include, but shall not be limited to, the following:

(1) Procedures to identify potential quality problems with work or materials and appropriate directions for solving and reporting such problems.

(2) Procedures establishing preventive measures and maintaining effective QC practices in all areas of the project.

Prior to procurement of items and materials, the Subcontractor shall submit a list of suppliers and second tier Subcontractors that shall include items to be supplied, item numbers, specifications, inspection and test requirements, performance data, anticipated inspection test dates, and other pertinent information as appropriate.

Inspection/test results, Certificates of Compliance and Certified Material Test Reports shall be submitted to and approved by the Engineer in accordance with Appendix A of this section and Section 105 - Submittals and Section 110 - Shop Drawings, Product Data and Samples.

The Subcontractor shall prepare and submit an Inspection and Test Plan to the Engineer for approval within ten (10) calendar days after the date of Notice to Proceed. Inspection and Test activities shall not commence until such approval is granted. The Inspection and Test Plan shall be developed for each specification section and shall identify all required inspections and tests required by that specification section, the required frequency, the accept/reject criteria, records required to document compliance, and the procedures or instruction to be used for control of each activity. The Subcontractor shall perform other inspections and tests as necessary to verify the quality of the work. The Inspection and Test Plan shall be in sufficient detail to allow the Engineer, or any other company having jurisdictional authority over the work, to indicate in the Plan any and all operations to be inspected by that organization. Hold points so indicated shall not be bypassed by the Subcontractor unless a written waiver is given by the witnessing organization.

The Subcontractor shall prepare quality control procedures and instructions for submittal to the Engineer for approval thirty (30) calendar days prior to the start of related work. Quality Control activities covered by such related activities shall not commence until approval is granted.

The Subcontractor shall prepare an index of the records that will be accumulated and maintained during the progress of the work to the documents control manager and submit for approval within thirty-five (35) calendar days after date of the Notice to Proceed.

Rejection of any submittal required by this section will not be accepted as a basis for any claim for delay.

106-2 Documentation/Submittal Control:

All activities necessary to satisfy the referenced standards and specifications shall be designated by written procedures. These documents shall be submitted to the Engineer for approval.

The document control procedures shall provide controls for the receipt and transmittal of submittals, contract drawings and specifications to assure all required documents are received and distributed in a timely manner and contain the necessary technical information.

The Subcontractor shall not change or alter approved submittals, procedures, specifications, drawings or any other pertinent documentation unless he submits a request for said change and receives the written approval of the construction manager.

QC procedures, methods and current documents shall be provided by the Subcontractor and made available at the locations where they are to be used.

All records and documents which are quality related shall be prepared, identified and maintained by the Subcontractor and shall be made available to the Engineer upon request. Records shall be protected from damage, deterioration or loss. Retention time for all quality records shall be not less than three (3) years after the date of Final Acceptance (see also General Conditions).

106-3 Preconstruction Conference:

The Subcontractor will be notified, fifteen (15) days in advance, the agenda of the preconstruction conference. The special equipment and special methods but not limited to the following, shall be discussed.

106-3.01 Special Equipment:

Equipment for producing, transporting, storing, applying and rolling materials.

106-3.02 Special Construction Methods:

Special construction methods of quality control inspection to achieve the tolerances shown in Appendix A for the special roads of Division XI.

106-3.03 Submittal:

Submittal of shop drawings, product/material data and samples along with control procedures.

106-3.04 Control Methods:

Control methods to be used in inspections and tests.

106-3.05 Quality Control Requirements:

Any aspect of this section, specifications and drawings shall be discussed.

106-4 Identification and Control of Items and Materials:

Control procedures shall be established to ensure that items or materials that have been accepted through shipping or receiving inspection are properly used and installed. Identification and traceability shall be provided throughout all inspections, test activities and records. For stored items, provisions shall be made for the control of item/material identification consistent with the expected duration and type of storage. Records of equipment or material identification shall be maintained traceable to the location of incorporation into work.

The Subcontractor shall develop and maintain a receiving inspection log, which shall contain the following information as a minimum:

(A) Purchase Order Number
(B) Item Number
(C) Supplier Name
(D) Quantity
(E) Item Description
(F) Reference to Applicable Contract Requirements
(G) Date Received
(H) Heat number, serial number or other I.D., as applicable
(I) Verification of receipt of all required supporting documentation
(J) QC Acceptance Sign-Off and Date

(K) Nonconformance number, if applicable

106-5 Inspections and Tests:

106-5.01 Testing Laboratory:

The Subcontractor shall employ the services of an approved certified material testing laboratory/laboratories to perform materials testing and control testing of materials incorporated into the work.

The testing laboratory shall conform to the standards of the nationally recognized association or agency that promulgates the standards referenced in these specifications for the work performed by said testing laboratory(s). Some of the specific testing laboratory requirements are:

(A) Asphalt, concrete and soil testing shall be supervised by an Engineer registered in the State of Arizona with applicable experience in the field of testing and inspection in these areas and shall conform to the requirements of ASTM E 329.

(B) Structural calculations and recommendations shall be supervised by a civil or structural Engineer registered in the State of Arizona.

(C) Electrical systems, power and distribution equipment shall be tested by an electrical testing laboratory that meets the standards of OSHA, Title 29, Part 1907 and is a certified member of the National Electrical Testing Association (NETA).

Dismissal and replacement of the certified material testing laboratory shall require the written approval of the Engineer. Inspections and tests to verify compliance with the specified requirements shall be performed by the SQC personnel or their test laboratory using recognized national standards or, in the absence of such standards, using written test procedures that have been reviewed and approved by the Engineer in accordance with this section of these specifications. The Subcontractor shall have adequate qualified QC personnel on-site during all production shift operations. The written test procedures shall include the following as a minimum:

(A) Prerequisites for the given test
(B) Required tools, equipment and instrumentation
(C) Necessary environmental conditions
(D) Acceptance criteria
(E) Data to be recorded
(F) Test results reporting forms

(G) Identification of items tested

Acceptance inspection/testing shall be performed by designated personnel other than those performing the work.

Procedures and instructions shall be readily available to inspection and test personnel at the time of inspection or test. When methods of inspection and test are changed, revisions shall be reflected in approved written procedures prior to implementation of the change on any work. Adherence to methods and processes reflected in approved work procedures and instruction shall be completed and continuous.

The Subcontractor shall provide the Engineer with not less than forty-eight (48) hours written notice of the occurrence of an assigned hold point.

The Subcontractor shall bear all costs for SQC inspections and tests as required and in accordance with the General Conditions.

Inspection/test results shall be submitted to the Engineer prior to incorporation of the item(s) into the work. Inspection/test results indicating noncompliance (failure) with specified requirements shall be reported to the Engineer immediately upon receipt. Certificates of Compliance shall be submitted fifteen (15) calendar days prior to the products' incorporation into the work.

Inspection and tests, conducted by person, firms or agencies other than the Subcontractor, shall not in any way relieve the Subcontractor of his responsibility and obligation to meet all specifications and the referenced standards.

Records (reports) of inspection and test activity are quality control records. Report of inspection and test activities shall identify the following as a minimum:

(A) Name of item(s) inspected/tested
(B) Quantity of items
(C) Inspection/test procedure reference (with Organization and Document ID)
(D) Date
(E) Name of inspector/tester
(F) Observations/comments
(G) Specified requirements (with section/paragraph no. ref.)
(H) Acceptability
(I) Deviations/nonconformances
(J) Corrective action
(K) Evaluation of results
(L) Signature of authorized evaluator

When materials or other products subject to testing are supplied from more than one source on the same day, the tests and test frequencies indicated in this section shall apply to each source of supply used. Full and complete testing of each source shall be accomplished in accordance with the requirements of this section.

106-5.02 Inspection and Test Status:

A documented system shall be developed and maintained to clearly identify the inspections and test status of materials and equipment throughout construction. Identification may be accomplished by means of stamps, tags or other control devices attached to or accompanying the material or equipment.

106-5.03 Control of Measuring and Test Equipment:

Control of Measuring and Test Equipment (M&TE) shall be provided and maintained to assure that construction conforms to the requirements of the specification. A system to control the accuracy of all such equipment shall be established and maintained. The system shall include provisions for the unique identification of each piece of measuring and test equipment with a number or designation permanently affixed to the device. Calibration of M&TE shall be performed at intervals specified in calibration procedures by the Subcontractor or an agency/vendor specifically approved and traceable to the National Institute of Standards and Technology (NIST). M&TE found to be out of tolerance, damaged or lost during use shall be documented with a nonconformance report. Work inspected or tested with out of tolerance or damaged equipment shall not be considered acceptable until the nonconformance is disposed of properly and all characteristics previously inspected or tested have been verified as correct. In the event that no national standards exist for calibration, the basis for calibration shall be documented.

106-5.04 Nonconformances:

A system shall be established to define the methods and responsibilities for the identification, documentation, control and processing of nonconforming equipment and material. A nonconformance shall be considered to exist when either material or equipment exhibits a deficiency in either physical inspection characteristics or documentation. This system shall apply to all material and equipment, including the actions associated with installation or construction which, for any reason, fails to conform to the specifications or other applicable approved product description. The Subcontractor shall provide the following to prevent use of nonconforming items/materials:

(A) Identification of nonconformances
(B) Documentation

(C) Evaluations/recommendations
(D) Separation/removal
(E) Immediate notification to the construction manager
(F) Cause of nonconformance
(G) Proposed corrective action.

The Subcontractor shall develop and maintain a nonconformance log to enable tracking of all nonconformances. This log shall contain the following information as a minimum:

(A) Sequential, unique number
(B) Date issued
(C) Originator
(D) System, affected/drawing number/serial number
(E) Description of nonconformance and source (e.g., supplier, Subcontractor, welder, etc.)
(F) Recommended/final disposition
(G) Date closed
(H) SQC manager's initials
(I) Remarks, as applicable

The SQC personnel shall have the authority to stop that portion of the work that does not comply with the contract requirements.

The dispositions for nonconforming items/materials will be approved by the Engineer.

Procedures shall be established that control the use, including logging, installation and removal, of status tags. Authorization for removal shall be defined. Intentional unauthorized removal of nonconformance status tags shall result in immediate dismissal and removal from the job site of all responsible personnel.

106-5.05 Corrective Action:

Prompt action shall be taken to identify the basic causes of nonconformances and the corrective action to prevent recurrence. The results of failure and discrepancy report summaries, supplier evaluations and any other pertinent applicable data shall be used for determining corrective action. Information developed during construction, test(s) and inspection(s) that support the implementation of required improvements and corrections shall be used to support the adequacy of corrective action taken.

106-5.06 Personnel Qualifications:

Activities that require qualified production, inspection and test personnel shall be identified and the minimum competence level shall be established as part of the SQCP. Personnel performing special processes (e.g., welding, brazing) or inspection/test tasks shall have the experience, training and certification and, where

required, the license commensurate with the scope, complexity or nature of the activity and shall be approved by the construction manager. Provisions shall be made for the following:

(A) Requirements for qualifications
(B) Orientation
(C) Evaluation
(D) Certification credential or license

Records of personnel qualifications shall be maintained by the Subcontractor as SQC records.

106-5.07 Audits:

The Subcontractor shall perform scheduled internal audits to verify that his QC procedures ensure total compliance with the specifications and all reference standards. Records of self audits shall be maintained as quality records and shall be made available to the construction manager upon request. The Subcontractor shall provide access to the audit locations upon notice by the construction manager.

106-5.08 Handling and Storage:

Handling, storage and preservation of equipment and material from the time of receipt to the time of turnover shall be performed in accordance with documented procedures to prevent damage, deterioration, distortion of shape or dimension, loss, degradation, loss of identification or substitution. Handling procedures shall include the use of special devices (e.g., crates, boxes, containers, dividers, slings, material handling and transportation equipment, and other facilities) for handling, and control provisions for inspection and maintenance of the special devices. Equipment and material requiring specific time intervals for inspection or test shall be appropriately marked and controlled.

106-5.09 Quality Control Records:

Records shall be developed, used and maintained and shall include, but not be limited to, those specifically prescribed in this section. A complete records index shall be developed based on the requirements for document and data submittals in each specific section of the specification. The records index shall indicate all records, documentation and data required by the contract to be furnished by the Subcontractor. The records identified shall provide objective evidence that all quality control program activities conform, including evidence that required verification testing has been performed and that evidence demonstrates the basis for decisions which were made. Records shall include the required authentications, authorities and any other information which will provide evidence of the authenticity of the record and the adequacy

of records shall be made on a systematic basis at a level of authority commensurate with the nature of the records. Only complete and properly authenticated documents shall be considered quality records. All quality records shall be indexed, filed and maintained in a manner that provides for timely retrieval, traceability to, identification with and acceptability of, material, equipment and systems. All quality control records shall be protected from deterioration and damage.

At a minimum, records shall contain:

(A) Name of equipment/material/system inspected or tested
(B) Specification reference by section and paragraph (where applicable)
(C) Quantity of items
(D) Location of installation
(E) Inspection/test procedure reference
(F) Date
(G) Signature of Inspector
(H) Observations/comments
(I) Test or Inspection Procedure/Required Results/Test Results and Comments

106-5.10 Supplier Quality Assurance:

A documented system shall be developed and maintained to assure that procured products conform to the requirements of these specifications. Written procedures shall provide for evaluation and selection of suppliers, using specified evaluation criteria, transmission of applicable design, manufacturing, quality and other associated technical requirements in purchase documents periodic assessment of supplier performance and an evaluation of the adequacy of procured products.

106-5.11 Samples:

In addition to the sample requirements of Section 110, all samples of materials, products or assemblies to be incorporated into the works shall be retained for a minimum period of one (1) year after the date of the certificate of final acceptance. The Subcontractor shall provide thirty (30) days notice to the Engineer of intent to discard or destroy such samples as may be in the possession of the Subcontractor or his Subcontractors.

106-6 Construction:

106-6.1 Requirements:

All materials required for the contract shall be new except where specified otherwise. The Engineer may elect to perform additional inspections and/or tests at the place of the manufacture, the

shipping points or at the destination to verify compliance with applicable specifications. Inspections and tests performed by the Engineer shall be for the Subcontractor Quality Assurance and shall not relieve the Subcontractor from the responsibility of meeting the specified requirements, nor shall such inspections/tests be considered to be a guarantee for acceptance of materials that will be delivered subsequent to the time items were tested.

Nonconforming materials, whether in place or not, will be rejected by the Engineer or his designee with written notification to the Subcontractor to correct or remove the defective materials from the project. If the Subcontractor fails to respond, the Engineer may order correction, removal and/or replacement of defective materials by others, in which case the Subcontractor shall bear all costs incurred by such actions.

Materials accepted on the basis of a Certificate of Compliance may be sampled and inspected/tested by the Engineer or its designee at any time. The fact that the materials were accepted on the basis of such certificate shall not relieve the Subcontractor of his responsibility to provide materials and equipment which comply with the specifications.

The Subcontractor shall impose upon his suppliers and second tier Subcontractors the same QC requirements, including inspection and test procedures, as imposed upon him by the specifications and referenced standards. The Subcontractor shall apply appropriate controls, designed to ensure that all materials supplied comply with the requirements of the specifications.

106-6.2 Warranties and Guarantees:

See General Conditions, Section 23.

106-6.3 Failure to Perform:

In the event the Subcontractor fails to adequately perform any or all of the provisions of this section, the Owner, at its sole discretion, reserves the right to have the Engineer perform any or all of the provisions of this section and backcharge the Subcontractor for the actual cost to the Owner of such services. This remedy for Subcontractor's failure to perform shall be in addition to any other right or remedy available to the Owner under this contract.

106-7 Method of Measurement:

The work under this section will not be measured separately for payment. For material partial payment, the specific quality control program items shall be approved and then the related payment shall be made.

The work of this section will be paid for under General Requirements - per lump sum.

SECTION 107 MISCELLANEOUS:

107.01 Archaeological Features:

The attention of the subcontractor is directed to Article 4, Archaeological Discoveries, Sections 41-841, 41-842, 41-844, and 41-846, of the Arizona Revised Statutes, which make it a felony, punishable by a fine and imprisonment to investigate, explore or excavate on State land, in or on prehistoric ruins, ancient burial grounds, fossilized footprints, hieroglyphics and all other archaeological features of Arizona without permits from the Arizona State Museum.

Section 6(a) of the Federal Archaeological Resources Protection Act of 1979 specifies that no person may excavate, remove, damage or otherwise alter or deface any archaeological resource located on public (Federal) lands or Indian lands unless such activity is pursuant to a permit issued under Section 4 of the Act. Violations of this act are considered a felony and are punishable by fine and imprisonment.

Although the Department will make every effort prior to construction to identify all cultural resources in a project area, previously unidentified archaeological materials could be found during the construction of the project. When archaeological, historical or paleontological features are encountered or discovered during any activity related to the construction of the project, the subcontractor shall stop work immediately at that location and shall take all reasonable steps to secure the preservation of those features.

The Engineer will contact Environmental Planning Services immediately and make arrangements for the proper treatment of those resources. The subcontractor shall not resume work until he/she is so directed by the Engineer. In the event of a suspension of work pursuant to this clause, the subcontractor shall be entitled to an equitable adjustment to the contract time.

107.02 Sanitary, Health. and Safety Provisions:

The subcontractor shall provide and maintain in a neat and sanitary condition such accommodations for the use of the subcontractors employees as may be necessary to comply with the requirements and regulations of the Arizona State Department of Health Services or other authorities having jurisdiction therein.

Attention is directed to Federal, State and local laws, rules and regulations concerning construction safety and health standards. The subcontractor shall not require any workers to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to their health or safety.

Occupational Safety and Health Standards shall apply at all times. Should the subcontractor fail to follow OSHA regulations, the Engineer may suspend the work by written notice until compliance has been achieved. Any such failure to comply with OSHA regulations shall constitute waiver of any right to claim for such suspended work. If regulations are in conflict, the more strict regulation will apply.

107.03 Public Convenience and Safety:

The subcontractor shall at all times so conduct his/her work as to insure the least possible obstruction to traffic.

The safety and convenience of the general public and the residents along the highway and the protection of persons and property shall be provided for by the subcontractor as approved by the Engineer.

The subcontractor shall submit a Safety Plan to the Engineer at the preconstruction conference detailing the procedures the subcontractor will implement to satisfy OSHA and the State Occupational Safety Guidelines related to the worker as well as public safety in the construction of excavations, structures and confined air spaces as identified by the Engineer. The subcontractor's Safety Plan shall include the requirement that all workers and visitors must wear hard hats while within the project limits.

The Safety Plan submitted by the subcontractor shall include proposed methods to prevent unauthorized persons from gaining access to the work areas.

107.04 Barricades and Warning Signs:

The subcontractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs and other traffic control devices and shall take all necessary precautions for the protection of the work and safety of the public.

Suitable warning lights shall be provided to control and direct traffic properly.

The subcontractor shall erect warning signs in advance of any place on the project where operations may interfere with the use of the road by traffic, and at all intermediate points where the new work crosses or coincides with an existing road. No signs, barricades, lights, or other protective devices shall be dismantled or removed without permission of the Engineer.

All signs, barricades, lights, temporary signals, and other protective devices shall conform to the requirements of the Arizona

Department of Transportation Traffic Control Manual for Highway Construction and Maintenance.

107.05 Use of Explosives:

When the use of explosives is necessary for the prosecution of the work, the subcontractor shall exercise the utmost care not to endanger life or property, including new work. The subcontractor shall be responsible for all damage resulting from the use of explosives.

The subcontractor shall furnish and erect special signs to warn the public of the subcontractor's blasting operations. Such signs shall be placed at appropriate points within the limits of the project and these signs shall be maintained as to be clearly evident to the public during all critical periods of the blasting operations.

If blasting is to be done involving the use of electric blasting caps, the signs shall include a warning statement that all mobile radio transmitters should be turned off.

In advance of doing any blasting work involving the use of electric blasting caps within 200 feet of any railroad track or structure, the subcontractor shall notify the railroad company of the locations, date, time and approximate duration of such blasting operations.

The method of use, storing and handling of explosives and liquid inflammable materials shall conform with all State and local laws, regulations and safety codes. All storage places shall be marked clearly and in large letters: DANGEROUS EXPLOSIVES.

Where no local laws or ordinances apply, storage shall be provided satisfactory to the Engineer and in general not closer than 1,000 feet from the road or from any building or camping area or place of human occupancy.

The subcontractor shall notify each property owner and public utility company having structures or facilities in proximity to the site of the work of the subcontractor's intention to use explosives. Such notice shall be given sufficiently in advance to enable them to take such steps as they may deem necessary to protect their property from damage.

The subcontractor shall obtain necessary permits from and comply with the requirements of the National Park Service, Forest Service, Bureau of Indian Affairs or other authority having jurisdiction over the area before any explosives are used.

107.06 Protection and Restoration of Property and Landscape:

The subcontractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location. Land monuments and property marks shall not be moved by the subcontractor until directed by the Engineer.

Private mail boxes within the limits of operations shall be temporarily or permanently relocated, as required, by the subcontractor in such a manner as to permit uninterrupted mail service.

Existing fences, pole lines, signs, buildings and structures that are to remain in place shall be protected from injury or damage.

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

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work or in consequence of the nonexecution thereof by the subcontractor, the subcontractor shall restore, at his/her own expense, such property to a condition similar to or equal to that existing before such damage or injury was done, by repairing, rebuilding or otherwise restoring as may be directed or he shall make good such damage or injury in an acceptable manner.

The subcontractor shall not deface, injure or destroy trees, shrubs or cacti except as required to complete the proposed construction. The attention of the subcontractor is called to the requirements of the Arizona Native Plant Law, which became effective on September 28, 1976 and subsequent amendments thereto. The subcontractor shall give the Arizona Commission of Agriculture and Horticulture at least ten days notice prior to any clearing operations.

Native plants as defined by the Statutes shall neither be transported from the land or offered for sale without the written permission of the Commission.

Notice shall be sent to:

Assistant Director
Division of Compliance
Arizona Commission of Agriculture and Horticulture
State Office Building, Room 414
1688 West Adams Street
Phoenix, Arizona 85007

Materials removed during construction operations such as trees, stumps, building materials, irrigation and drainage structures, broken concrete and other similar materials shall not be dumped on either private or public property without the subcontractor having obtained written permission from the owner in the case of private property or from a responsible official of the agency with jurisdiction over the land in the case of public property. Written permission will not be required, however, when materials are disposed of at an operating, public dumping ground.

Under no circumstances shall the disposal of debris from construction operations be such as to create a blemish on the landscape.

Hauling outside of slope staked areas will not be permitted except around concrete structures, structural plate pipe and at locations where topographical or other features render it impracticable to confine hauling operations within slope staked areas.

Haul routes outside of slope staked areas shall be as short as practicable and shall be so located as to minimize defacement of or injury to landscape features and vegetation. Such haul routes shall be obliterated and the ground restored to a condition similar to or equal to that existing before such hauling was started.

107.07 Prevention of Air and Noise Pollution:

The subcontractor shall control, reduce, remove or prevent air pollution in all its forms, including air contaminants, in the performance of the subcontractor's work.

The subcontractor shall comply with the applicable requirements of Title 49 - Public Health and Safety, Chapter 3, Air Quality, of the Arizona Revised Statutes and with the Arizona Administrative Code, Title 18 Environmental Quality, Chapter 2, Air Pollution Control and Chapter 3, Air Pollution Control Hearing Board, adopted by the Arizona Department of Environmental Quality pursuant to the authority granted by the Statutes.

The subcontractor shall comply with all local sound control and noise level rules, regulations and ordinances which apply to any work performed pursuant to the contract.

Each internal combustion engine used for any purpose on the work or related to the work shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated on the work without its muffler in good working condition.

107.07 Prevention of Landscape Defacement; Protection of Streams, Lakes and Reservoirs:

The subcontractor shall give special attention to the effect of the subcontractor's operations upon the landscape and shall take special care to maintain natural surroundings undamaged.

The subcontractor shall take sufficient precautions, considering various conditions, to prevent pollution of streams, lakes, and reservoirs with fuels, oil, bitumens, calcium chloride, fresh portland cement, fresh portland cement concrete, raw sewage, muddy water, chemicals or other harmful materials. None of these materials shall be discharged into any channels leading to such streams, lakes or reservoirs.

Where the subcontractor's working area encroaches on a running or an intermittent stream, barriers shall be constructed and maintained between the working areas and the stream or stream bed adequate to prevent the discharge of any contaminants into the stream or stream bed.

Frequent fording of running streams with construction equipment will not be permitted; therefore, temporary bridges or other structures shall be used whenever an appreciable number of crossings is necessary.

Unless approved in writing by the Engineer, mechanical equipment shall not be operated in running streams.

Streams, lakes and reservoirs shall be promptly cleared of falsework, piling, debris or other obstructions placed thereby or resulting from construction operations.

At the time of the preconstruction conference, the subcontractor shall submit, for the Engineer's approval, a program which includes all the measures which the subcontractor proposes to take for the construction of permanent erosion control work specified in the contract and all the temporary control measures to prevent erosion and pollution of streams, lakes and reservoirs.

Permanent erosion control work and pollution prevention measures shall be performed at the earliest practicable time consistent with good construction practices. Temporary work and measures are not meant to be performed in lieu of permanent work specified in the contract.

Construction of drainage facilities as well as the performance of other contract work which will contribute to the control of erosion and sedimentation shall be carried out in conjunction with earthwork operations or as soon thereafter as possible.

Except for that approved in writing by the Engineer, the subcontractor shall perform no clearing and grubbing or earthwork until the subcontractor's program has been approved.

If in the opinion of the Engineer, clearing and grubbing, excavation, or other construction operations are likely to create an erosion problem because of the exposure of erodible earth material, the Engineer may limit the surface area to be disturbed until satisfactory control measures have been accomplished. Unless otherwise permitted by the Engineer, the subcontractor shall not expose an area of erodible earth material greater than 750,000 square feet at any one location.

The Engineer may order the subcontractor to provide immediate measures to control erosion and prevent pollution. Such measures may involve the construction of temporary berms, dikes, dams, sediment basins and slope drains; the use of temporary mulches, mats and seeds and the use of other devices, methods, items, etc., as necessary.

At any time the subcontractor proposes to change his/her schedule of operations, the subcontractor shall review and update his/her erosion and pollution control program and submit it to the Engineer for approval.

The subcontractor shall not be entitled to additional compensation or an extension of contract time for any delays to the work because of the subcontractor's failure to submit an acceptable erosion and pollution control program.

Erosion control and pollution prevention work specified in the contract which is to be accomplished under any of the various contract items will be paid for as specified under those items.

The cost of any erosion control and pollution prevention work which may be proposed by the subcontractor in his/her program, in addition to that specified in the contract, will be considered as included in the prices bid for contract items.

107.09 Subcontractor's Responsibility for Work:

The subcontractor shall develop a stormwater management plan for submission to the Engineer outlining the procedures the subcontractor proposes to use in the control and disposal of storm water that falls on or flows into the work site. The plan shall preclude measures that could cause damage to surrounding

properties. The subcontractor shall submit the plan within 15 calendar days after the preconstruction conference.

Until final written acceptance of the project by the Engineer, the subcontractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work. The subcontractor shall rebuild, repair, restore and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work as specified in Exhibit B of these specifications.

In case of suspension of work from any cause whatever the subcontractor shall be responsible for the project and shall take such precautions as may be necessary to prevent damage to the project, provide for normal drainage and shall erect any necessary temporary structures, signs or other facilities at the subcontractor's expense. During such period of suspension of work, the subcontractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings and soddings, furnished under his/her contract and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

107.10 Environmental Analyses:

The subcontractor shall prepare an acceptable environmental analysis under the following conditions:

(A) If the subcontractor elects to produce material from a subcontractor-furnished source,

(B) If the subcontractor elects to utilize a site other than the site furnished by the Department to set up a plant for the crushing and processing of base and surfacing materials, or

(C) If the subcontractor requests that the Engineer approve access to a controlled access highway at points other than legally established access points.

The subcontractor shall promptly advise the Engineer that he/she is preparing the analysis and shall submit it upon completion. The subcontractor should anticipate needing a minimum of 30 days to coordinate with the necessary jurisdictions or agencies and to prepare the analysis. The analysis will be reviewed by the Engineer and the subcontractor will be advised whether or not the analysis is acceptable as soon as the necessary determinations have

been made. The subcontractor shall allow fourteen (14) days for the Engineer's review.

An Environmental analysis shall address itself to all environmental effects, including, but not necessarily limited to, the following:

(A) The location of the proposed source and haul road and the distance from the source to either an existing highway or an established alignment of a proposed Federal, State or County highway along with vicinity maps, sketches or aerial photographs.

(B) The ownership of the land.

(C) The identity and location of nearby lakes, streams, parks, wildlife refuges or other similar protected areas.

(D) The former use, if known, of the source and haul road and their existing condition.

(E) The identification of present and Planned future land use, zoning, etc., and an analysis of the compatibility of the removal of materials with such use.

(F) The anticipated volume of material to be removed; the width, length and depth of the excavation; the length and width of the haul road and other pertinent features and the final condition in which the excavated area and haul road will be left, such as sloped sides, topsoil replaced, the area seeded, etc.

(G) The archaeological survey of the proposed source prepared by a person with acknowledged credentials, which credentials shall be attached to the survey. The survey shall be prepared in a State Historic Preservation Office standardized format. The survey shall identify cultural resources within the potential impact area of the materials source processing area, and haul road. Additionally the survey report shall identify historic or archaeologic sites in the vicinity.

(H) If the proposed source and haul road will utilize Prime and Unique Farm land or farm land of statewide importance, a description of such remaining land in the vicinity and an evaluation whether such use will precipitate a land use change.

(I) A description of the visual surroundings and the impact of the removal of materials on the visual setting.

(J) The effect and mitigation of such effects on access, public facilities and adjacent properties.

(K) The relocation of business or residences.

(L) Procedures to minimize dust in pits and on haul roads and to mitigate the effects of such dust.

(M) A description of noise receptors and procedures to minimize impacts on these receptors.

(N) A description of the impact on the quality and quantity of water resulting from the materials operation shall be provided. The potential to introduce pollutants or turbidity to live streams and/or nearby water bodies shall be addressed. Measures to mitigate potential water quality impacts shall be coordinated through the Arizona Department of Environmental Quality.

(O) A description of the impact on endangered or threatened wildlife and plants and their habitat. The analysis of potential impact to plants and wildlife shall be coordinated through the Arizona Game and Fish Department and U.S. Fish and Wildlife Service. Compliance with the Arizona Native Plant Law shall be coordinated through the Arizona Commission of Agriculture and Horticulture.

(P) A discussion of the effects of hauling activities upon local traffic and mitigating measures planned where problems are expected.

(Q) A description of the permits required, such as zoning, health, mining, land use, flood plains (see Section 404 of the Clean Water Act), etc.

(R) The effect of removing material and/or stockpiling material on stream flow conditions and the potential for adverse impacts on existing or proposed improvements within the flood plain which could result from these activities.

Guidance in preparing the Environmental Analysis is available from ADOT's Environmental Planning Services, 205 South 17th Avenue, Room 240E, Phoenix, AZ 85007, phone (602) 255-7767.

SECTION 108 MOBILIZATION AT SITE

108-1 Description:

The work specified in this section consists of preparatory work and operations, including but not limited to, those necessary for the movement of personnel, equipment, transportation, supplies and incidentals to the Project Site; for the establishment of all offices, buildings and other facilities necessary for support of work on the project; and for all other work and operations which must be performed or costs incurred prior to beginning work on the various contract items on the Project Site.

Provide a layout of the construction site including fences, roads, buildings, parking and storage areas within seven (7) days after the date of the Notice to Proceed.

108-1.01 Items Not Included:

Items which are not to be included in the item of Mobilization are comprised of, but not limited to:

A. Any portion of the work covered by a specific bid item or incidental work which is to be included in a bid item or items.

B. Profit, interest on borrowed money, overhead and management costs.

108-1.02 Delivery:

Delivery to the Project Site of construction tools, equipment, materials and supplies shall be accomplished in conformance with local governing regulations.

108-1.03 Storage:

Refer to Section 202, Storage and Protection.

108-2 Materials (Products):

Provide construction tools, equipment, transportation, materials and supplies of the type and quantities which will facilitate the timely execution of the work and conform to the requirements of the State and Federal OSHA Codes and comply with all local rules and regulations.

108-3 Execution and Removal:

A. Provide personnel, products, construction materials, equipment, transportation, tools and supplies at the

Project Site at the time they are scheduled to be installed or utilized.

B. Locate facilities appropriately close to the portion of the work for which it will be used.

C. Upon completion of the work, remove construction tools, apparatus, equipment, unused materials and supplies, plant and personnel from the Project Site.

108-4 Measurement:

The work of this section will be measured as a unit, acceptably performed and will include accumulating tools, apparatus, equipment, materials and personnel, and manning the contract.

SECTION 109 STORAGE AND PROTECTION

109-1 Description:

The work specified in this section consists of providing storage and protection of the materials, products and supplies which are to be incorporated into the construction and indicating such storage areas on the working drawings with the locations and dates when such areas will be available for each purpose.

109-2 Materials:

Materials required for the storage and protection of the items specified shall be of type and quality to perform the functions specified by the material supplier and the technical sections in which specified. Storage areas, enclosures, covers, pallets and materials in public view on the job site shall be finished or painted to present an appearance acceptable to the construction manager.

109-3 Execution:

109-3.01 Storage:

A. Store items in a manner which will prevent damage to the property of the owner in the areas affected by the work.

B. No hydraulic fluids, gasoline, liquid petroleum, gases, explosives, diesel fuel, and other flammables may be stored at the job site, except a one (1) day supply of diesel fuel may be stored in open excavations.

109-4 Method of Measurement:

The work of this section will not be separately measured for payment.

109-5 Submittals:

A. Submit working drawings showing locations of storage areas not indicated on the contract drawings.

B. Submit descriptions of proposed methods and locations for storing and protecting products.

SECTION 110 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

110-1 Description:

The work under this Section consists of preparing and submitting Shop Drawings, Product Data, Samples and record documents required by other Specification sections.

110-2.01 Changes:

The subcontractor shall take all precautions that changes in products or materials or samples for which Shop Drawings, Product Data or Samples have been submitted will not be permitted unless those changes have been accepted and approved, in writing, by the Engineer.

110-2.02 Applicable Standards:

The subcontractor shall prepare Shop Drawings and record documents to a high standard of quality, such as that set forth in MIL-STD-100, ANSI Standard Drafting Manual, or other relevant lower tier specification defining equal drafting quality for microfilming.

110-3 Shop Drawings:

110-3.01 Drawing Size:

The subctonractor shall prepare Shop Drawings on a reproducible sepia sheet size of 22 inches by 34 inches to a scale large enough to easily depict and annotate each of the various items.

110-3.02 Inclusions:

The subcontractor shall include the following material along with the Shop Drawings as they apply to the subject:

A. Contract title and number.

B. Respective Contract drawing numbers.

C. Applicable specification Section numbers.

D. Relation to adjacent structure or materials.

E. Field dimensions, clearly identified as such.

F. Applicable standards, such as ASTM or Federal Specification number, AASHTO, AWWA, UBC and pertinent specifications or standards.

G. Identification of deviations from the contract drawings and specifications.

H. Contractor's stamp, initialed or signed, certifying:

1. Verification of field measurements.

2. Review of submittals for compliance with Contract requirements.

3. Compatibility of the work shown thereon with that of affected trades.

110-4 Product Material Data:

110-4.01 Modification of Standards:

The subcontractor shall modify ADOT construction standard drawings and MAG uniform standard details for public work construction, standard and/or schematic drawings to the project site conditions applicable to the contract. Supplement standard information with additional information applicable to this contract.

The subcontractor shall modify manufacturer's standards and/or schematic drawings, diagrams, schedules, performance charts, illustrations, calculations, and other descriptive data to delete information which is not applicable to the contract. Also indicate dimensions, clearances, performance characteristics, capacities and any other diagrams, as applicable.

110-4.02 Inclusions:

The subcontractor shall include the following:

A. Contract title and number

B. Respective contract drawing numbers.

C. Applicable contract specification Section numbers.

D. Applicable standards, such as ASTM or AASHTO.

E. Identification of deviations from the contract drawings and specifications. Provide reasoning and justification with all proposed deviations.

F. Subcontractor's stamp, initialed or signed, certifying:

1. Dimensional compatibility of the product with the space in which it is intended to be used.

2. Review of submittals for compliance with contract requirements.

3. Compatibility of the product with other products with which it is to perform or with which it is to be placed in juxtaposition.

110-4.03 Certificates of Compliance:

The subcontractor shall submit Certificates of Compliance for those products for which no samples and test results are specified. A copy of certificate shall also accompany the product for which the certificate is prepared. The certificates shall:

A. State that the product complies with the respective specification and contract drawing requirements.

B. Be accompanied by a certified copy of test results pertaining to the product.

C. Show the submittal date, subcontractor's name and address, contract title and number, product represented and its location in the contract, producer's name, product trade name and catalog number, place of product origin, test date, testing organization's name and address, quantity of the product to be furnished, and related contract drawing and specification Section numbers.

D. Be signed by an officer or another authorized representative of the producer, and notarized.

E. Be submitted in six copies, and

F. Be received by the Document Control Manager not later than 30 days before the products are to be installed.

110-4.04 Samples:

The subcontractor shall use office samples of sizes and quantities to clearly illustrate full color range and functional characteristics of products and materials, including attachment devices, incorporating the following information:

A. Contract title and number.

B. Respective contract drawing numbers.

C. Applicable specifications Section numbers.

D. Applicable standards, such as ASTM, ADOT or Federal Specification number.

E. Identification of deviations from the contract drawings and specifications.

F. Contractor's stamp, initialed or signed, certifying:

1. Dimensional compatibility of the product with the space in which it is intended to be used.

2. Review of submittals for compliance with contract requirements.

3. Compatibility of the product with other products with which it is to perform or which will be next to it.

110-4.05

The subcontractor shall furnish required samples at no additional cost to the Owner.

110-5 Submittals:

A. The subcontractor shall be required to submit the following:

1. One reproducible sepia and five prints of each shop drawing.

2. Six copies of manufacturer's standard schematic drawings.

3. Four copies of manufacturer's calculations, and six copies of manufacturer's standard data.

4. Six copies of manufacturer's printed installation, erection, application, and placing instructions.

5. Three samples of each item specified in the various specification sections, unless otherwise specified.

6. Six copies of inspection, test reports, and certificates of compliance.

7. Erasable sepia shall indicate a Engineer control number for each drawing, which the subcontractor shall obtain from the Engineer upon request.

This control number shall be placed on the appropriate sepia by the subcontractor.

All prints submitted shall contain this Engineer control number.

110-6 Subcontractor Responsibilities:

The subcontractor shall verify field measurements, catalog numbers, and similar data. Make sure that catalog data clearly identifies item(s) selected.

The subcontractor shall not start work for which submittals are required until submittals bearing the stamp of the Engineer and signature indicating review and acceptance have been received.

The subcontractor shall make sure before making submittals that products will be available in the quantities and in the time required by the contract.

The subcontractor shall submit a final, corrected, reproducible sepia of as-built contract drawing showing the work as actually installed, placed, erected, and applied.

110-7 Review by the Engineer:

Reproducible shop drawings, one copy of marked-up shop drawings, one copy of product data, and one sample will be returned to subcontractor by the Document Control Manager within ten (10) working days after submittals have been received.

Subcontractor's responsibility for unauthorized changes, compatibility, errors, and omissions in submittals will not be reduced, waived or otherwise limited by the review and acceptance of submittals by the Engineer.

110-8 Measurement:

The work of this Section will not be measured separately for payment.

SECTION 201 CLEARING AND GRUBBING

201-1 Description:

The work under this section shall consist of removing and disposing of all vegetation, rubbish, debris and other objectionable matter from within the project site limits as shown on drawings, including but not limited to, box culvert construction areas, road approaches, areas through which ditches and channels are to be excavated. Clearing and grubbing shall be performed in advance of grading operations and in accordance with the requirements of these specifications.

All vegetation, including trees and objects designated to remain, or be transplanted shall be preserved from injury or defacement. Existing property, utilities and facilities shall be protected. There shall not be any construction or private activity outside of twenty-five (25) feet from any and all construction limits. The outside of the twenty-five (25) foot limit shall remain undisturbed.

201-2 Blank:

201-3 Construction Requirements:

(A) Clearing and Grubbing:

The entire length of the project, including the borrow pits, to the widths specified below, shall be cleared and grubbed, unless otherwise shown on the project plans or specified herein.

The area above the natural ground surface shall be cleared of all vegetation, such as trees, logs, upturned stumps, roots, brush, grass, weeds, and all other objectionable material within the following limits:

> Construction areas in the Proving Grounds, including structures, frontage roads, road approaches, ditches and channels that are to be constructed.

Stumps, matted roots and roots larger than two (2) inches in diameter shall be removed from within eighteen (18) inches of the existing ground surface in areas which are either to be cut or filled, including that portion of the designate stockpile area on which material is to be placed. The area to be treated shall extend the full width of the embankment prism in the case of fills and the full width of cut sections.

Within the limits of clearing, the areas below the natural ground surface, except in embankment areas where the finished subgrade elevation is five (5) feet or more above the natural ground, shall

be grubbed to a depth necessary to remove all stumps, roots, buried logs and other objectionable material.

In embankment areas, where the subgrade is five (5) or more feet above the natural ground line, all trees, stumps and roots less than or equal to two (2) inches shall be cut off not more than one (1) foot above the natural ground or shall be completely removed where a structure is to be constructed, or where unsuitable material is to be removed.

Cavities resulting from the removal of stumps or other materials, except in areas to be excavated, shall be backfilled with material approved by the Engineer. The material shall be compacted to a density of not less than ninety-five (95) percent of maximum dry density at a moisture content within one (1) percent below and to four (4) percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

Scarred surfaces, resulting from the work, on trees and shrubs that are to remain, shall be treated with an approved asphaltum base tree paint.

201-3.02 Removal and Disposal of Materials:

In the disposal of all tree trunks, stumps, brush, limbs, roots, vegetation and other debris, the Subcontractor shall comply with the requirements of Title thirty-six (36) - Public Health and Safety, Chapter six (6), Article eight (8), Air Pollution, of the Arizona Revised Statutes and with the Rules and Regulations for Air Pollution Control, Article seven (7), adopted by the Arizona Department of Health Services pursuant to the authority granted by the Statutes.

Burning will be permitted only after the Subcontractor has obtained a permit from the Arizona Department of Health Services and from any other Federal, State, County or City Agency that may be involved.

Combustible material may be reduced to chips of a maximum thickness of one-half (1/2) inch and disposed of in areas between the slope lines and right-of-way lines as approved by the Engineer. The chips may either be buried or distributed uniformly on the ground surface and mixed with the underlying earth to such extent that the chips will not support combustion.

The roadway and adjacent areas shall be left with a neat and finished appearance. No accumulation of material shall remain on or adjacent to the right-of-way.

201-4 Method of Measurement:

Clearing and grubbing will be measured by the acre. Measurement will be to the nearest tenth of an acre measured on a horizontal plane.

SECTION 202 TREES & CACTI RESTORATION

202-1 Description:

The work under this section shall consist of salvaging of selected trees and cacti protected by state and federal law, including trees and cacti to remain in place or to be transplanted on Project site, and disposing of unsalvageable plant materials.

202-1.01 Regulatory Requirements:

The Subcontractor shall submit Native Plant Application to Arizona Commission of Agriculture and Horticulture when approved by Owner.

The Subcontractor shall purchase permits and tags for protected plant material to be removed from Owner's property from Arizona Commission of Agriculture and Horticulture and transplant and handle protected plant material in accordance with regulations of Arizona Commission of Agriculture and Horticulture.

The Subcontractor shall dispose of debris and surplus soil in accordance with governing regulatory agencies and obtain permits for transportation of debris to disposal site.

The Subcontractor shall not close or obstruct roadways without permits and shall conduct all construction operations with minimum interference to facilities and roadways under construction.

202-1.02 Warranty:

The Subcontractor shall warrant to replace selected trees and cacti which die with healthy trees and cacti of same species and size for one (1) year following date of Substantial Completion.

202-2 Materials:

202-2.01 Commercial Fertilizers:

The Subcontractor shall provide the following commercial fertilizers with organic amendments and tree guying materials:

Iron-Sulfate Mix
(a) Manufacturer: Duvall.
(b) Iron-Sul, ground ferrous sulfate with maximum twenty (20) percent iron and minimum thirty (30) percent sulphur.

Root Stimulator: Vitamin B-1.

Planting Tabs: Agriform.

Organic Amendments

Mulch: Approved nitrogenized sawdust or forest humus.

202-2.02 Tree Guying Materials:

The Subcontractor shall provide the following tree guying materials.

Hose Covering: Minimum one-half (1/2) inch, two (2) ply, reinforced rubber garden hose.

Tree Guys: Minimum ten (10) gauge, pliable, zinc-coated, iron wire.

Anchors For Holding Guys: Minimum thirty-six (36) inch long two by four (2x4) redwood.

Flags for Guys: Minimum one-half (1/2) inch diameter by sixty (60) inches long white or orange plastic tubing.

202-3 Construction Requirements:

202-3.01 Preparation and Inspection:

The Subcontractor shall be responsible for clearing access to trees, marking trees which are proposed for salvage, verifying individual marks on selected trees and cacti, and having utility companies locate any buried utilities before digging.

202-3.02 Pruning:

The Subcontractor shall prune each tree to preserve its natural character in accordance with American Standard for Nursery Stock by American Association of Nurserymen or as follows:

(A) Remove suckers, deadwood, and broken or badly bruised branches.

(B) Paint cuts over three-quarter (3/4) inch in diameter and exposed cambium of bruised areas with tree paint.

(C) Do not prune cacti unless directed otherwise.

202-3.03 Removing Trees:

The Subcontractor shall transplant trees, including removal, boxing or bagging, digging, pruning, transporting, holding, and tieing foliage before digging, in accordance with American Association of Nurseryman standards.

The Subcontractor shall box trees as follows:

(A) Dig side trenches after tying foliage.
(B) Install custom wood sides and let trees sit for a minimum of two (2) weeks with abundant watering.

(C) Tip trees, cut bottom roots and install bottom.

(D) Set tree upright in hole for a minimum of 1 week.

(E) Strap tree box securely and carefully move tree to holding areas.

The Subcontractor shall use a boom crane to handle trees.

202-3.04 Removing Cacti:

The Subcontractor shall take proper precautions in removing cacti as follows:

(A) Mark north side of cacti with chalk and flagging to identify original orientation.

(B) Cut shallow roots by forcing a sharp shovel blade to it's depth into soil completely around plant one (1) foot away from base.

(C) Dig under and carefully pry and lift plant out of ground.

(D) Allow loose soil to fall away from roots.

(E) Minimize injury to plant.

(F) Prune damaged roots.

(G) Prune back remaining lateral roots to five (5) to ten (10) inches long.

(H) Dust cut roots and other wounds immediately with powdered sulfur.

(I) Place cacti in shaded open area for 2 weeks to allow roots to heal.

(J) Use truck-mounted cradle to handle Saguaros.

The cacti shall be replanted in the "cactus garden" as shown in the attached figure.

202-3.05 Holding:

The Subcontractor shall take proper precautions in holding cacti as follows:

(A) Place trees and cacti in designated holding areas.

(B) Maintain trees in accordance with American Association of Nurseryman standards.

202-3.06 Planting Boxed/Bagged Trees:

The Subcontractor shall plant trees in accordance with American Association of Nurseryman standards.

(A) Excavate pits to twice the size of the rootball of the tree to be planted as shown on the drawing.

(B) Remove trees from containers without disturbing rootball. Set trees in pit, cradling and supporting rootball.

(C) Position trees in same orientation as formerly orientated.

(D) Set trees in pit so that when the backfill has been water-settled the top of the rootball will be a minimum of two (2) inches below finish grade.

(E) Backfill pit with blended mixture of one part mulch, three parts native soil, one-half (1/2) part gypsum, and one-fourth (1/4) cup iron-sulfate mix per cubic yard.

202-3.07 Iron-Sulfate Mix:

The Subcontractor shall get approval of the Subcontractor seventy (72) hours in advance of applying iron-sulfate mix. Iron-sulfate mix may then be applied before backfilling and setting of plants. The Subcontractor shall take precautions not to allow concentrations of iron-sulfate mix to come in contact with rootball.

(A) One (1) handful in each pit for fifteen (15) gallon boxes.

(B) Two (2) handsful in each pit for twenty-four (24) inch boxes.

(C) Four (4) handsful in each pit for thirty-six (36) inch boxes.

(D) Seven (7) handsful in each pit for forty-two (42) inch boxes.

(E) Ten (10) handsful in each pit for fifty (50) inch boxes.

(F) Fifteen (15) handsful in each pit for fifty-four (54) inch boxes.

(G) Twenty-eight (28) handsful in each pit for sixty-six (66) inch boxes.

(H) Forty (40) handsful in each pit for seventy-six (76) inch boxes.

(I) Fifty (50) handsful in each pit for eighty-two (82) inch boxes.

(J) Seventy (70) handsful in each pit for ninety (90) inch boxes.

The Subcontractor shall place one (1) planting tab per one-half (1/2) inch tree trunk diameter approximately six (6) inches below finish grade and apply Root Stimulator at rate of one (1) tablespoon per gallon.

202-3.08 Guying:

The Subcontractor shall provide guys to trees immediately after planting, providing a minimum of three (3) guys per tree to give equal support to a tree. Guys from trees shall be isolated with hose covering and warning flags installed to each. Guy wires shall be anchored with anchors buried at least two (2) feet below finished grade, tightening guy lines to firm tension.

202-3.09 Mulching:

Mulch trees with at least two (2) inches of mulch immediately after planting.

202-3.10 Planting Cacti:

The Subcontractor shall plant cacti in dry soil and in original orientation, but shall plant saguaros two (2) inches deeper than original depth.

The Subcontractor shall backfill the pit with blended mixture of one (1) part mulch and four (4) parts native soil and apply root stimulator at a rate of one (1) tablespoon per gallon.

The Subcontractor shall irrigate ocotillos well after planting, then allow soil to dry to natural state, but do not irrigate saguaros until new growth appears at apex.

202-4 Disposition of Unselected Salvageable Trees and Cacti:

The Subcontractor shall assume possession of unselected salvageable trees and cacti and remove unselected salvageable trees and cacti from Project site in accordance with requirements of Arizona Commission of Agriculture and Horticulture.

202-4.01 Removal of Unsalvageable Trees and Debris:

The Subcontractor shall assume possession of unsalvageable trees which are cut down for access to salvageable trees and resultant debris.

The Subcontractor shall obtain approval from the Subcontractor before cutting down unsalvageable trees forty-eight (48) inches above ground.

The Subcontractor shall take all precautions to remove and dispose of contaminated, vermin-infested or dangerous materials immediately upon discovery by safe means so as not to endanger the health of workers and the public and shall transport debris to an approved disposal site.

202-4.02 Protection:

The Subcontractor shall protect bench marks and existing work from damage or displacement, maintain designated site access for vehicle and pedestrian traffic and conduct operations with minimum interference to private roadways.

202-5 Submittals:

The Subcontractor shall submit six (6) copies of properly completed and originally signed Arizona Commission of Agriculture and Horticulture Native Plant Application, Statement of Facts Pertaining to the Removal of Arizona Protected Native Plants from Private Lands. The Subcontractor shall not start the work until after the drawings are approved. Two (2) Engineer-approved copies will be returned. Approval will be for form only, not for itemization of plant material.

The Subcontractor shall prepare the drawings after surveying the project trees and cacti. Seven (7) days before starting the work the Subcontractor shall submit six (6) copies of drawings with tabulation of selected trees and cacti, listing:

1. Individual identifying mark,

2. Classification (to remain in place or for transplanting on Project site),

3. Species,

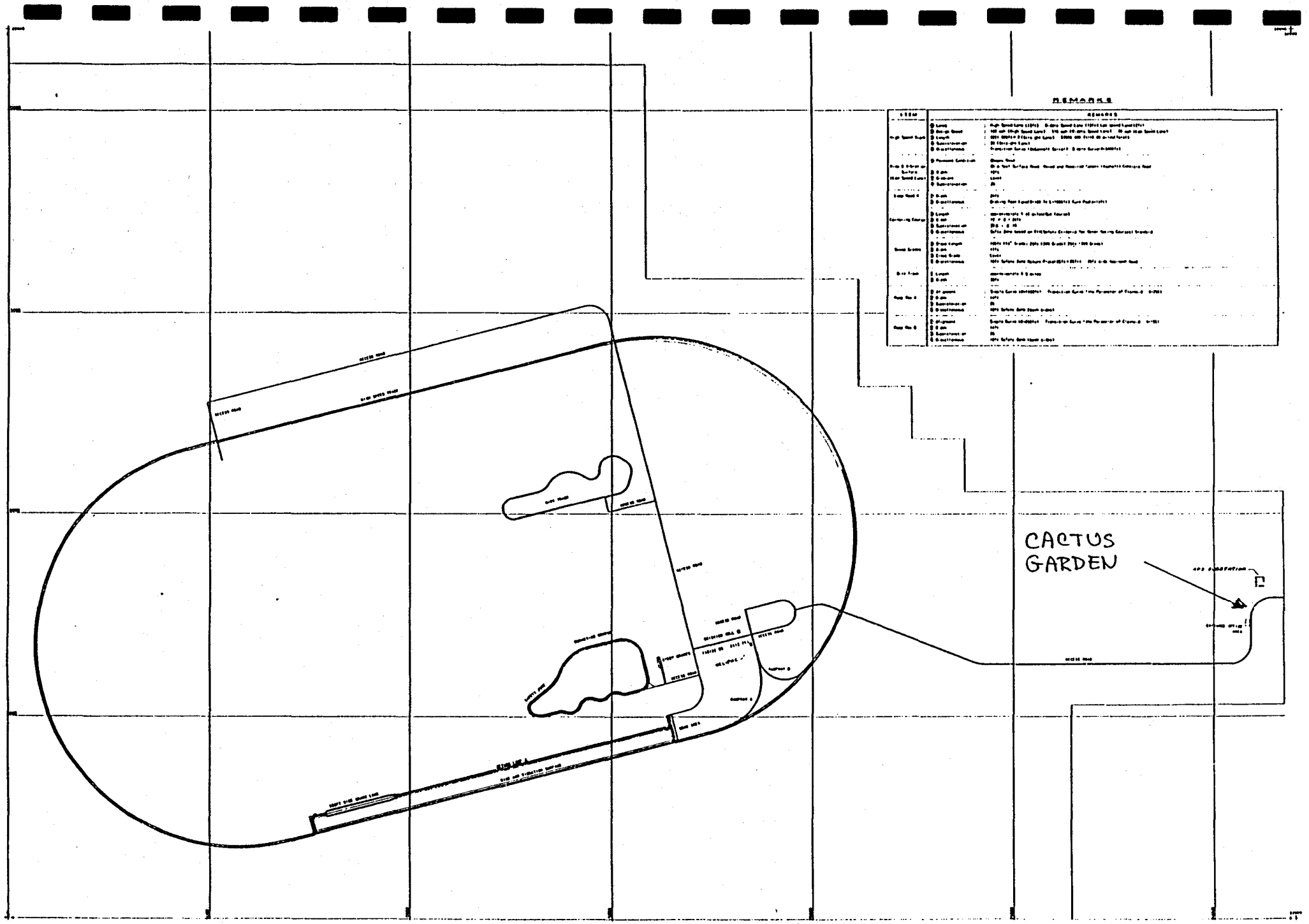
4. Size (height and caliper),

5. Status (no action, in place, in holding area or transplanted) and

6. State of health.

202-6 Method of Measurement:

Trees and Cacti Restoration will be measured by the unit each. The Subcontractor shall make allowance for relocation of five (5) cacti. At this time removal and relocation of trees are not planned.


REMARKS
CACTUS
GARDEN

SECTION 203 EARTHWORK:

203-1 Description:

The work under this section shall consist of performing all operations necessary to excavate all materials, regardless of character and subsurface conditions, for roadways, buildings and facilities; to excavate drainage and irrigation ditches and channels; to excavate trenches for pipe, culverts and other facilities; to excavate all materials necessary for the construction of reinforced concrete box culverts and reinforced concrete underpasses; to excavate borrow material for use as specified; to construct embankments; to place backfill for structures, pipe, culverts and reinforced concrete box culverts and reinforced concrete underpasses and other facilities; to backfill holes, pits and other depressions within the project access road and other facilities; to remove and replace unsuitable material; to excavate and grade road approaches, driveways and connections; to construct dikes and berms; and to apply water for compaction, all as designated on the project plans, directed by the Engineer and specified herein.

203-2 General:

All construction operations shall be conducted such that existing utilities and other facilities which are to remain in place will not be damaged. Temporary pavements, facilities, utilities and installations shall also be protected until they are no longer required. When temporary supports and other protective means are no long required, they shall be removed and disposed of by the subcontractor.

When hauling is done over highways, the loads shall comply with legal load requirements, all material shall be removed from shelf areas of vehicles in order to eliminate spilling of material and loads shall be watered or covered to eliminate dust.

All suitable material removed from excavated areas shall be used instead of borrow in the construction of embankments and other designated areas if approved by the Engineer.

203-2.01 Subcontractor Quality Control:

(A) General Requirements:

It shall be the responsibility of the subcontractor to administer a Quality Control Plan, hereinafter referred to as the "Plan", sufficient to assure that all earthwork operations are performed in accordance with the requirements of these specifications. The Plan shall meet the requirements of Section 106 of these specifications and the requirements specified below. The Plan may be operated

wholly or in part by a subcontractor or an independent organization; however, the Plan's administration, including compliance with the Plan and its modification, shall remain the responsibility of the subcontractor.

(B) Elements of the Plan:

The Plan shall address all elements which affect the quality of the earthwork including, but not limited to the following:

(1) Removal and Replacement of Unsuitable Subgrade Materials

(2) Construction of Embankments

(3) Placement of Backfill Materials, including pipe bedding and backfill as specified in Section 501 of these specifications.

(4) Compaction

(C) Other Requirements:

The Plan shall include the use of Operations Technicians, including the following:

(1) Quality Control Technician (QCT)

This person will be expected to assure that the materials aspects of the Earthwork Items meet the requirements of the specifications. The Plan shall detail the frequency of each type of test, which shall include field density tests for compaction monitoring and gradation, moisture and PI tests to determine material suitability according to the Subgrade Acceptance chart or other materials requirements. The Plan shall detail the type of equipment to be utilized, test methods and means of documentation.

If more than one individual is required to accomplish these requirements, the Plan shall so note. Included also shall be the criteria utilized by the QCT to correct or reject unsatisfactory materials.

The Engineer reserves the right to check the records of the QCT at any time. The Engineer may take field density tests or obtain samples for classification testing at any time to confirm the effectiveness of the activities of the QCT.

203-3 Roadway Excavation:

203-3.01 Description:

Roadway excavation shall consist of excavating and grading all types of materials encountered in constructing the roadway, culverts, conduits, parking areas, driveway entrances, cut ditches and channels adjacent to the roadway and other road-related areas as designated on the project plans or specified herein, and the placement of the excavated material, wherever practicable, in embankments as provided under Subsection 203-10 of these specifications.

203-3.02 Blank:

203-3.03 Construction Requirements:

(A) General:

All roadway excavation shall be finished to a reasonably smooth and uniform surface and shall not vary by more than 0.04 foot (13mm) above or below the grade established and shall be in reasonably close conformance to the lines, dimensions and cross sections shown on the project plans or established by the Engineer. When Portland Cement Concrete Pavement or Asphaltic Concrete Pavement are to be placed directly on the Subgrade, the finished surface shall not vary by more than 0.04 foot (13mm) below or 0.02 foot (6mm) above the established grade. When roadway excavation is made in rock, the full cross section width of the roadway between the ditches shall be overexcavated a minimum depth of six inches below the subgrade elevation. The overexcavated area shall be filled with embankment material satisfactory to the Engineer and compacted and finished in accordance with the requirements of the Specifications. In situations where only part of the roadway section intersects areas of rock, that portion occurring in the rock zone shall be overexcavated and backfilled as noted above and brought up to match the adjoining subgrade.

No measurement or direct payment will be made for the work in overexcavating the rock areas, or placing the embankment material, the cost being considered as included in the cost of contract items.

All suitable excavated material shall be used as far as practicable in the construction of embankments and in other designated areas.

No excavated material shall be wasted without the approval of the Engineer. Wasted material shall be disposed of by the subcontractor in a manner approved by the Engineer.

During construction, the roadway shall be maintained in a well-drained condition at all times.

The top 6" of the cut areas after being cut to subgrade shall be scarified and recompacted to a density of not less than 95 percent of maximum dry density at a moisture content within 1 percent below and to 4 percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

(B) Slopes:

Earth slopes shall be finished to reasonably smooth surfaces and shall be free of all debris and loose material.

All shattered or loosened material shall be removed from rock cut slopes.

Adjustments in slopes shall be made, as directed by the Engineer, to avoid damage to standing trees, marring weathered rock or to harmonize with existing landscape features. The transition of such adjusted slopes shall be gradual. At the intersections of cuts and fills, slopes shall be adjusted and warped to flow into each other or into the natural ground surfaces without noticeable break.

Except in solid rock, the intersection of roadway cut slopes with the ground surfaces shall be rounded as shown on the project plans. Rock that is disintegrated to such an extent that it will work and handle as earth shall be considered as earth and the slopes shall be rounded the same as earth slopes. A layer of earth overlaying a rock cut shall be rounded above the rock in the same manner as earth slopes.

(C) Unsuitable Material:

Material below the natural ground surface in embankment areas and below the finished subgrade elevation in excavation areas that is unsuitable shall be excavated and disposed of as directed by the Engineer.

When unsuitable material is removed and disposed of, the resulting space shall be filled with material suitable for the planned use. Such suitable material shall be placed and compacted in accordance with the requirements of Subsection 203-10 of these specifications.

(D) Surplus Material:

Unless otherwise indicated on the project plans or specified herein, surplus excavated material shall be removed from the job site and disposed of by the subcontractor in a manner approved by the Engineer and in accordance with the requirements of Subsection 107.12 of these specifications.

Shortages of material caused by the disposal of any material by the subcontractor before plans embankment quantities are satisfied shall be replaced by the subcontractor without compensation.

203-3.04 Method of Measurement:

Roadway excavation will be measured by the cubic yard in the original space occupied and the volume of material removed will be computed in cubic yards by the average end area method.

203-4 Drainage Excavation:

203-4.01 Description:

Drainage excavation shall consist of the excavation of ditches, channels or waterways, except that excavation which is required to construct ditches paralleling the roadway and constituting a part of the roadway prism shall be considered as roadway excavation.

203-4.02 Blank

203-4.03 Construction Requirements:

Ditches, channels and waterways shall be constructed in reasonably close conformity to the lines, grades and slopes as staked.

When necessary, in order to provide outfall, the gradient of ditches, channels and waterways may be continued outside of the limits of the right-of-way with proper authorization from the property owner. Absolute smoothness in lines and slopes will not be required, but the finish shall be consistent with the character of the material encountered. All waterways shall be constructed to drain effectively.

Suitable materials from ditch, channel or waterway excavation shall be used in the construction of embankment or for other purposes as shown on the project plans or specified herein. Unsuitable and surplus excavation material shall be disposed of as directed by the Engineer.

203-4.04 Method of Measurement:

Drainage excavation will be measured by the cubic yard in the original space occupied and the volume of material removed will be computed in cubic yards by the average end area method.

203-5 Structural Excavation and Structure Backfill:

203-5.01 Description:

Structural excavation shall consist of the excavation and removal of all materials necessary for the construction of concrete box culverts, inlet and outlet wings or other specific items designated on the project plans as structural excavation; the control and removal of water, the construction or installation of all facilities necessary to accomplish the work, and the subsequent removal of such facilities, except when designated on the project plans or specified herein to remain in place.

Structure backfill shall consist of furnishing, placing and compacting backfill material around structures to the lines designated on the plans, directed by the Engineer and as specified herein.

203-5.03 Construction Requirements:

(A) Excavation:

The subcontractor shall notify the Engineer sufficiently in advance of the beginning of excavation to allow measurements to be taken of the undisturbed ground. The required excavation shall then be performed in reasonably close conformity to the lines, grades and cross sections established by the Engineer or shown on the project plans.

The sides of excavations may be sloped as required by soil conditions to stabilize the sides for safe working conditions. Such excavation shall be limited to the amount considered necessary for safety.

When structure footings, concrete box culverts or other structures are to rest on an excavated surface other than rock and no piles are used, care shall be taken to protect the surface from water and not disturb the bottom of the excavation. If suitable material in the bottom of the excavation is disturbed or is removed for the subcontractor's convenience, the foundation shall be restored by the subcontractor, at his expense, to a condition at least equal to the undisturbed foundation as determined by the Engineer.

When undisturbed original material at the planned grade of the excavation is determined by the Engineer to be unsuitable material, such material shall be removed to the limits directed by the Engineer and the resulting excavation backfilled with structure backfill material.

When, during the course of structural excavation, material is removed outside the designated pay limits, the subcontractor shall backfill said excavated areas in accordance with the requirements for structure backfill as specified herein, and no compensation will be made for the additional material or work required.

Excavated material which is not suitable for, or not used as, structure backfill shall be utilized either for the construction of embankment or disposed of, in accordance with the applicable requirements of Subsections 203-10 or 203-3 of these specifications respectively.

Suitable materials from structure excavation shall be used in the construction of the embankment or other purposes shown on the project plans or specified herein, unless otherwise designated for disposal.

Prior to placing concrete or masonry the area excavated shall be inspected and approved by the Engineer.

(B) Backfill:

(1) Structural Backfill:

Structural backfill material shall be selected from excavation borrow pits or from a source selected by the subcontractor. It shall not contain frozen lumps, stones larger than three inches in diameter, chunks of clay or other objectionable material. Backfill material to be used for metal pipes or similar items of metal shall have a value of resistivity not less than 2000 ohm-cm or the value shown on the project plans, whichever is less. When resistivity is not shown on the project plans, the backfill material shall have a value of resistivity not less than that of the existing in-place material or 2000 ohm-cm, whichever is less. Backfill material shall have a pH value between 6.0 and 9.0 inclusive, for all installations. Tests for pH and resistivity shall be in accordance with the requirements of Arizona Test Method 236.

Structural backfill material shall have no more than 65 percent passing the No. 200 sieve as determined by Arizona Test Method 201. However, soils with a CH classification, as determined by the Unified Soil Classification System (ASTM D 2487 or ASTM D 2488), shall not be utilized as structural fill, regardless of the percentage passing the No. 200 sieve.

The plasticity index shall not exceed 18 when tested in accordance with the requirements of AASHTO T 90.

(3) Placement of Backfill:

All earth material which has loosened or collapsed into the excavation from the adjacent ground and all trash, forms and loose, large rock shall be removed from the excavation before backfill is placed.

Backfill material shall not be placed against the back of concrete abutments, concrete retaining walls, or cast-in-place concrete structures until the concrete has developed its full design strength.

Backfill material shall not be placed against concrete structures not designed to retain earth loads until the concrete has attained a minimum compressive strength of 2000 psi and in no case less than 72 hours.

Unless otherwise shown on the project plans or designated herein, minor structures such as catch basins which are furnished as precast structures shall be placed on a layer of structure backfill at least six inches in depth. The layer shall have been shaped to fit the bottom surface of the precast unit and compacted to a density of not less than 90 percent of maximum dry density at a moisture content within 1 percent below and to 4 percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

After the unit has been initially set in place and checked for line and grade, it shall be removed and any defects in its bearing area shall be corrected by trimming and by placing and compacting similarly moistened structure backfill. The process of removal, correction and replacement shall continue until the imprint of the unit on the bearing area indicates essentially uniform contact and the unit is in reasonable conformity with the lines and grades shown on the project plans.

Where a structure is located within a paved area, all backfill material above finished subgrade elevation shall conform to the requirements of the typical pavement section of the same elevations.

Backfill compacted by pneumatic or mechanical tamping devices shall be placed in layers not more than eight inches in depth before compaction.

(4) Compaction of Backfill:

Backfill material shall be compacted to a density of not less than 95 percent of maximum dry density at a moisture content within 1 percent below and to 4 percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

Backfill material may be compacted by either mechanical or pneumatic tamping devices. Compaction equipment or methods which may cause excessive displacement shall not be used.

203-5.04 Method of Measurement:

(A) Structural Excavation:

Structural excavation will be measured by the cubic yard based on the volume calculated from the pay limits shown on the project plans.

No measurement will be made of excavation required because of slides, cave-ins, siltings or filling due to the lack of support of sides, the action of the elements or the carelessness of the subcontractor.

(B) Structure Backfill:

Structure backfill will be measured by the cubic yard of material based on the volume calculated from the pay limits shown on the plans.

203-6 Graded Ditches:

203-6.01 Description:

Graded ditches shall consist of triangular-shaped and flat bottomed ditches as detailed on the project plans, excavated and finished to the details as shown on the project plans.

203-6.02 Blank

203-6.03 Construction Requirements:

In general, graded ditches shall be constructed to the lines and at the locations designated on the project plans; however, the Engineer will consider the topography and will determine where the

ditches are to be constructed and for what length the subcontractor will stake the ditches.

203-6.04 Method of Measurement:

Graded ditches will be measured by the linear foot along the center line of the ditches, parallel to the ground surface.

203-7 Dikes

203-7.01 Description:

Dikes shall consist of placing material to the lines and grades required to intercept the flow of the surface water and to direct it down continuing slopes to an appropriate discharge point.

203-7.02 Construction Requirements:

Dikes shall be constructed at the locations designated on the project plans or as directed by the Engineer, in accordance with the details shown on the project plans, using material from roadway excavation, drainage excavation, structural excavation or borrow.

The material shall be placed in layers not exceeding eight inches in depth before compaction and compacted to a density of not less than 95 percent of maximum dry density at a moisture content within 1 percent below and to 2 percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

203-7.03 Method of Measurement:

Dikes will not be measured for payment but will be included in the cost of contract items.

203-8 Blank.

203-9 Borrow:

203-9.01 Description:

The work under this section shall consist of furnishing and placing suitable and satisfactory material obtained from sites within the project boundaries as indicated on the project plans for use in embankments, shoulders, berms, dikes and other similar purposes. The widening of roadway cuts and ditches and similar work within the project boundaries shall be considered as roadway excavation, not borrow.

203-9.02 Materials:

Borrow shall be secured from material sources in accordance with the requirements of Section 1001 of these specifications. The material shall be of a quality suitable for the purpose intended, free of vegetation or other unsatisfactory material . Borrow placed within three feet of finished subgrade elevation shall have a soil support value equal to or greater than the design soil support value for the pavement structure of the area in which the borrow will be placed.

Soils with an R-value of less than 26, and CBR value less than 8 or 12 (depending on the design basis), or with more than 65% passing the #200 sieve will not be acceptable for embankment or pavement subgrade. Soils with a CH (Inorganic clays of high plasticity, fat clays) (per MIL-STD-619B) shall not be used regardless of the percentage passing the No. 200 sieve.

Surplus excavated materials shall be disposed of at the stockpile location noted on the Project Plans as approved by the Engineer. The area on which material is to be placed shall be cleared and grubbed. Stockpiled material shall not exceed 8 feet in height measured from natural ground with side slopes not exceeding 3:1. The top of the stockpile shall be graded to drain with no internal depressions.

203-9.03 Construction Requirements:

Borrow material shall be placed in accordance with the requirements of Subsection 203-10 of these specifications.

203-9.04 Method of Measurement:

Borrow will be measured by the cubic yard in the original space occupied and volume of material removed will be computed in cubic yards by the average end area method.

No measurement will be made for borrow material placed prior to completion of roadway excavation, drainage excavation or structural excavation, when such placement results in unauthorized wasting of roadway, drainage or structural excavation materials.

203-10 Embankment Requirements:

203-10.01 Description:

Embankment requirements shall apply to the construction of roadway embankments, including the widening of embankment sections with surplus material and the preparation of the areas upon which embankment material is to be placed; the construction of dikes and berms; the placing and compacting of material where unsuitable

material has been removed; and the placing and compacting of embankment material in holes, pits and other depressions within the roadway area, in accordance with the requirements of these specifications.

203-10.03 Embankment Construction Requirements:

(A) Placement:

All embankments shall be constructed to a reasonably smooth and uniform surface and shall not vary by more than 0.04 foot (13mm) above or below the grade established and in reasonably close conformity to the lines, dimensions and cross sections shown on the project plans or established by the Engineer. When Portland Cement Concrete Pavement or Asphaltic Concrete are to be placed directly on the subgrade, the finished surface shall not vary by more than 0.04 foot (13mm) below or 0.02 foot (6mm) above the established grade.

Embankment construction shall not be started until clearing and grubbing for the embankment area is completed in accordance with the requirements of Section 201 of these specifications. When embankment material is to be placed over existing bituminous surfacing, the surfacing shall be scarified prior to placing embankment material, unless otherwise directed by the Engineer.

In constructing embankments on hillsides or against existing embankments, or when constructing embankments one-half width at a time, the slopes of the original hillside, except where solid rock is encountered, the existing embankments, or the half-width of new embankments shall be cut into a minimum of six feet horizontally, as the work is brought up in layers, in order to minimize the possibility of slippage between the existing materials and the new embankment material. The material thus cut out shall be recompacted along with the new embankment material.

Embankment of earth material shall be placed in uniform horizontal layers not exceeding eight inches in depth before compaction and shall be compacted in accordance with the requirements of these specifications before the next layer is placed.

Embankment material shall have no more than 65 percent passing the No. 200 sieve as determined by Arizona Test Method 201. However soils with a CH classification as determined by the Unified Soils Classification (ASTM D 2487 or ASTM D 2488) shall not be utilized as structural fill regardless of the percentage passing the No. 200 sieve.

When the embankment material, resulting from the required excavations, consists predominately of rock fragments of such size that the material cannot be placed in an eight-inch layer without

crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment in layers not exceeding in thickness the approximate average size of the larger rocks being excavated, but not larger than 2 feet. It may be necessary to reduce the size of the excavated material by crushing or otherwise breaking down the material in order to comply with this requirement.

The placing of individual rocks and boulders greater than 24 inches in diameter will be permitted provided they do not exceed 36 inches in maximum dimension, are carefully distributed to prevent nesting and the interstices are filled with finer material and compacted to form a dense and compact mass. Each layer shall be leveled and smoothed by evenly distributing spalls and finer fragments of rock and earthen material with suitable leveling equipment.

Embankment material containing broken concrete, rock or other solid materials which are larger than three inches in greatest dimension shall be placed so that no surface of said material is less than two feet below the finished subgrade elevation or within three feet horizontally of any piling, structures pole or sign foundations and underground conduit. It may be necessary to reduce the size of the excavated material by crushing or otherwise breaking down the material in order to comply with this requirement.

Concrete with any dimension greater than two feet shall be removed and wasted or reduced to a maximum of 24 inches before placing in embankment.

Embankment construction shall not take place when the material is frozen or a blanket of snow prevents proper compaction of the embankment material.

(B) Compaction:

(1) Earth:

Embankment, constructed in layers of the depth specified herein, shall be compacted by rolling, tamping, or any other suitable means. Each layer of the embankment material shall be compacted to the specified density before the next layer is placed. Effective spreading equipment shall be used on each layer to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulation of the material will be required to assure uniform density. Water shall be added or removed, if necessary, in order to obtain the required density. Construction equipment shall be routed uniformly over the entire surface of each layer, insofar as is practicable, and separate pieces of equipment shall not follow in the immediate tracks of preceding equipment.

Where embankments five feet or less in height are to be constructed, the top six inches of the ground on which the embankment material is to be placed shall be compacted to a density of not less than 95 percent of maximum dry density at a moisture content within 1 percent below and to 4 percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

Each layer of roadbed embankment shall be compacted to a density of not less than 95 percent of the maximum density, as determined herein. Embankment material placed in dikes shall be compacted to a density of not less than 95 percent of maximum dry density at a moisture content within 1 percent below and to 4 percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

(2) Rock:

Density requirements will not apply to portions of embankment constructed of materials that cannot be tested by approved methods.

Rocky materials shall be placed, spread and leveled in 24-inch thick layers, when possible, over the full width of the embankment, with sufficient earth or other fine material so deposited to fill the interstices to produce a dense compact embankment. The average dimension of the largest rock shall not exceed 24 inches. Vibratory compactors, grid, paddle-foot, or vibratory rollers or other compacting equipment approved by the Engineer shall be used for fills constructed of materials which are predominantly rock.

Rolling may be omitted on any layer, or portion thereof, when, in the judgement of the Engineer, it is physically impractical. In addition to the above rolling, each layer shall be further compacted by routing the hauling equipment uniformly over the entire width of the embankment. Additional compaction of rock embankments may be required at the discretion of the Engineer.

SECTION 204 BORROW PITS

204-1 Description:

Borrow pits are located as shown on the project plans.

Borrow will conform to requirements as shown in Section 203 of these specifications.

Structural fill for the test track, other roadways, buildings, and other structures will be obtained from designated borrow areas and excavations required for various elements of the project. The fill material shall be free of roots, grass, other vegetable matter, clay lumps, rocks larger than 6 inches or other deleterious materials. The fill material shall have no more than 65 percent passing the No. 200 sieve. However, soils with a CH classification shall not be utilized as structural fill, regardless of the percentage passing the No. 200 sieve.

The subcontractor shall submit a plan to the Engineer for developing Borrow Pits which shall include the following restrictions:

A. The depth of the pit shall not vary by more than 2-4 feet from natural ground so as not to affect adjoining washes. The contour may be stepped. The steps shall not be steeper than 4:1.

B. The pit shall be contoured to blend in with the surrounding terrain with side slopes being not steeper than 4:1.

C. The number of haul roads shall be kept to a minimum and shall be approved by the Engineer as to number and location.

D. The haul road width shall be kept to a minimum as approved by the Engineer and all construction and private activity shall not deviate more than 25' from the construction limits of the haul road.

The subcontractor shall seed all Borrow Pits after restoration work has been completed.

Work on the Borrow Pits or haul road shall not commence until approval is given in writing by the Engineer.

SECTION 205 PRE-WETTING AND PROOF ROLLING

205-1 Description:

Work under this section shall consist of pre-wetting and proof rolling of existing ground in accordance with the following requirements.

205-3 Construction Requirements:

Subsequent to clearing and grubbing, all areas within the roadway design prism on which structural fill is to be placed shall be wetted and proof rolled. Cut areas less than 3 feet in depth also require wetting the proof rolling.

Subsequent to clearing and grubbing, each area to be treated shall have applied to it an amount of water not less than 2.5 nor more than 4.5 gallons per square foot of treated area. The water shall be applied by sprinklers operating continuously to provide the specified amount of water in a period of time not to exceed sixteen (16) hours nor be less than eight (8) hours. Sprinkling will not be allowed when the nominal wind velocity is in excess of twenty (20) miles per hour. Flooding, dumping, or otherwise applying water in a single or discontinuous application will not be allowed.

The type of style of sprinkler to be used is not specified. The equipment selected shall be capable of delivering the required amount of water within the time frame specified. The sprinkler selected shall also provide an even coverage or uniform application of water within its area of coverage. Spacing of multiple sprinkler setups shall be such that areas to be treated receive the required amount of water; overlapping of the areas of coverage of individual sprinklers may be required. The amount of water applied shall be monitored by use of flow meters or other devices in order to ascertain that the required quantity of water has been applied to a particular area.

The infiltration period is defined as the period of time between the end of prewetting and the initiation of compaction. For all areas treated, the infiltration period shall not be less than one (1) day (twenty-four (24) hours) nor more than three (3) days (seventy-two (72) hours) provided specified moisture contents are achieved. The period of time is estimated as that required to allow the water applied to infiltrate the soil to a depth of at least 1-3 feet below existing site grades.

The areas prewetted shall be compacted using a self-propelled vibratory compactor having a steel drum roller or rubber tires. Vibratory sheep foot rollers with short pads may be used with Engineering approval. The compactor shall have a total static

weight of at least twenty-four-thousand (24,000) pounds. The weight of the vibrating portion (including the drum, shaft, and internal machinery) shall be at least fourteen-thousand (14,000) pounds. The frequency of vibration during operation shall be at least one-thousand-seven-hundred-fifty (1,750) cycles per minute and the dynamic force at the operating frequency shall be not less than fifty-thousand (50,000) pounds. The maximum roller speed during operation shall be no greater than 2.5 miles per hour.

Prewetting and proof rolling, regardless of the specific equipment or procedures used, shall result in the treated soils to a depth of twelve (12) inches being compacted to a dry density equal to a minimum of ninety-five (95) percent of maximum dry density at a moisture content within one (1) percent below to four (4) percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D1557 (modified Proctor).

205-4 Method of Measurement:

The work will be measured by the square yard of area compacted.

SECTION 206 FURNISH WATER SUPPLY

206-1 Description:

The work under this section shall consist of developing and obtaining an adequate water supply or using the Owner furnished wells and furnishing all water required for the work.

Three wells, as designated on the project plans are being developed on the project for use by the subcontractor.

These well sites may be used by the subcontractor and after use on the project, will be abandoned by others.

The wells will have a 12" casing.

The total water usage shall not exceed more than 1000 acre feet per year and shall be monitored by a metering device and records supplied to the Engineer monthly.

It shall be the subcontractor's responsibility to furnish all equipment, materials and labor to complete the work in the section.

206-2 A.D.W.R. REPORTING:

The subcontractor shall submit an annual report and six copies titled "Annual Water Withdrawal and Use Report" as required by A.R.S. 45-632 to the contractor. Included within the above annual report are the following:

(1) The quantity of water from any source, including effluent, used for industrial process purposes during the reporting year, as measured with a measuring device in accordance with the Arizona Department of Water Resources measuring device rules, A.A.C. R12-15-901, et seq.

(2) The quantity of water from any source, including effluent, used for landscape watering purposes during the reporting year, as measured with a measuring device in accordance with the Arizona Department of Water Resources measuring device rules, A.A.C. R12-15-901 et seq.

(3) The quantity of water from any source, including effluent, used during the reporting year for purposes other than the purposes listed in 1 and 2 above, as measured with a measuring device in accordance with the Arizona Department of Water Resources measuring device rules, A.A.C. R12-15-901, et seq.

(4) An estimate of the quantity of wastewater generated during the reporting year.

(5) An estimate of the quantity of wastewater recycled during the reporting year.

(6) A description of the primary purposes for which water from any source, including effluent, is used.

In addition to the Annual Water Withdrawal and Use Report as required by A.R.S. 45-632, the Subcontractor shall submit a report estimating the amounts of water used for the following categories:

a. Pre-wetting requirements and total area requiring pre-wetting.

b. Soil compaction requirements and total cubic yards of soil requiring treatment.

c. Dust control.

d. Equipment washing.

e. Miscellaneous demands.

Estimates of the amount of water used for these categories shall be provided to the Contractor no later than January 15 of the following calendar year. Calculations and assumptions used to arrive at the aforementioned estimates must be clearly described and included in the Annual Water Withdrawal and Use Report.

206-3 Construction Requirements:

The use of pressure pumps and spray bars on all sprinkling equipment used on the roadway will be required. The use of gravity flow spray bars and splash plates will not be permitted.

206-4 Method of Measurement

The work will be measured as a single complete lump sum item.

SECTION 207 DUST CONTROL

207-1 Description:

The work under this section shall consist of applying all water required for the control of dust as considered necessary for the safety and convenience of the traveling public, for the reduction of the dust nuisance to adjacent property, for the allaying of dust in crusher and pit operations and on roads used to haul materials, and for other purposes as directed by the Engineer.

207-2 Blank:

207-3 Construction Requirements:

The use of pressure pumps and spray bars on all sprinkling equipment used for the application of dust control will be required. The use of gravity flow spray bars and splash plates will not be permitted.

When it is required that chemical additives be mixed with the water for the suppression of dust, the use of such chemical additives and adding them to the water will be, if required, approved by the Engineer.

Unless otherwise permitted by the Engineer, at least one (1) mobile unit with a minimum capacity of one-thousand (1,000) gallons shall be available for applying water on the project at all times.

All water used shall be metered by the Subcontractor.

207-4 Method of Measurement:

No measurement will be made for dust control.

SECTION 303 AGGREGATE BASE COURSE

303-1 Description:

The work under this section shall consist of furnishing, placing and compacting aggregate bases in accordance with the details shown on the project plans and the requirements of these specifications.

303-2 Materials:

Aggregate for the various classes of and aggregate bases shall consist of stone, gravel or other approved inert material of similar characteristics, and shall be clean and free from vegetable matter and other deleterious substances.

Aggregate bases shall conform to the requirements shown below:

Material Class 2

Gradation	Sieve	% Passing
	1-1/2"	100
	1"	90 - 100
	#8	35 - 55
	#200	0 - 8.0
PI	Maximum three (3)	
Compaction	100% (ATM 225, 226 & 227)	
Placement	Lifts less than six (6) inches	

NOTES:

1. The percentage, by weight, passing each sieve will be determined in accordance with the requirements of Arizona Test Method 201.

2. The PI (Plasticity Index) will be determined in accordance with the requirements of AASHTO T 90.

3. At least thirty (30) percent by weight of the aggregate material retained on the No. eight (8) sieve shall have at least one rough and angular surface which has been produced by crushing, when tested in accordance with the requirements of Arizona Test Method 212.

4. Resistance to abrasion will be determined in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

Maximum loss of nine (9) percent at one-hundred (100) revolutions.

Maximum loss of forty (40) percent at five-hundred (500) revolutions.

When production of aggregate requires composite mixing of materials from more than one (1) source to meet the gradation requirements specified herein, the material from each source shall meet the abrasion requirements specified herein.

303-3 Construction Requirements:

303-3.01 Placement:

Aggregate bases shall have water added to them and shall be mixed and processed to produce a uniform blend of material before final placement. After processing, the material shall be placed and spread on the prepared base in a uniform layer or layers not exceeding six (6) inches in compacted depth, unless otherwise approved in writing by the Engineer. The method of dumping or spreading shall be determined by the Subcontractor. The spread material shall be free of segregation.

303-3.02 Compaction:

Each layer of aggregate base shall be compacted to a density of not less than one-hundred (100) percent of the maximum density determined in accordance with the requirements of Arizona Test Methods 225, 226 and 227.

303-3.03 Finishing:

The final layer of base shall be finished with equipment capable of shaping and grading the finish surface within the tolerances shown in Appendix A.

The finished surface of aggregate base shall not vary from the grades established by the Engineer by more than the tolerances shown in Appendix A.

The final compacted layers of aggregate base shall be maintained in a condition satisfactory to receive any subbase, base or surfacing material or traffic, when so required.

Areas not within the allowable tolerance shall be corrected by scarifying, placing additional material, remixing, reshaping and recompacting to the specified density and surface tolerance.

303-4 Submittal:

The Subcontractor shall submit certificates of compliance of the materials to be used and laboratory and field test results.

303-5 Method of Measurement:

The quantity of aggregate base course will be calculated by the cubic yard in place, using project plan dimensions.

SECTION 401 PORTLAND CEMENT CONCRETE PAVEMENT

401-1 Description:

The work under this section shall consist of furnishing all materials and constructing a pavement surface using portland cement concrete and shall include coring operations, furnishing and placing dowels and tie bars, furnishing and placing miscellaneous reinforcing steel and joint materials, and constructing joints in accordance with the details shown on the project plans and the requirements of these specifications.

The subcontractor shall proportion, mix, place, finish, and cure concrete in accordance with the requirements of these specifications.

401-2 Materials:

Portland cement concrete for pavement shall consist of a mixture of hydraulic cement, fine aggregate, coarse aggregate, water, and admixtures.

Unless otherwise provided, portland cement concrete pavement shall conform to the requirements of Section 1006. Concrete shall be Class P.

Materials for expansion joint filler and joint seal shall conform to the requirements of Section 1011 of the Standard Specifications unless otherwise shown on the project plans or specified herein.

Materials for tie bars and dowel bars shall conform to the requirements of Section 1003. Materials for dowel bars shall conform to the requirements of AASHTO M 254 with Type B coating except that the core material shall conform to the requirements of ASTM A615, Grade 40. When epoxy coated reinforcing steel is designated, it shall conform to the requirements of 1003-5.

Dowel bars in transverse portland cement concrete joints shall be placed in accordance with these specifications and shall be thoroughly and uniformly coated with a waterproof grease prior to placement.

Liquid membrane curing compound shall conform to the requirements of Subsection 1006-2.05.

Wire mesh shall in all respects, fulfill the requirements in accordance with ASTM A-82.

Mesh reinforcements shall conform to ASTM A-185. The gage of the wire and dimension of the mesh are as shown on the project plans.

401-3 Construction Requirements:

401-3.01 General:

All concrete pavement shall be constructed with fixed side forms.

When lots are shown on the project plans, concrete shall be placed in a single monolithic pass within designated lots. Paving widths which are less than the full main roadway width shall be constructed with longitudinal construction joints that are located on the lane line or at the edge of the main roadway.

Concrete pavement on the Oval Track has special surface finishing requirements. See Division XI of these specifications.

401-3.02 Pavement Base:

The subgrade surface upon which the concrete pavement is to be placed shall conform to the finish and elevation requirements specified for the material involved. The surface shall be free of all loose and extraneous material and the surface shall be uniformly moistened immediately prior to placing concrete when the ambient temperature is greater than 85 degrees Fahrenheit as verified with a Engineer-furnished calibrated thermometer.

Curing compound may be applied after placement of required load transfer dowel assemblies; however, uniform coverage with curing compound must be achieved under the dowel assemblies and spot spraying or additional applications of curing compound may be required to achieve uniform coverage. If load transfer dowel assemblies are placed after application of curing compound, the curing compound shall be allowed to set up prior to dowel placement. Curing compound membrane which is damaged during placement of load transfer dowel assemblies or during other operations shall be repaired with a reapplication of curing compound prior to placement of Portland cement concrete pavement.

401-3.03 Forming:

(A) General:

The subcontractor will place one stake for elevation control and alignment on each side of the roadway at 50-foot intervals and at grade breaks in accordance with the subcontractor's staking plan. The subcontractor shall make any additional projections necessary to establish line and grade.

(B) Fixed Form-Manual Method:

Forms shall be set to the required lines and grades well in advance of placing concrete and shall be as approved by the Engineer prior to concrete placement.

Forms shall be made of steel and have an approved section with a base width of at least four inches and a depth equal to or greater than the thickness of the pavement. The forms shall be staked with steel stakes of appropriate lengths. Each form section shall have a stake pocket at each end and at intervals of not more than five feet. The stake pockets shall have a device for locking the form to the steel stakes. Each form section shall be straight and free of bends and warps at all times. The top of each form section shall not vary from a true plane by more than 1/8 inch in ten feet and the inside face shall not vary more than 1/4 inch in ten feet.

Wood or other rigid forms (see Special Roads, Section 1100) may be used in irregular areas as approved by the Engineer.

Forms shall be thoroughly cleaned and oiled each time they are used.

Before forms are placed, the underlying material shall be finished to the required grade and shall be firm and smooth. The forms shall be uniformly supported upon the subgrade or base and shall be placed to the required grade and alignment. Forms shall be supported so that they will not deviate more than 1/8 inch from the proper elevation during paving operations.

Forms shall remain in place until the day after placing the concrete and shall be removed in a manner that will prevent damage to the pavement. Pry bars shall not be used between the forms and the pavement under any circumstances.

401-3.04 Placing and Finishing:

(A) General:

When daytime ambient temperatures are expected to exceed 100 degrees Fahrenheit and when directed by the Engineer, concrete shall be placed only between the hours of 8:00 P.M. and 8:00 A.M.

Immediately prior to placing concrete, the subcontractor shall verify that the elevations of fixed forms are such that the thickness and finished grade of the pavement will be in accordance with the requirements of the project plans and these specifications.

Concrete shall be placed using methods that result in a minimum of handling and segregation and in a manner that will result in the concrete being distributed uniformly across the front of the paving machine.

Concrete placement shall be continuous between expansion or construction joints. The concrete shall be struck off, consolidated and floated by mechanical methods. The subcontractor may, with the approval of the Engineer, use a free floating, oscillating screed device, which is a minimum of 10 feet in length and attached to the paver, in conjunction with or in lieu of tubular floats. When pavement widths are less than ten feet and where it is impractical to use mechanical methods, manual methods may be used to finish the concrete surface.

If surface drying or cracking should occur prior to the application of curing material, the entire surface of the concrete shall be kept damp by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The water from the nozzle shall not be applied directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

The subcontractor shall protect the base or subgrade when equipment is cleaned at the end of each days production. All concrete deposited on the base or subgrade during the cleaning operation shall be removed from the base or subgrade immediately after cleaning is completed. Any damage to the base or subgrade, shall be repaired, as approved by the Engineer, prior to commencing paving operations. Water will not be permitted to pond on the roadway.

Any concrete which is spilled, splattered, or scattered on existing pavement shall be removed before the end of each day's paving operations.

It is important in the performance of the work and in the operation of equipment that no work shall lag and all operations shall be completed within the optimum or specified time; therefore, the Engineer may order the work suspended, if necessary, to maintain proper balance of operations so as to insure satisfactory results.

(B) Fixed Form Method:

Three types of self-propelled mechanical equipment, the spreader, the finisher, and the float will be required; however, a single machine combining two or more of these operations may be used if it has been demonstrated that such a machine will accomplish satisfactory results. All wheels of all machines that ride on finished concrete surfaces shall be equipped with rubber tires.

The concrete shall be spread uniformly between the forms, immediately after it is placed, by means of the spreading machine. The spreader shall be followed by the finishing machine equipped with not less than two oscillating or reciprocating screeds. The spreading machine or the finishing machine shall be equipped with

vibrating equipment that will vibrate the concrete for the full paving width. Vibrators shall be used adjacent to the longitudinal edge of the pavement. These vibrators shall be attached to the rear of the spreading machine or to the finishing machine. Vibrators shall not rest on new pavements or side forms or contact any tie bars, and power to the vibrators shall be such that when the motion of the machine is stopped, vibration will cease. Vibrators shall operate at a minimum of 8,000 impulses per minute.

The concrete shall be spread full width before being struck off by the finishing machine. The concrete shall be struck off and consolidated so that the surface will conform to the finished grade and cross section shown on the project plans and at the same time leave sufficient material for the floating operation. The spreading or finishing machine shall move over the pavement as many times and at such intervals as may be required to insure thorough consolidation.

After the pavement has been struck off and consolidated, it shall be floated with an approved longitudinal float.

The subcontractor may use a longitudinal float composed of one or more cutting and smoothing floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more wheels riding on, and constantly in contact with, the forms.

The subcontractor may use a longitudinal float which is worked with a sawing motion while being held in a floating position parallel to the roadway centerline and while passing gradually from one side of the pavement to the other. Movements ahead along the centerline of the roadway shall be in successive advances of not more than one half the length of the float.

In lieu of using either type of longitudinal float, a single machine which will effect satisfactory consolidating, finishing and floating may be used. This machine may be towed by a spreading machine. This combination finishing/floating machine shall be equipped with screeds and vibrators as hereinbefore specified for finishing machines. Floating shall be accomplished with a non-oscillating float held in a suspended position from the frame.

If any spreading, finishing and floating equipment is not maintained in full working order or if the equipment used by the subcontractor proves inadequate to obtain results prescribed, such equipment shall be improved or satisfactory equipment substituted or added.

(C) Fixed Form-Manual Method:

Manual methods may be permitted by the Engineer in areas inaccessible to mechanical equipment.

When manual methods are permitted, concrete shall be deposited, spread and struck off to such an elevation that, when properly consolidated, the surface will conform to the required lines and grades. The strike board shall be moved forward with a combined longitudinal and transverse motion so that neither end is raised from the side forms. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times.

The concrete shall be consolidated by internal vibration. Vibrators shall operate at a minimum of 8,000 impulses per minute. Use of vibrators for shifting of the concrete mass will not be permitted.

After consolidation, the concrete shall be tamped to the proper surface elevation and cross section with an approved tamping or screeding device or with a mechanical vibrating unit spanning the full width between forms. A small surplus of concrete shall be kept in front of the tamper or vibrating unit. Tamping or vibrating shall continue until the required cross section is obtained and the mortar is flushed slightly to the surface.

Other approved methods may be used to finish the concrete.

On grades in excess of five percent a second strike board shall follow behind the tamper or vibrating unit and shall be used in the same manner as the tamper to remove waves caused by the flow of concrete.

(D) Joint Finishing and Edging:

The pavement edges and joints shall be edged in accordance with the details shown on the project plans.

(E) Surface Texturing:

Surface texturing of the plastic concrete shall begin immediately after placement and finishing of the concrete. All excessive surface water shall be dispersed prior to commencing texturing operations. Texturing shall be performed by applying a longitudinal burlap drag followed by transverse texturing using steel tines.

Burlap and steel tines shall be supported by rolling mechanical bridges. They shall not be supported manually except in areas inaccessible to the bridges.

Rolling mechanical bridges supporting steel tines shall be equipped and shall operate with automatic sensing and control devices which follow the same control line as the slip form paver. This machine shall be used for texturing the pavement only. Burlap shall not be

supported on the same rolling mechanical bridge used to support the steel tines.

Burlap shall be four-ply, 10-ounce material and shall traverse the full width of the pavement to within one foot of the pavement edge.

The timing of the texturing operations is critical. Grooves that close following texturing will not be permitted and texturing shall be completed before the surface will be torn or unduly roughened by the texturing operation.

Hand tine brooms shall be provided and available at the job site at all times.

Tine texturing shall be performed so that the grooves produced will be uniform. Texture shall be normal to the center line of the roadway and shall extend over the entire roadway width to within three inches of the pavement edge. Swerving groove patterns will not be permitted.

Texture grooves shall be 1/16 to 1/8 inch in width and 3/32 to 7/32 inch in depth. The textured groove depth will be measured in accordance with the requirements of Arizona Test Method 310. The center-to-center spacing of the grooves shall be one-half inch to one inch.

If necessary, hardened concrete shall be textured by any method that will produce the required grooves.

(F) Curing:

Curing compound shall be applied to the concrete within 15 minutes after surface texturing operations and before any drying shrinkage or craze cracks begin to appear. In the event of surface drying or cracking, application of water with an atomizing nozzle shall be started immediately and shall be continued until application of curing material is begun or resumed; however, curing compound shall not be applied over any resulting freestanding water.

Liquid curing compound shall be applied in one or more applications totalling not less than one gallon per 100 square feet. The curing compound container shall be equipped with a calibrated sight glass for verification of quantities used.

When the ambient temperature is above 85 degrees Fahrenheit, as verified by an Engineer-furnished, calibrated thermometer, the subcontractor shall fog the surface of the concrete with an atomized mist of water, or Engineer approved alternate, within 15 minutes after placement of the concrete. The surface of the pavement shall be kept moist until initial joint sawing is completed or three (3) days after placement which ever is longer;

fogging done after curing material has been applied shall not begin until the curing compound has set sufficiently to prevent displacement.

When misting is required, the entire surface of the concrete shall be kept damp by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

Concrete curing shall be continued for not less than seven days and any damaged curing material shall be repaired immediately.

401-3.05 Joints:

(A) General Requirements:

Joints in concrete pavement will be designated as transverse expansion joints, longitudinal or transverse construction joints, or longitudinal or transverse weakened plane joints.

The faces of all joints shall be constructed perpendicular to the surface of the concrete pavement.

Joints shall be constructed of the type, to the dimensions, and at the locations shown on the plans and as specified herein.

Concrete placed in lanes adjacent to previously placed concrete shall have transverse weakened plane joints located to align with the weakened plane joints in the previously placed concrete.

(B) Longitudinal Joints:

Longitudinal joints in the main roadway shall be weakened plane joints or construction joints. Weakened plane joints shall be constructed by sawing.

Longitudinal weakened plane joints shall be constructed between traffic lanes and also between traffic lanes and shoulders if concrete shoulders wider than five feet are specified.

Longitudinal joints in ramps and tapers shall be either weakened plane joints or construction joints. The location of longitudinal joints in ramps and tapers shall be as approved by the Engineer.

Unless otherwise shown on the project plans, tie bars shall be placed in all longitudinal construction joints and longitudinal weakened planet joints either by acceptable mechanical methods while the concrete is still plastic or after the concrete has hardened.

Tie bars shall be provided as shown on the plans and spaced 30 inches center-to-center. Tie bars placed in pavement which is constructed without load transfer dowel assemblies shall be two feet long. Tie bars placed in pavement which is constructed with load transfer dowel assemblies shall be 20 inches long. Tie bars shall be placed within one inch of mid-depth of the slab. Tie bars placed in adjacent slabs of different thickness shall be placed at mid-depth of the thinner slab.

(C) Transverse Joints:

Transverse construction joints with tie bars shall be formed as shown on the plans and as specified herein. They shall be placed at the end of each day's production, or when placement of concrete is discontinued for more than 90 minutes. Excess concrete shall not be placed beyond a construction joint at the end of a day's production.

Tie bars shall be deformed No. 8 reinforcing steel bars, two feet in length, spaced 18 inches center-to-center. All tie bars shall be placed at mid-depth in the slab.

Transverse construction joints shall be formed perpendicular to the center line of the roadway.

Transverse weakened plane joints shall be sawed as shown on the project plans. Sawed joints shall extend over for the full main roadway width with a right-forward skew extending the entire width at a rate of two feet longitudinally per 12 feet of width transversely. The sequence of spacing between adjacent transverse weakened plane joints shall be 15, 13, 15, 17 feet unless otherwise shown on the project plans.

Transverse weakened plane joints in ramps and crossroads shall be constructed perpendicular to the centerline of the ramp or crossroad.

Transverse weakened plane joints shall be constructed at least six feet from transverse construction joints as measured along any longitudinal joint between lanes. The last sawed joint before a construction joint shall be omitted if it cannot meet the spacing requirements. A new joint sequence shall be started after a construction joint. The first weakened plane joint after a construction joint shall be constructed with the closest portion of the joint located six feet from the transverse construction joint.

401-3.06 Joint Construction:

(A) Sawed Joints:

Longitudinal or transverse weakened plane joints shall be sawed to the dimensions shown on the plans. Excess water from the sawing operation will not be permitted to stand on any subgrade to be paved. The subcontractor shall provide and maintain acceptable methods to control the water used in the sawing so the subgrade is not damaged.

Sawed joints shall be constructed before uncontrolled pavement cracking occurs; however, joints shall not be sawed until the concrete has hardened enough to prevent excessive tearing or raveling during sawing operations. The exact time when sawing will be done shall be determined by the subcontractor.

The subcontractor shall maintain an additional concrete span saw on the project site at all times during which sawed joints are being constructed. The additional saw shall be maintained in good operating condition and shall be readily available as a substitute for the primary concrete saw.

Any procedure used to saw joints which results in premature, uncontrolled cracking shall be revised immediately. The subcontractor shall repair damaged areas or random cracks as specified and as directed by the Engineer.

If joints are sawed in stages, the initial saw cut shall be of the minimum specified width and shall be sawed to the depth shown on the plans.

Suitable guide lines or other devices shall be used to assure that joints are constructed at the locations shown on the plans.

After sawing the joints the following procedure shall apply:

1. Prior to applying the sealant each joint face shall be thoroughly cleaned. The method of cleaning may be subject to regulation by state or local environmental quality enforcement agencies. When not otherwise mandated by law or regulation, the subcontractor shall clean the joints by sand blasting. The joints shall then be further cleaned by use of high pressure air jets so that each face is clean, dry and dust-free. The air used in cleaning shall be free of oil or water.

2. The sealant used shall be silicone joint sealant conforming to the requirements of Subsection 1011-8 and shall be applied in accordance with the manufacturer's recommendations. All recommended manufacturer's field testing shall be done by the Engineer. Necessary repairs resulting from field testing shall be immediately repaired by the subcontractor, cost to be considered

incidental to the sealant pay item. Any sealant spilled on the concrete pavement shall be removed.

Immediately prior to applying joint sealant, an expanded closed cell polyethylene foam backer rod approved by the Engineer shall be inserted along the joint as shown on the plans. The backer rod shall be compatible with the joint sealant to be applied.

Joints shall be sealed within ten working days after the concrete has been placed and prior to opening the pavement to any traffic.

(B) Construction Joints:

Longitudinal and transverse construction joints shall be formed in accordance with the details shown on the plans or as directed by the Engineer.

When concrete is not finished, textured, and protected with curing material within one hour after placement, the Engineer may order the subcontractor to construct a transverse construction joint by sawing at the location established by the Engineer. All concrete placed beyond the construction joint shall be removed and disposed of by the subcontractor, at his expense, prior to continuing paving operations.

(C) Transverse Expansion Joints:

Transverse expansion joints shall be formed in accordance with the details shown on the project plans or as directed by the Engineer.

401-3.07 Opening Pavement to Traffic:

Pavement shall not be opened to traffic less than seven days after placement, and until all joints are sealed and the concrete has attained a compressive strength of at least 3,000 pounds per square inch, unless otherwise approved by the Engineer.

401-4 Pavement Evaluation and Remedial Measures:

401-4.01 Pavement Surface Texture:

The depth of surface texture grooves will be measured in accordance with the requirements of Arizona Test Method 310.

401-4.02 Pavement Smoothness:

Pavement smoothness shall be evaluated by testing with a profilograph.

Profilograph equipment will be furnished by the subcontractor. All profilograph measurements shall be made by a team composed of one engineer and one subcontractor employee. The work shall be shared equally. At the completion of each profilograph run both operators shall sign the profilogram, certifying that they are in agreement that the equipment was found to be operating correctly and that the profilogram is a correct representation of the surface profile.

A pavement Profile Index shall be obtained as soon as possible after concrete placement.

Two profilograph readings shall be taken in each mainline traffic lane, each distress lane and each ramp lane including tapers. The profilograph readings shall be taken in the vehicle wheel paths, three feet from each lane edge of traffic lanes or 18 inches from the lane edge or pavement edge of distress lanes.

The tested profile shall begin 50 feet prior to the concrete placed during any day's production and shall end 50 feet before the end of the placed concrete. The tested profile will include bridge approaches and 50 feet of any pavement which abuts the new pavement.

If, during any day's production, less than 3,000 lane-feet of pavement is placed, that pavement shall be tested with the subsequent day's production.

The subcontractor shall broom the pavement or clean the pavement by other approved methods immediately prior to profilograph testing.

Surface profiles will be evaluated by the engineer in accordance with the provisions of Arizona Test Method 801. The Profile Index for a traffic lane will be the average of the two Profile Indexes obtained for that lane.

All mainline traffic lanes, distress lanes, ramp lanes and tapers shall have a Profile Index of 9 inches or less per mile per 0.1 mile section.

Profile Indexes greater than 9 inches per mile per 0.1 mile section shall be reduced to less than 9 inches per mile per 0.1 mile section by grinding or pavement removal and replacement as specified herein.

Grinding of pavement which has a Profile Index of 9.0 inches or less per mile per 0.1 mile section will only be permitted to correct deviations in excess of 0.3 inches in 25 feet ("must-grinds") as specified herein and when directed by the Engineer.

The subcontractor shall remove high pavement areas with vertical deviations greater than 0.3 inches in 25 feet or less. High pavement areas shall be removed with grinding devices or multiple-saw devices as approved by the Engineer. Grinding machines shall be of the rotary type with a wheel base of at least 10 feet and with vertically adjustable grinding wheels. Bush hammers or other impact devices shall not be used.

After removal of high areas, the affected 0.1 mile pavement section shall be reprofiled; however, if the original Profile Index for the pavement section was within the specified range, only that portion of the pavement which originally contained high areas shall be reprofiled.

Evaluations of pavement depressions will be made based on the presumed correction of adjacent high areas. When the pavement contains depressions greater than 0.3 inches in 25 feet or less, the subcontractor shall grind adjacent pavement as directed by the Engineer and the pavement shall be reprofiled as specified above.

When the pavement contains depressions greater than 0.5 inches in 25 feet or less, the pavement shall be repaired as directed by the Engineer. Such repairs may include additional grinding or full-depth pavement replacement. Upon completion of repairs, the pavement shall be reprofiled as required.

If, after the repair of high and/or depressed areas, the pavement does not conform to the specified profile requirements, additional pavement grinding and profile measurements shall be performed as directed by the Engineer.

In addition to the Surface Profile Index requirements, the pavement surface will be tested with a ten-foot straightedge. The surface shall not vary in any direction by more than 1/8 inch, except at longitudinal and transverse construction joints. The surface shall not vary by more than 1/4 inch across any longitudinal or transverse construction joint. Grinding will be required to ensure that these requirements are satisfied.

The pavement shall be ground in a manner that does not form a smooth or polished pavement surface.

All pavement profile repairs shall be made prior to pavement thickness evaluations.

Remedial work required to correct pavement smoothness deficiencies shall be performed by the subcontractor at no additional expense to the Owner.

The subcontractor shall provide for the maintenance and protection of traffic during pavement profile repairs and subsequent pavement

profile measurements as directed by the Engineer and at no additional expense to the Owner.

401-4.03 Pavement Cracks:

(A) General:

Cracks penetrating the full depth of the pavement shall be repaired or the cracked pavement shall be removed and replaced, as specified herein, prior to opening the pavement to public traffic.

Within 28 days after concrete placement and prior to acceptance of the work, the Engineer will perform a pavement crack survey. The pavement shall be cleaned prior to the crack survey.

Cracks which are visible without magnification and which require repair and pavement slabs which require replacement will be marked by the Engineer and shall be repaired or replaced by the subcontractor as specified, and at no additional cost to the Department.

Cracks observed later than 28 days after concrete placement and prior to final acceptance of the work shall be repaired by the subcontractor as specified and the cost of such repairs will be shared equally by the subcontractor and the Department.

The subcontractor shall provide the Engineer with detailed information concerning the methods and materials to be used for crack repair and the subcontractor shall obtain the Engineer's approval of the proposed methods and materials prior to beginning the required repairs. The subcontractor, at his option and expense, may core cracked pavement, as approved by the Engineer, to determine the extent of cracking.

(B) Crack Repair:

(1) General:

Random cracks shall be repaired using the methods and under the conditions specified herein.

Crack repair shall begin within seven days after completion of the pavement crack survey and shall be completed within 30 days after the start of repairs.

Payment for pavement slabs which require repairs will be adjusted as specified in Subsection 401-6.

(2) Crack Repair Requirements:

(a) Cracks in Jointed Pavement Constructed With Load-Transfer Dowel Assemblies:

Longitudinal cracks which occur more than 54 inches from a longitudinal joint or less than 12 inches from a longitudinal joint shall be repaired by the routing-and-sealing method.

Transverse cracks shall be repaired by the epoxy-injection method after any immediately adjacent uncracked joints are deepened to 1/2 inch above the dowels.

(b) Cracks in Jointed Pavement Constructed Without Load-Transfer Dowel Assemblies:

Longitudinal cracks which occur more than 54 inches from a longitudinal joint or less than 12 inches from a longitudinal joint shall be repaired by the routing-and-sealing method.

When a transverse crack crosses or terminates in a transverse contraction joint, the uncracked portion of the joint shall be filled with an approved gray colored epoxy and the crack shall be repaired by the routing-and-sealing method.

When a transverse crack approximately parallels and is within five feet of an uncracked contraction joint, the uncracked joint shall be cleaned and filled with an approved gray colored epoxy and the crack shall be repaired by the routing-and-sealing method.

When a transverse crack is more than 5 feet from a transverse joint, either cracked or uncracked, the joint shall be resawed and resealed as originally specified, and the crack shall be repaired by the routing-and-sealing method.

(c) Cracks Occurring Within Wheel Path:

Cracks occurring within the wheel paths, which are exclusive of the areas defined under subsections (a) and (b) above, shall be considered unrepairable and the pavement shall be removed and replaced in accordance with the requirements of 401-4.03(C).

(3) Crack Repair Methods

(a) Routing-and-Sealing Method

When the routing-and-sealing crack repair method is specified, the top of the crack shall be routed with an approved routing machine to a depth of at least 3/4 inch and to a width not less than 3/8 inch or more than 5/8 inch. The routing machine shall be capable of closely following the path of the crack and of widening the top of the crack to the required section without spalling or otherwise damaging the concrete. Loose and fractured concrete shall be

removed and the routed crack shall be thoroughly cleaned and then sealed with an approved gray colored silicon sealant.

(b) Epoxy-Injection Method

When the epoxy-injection crack repair method is specified, the crack shall be pressure-injected with an approved gray colored epoxy.

Pressure injection of epoxy shall be done only between the hours of 11:00 p.m. and 7:00 a.m.

(C) Pavement Removal and Replacement

Portland cement concrete pavement, having cracks not repairable in accordance with Subsection 401-4.03(B), shall be removed and replaced as directed by the Engineer.

Cracked pavement shall be removed and replaced to the limits established by the Engineer and will generally require removal of the full lane width of the slab over a length of at least six feet.

Pavement slabs containing a single diagonal crack intersecting the transverse and longitudinal joints within 1/3 of the width and length of the slab from the corner shall be repaired by removing and replacing the smaller portion of the slab as directed by the Engineer.

Pavement slabs containing multiple cracks through the full depth of the slab, separating the slab into three or more parts, shall be entirely removed and replaced as directed by the Engineer.

Excessively cracked pavement shall be removed and replaced over the full pavement width, as directed by the Engineer.

Pavement to be removed shall be cut full-depth prior to removal. In order to minimize over-cutting, four-inch diameter full-depth cores shall be drilled at the corners of the pavement to be removed as directed by the Engineer.

Base material which is damaged as a result of pavement removal shall be repaired or replaced by the subcontractor as approved by the Engineer.

Removed pavement and base material shall be disposed of by the subcontractor, as approved by the Engineer.

After removal of cracked pavement, tie bars and dowel bars shall be placed by drilling and anchoring, using an approved epoxy, at approximately mid-depth in the existing concrete pavement. Tie bars shall be placed in transverse construction joints and shall be

24-inch-long, deformed, No. 8 bars placed 18 inches center-to-center. Tie bars shall be placed in longitudinal construction joints which are greater than 50 feet in length and shall be 24-inch-long, deformed, No. 5 bars placed 30 inches center-to-center. Dowel bars shall be placed in construction joints which coincide with existing transverse weakened plane joints. The dowel bars shall be 18-inch-long, smooth, 1-1/4 inch diameter bars placed at distances of 6, 24, 42, 90, 117 and 135 inches from the adjacent longitudinal joint which is nearest to the outside distress lane.

Replacement concrete shall be placed, finished and cured in accordance with the requirements specified for the original pavement.

401-4.04 Pavement Thickness:

Concrete pavement shall be constructed to the specified thickness. Tolerances allowed for base and subgrade construction and other provisions of these specifications which may affect thickness shall not be construed to modify such thickness requirements.

To determine thickness acceptability, the subcontractor shall drill four-inch minimum diameter cores at the locations specified by the Engineer.

The Engineer will determine average core thickness in accordance with the provisions of AASHTO T 148, except that measurements will be read to the nearest thousandth of an inch and the average of the measurements will be reported to the nearest hundredth of an inch.

When calculating average core thickness, cores which exceed the specified thickness by more than 0.25 inch will be considered to have the specified thickness plus 0.25 inch. The Engineer may make field length measurements in lieu of measurements in accordance with the provisions of AASHTO T 148 when the original core in any secondary unit, as defined below, meets or exceeds the specified thickness.

However, measurements will be made in accordance with the provisions of AASHTO T 148 when any question arises concerning pavement thickness and on all cores used to determine the average pavement thickness for payment.

A secondary unit of pavement will consist of 1,000 linear feet, or fraction thereof, of each main-line traffic lane and each shoulder in each primary unit. Additionally, each 1,300 square yards of pavement in ramps, tapers, intersections, crossroads, etc., will be considered as a secondary unit, regardless of when the concrete was placed.

One core shall be drilled in each secondary unit. If the length of that core is not deficient by more than 0.25 inch, that secondary unit will be paid for at 100 percent of the contract unit price. If the length of that core is deficient by more than 0.25 inch but less than 1.00 inch, two additional cores shall be drilled within the secondary unit and the length of the three cores will be averaged. If the average length of the three cores is not deficient by more than 0.25 inch, the secondary unit will be paid for at 100 percent of the contract unit price. If the average length of the three cores is deficient by more than 0.25 inch, payment for the secondary unit will be made in accordance with the provisions of Table 401-1.

If the core in a secondary unit is deficient by more than 1.00 inch, that core will not be used to determine the average thickness of the secondary unit and additional cores shall be drilled at intervals not exceeding ten feet in each direction from the deficient core, measured parallel to the center line, until one core is obtained in each direction which is not deficient by more than 1.00 inch. The pavement between these two cores will be evaluated separately from the balance of the pavement in that secondary unit. The limits for the evaluation will be between the longitudinal weakened plane or construction joint on each side of the core and between the next transverse weakened plane, construction, or expansion joint beyond each of the last two cores. Unless the Engineer allows the pavement to remain, it shall be removed and replaced with pavement of the specified thickness and no payment will be made for removal of the deficient pavement. If deficient pavement is allowed to remain, no payment will be made for the deficient pavement and one additional core shall be drilled in the remaining portion of the secondary unit and that portion will be separately evaluated for payment as hereinbefore specified.

If deficient pavement is removed either by the order of the Engineer or at the option of the subcontractor, it shall be removed and replaced within the evaluation limits. After the pavement has been replaced, one core shall be drilled at random in the secondary unit outside of the limits of the replaced pavement and one core shall be drilled in the new pavement. Pavement represented by the drilled core outside of the limits of the replaced pavement will be evaluated for payment as hereinbefore specified. If the core drilled in the replaced pavement is less than the specified thickness no payment will be made for the replaced pavement.

At all locations where cores have been drilled, the resulting holes shall be filled with concrete as approved by the Engineer and at the subcontractor's expense.

401-5 Submittals:

At least two weeks prior to the portland cement concrete pavement construction, the subcontractor shall submit the six (6) copies of the following:

(1) Concrete Placement:

A detailed sequence and schedule of concrete placement operations including, but not necessarily limited to, width of pavement to be placed, proposed equipment, production rates, working hours, concrete hauling, placement methods, curing, sawing and sealing methods.

(2) Staking Plan:

A detailed staking plan for subgrade controls, including offset requirements.

(3) Traffic Control Plan:

A traffic control plan for pavement construction operations which includes provisions for the placement and maintenance of barriers required to protect the pavement from traffic for a minimum of seven days after concrete placement.

(4) Alternate Paving Plan:

An alternate paving plan may be submitted if the subcontractor chooses to use the methods differently than specified.

The subcontractor shall not start the work until after the submittals are approved.

401-6 Method of Measurement:

All portland cement concrete pavement will be measured by the square yard, calculated from the dimensions shown on the project plans. Any opening in excess of one square yard will not be measured for payment. No allowance will be made for pavement placed in excess of the specified dimensions.

401-6.01 Special Methods of Measurement:

The special methods of measurement shall be adopted taking into account pavement tolerances and special construction methods for Section 1101 - Choppy Road (High Speed Track) and Section 1102 - Waved and Repaired Concrete Road, of these specifications.

SECTION 402 LOAD TRANSFER DOWEL ASSEMBLY:

402-1 Description:

The work under this section consists of furnishing all material for load transfer dowel assemblies including load transfer dowels and placing the assemblies in portland cement concrete pavement at the locations and in accordance with the details shown on the project plans and the requirements of these specifications.

402-2 Materials:

Dowel bars shall be plain round bars, one (1) inch in diameter and twenty-eight (28) inches in length and shall conform to the requirements of AASHTO M 254 with Type B coating, except that the core material shall conform to the requirements of ASTM A 615, Grade forty (40).

The following suppliers may be contacted for powdered epoxy resins to coat dowel bars:

Scotchkote 202, 213
3M Company
St. Paul, Minnesota 55101

Corvel ECA-1400-Green
ECA-1440-3
ECA-1558-Red-27000
Polymer Corporation
Reading, PA, 19603

Micron 650-Blu Epoxy
Republic Steel Corp.
Cleveland, Ohio

Epoxiplate R-346, R-347, R-348
R-349, R-352, R-361, R-371
Armstrong Products
Warsaw, Indiana 46580

LSU 431-Formula 907-2-5
Ciba-Geigy Corp.
Ardsley, New York

Flintflex 531-6020, 531-5068,
531-6080, 531-6085
Dupont Company
Wilmington, Delaware

Mobilox 1004 R-2
Mobile Chemical Company
Cleveland, Ohio

Epoxy Powder 720-a-009
Cook Paint and Varnish
Kansas City, Missouri

Nap-Guard 7-2000
Napco Corporation
Houston, Texas

Corflex CF-4650 Green
Carboline/Ferro Company
St. Louis, Missouri 63144

Interpon HD-33
International Paint Co.
Houston, Texas

Oxyplast El-704-P-9 Fuller O'Brien South San Francisco, CA.	DK 23-0548, DK 23-0602 DK 23-0679 Hysol Division The Dexter Corporation Olean, New York 14760

The powdered epoxy resin selected by the Subcontractor and furnished by the manufacturer shall be of the same material and quality as the resins listed above.

The approved powders are based on specified dowel bar preparation and powder application and curing methods and these identical methods shall be followed during fabrication.

402-2.01 General Requirements:

1. Certification:

The Subcontractor shall furnish a certificate from the manufacturer, which properly identifies the batch and/or lot number, material, quantity of batch, date of manufacturer, and name and address of manufacturer. A statement shall also be submitted certifying that production bars and prequalification bars have been identically prepared and applied with epoxy powders.

2. Material for Repair:

The Subcontractor shall furnish Patching or repair material, compatible with the coating and inert in concrete, from the epoxy manufacturer. This material shall be suitable for repairs of areas of the coating damaged during fabrication and/or handling in the field.

402-2.02 Applications Requirements:

1. Coating Applicator:

The coating applicator's facilities shall be subject to approval by the Engineer. Applications for approval of facilities shall be made to the Engineer by the coating applicator.

2. Surface Preparation:

The surface of bars to be coated shall be blast cleaned in accordance with the Steel Structures Painting Council-Surface Preparation Specification No. 10 (SSPC-SP10), Near White Blast Cleaning. After blasting, the cleaned surface of the bar shall be as defined by SSPC-Vis 1, Pictorial Standards Asa 2 1/2, or CSa 2 1/2 as applicable.

The powdered epoxy resin coating shall be applied to the cleaned surface as soon as possible after cleaning and before visible oxidation occurs. In no case shall more than eight (8) hours elapse between cleaning and coating.

3. Coating Application:

The powdered epoxy resin coating shall be applied in accordance with the requirements of the coating manufacturer. The epoxy coating may be applied before or after fabrication of the dowel bars.

4. Coating Thickness:

The epoxy coating shall be applied as a smooth uniform coat. After curing, the coating thickness shall be a minimum of seven (7) mils. Coating thickness shall be controlled by taking measurements on a representative number of bars from each production lot.

5. Continuity of Coating:

The coating shall be checked visually after cure for continuity. It shall be free of holes, voids, contamination, cracks and damaged areas.

The coating shall not have more than two (2) holidays (pinholes not visible to the naked eye) in any linear foot of the coated bar. A holiday detector shall be used, in accordance with the manufacturer's instructions, to check the coating for holidays.

6. Coating Cure:

The coating applicator shall check each production lot to determine that the entire production lot of coated bars is in a fully-cured condition.

7. Quality Control:

The coating applicator shall be responsible for performing quality control and tests. This will include inspection for compliance with the requirements of Coating Thickness, Continuity of Coating and Coating cure.

402-2.03 Plant Inspection:

The Engineer reserves the right to have its authorized representative observe the preparation, coating and test of the dowel bars. The representative shall have free access to the

plant, and any work done when access has been denied shall be automatically rejected.

If the representative elects, lengths of coated bars may be taken from the production run on a random basis, for test, evaluation and check purposes by the Engineer.

402-2.04 Shop Repair of Coated Bars:

Epoxy coated dowel bars which do not meet the requirements for Coating Thickness, Continuity of Coating, or Coating Cure shall not be repaired.

Reinforcement bars with these defects shall be replaced or alternately, stripped of epoxy coating, recleaned and recoated in accordance with the requirements of these specifications.

Coating breaks due to fabrication and handling shall be repaired with patching material if the defective area is greater than the cross-sectional area of the reinforcement bar. Defects which are smaller than the cross-sectional area need not be repaired.

The repair of coating breaks shall be limited to bars of which the total of the defective coating areas does not exceed five (5) percent of the surface area of the dowel bar. Bars with greater than five (5) percent damage shall be replaced or alternately, stripped of epoxy coating, recleaned and recoated in accordance with the requirements of this specification.

402-2.05 Field Repair:

The Subcontractor shall be required to field repair damaged areas of the bar coating, and to replace bars exhibiting severely damaged coatings. The material used for field repair shall be that supplied by the coating applicator.

Field repair shall be performed wherever the area of coating damaged exceeds the cross-sectional area of the dowel bar.

Field repair shall not be allowed on bars which have severely damaged coatings. A severely damaged coating is defined as coating which has a total damaged area greater than five percent of the surface area of the dowel bar as determined by the Engineer. Dowel bars having severely damaged coating as determined by the Engineer, shall not be incorporated in the work and shall be removed from the work site. All such bars shall be replaced in kind by the Subcontractor at no additional coat to the Engineer.

Anchor straps shall conform to the requirements on the project plans.

All legs, spacer bars and tie bars shall conform to the requirements of Section 1003 of these specifications..

402-3 Construction Requirements:

Load transfer dowel assemblies shall be placed at each transverse weakened plane joint as shown on the project plans.

Dowel assemblies shall be constructed such that the dowels are placed at mid-depth of the slab and centered about the weakened plane joint.

Dowel bars shall be placed to a vertical and a horizontal tolerance of ± 1/2 of an inch of the specified depth, centering, and spacing.

Dowel bars shall be placed parallel to the pavement center line and pavement surface within a tolerance of ± 3/8 inch for the full dowel length.

Dowel assemblies shall be secured in position on the prepared base in a manner that will hold the assembly in position without disruption throughout construction. Wires or bars used to maintain the assemblies' shape for shipment shall be removed prior to placing concrete if, in the opinion of the Engineer, the wires or bars will offer restraint to early shrinkage of concrete or if the wires or bars extend across transverse joints.

The location of each dowel assembly shall be marked outside the limits of the pavement construction operations in such a manner as to insure the centering of the saw cut about the dowel location.

The Subcontractor shall supply equipment and methods of operation such that there is no interference with or movement of dowel assemblies. Final dowel positions shall not exceed the placement tolerances specified above.

Immediately prior to concrete placement, the dowel bars shall be uniformly coated with a thin film of heavy waterproof grease for the full length of the dowel.

402-4 Submittals:

The Subcontractor shall furnish a Certificate of Compliance from the coating applicator with each shipment of coated bars. The Certificate of Compliance shall (1) verify that the coated bars and coating material have been tested in accordance with the requirements of these specifications, (2) state the actual test results for each requirement, and (3) state that the actual test results comply with the requirements.

Submittals shall conform to the requirements of Section 105 of these specifications.

402-5 Method of Measurement:

Load transfer dowel assemblies will not be measured for payment, but will be considered as included in contract items.

SECTION 404 BITUMINOUS TREATMENTS

404-1 Description:

The work under this section shall consist of furnishing all materials and constructing or applying a single or multiple course bituminous treatment in accordance with the requirements of these specifications and in reasonably close conformity with the lines shown on the project plans or established by the Engineer.

The kind of bituminous treatment may consist of one (1) or a combination of the following:

Prime Coat
Tack Coat
Chip Seal Coat

404-2 Materials:

404-2.01 Bituminous Materials:

The bituminous material shall be of the type and grade specified in the special provisions and shall conform to the requirements of the following Subsections:

Asphalt Cement	1005-3.01
Liquid Asphalt	1005-3.02
Emulsified Asphalt	1005-3.03
Emulsified Asphalt (Special Type)	1005-3.04

Application temperatures of bituminous materials shall conform to the requirements of Table 1005-5 of these specifications.

404-2.02 Aggregate Materials:

(A) General:

There is no Engineer-furnished source of aggregate material. The Subcontractor shall provide a source in accordance with the requirements of Section 1001 of these specifications.

Aggregate material will be sampled for acceptance in the final stockpile before incorporation into the work. The aggregate material will be deemed to be acceptable when the test values for each specified aggregate characteristic are within the specified limits.

(B) Blotter Material:

Blotter material shall be a natural sand, crushed sand, volcanic cinders, or other approved material and shall be free of deleterious amounts of foreign substances.

The grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	80-100
No. 16	45- 80
No. 200	0- 5.0

(C) Cover Material:

Aggregate for cover material shall be of clean sand, gravel or crushed rock and shall be free from lumps or balls of clay and shall not contain calcareous or clay coatings, caliche, synthetic materials, organic matter or foreign substances.

The grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201.

The chip seal road in Loop Road A shall be one-quarter (1/4) inch maximum size as shown in Section 1104 of these specifications.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	0- 25
No. 8	0- 5
No. 200	0- 2.0

A representative portion of the coarse material will be taken and tested.

The loss on abrasion will be determined in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

Maximum loss of nine (9) percent at one-hundred (100) revolutions.

Maximum loss of forty (40) percent at five-hundred (500) revolutions.

The percent of carbonates in aggregate shall be a maximum of thirty (30) when tested in accordance with the requirements of Arizona Test Method 238.

The percent of crushed faces shall be at least seventy (70) when tested in accordance with the requirements of Arizona Test Method 212.

The Flakiness Index shall be a maximum of twenty-five (25) when tested in accordance with the requirements of Arizona Test Method 233.

The Bulk Specific Gravity shall range from 2.30 to 2.85 when tested in accordance with the requirements of Arizona Test Method 211.

404-3 Construction Requirements:

404-3.01 Weather Limitations:

Bituminous material used in chip seal coats shall be applied to an existing bituminous surface only when the existing bituminous surface is dry and the pavement surface temperature is at least eighty-five (85) degrees Fahrenheit.

Bituminous material used in prime coats shall normally be applied to an existing aggregate surface only when the ambient air temperature in the shade is at least seventy (70) degrees Fahrenheit and when the existing aggregate surface is slightly damp.

Despite the required minimum surface temperature and surface condition, the Engineer, at any time, may require that work cease or that the work day be reduced in the event of weather conditions either existing or expected which would have an adverse effect upon the bituminous treatment.

Chip seal shall not be applied for at least seven (7) days after completion of new bituminous paving.

The chip seal shall be placed only when the roadway surface is dry and there is no imminent threat of rain. The ambient temperature must be at least sixty degree (60°) Fahrenheit and rising.

Caution should be exercised in the placement of asphalt chip seal between the dates of October 1 and April 1.

404-3.02 Equipment:

(A) Distributor Truck:

Distributor trucks shall be of the pressure type with insulated tanks. Gravity distributors will not be permitted.

Spray bars and extension shall be of the full circulating type. The spray bar shall be adjustable to permit varying height above the surface to be treated.

The nozzle spacings, center to center, shall not exceed six (6) inches. The valves shall be operated so that one or all valves may be quickly opened or closed in one (1) operation. The valves which control the flow from the nozzles shall be of a positive acting design so as to provide a uniform, unbroken spread of bituminous material on the surface.

The distributor shall be equipped with devices and charts to provide for accurate, rapid determination and control of the amount of bituminous material being applied. The distributor shall be equipped with a tachometer of the auxiliary wheel type registering speed in feet per minute. The distributor shall also be equipped with pressure gauges and an accurate thermometer for determination of the temperature of bituminous material. The spreading equipment shall be designed so that uniform application of a bituminous material can be applied in controlled amounts ranging from 0.05 to 2.0 gallons per square yard. Transverse variation rate shall not exceed ten (10) percent of the specified application rate. The distributor shall be equipped with a hose and nozzle attachment to be used for spotting skipped areas and areas unaccessible to the distributor and booster tanks shall be maintained as to prevent dripping of bituminous material from any part of the equipment.

Equipment which fails to provide an acceptable application of bituminous material shall be removed from the project.

(B) Power Brooms:

Power brooms shall be of the rotary type equipped, maintained and operated so that the bristles are of reasonably uniform length and capable of cleaning without gouging or tearing the surface.

(C) Rollers:

Rollers shall be of the oscillating type having a width of not less than four feet with pneumatic tires of equal size and diameter and with treads satisfactory to the Engineer. Wobble-wheel rollers will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be inflated to ninety (90) pounds per square inch, or such lower pressure as designated by the Engineer, and maintained so that the air pressure will not vary more than five (5) pounds per square inch from the designated pressure. Pneumatic tired rollers shall be constructed so that the total weight of the compactor can be varied to produce an operating weight per tire of not less than two-thousand (2,000) pounds. The total operating weight of the roller shall be varied as directed by the Engineer.

The roller shall not travel in excess of twelve (12) miles per hour.

(D) Aggregate Spreaders:

Aggregate spreaders shall be self-propelled continuous feed units supported by at least four (4) wheels equipped with pneumatic tires mounted on two (2) axles.

Aggregate spreaders shall be equipped with positive controls so that the required amount of material will be deposited uniformly over the full width of the bituminous material. Aggregate application rates are expected to vary from four (4) to forty (40) pounds per square yard, depending on the type of construction.

Where it is necessary to apply aggregate at a rate less than four (4) pounds per square yard, other means such as a sand slinger may be used with the approval of the Engineer.

404-3.03 Traffic Control:

In the construction or application of a bituminous treatment, the treated roadway surface shall not be used by the Subcontractor, his agents, or others until it has been definitely established to the satisfaction of the Engineer that it will not be damaged or marred under the action of traffic. No traffic of any description shall be allowed on any bituminous application until approved by the Engineer. The Subcontractor shall erect and maintain approved barricades, signs and other traffic control devices and shall use every possible means to protect the work and to exclude traffic from the roadway surface for as long a time as may be required. Traffic shall be handled in the manner most convenient to the traveling public. When traffic is handled on a one (1) way basis, the Subcontractor shall provide such flagmen and pilot trucks as deemed necessary to insure adequate protection for the roadway surface. Traffic may be detoured around the work, provided that detours are constructed and maintained in a satisfactory manner and properly signed. When it is necessary to provide for traffic across a bituminous treated surface, the crossing shall be blotted with material, as directed, before the crossing is opened to traffic.

404-3.04 Preparation of the Surface:

Immediately before applying the bituminous material, the area to be surfaced shall be cleaned of dirt and other objectionable material.

When the work consists of a chip seal coat or when blotter material is applied, self-propelled rotary power brooms along with hand brooms, if necessary, shall be used immediately in advance of applying the bituminous material.

When a bituminous treatment is to be applied to an existing aggregate surface, the surface shall be uniformly smooth, firm and reasonably true to grades and cross sections as shown on the project plans, and shall be so maintained throughout the placing of the bituminous treatment. In no event shall a bituminous treatment be placed on a soft, uneven base. Any holes, depressions or irregularities shall be repaired. All loose and unsuitable material shall be removed and replaced by suitable material, which shall be compacted to produce a dense surface conforming to the adjacent area. Uniformity of surface texture is of the utmost importance.

When required, the existing aggregate surface on which the bituminous treatment is to be placed shall be lightly bladed, watered and compacted immediately prior to the application of bituminous material. In extremely dry areas, additional light applications of water may be required prior to the application of the bituminous material to facilitate penetration of the bituminous material.

404-3.05 Application of Bituminous Material:

The bituminous material shall be applied as soon as possible after preparation of surfaces. At the time of application, temperatures of the asphalt shall be within the ranges specified in Table 404-1 of these specifications. The Engineer may require a specific temperature within the ranges.

For each kind of bituminous treatment, the type and grade of bituminous material will be specified. The variation from the specified rate of application shall not exceed ten (10) percent.

For each kind of bituminous treatment, the approximate rate of bituminous material to be applied will be specified in the special provisions; however, the Engineer will specify the exact rate based on the surface to be treated and the characteristics of the aggregate material. The rate to be applied for each kind of bituminous treatment may vary substantially because of different surface conditions within the project limits.

The bituminous material shall be uniformly applied to the prepared surface at the rate specified by the Engineer and in one (1) application.

Bituminous materials shall be heated by a retort or steam coils in such a manner that steam will not be introduced directly into the bituminous material.

The various types or grades of bituminous materials shall be mixed with materials or applied at temperatures within the limits given in Table 1005-5 of these specifications and at no time shall the

Subcontractor increase the temperature of the bituminous material above the higher limit specified.

When a chip seal coat is applied, the spray bars on the distributor truck shall be controlled by a boot man riding at the rear of the distributor where the operation of all sprays is in his full view.

In order to obtain uniform distribution, the distribution shall be promptly started or stopped at the junction of two (2) applications in a manner that will not result in overlaps or gaps in the applications.

The distribution shall be promptly cut off prior to the decrease in uniform flow caused by the distributor tank becoming empty, when there is a decrease in uniform flow due to any reason whatever, or when the forward movement of the distributor slows down or stops.

In the event that any spots are missed in the application or any areas develop that do not have a uniform spread or penetration, such areas shall be remedied without unnecessary delay as directed.

Care shall be taken to prevent the spraying or splattering of bituminous material on adjacent pavements, structures, curb, guard rail, trees and shrubbery or any other object outside of the area designated for spraying.

Unused bituminous material shall not be disposed of within the right-of-way lines, unless permitted by the Engineer.

404-3.06 Application of Cover Material:

Immediately following the application of the bituminous material, the chips shall be spread with a self-propelled mechanical spreader. The chip spreading equipment shall be capable of applying a uniform application of cover material. The self-propelled requirement may be waived for projects under ten-thousand (10,000) sq. yds.

At the time of application, precoated aggregate shall be within the temperature range of two-hundred-fifty (250) degrees Fahrenheit and three-hundred-fifty (350) degrees Fahrenheit measured at a point six (6) to twelve (12) inches below the top of the load.

At the time of application, uncoated chips shall not contain moisture in excess of a saturated, surface dry condition when liquid or paving grade asphalt are used as the seal coat binder.

At the time of application, chips shall be surface wet but free from running water when emulsified asphalt is used as the seal coat binder.

The precise application rate for cover material will be determined by the Engineer within the ranges of fifteen (15) to twenty-five (25) lbs./sq. yd. for the one-quarter (1/4) inch size and twenty (20) to thirty (30) lbs./sq. yd. for the three-eighth (3/8) inch size.

When so directed by the Engineer and within forty-eight (48) hours after application of the precoated chips, all chipped surfaces on major streets shall receive a flush coat in accordance with Section 333 of MAG specifications. The exact rate of application shall be as directed by the Engineer.

404-3.07 Rolling Cover Material:

Following the spreading of cover material, the surface shall be promptly rolled with self-propelled pneumatic tired compactors. A sufficient number of compactors shall be provided to cover the width of the material spread in one pass of the compactors and this rolling shall continue until a minimum of three passes has been completed.

404-3.08 Removing of Loose Cover Material:

All loose cover material shall be removed from the paved surface by brooming in not less than twelve (12) hours nor more than thirty-six (36) hours after application; however, if because of weather conditions, temperature or other reasons, the Engineer determines that conditions are not conducive to obtaining the best results, brooming shall be discontinued until the Engineer has considered all conditions and has determined the best time for the removal of the cover material. The cover material shall be removed by means of a power broom which shall be in good condition and of a design suitable for the work. The action of the broom shall be such that particles which are stuck to the bituminous material will not be dislodged.

404-3.09 Application of Blotter Material:

The approximate amount of blotter material, when required as a part of a bituminous treatment, will be specified in the special provisions; however, the Engineer will specify the exact rate to be applied based on the characteristics of the bituminous treated surface.

Blotter material, at the time of spreading, shall be at least as dry as material dried to a saturated surface dry condition in accordance with the requirements of Arizona Test Method 211.

Blotter material shall be uniformly spread by means of a sand slinger or other equipment approved by the Engineer. Any oversize aggregate or foreign material picked up during stockpiling or

loading operations shall be eliminated before entering the spreader. Supplemental spreading or smoothing shall be done by hand methods where necessary.

Prior to final acceptance and when ordered by the Engineer, the Subcontractor shall remove and dispose of any excess blotter material. The method of removal and the disposal of any excess blotter material shall be the Subcontractor's responsibility.

404-3.10 Joints:

Transverse joints shall be made with the preceding work, at intersections and at all existing pavements and structures. Transverse joints shall be made by any method approved by the Engineer prior to the start of the work.

Longitudinal joints shall be butt joints.

Joints shall be cleaned as deemed necessary by the Engineer prior to the application of bituminous material in the adjacent strip.

Regardless of the width of the roadway to be sealed, the number of longitudinal joints shall be kept to a minimum and shall be located to the greatest degree possible so that they will coincide with painted lines between traffic lanes.

404-3.11 Prime Coat:

The Subcontractor shall furnish emulsified asphalt, grade SS-1h, SS-1, or otherwise approved grade material. The application rate is 0.6 gal/s.y. unless otherwise approved by the Engineer, MC grade is not acceptable.

When it is deemed necessary, areas having excess bituminous material shall be blotted with material as directed.

When so directed, the surface of the completed prime coat shall be rolled with a pneumatic tired roller.

The integrity of the prime coat shall be maintained at all times until the next course is placed or until final acceptance. In the event traffic has caused holes or breaks in the surface, such holes or breaks shall be satisfactorily repaired by the Subcontractor.

404-3.12 Tack Coat:

Tack coat shall be applied to a primed surface or to the surface between layers of bituminous mixed materials.

The material to be used for bituminous tack coat will be specified by the Engineer and shall conform to the requirements of Section 1005 of these specifications.

The type, grade or designation, and the rate of application for the specific usage will be specified by the Engineer. The following table shows the various types of material and the approximate application rates from which the Engineer may select the tack coat:

Approximate

Application Rates, Gal. per Sq. Yd.

Type, Grade or Designation	All Other Tack Coats
Emulsified Asphalt (Special Type)	0.12
Emulsified Asphalt (Other than Spec. Type)	0.08
Asphalt Cement (Grade Spec. by Engr.)	0.06

If emulsified asphalt of any designation or type is used it shall have broken before asphaltic concrete is placed. If held over night, the emulsified asphalt shall be reheated and agitated prior to further application.

The Engineer may either reduce the rate to be applied or eliminate the use of tack coat in any part of the work if, in his judgment, the bituminous mixed material to be placed will be effectively bonded to the underlying surface; however, in the case of asphalt cement applied immediately prior to placing the asphaltic concrete friction course, the Engineer may adjust the rate to be applied within the stated limits.

Bituminous material shall be applied only as far in advance of the placement of the bituminous mixed materials as is necessary to obtain the proper condition of tackiness. In no event shall more bituminous material be applied in one (1) day than will be covered by bituminous mixed materials during that same day.

404-3.13 Blank:

404-3.14 Chip Seal Coat:

The Subcontractor shall furnish cationic rapid set emulsified asphalt, Type CRS-2p grade material or approved equal. It shall contain polymer modifier. Emulsified asphalt shall meet the requirements of Section 1005-3.03 of these specifications.

The aggregate shall be precoated prior to spreading. The emulsion shall be applied to the pavement surface prior to spreading the aggregate. Additional emulsion as approved by the Engineer shall be applied after rolling to minimize pull-up of aggregate during use.

When tested in accordance with ASTM C-136 and C-117, gradation shall comply with table shown below:

Sieve Size	**Percent Passing**
1/2 inch	100
3/8 inch	90-100
No. 4	5- 30
No. 8	0- 10
No. 30	0- 5
No. 200	0- 2

Precoated Chips:

The aggregate shall be heated and precoated with emulsified asphalt as specified in Section 1005 of these Specifications. The quantity of bituminous material used shall not be more than 0.50 percent of the combined weight of the bituminous material and the aggregate.

The final percentage of asphalt used for coating shall be as directed by the Engineer. The precoating shall be done in a pug mill mixing facility for a minimum of thirty (30) seconds or until the asphalt is present on the aggregate, whichever is greater. With approval of the Engineer, a drum mix plant may be used; however, the end result shall produce a uniform, dust-free product.

TABLE 404-1
APPLICATION TEMPERATURE OF EMULSIFIED ASPHALTS

Grade of Emulsified Asphalts	Distributor Application Temperature, Degree F.	
	Min.	Max.
CRS-2p	125	185
SS-1, SS-1h	75	130

The quantity of CRS-2p emulsified asphalt will be between the range of 0.20 and 0.40 gals./sq. yd. The exact rate of application will be determined by the Engineer.

The bituminous material shall be placed using a distributor as specified. Application methods shall ensure that a uniform distribution is obtained over the area to be sealed.

The chips shall be spread before the bituminous material sets. The maximum distance that the bituminous material is applied in advance of the chips will be determined by the Engineer.

The surfaces of structures, trees and shrubbery adjacent to the areas being seal-coated shall be protected in such a manner as to prevent their being spattered with bituminous material or marred. The Subcontractor shall be responsible for all damage to such structures or landscaping.

Cover material shall be applied at the rate of approximately 0.01 cubic yard per square yard however, the Engineer will specify the exact rate to be applied based on the characteristics of the aggregate material and the surface to be treated.

The Subcontractor shall submit a minimum seventy-five (75) pound sample of cover material to the Engineer at least ten (10) calendar days prior to beginning application of the cover material for testing.

Chip seal coat shall be placed between the dates shown as applicable to the average elevation of the project.

Average Elevation of Project, Feet	**Beginning and Ending Date**
0 - 3,499	March 15 to May 31 and September 1 to November 15

The minimum traffic free period for a newly-applied chip seal coat shall be three (3) hours; however, the Subcontractor's hauling equipment may use the new seal coat during the traffic free period at a speed not to exceed fifteen (15) miles per hour. After the traffic free period, yet prior to removing the loose cover material, all traffic allowed by the Engineer shall be limited to a speed not to exceed twenty-five (25) miles per hour.

404-4 Tests:

The chips' weight loss shall not exceed forty (40) percent at five-hundred (500) revolutions where tested in accordance with ASTM C-131.

The chips shall not show a loss in excess of twelve (12) percent when tested in accordance with AASHTO T-104 (Sodium Sulfate Soundness).

A minimum of seventy-five (75) percent of the material, by weight, retained on the No. eight (8) sieve, shall have at least one (1) fractured face produced by the crushing operation.

404-5 Submittals:

At least two (2) weeks prior to applying bituminous surface treatment and construction, the Subcontractor shall submit the six (6) copies of the following:

(1) Bituminous surface treatment:

A detailed sequence and schedule of bituminous surface treatment, placement and construction.

(2) Traffic Control Plan:

A traffic control plan for bituminous surface treatment operations which includes provisions of barriers and other traffic units.

(3) Certificate of Compliances:

The Subcontractor shall submit the Certificates of Compliance from the manufacturer of all materials, including but not limited to, aggregates, asphalt cement, liquid, asphalt, emulsified asphalt, and emulsified asphalt-special type.

(4) Alternate Bituminous Treatment:

An alternate bituminous treatment plan may be submitted if the owner or Subcontractor chooses to use similar material.

The Subcontractor shall not start the work until after the submittals are approved.

404-6 Method of Measurement:

Prime will be measured by the ton of bituminous material. Measurement will be made only for the quantity of bituminous

material used in accordance with the requirements of these specifications.

Blotter will not be measured for payment.

Tack will be measured by the ton of bituminous material which shall include hours for applying.

Bituminous material that is required to be diluted prior to application will be measured by the ton of diluted material.

Chip Seal Coat will be measured by the square yard which includes finish application, asphalt and chips - complete in place.

SECTION 406 ASPHALT CEMENT

406-1 Description:

Asphalt Cement shall conform to the requirements of Section 416 and 1005 of these specifications.

The grade to be used shall be AC-30 for the Asphaltic Concrete Roads shown on the project plans.

406-2 Method of Measurement:

Asphalt Cement will be measured as per Section 416 of these specifications.

SECTION 407 MINERAL ADMIXTURE

407-1 Description:

Mineral Admixture shall conform to the requirements of Section 416.

407-2 Method of Measurement:

Mineral Admixture will be measured as per Section 416.

SECTION 408 POLYMER ASPHALT CEMENT MORTAR:

408-1 General Requirements:

The work under this section shall consist of furnishing all materials and constructing or applying polymer asphalt cement mortar in accordance with the requirements of these specifications and as shown on the project plans.

The subcontractor shall furnish polymer asphalt cement which shall be petroleum asphalt prepared by refining of crude petroleum and modified with a polyolefin based polymer supplied by Exxon Chemical to provide the modified asphalt properties specified below. For asphalt containing an anti-stripping additive, requirements will be extended five percent for all characteristics except softening point and flash point.

408-2 Materials:

408-2.01 Polymer Asphalt Cement Test:

The polymer asphalt cement shall conform to the following requirements when tested in accordance with the specified test method:

Test	Test Method	Limits
Compatibility, 16 hrs. 275°F	ECA-01	Homogeneous
Penetration at 77°F, dmm	AASHTO T 49	40 Min.
Viscosity at 275°F, cst	AASHTO T 201	150-2000
Ring & Ball (R&B) Softening Point, Deg.,F	AASHTO T 53	145 Min.
Penetration at 39.2°F, 200g., 60 sec, dmm	AASHTO T 49	12 Min.
Flash Point, Cleveland Open Cup (COC), Deg. F	AASHTO T 48	425 Min.
After Rolling Thin Film Oven (RTFO) (AASHTO T 240):		
Penetration Ratio at 77°F Unaged/Aged	AASHTO T 49	4.0 Max.
Mass Loss %	AASHTO T 240	1.0 Max.

408-2.02 Tack Coat:

The tack coat shall be applied to surface area using AC-30 with 3% anti-stripping additive at a rate that is determined by the engineer (0.05 to 0.15 gal per sq. yard).

408-3 Construction Requirements:

The subcontractor shall use the equipment as described in Section 404 of these specifications.

The subcontractor shall prepare the surface as described below.

Immediately before applying the mortar, the area to be surfaced shall be cleaned of dirt, loose material, and other objectionable material. On this project power brooms may be used. When necessary, cleaning shall be supplemented by hand brooms. Water flushing will not be permitted in areas where cracks are present in the pavement surface.

The mortar shall not be applied until an inspection of the surface has been made by the Engineer and he has determined that it is suitable.

408-3.01 Tack Coat:

A tack coat shall be applied in accordance with Section 404 of these specifications.

408-3.03 Composition of the Polymer Asphalt Cement Mortar Mix:

The composition of mix should conform to mix designs which have been submitted and/or adjusted by the engineer prior to construction.

408-3.04 Weather limitations:

The mortar shall not be applied unless the ambient temperature is at least 65°F and rising. The mixture shall not be applied during unsuitable weather.

408-3.05 Protection of Uncured Surface:

Adequate methods such as barricades shall be used to protect the uncured surfaces from all types of traffic.

408-3.06 Mixing and Application:

The mix shall be uniform in mixture and gradation with no segregation to be allowed. The mix should be stored during construction in some type of heated storage vessel to maintain the appropriate temperature of the mix as specified by the engineer. The mix shall be placed in such a manner that the surface is free of marks or blemishes from hand rakes or rollers. Transverse joints shall be kept to a minimum. A vibratory plate compactor shall be used to compact this mixture. A minimum of two passes with this vibratory plate is required with this mix and is subject to the approval of the engineer.

408-3.07 Rolling:

As soon as the asphalt mortar has been set sufficiently to prevent any material from bigh picked up, it shall be rolled until all ridges have been ironed out and a uniform surface is obtained. (At least two (2) passes with a vibratory plate compactor.

408-4 Submittals:

At least two weeks prior to applying polymer asphalt mortar surface treatment and construction, the subcontractor shall submit six (6) copies of the following:

1. Polymer Asphalt Cement Mortar Mix Design

2. Special construction methods.

408-5 Method of Measurement:

Polymer Asphalt Cement Mortar will be measured by the Square Yard which includes tack, bituminous binder and aggregate complete, in place.

SECTION 409 ASPHALT CEMENT MORTAR:

409-1 General Requirements:

The work under this section shall consist of furnishing all materials and constructing or applying asphalt cement mortar in accordance with the requirements of these specifications and as shown on the project plans.

The materials and construction requirements for asphalt cement mortar shall comply with the requirements of Section 408, except paragraph 408-2.01.

The bituminous material shall be AC-30.

SECTION 416 ASPHALTIC CONCRETE - END PRODUCT

416-1 Description:

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture if required, and an asphalt cement to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications.

It is the intent of this specification that the subcontractor acquire and make all arrangements for a source or sources of material; that he furnish Certificates of Compliance as hereinafter specified; that he furnish a mix design which will meet the design criteria specified hereinafter; and that he provide all the equipment, materials, and labor necessary to furnish and place the asphaltic concrete in accordance with the requirements specified herein.

The subcontractor is advised that the Engineer will not take samples for quality control and will in no manner assist in any degree or in any aspect of the subcontractor's operation in the production of asphaltic concrete, beginning from the production of aggregate through the compaction of the asphaltic concrete.

Because of the very limited degree of participation by the Engineer, it is understood that the subcontractor will provide personnel capable of producing, placing, and compacting of aggregates and asphaltic concrete, and for all areas of quality control so that the acceptance of all materials, as hereinafter specified, will be free of penalties.

The subcontractor's attention is called to the special materials, placement and finishing requirements related to the curved portions of the Oval Track and other special surfaces as described in Division XI of these specifications.

416-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed by the subcontractor on the basis of the following criteria and tested in accordance with the requirements of the following test methods:

	Criteria	Requirements 1/2" Mix	3/4" Mix	Arizona Test Method
1.	Voids in Mineral Aggregate, Percent, Range	15.5-18.5	15.0-18.0	815
2.	Effective Voids, Percent, Range	3.5-4.5	4.0-5.0	815
3.	Absorbed Asphalt, Percent, Range	0-1.0	0-1.0	815
4.	Index of Retained Strength, Percent, Minimum	50	50	802
5.	Wet Strength, psi, Minimum	150	150	802
6.	Stability, Pounds, Minimum	2000	2000	815
7.	Flow, 0.01 Inch, Range	8-16	8-16	815

MINERAL AGGREGATE GRADING LIMITS

Sieve Size	Percent Passing 1/2" Mix No Admix.	1/2" Mix Incl. Admix.	3/4" Mix No Admix.	3/4" Mix Incl. Admix.
1"			100	100
3/4"	100	100	90-100	90-100
1/2"	90-100	90-100	----	----
3/8"	70- 85	70- 85	65- 80	65- 80
No. 8	43- 51	44- 52	40- 49	41- 50
No. 40	12 -20	13- 21	12 -20	13- 21
No. 200	2.0-5.0	3.0-6.5	2.0-5.0	3.0-6.5

416-3 Materials:

For comparative purposes, quantities shown on the project plans have been calculated based on the following data:

	1/2" Mix	3/4" Mix
Unit Weight, Pounds per Cubic Foot	145.0	145.0
Percent, Asphalt Cement	5.5	5.5
Percent, Mineral Admixture (1)	2.0	2.0

(1) Percent of dry weight of aggregate

416-3.01 Mineral Aggregate:

The subcontractor shall provide a source of material in conformance with the requirements of Section 1001 of the Standard Specifications and any modifications thereto as set forth elsewhere in these special provisions.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	AASHTO T 85, Arizona Test Method 211	2.35 - 2.85
Combined Water Absorption	AASHTO T 85, Arizona Test Method 211	0 - 2.50
Sand Equivalent	AASHTO T T176	Minimum 45
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Crushed Faces	Arizona Test Method 212	Minimum 50% (1/2" Mix) Minimum 50% (3/4" Mix)

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be the source of mineral aggregate. All sources shall meet the requirements for abrasion.

416-3.02 Mineral Admixture:

When the mix design includes a mineral admixture, the amount used shall be 1.0 to 2.0 percent, by weight, of the mineral aggregate, with the exact amount to be specified in the mix design. Mineral admixture shall be either portland cement, blended hydraulic cement or lime conforming to the following requirements:

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Lime	ASTM C 977

416-3.03 Bituminous Material:

Bituminous material shall be asphalt cement conforming to the requirements of Section 1005 of the Standard Specifications. The grade to be used shall be AC-30.

416-3.04 Certification and Testing:

A Certificate of Compliance conforming to the requirements of Section 105 of the Standard Specifications shall be furnished before asphaltic concrete production commences for all material characteristics listed hereinbefore where a test requirement is specified. Tests on aggregates shall be performed on materials furnished for mix design purposes and composited to the mix design gradation and shall be representative of materials used in subsequent production.

416-4 Mix Design:

Utilizing mineral aggregate which has been crushed, processed, separated and stockpiled, a mix design shall be formulated and submitted by the subcontractor to the Engineer.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing.

The mix design shall be prepared by a mix design laboratory that has met the requirements of the Engineer's system for the evaluation of testing laboratories.

The use of a mix design developed for a previous project under these specifications may be proposed by the subcontractor provided the methods of producing mineral aggregate has not changed since the development of the mix design, the asphalt cement and mineral admixture type and source of supply have not changed, the mix design test values meet all current specification requirements, and the previous use of the mix design was satisfactory to the Engineer. The Engineer will determine whether a previously used mix design can be approved for use based upon the evidence provided by the subcontractor of current stockpile gradations, crushed faces, and sand equivalent, and the evidence provided by the subcontractor that the results obtained during production under the previously used mix design were satisfactory. Should the Engineer question the evidence provided or determine the previous use was not satisfactory, the subcontractor shall prepare and submit a new mix design in accordance with these specifications.

The mix design shall contain as a minimum:

(1) The name and address of the testing organization and the person responsible for the mix design testing.

(2) The specific location(s) of the source(s) of mineral aggregate.

(3) The supplier, refinery, and type of asphalt cement, and the source and type of mineral admixture, and the percentage of each to be used.

(4) The anticipated mineral aggregate gradation in each stockpile.

(5) Mix design gradation.

(6) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, crushed faces, immersion compression results (Index of Retained Strength, wet and dry strengths), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density. Historical abrasion values may be supplied on existing sources.

The mix design shall be submitted on a laboratory bituminous mixture design form and signed by a person authorized by the subcontractor to act in such matters on his behalf.

The mix design and representative samples of the mineral aggregate used for the mix design shall be submitted to the Engineer for determination of sand equivalent at least two working days prior to the start of asphaltic concrete production. The sand equivalent

will be determined in accordance with the requirements of AASHTO T-176. Should the sand equivalent determined by the Engineer be less than 90 percent of the value contained in the subcontractors mix design, the subcontractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in his aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information, for further action and resubmission by the subcontractor.

If the subcontractor elects to change his source of material, the subcontractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

Should a mix design prove unsatisfactory to the subcontractor during production, the subcontractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

416-5 Contractor Quality Control:

416-5.01 General Requirements:

It shall be the responsibility of the subcontractor to administer a Quality Control Plan, hereinafter referred to as the "Plan" sufficient to assure a product meeting the requirements of these specifications. The Plan shall meet the requirements of Subsection 106.04(B) of these specifications and the requirements specified below. The Plan may be operated wholly or in part by a second tier subcontractor or an independent organization, however, the Plan's administration, including compliance with the Plan and its modification, shall remain the responsibility of the subcontractor.

416-5.02 Elements of The Plan:

The Plan shall address all elements which affect the quality of the asphaltic concrete including, but not limited to the following:

(A) Mix Design
(B) Aggregate Production
(C) Quality of Components
(D) Stockpile Management
(E) Proportioning
(F) Mixing, including addition of Mineral Admixture, if required
(G) Placing and Finishing
(H) Joints
(I) Compaction

416-6 Construction Requirements:

The subcontractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading and finishing of asphaltic concrete and for the applying of bituminous material, such as tack coats, prime coats and provisional seals, all in accordance with the appropriate portions of the Standard Specifications. Documentation of the aforementioned items shall be in conformity to the requirements of the Arizona Department of Transportation Construction Manual.

Mixing plants shall conform to the requirements of AASHTO M 156 except as modified herein.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 325 degrees Fahrenheit. A recording pyrometer or other approved thermometric instrument sensitive to a rate of temperature change not less than ten degrees F. per minute shall be placed at the discharge chute of the drier so as to automatically record the temperature of the asphaltic concrete or mineral aggregate. A copy of the recording shall be delivered to the Engineer at the end of each shift of production.

If a mineral admixture is necessary to produce asphaltic concrete that meets the design criteria, the mineral admixture shall be mechanically mixed with the mineral aggregate prior to combining the mineral aggregate and asphalt cement. The Engineer may direct a spray of water be applied either to control the loss of the mineral admixture or to comply with any mix design requirements for wet mixing of aggregate and admixture.

If a drum mix plant is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. The mineral admixture shall be weighed across a weigh belt, or an approved alternative weighing system, with a weigh totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles without the aid of conveyor belts for a distance of at least 3 feet. Mixing devices which permit the aggregate to fall through mixing blades onto a belt or chute are not acceptable. The mixing devices rated capacity in tons per hour shall not be exceeded by the rate of aggregate feed to the mixer. The mixer shall be constructed to prevent the leakage of the contents. The mixer shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected on a belt prior to entry into the drum. The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates. If a batch plant is used, the

mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding asphalt cement.

The subcontractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphaltic concrete.

If a mineral admixture is used, a positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal system shall be placed between the metering device and the drum dryer, and utilized during production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impracticable.

Pavers shall be equipped with an activated screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time the Engineer may require the work to cease or that the work day be reduced in the event of weather conditions, either existing or expected, which would have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be wiped when necessary with an approved product in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on ten foot or wider shoulders that are to receive formed rumble strips, any longitudinal joint between the shoulder and the travel lane shall be located at the travel lane edge of the formed rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All outside edges shall be rolled while the mixture is still hot.

All holes where samples and cores are taken shall be repaired by the subcontractor utilizing hot asphaltic concrete. All holes shall be in a dry condition prior to repair.

The subcontractor shall schedule his paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the subcontractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The subcontractor shall schedule his paving operations in such a manner as to eliminate exposed longitudinal edges over weekends or holidays.

416-7 Acceptance:

416-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

Sand Equivalent

Coating of Mineral Aggregate
Material Spread
Gradation
Asphalt Cement Content
Effective Voids
Stability
Compaction
Smoothness

416-7.02 Sand Equivalent of Mineral Aggregate:

At any time during production, the Engineer may obtain and test samples of the mineral aggregate for determination of the sand equivalent. The sand equivalent will be determined by the engineer in accordance with the requirements of AASHTO T 176. Mineral aggregate will be accepted when the running average of three sand equivalent tests is equal to or greater than 90 percent of the sand equivalent determined in Subsection 416-4 of these specifications. When the mineral aggregate fails to meet this requirement, the subcontractor has the options of submitting a revised mix design conforming to the requirements of Subsection 416-4 of these specifications or correcting deficiencies in his aggregate stockpiles.

416-7.03 Material Spread:

A spread lot shall be considered to be one-half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(C)(1) of these specifications. Information pertaining to each lot shall be recorded by the subcontractor on forms provided by the Engineer.

Information recorded shall include the project number, date each spread lot was placed, the spread lot number, beginning and ending station, the project plans thickness and tons placed in each lot. The form shall be signed by the subcontractor and given to the Engineer at the end of each produced lot. The Engineer will calculate the quantity required in the area represented by the lot using the mix design weight per cubic foot. This calculation will be compared to the actual quantity placed.

A lot will be considered to be acceptable, if the actual spread quantity varies by no more than -2.0 to +5.0 percent from the required quantity.

416-7.04 Gradation, Asphalt Cement Content, Effective Voids and Stability:

A lot shall be considered to be one shift's production; however, production consisting of less than one shift, such as at the

beginning or at the completion of production will also be considered to be a lot. If changes are made in the mix design, new lots will be established.

Four samples shall be taken for each lot by the subcontractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples shall be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 and delivered to the Engineer, immediately after being taken. The minimum weight of the sample shall be 50 pounds. The Engineer will split the sample and save one-half for 30 days.

The material will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 416. Effective voids will be determined in accordance with the requirements of Section 9 of Arizona Test Method 416. Acceptance testing results will be furnished to the subcontractor within five working days of receipt of samples by the Engineer.

In the event the subcontractor elects to question the test results obtained for a particular lot, he may make a written request for additional testing of that lot. The samples previously saved will be tested in accordance with the requirements of Arizona Test Method 416 in an independent approved laboratory designated by the Engineer. New total percentage of lot within UL and LL, for all characteristics will be determined and the results of these determinations will be binding on both the subcontractor and the Engineer. The subcontractor shall pay for this testing; however, if a lot previously in reject is brought out of reject, the Engineer will reimburse the subcontractor for these costs. if a lot remains in reject, the subcontractor will not be reimbursed.

Should the average of the stability test results for a lot fall below 1750 for a 3/4" or 1/2" mix, production shall cease until the subcontractor proposes a corrective action the Engineer finds acceptable. Should corrective actions proposed by the subcontractor prove ineffective, production shall cease until the subcontractor submits a revised mix design.

The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each measured characteristics are as follows:

Measured Characteristic	**Lower Limit**	**Upper Limit**
Gradation		
3/8-inch sieve	TV-6.0	TV+6.0
No. 8 sieve	TV-5.5	TV+5.5
No. 40 sieve	TV-4.0	TV+4.0
No. 200 sieve	TV-2.0	TV+2.0
Asphalt Cement Content	TV-0.50	TV+0.50
Effective Voids	TV-2.0	TV+1.0

TV: Target Value

Note: Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the center of the tolerance range.

The subcontractor shall instruct the referee testing laboratory to provide copies of referee test results and all supporting laboratory test data to the Engineer immediately upon completion of any referee testing. Payment shall be provided by the subcontractor to the referee testing laboratory prior to the start of any referee testing.

416-7-05 Compaction:

Compaction control shall be the responsibility of the subcontractor. The number and types of rollers shall be the subcontractors responsibility and shall be sufficient to meet these requirements.

A lot for compaction purposes shall be identical to the lot described in Subsection 416-7.04 of these specifications. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(C)(3) of these specifications. Each lot shall be tested for acceptance.

Twenty samples shall be taken for each lot by the subcontractor, under the observation of the Engineer. The Engineer will designate 10 random locations within the lot and the subcontractor shall take two cores at each location. The Engineer will save one core from each location for 5 working days after written notification to the subcontractor of test results for the lot. Randomly selected locations will be determined to the nearest one-half foot in the transverse direction and to the nearest foot in the longitudinal direction of the pavement course; however, the outside one (1) foot of the unconfined pavement course will be excluded from testing. The areas of the pavement surface from one (1) foot inside of the traffic lane edge of a rumble strip to the outside edge of the shoulder will also be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course the compacted joint will not be excluded from the testing. Samples shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after the lot placement. The cores shall be delivered to the Engineer immediately upon being taken. The material will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing results will be furnished to the subcontractor within five working days of receipt of samples by the Engineer.

The minimum acceptable compaction levels as a percent of laboratory density is given in Appendix A. The laboratory density will be the

average of the four laboratory densities determined in Subsection 416-7.04 of these specifications.

Items not specified in Appendix A shall have a minimum density of 95%.

In the event the subcontractor elects to question the compaction test results obtained for a particular lot, he may make a written request for additional testing for that lot. The samples previously saved will be tested in an independent testing laboratory designated by the Engineer in accordance with the requirements of Arizona Test Method 415. The subcontractor shall pay for this testing; however, if a lot previously in reject is brought out of reject, the Engineer will reimburse the subcontractor for these costs. If a lot remains in reject, the subcontractor will rework the rejected lot.

416-7.06 Smoothness:

The final asphaltic concrete surface will be tested by the Engineer. The finished surface shall not vary more than 1/8 inch from the lower edge of a ten foot straightedge when the straightedge is placed longitudinal direction. All deviations exceeding the specified tolerance shall be corrected by the subcontractor.

416-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement and mineral admixture. Measurement will include any tonnage used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsection 416-7.04 of these specifications for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the subcontractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results.

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 416-6 of these specifications.

SECTION 501 PIPE CULVERT AND STORM DRAINS

501-1 Description:

The work under this section shall consist of furnishing pipe and all other materials required and the installing of pipe with joints and required accessories including excavating, and furnishing, placing and compacting backfill material, all in accordance with the details shown on the project plans and the requirements of these specifications.

At each location where a pipe is to be installed, the project plans will specify the size and approximate length at that location, such as the wall thickness, corrugation configuration, coatings, linings, class and strength. End sections shall be of the same material and coating as the pipe to which they are attached.

When trenching in excess of five feet is required, prior to construction the Subcontractor shall submit in writing to the Engineer a detailed description of his proposed trenching operations, including shoring methods.

501-2 Materials:

501-2.01 All materials shall conform to the requirements of Section 1010 of these specifications.

501-3 Construction Requirements:

501-3.01 Preparation of Foundations, Trenches, and Embankments:

A trench condition is defined as a trench which has vertical slopes to a point at least one (1) foot above the top of the pipe and its maximum width is as detailed on the project plans.

Unless specified otherwise, the Subcontractor may install pipe in either a non-trench condition or a trench condition in natural ground or in embankment.

Where rock, hardpan, or other unyielding material is encountered, such material shall be removed below the vertical limits as shown on the project plans. The depth to be removed shall be at least twelve (12) inches or as designated by the Engineer. The width to be removed shall depend on whether a trench or non-trench condition exists. If a trench condition exists, the width of the trench as shown on the project plans, shall be maintained throughout the additional depth. If a nontrench condition exists, the width of the removal shall be a minimum of the outside diameter of the pipe plus two (2) feet for pipe under four (4) feet in diameter, or a minimum of the outside diameter of the pipe plus three (3) feet for

pipe of four (4) feet or more in diameter. The overexcavated area shall be backfilled with structure backfill material as designated in Section 203-5.03(B)(1) of these specifications and compacted in layers not exceeding six (6) inches in depth.

When a firm foundation is not encountered at the bottom of the vertical limits as shown on the project plans due to soft, spongy, or other unstable soil, such unstable soil shall be removed for a width of at least the horizontal outside dimension of the pipe on each side of the pipe and to the depth specified by the Engineer. The unstable soil removed shall be replaced with structure backfill material as designated in Section 203-5.03(B)(1) of these specifications and compacted in six (6) inch lifts.

The completed foundation shall be firm for its full length and width. When specified on the project plans, the foundation shall have a longitudinal camber of the magnitude specified.

501-3.02 Bedding:

(A) Bedding Material:

(1) General:

Bedding material for all pipe shall conform to the following aggregate gradation:

Sieve Size	Percent Passing
1 1/2 inch	100
1 inch	90- 100
No. 8	35- 80
No. 200	0- 8

The plasticity index of the bedding material for all pipe shall not exceed eight (8) when tested in accordance with the requirements of AASHTO T 90.

Bedding material for all pipe shall have a value of resistivity not less than two-thousand (2,000) ohm-cm or the value shown on the project plans, whichever is less. When resistivity is not shown on the project plans, the bedding material shall have a value of resistivity not less than that of the existing in-place material or two-thousand (2,000) ohm-cm, whichever is less.

Bedding material shall have a pH value between 6.0 and 9.0, inclusive, for all metal pipe installations. Bedding material shall have a pH value between 6.0 and 12.0, inclusive, for all concrete or plastic pipe installations. Tests for pH and resistivity shall be in accordance with the requirements of Arizona Test Method 236.

(2) Standard Aggregate Bedding Material:

Standard bedding material shall conform to the aggregate requirements here-in-before specified and may be compacted, or placed as an aggregate slurry as herein specified. Jetting shall not be allowed.

The maximum water content in an aggregate slurry mixture shall be thirty-five (35) gallons of water per ton of bedding material. Unless otherwise approved by the Engineer, the slurry shall be compacted with internal vibrators in accordance with the requirements of Subsection 601-3.03(C) of these specifications. Aggregate slurry shall be thoroughly mixed in a mixer approved by the Engineer.

(3) Cement-Treated Slurry Bedding Material:

When pipe culverts or storm drains thirty-six (36) inches in diameter or larger are placed in a trench condition, the bedding material from bottom of pipe to springline shall be a cement-treated slurry. Cement-treated slurry bedding material shall conform to the gradation specified for bedding material under 501-3.02(A)(1) and additionally shall have a cement content of one (1) sack per cubic yard. Cement-treated slurry shall be thoroughly mixed in a mixer or at a central batch plant as approved by the Engineer and shall have a slump of eight (8) to eleven (11) inches.

(B) Placement of Bedding Material:

(1) General:

All trash, forms, sheeting, bracing, and loose rock or loose earth shall be removed from the area into which bedding material is to be placed.

Bedding material shall be placed under and around the pipe to the elevation at the point of maximum width of the pipe (springline), as shown on the project plans. At the Subcontractor's option, bedding material may be placed above the springline of the pipe.

Bedding material shall be placed in a manner which will prevent distortion, damage to, or displacement of the pipe from its intended location. Bedding material shall also be placed so that adequate support will be provided in the haunch support areas for the pipe. Voids or loose soils which are found to occur due to improper placement or compaction of bedding materials will result in rejection of that portion of the pipe installation. Replacement of the pipe will be at the Subcontractor's expense.

(2) Standard Aggregate Bedding Material:

Standard aggregate bedding material shall be placed either in uniform horizontal layers not exceeding eight (8) inches in depth before compaction or in uniform horizontal layers not exceeding four (4) feet in depth when placed as a slurry.

(3) Cement-Treated Slurry Bedding Material:

Cement-treated slurry bedding material shall be placed in a uniform manner that will prevent voids in, or segregation of, the bedding material, and will not float or shift the culvert or pipe. Cement-treated slurry bedding material shall be placed from bottom of pipe to pipe springline. No backfilling above the cement-treated slurry shall be commenced until twenty-four (24) hours after the cement-treated slurry has been placed.

(C) Compaction of Bedding Material:

(1) General:

Compaction of bedding material shall be performed without damage to the pipe and surrounding material in-situ. Special care shall be taken in placing, shaping and compacting all bedding material under haunches of pipe to prevent moving the pipe or raising it from its bedding.

(2) Standard Aggregate Bedding Materials:

Standard aggregate bedding material shall be compacted to at least ninety-five (95) percent of the maximum density determined in accordance with the requirements of Arizona Test Methods, 225, 226, 227, 230 or 231, and 232.

When standard aggregate bedding material is placed as an aggregate slurry, the material placed below the springline of the pipe shall be compacted prior to placement of material above the springline of the pipe.

Ponding or jetting will not be permitted in any case.

The Subcontractor shall excavate holes in the compacted aggregate slurry to the depths and at the locations designated by the Engineer. These holes shall be of such size as to allow the required density testing to be performed in a safe manner. Upon completion of the tests, the Subcontractor shall refill the excavated areas and compact the material to the required density in a manner satisfactory to the Engineer.

(3) Cement-Treated Slurry Bedding Material:

Cement-treated slurry bedding material shall not require additional compaction after placement up to pipe springline if it meets the material requirements of Subsection 501-3.02(A) of these specifications and is placed as outlined in Subsection 501-3.02(B) of these specifications. The Engineer may require the use of vibrators with cement-treated slurry bedding if the fluidity of the mixture is not sufficient to fill all voids. No density tests will be required in the cement-treated slurry bedding material as placed up to pipe springline.

501-3.03 Installation:

(A) General:

Pipe shall be handled carefully. Proper facilities shall be provided for handling and lowering the sections of pipe. All pipes which show defects due to negligence or rough handling shall be removed and replaced if so ordered by the Engineer. If damaged galvanized steel pipe is not replaced it shall be repaired in accordance with the requirements of AASHTO M 36. Damage to the coating of bituminous coated pipe shall be repaired using material conforming to the requirements of AASHTO M 190.

Pipe shall be installed in reasonably close conformity with the lines, grades and dimensions shown on the project plans or specified by the Engineer.

Prior to the staking of pipe culverts a study of the normal flow of the drainage shall be made. As a result of the study, a change in length or location of pipe may be required, as approved by the Engineer, to attain proper placement of the pipe. Pipe profiles shall be approved by the Engineer prior to constructing or installing each structure.

Unless otherwise permitted by the Engineer, the installing of the pipe shall begin at the downstream end.

Bell or groove ends of rigid conduits and outside circumferential laps of flexible conduits shall be placed facing upstream.

Helical corrugated pipe shall be installed with the separate sections firmly joined together with the corrugations in alignment.

Where there is restricted cover, the bolts of the bands connecting flexible pipe shall be advanced so that the tops of the bolts will be in line with or below the top of the pipe.

When aluminum alloys come in contact with concrete, the contacting surfaces shall be coated either with asphalt mastic conforming to

the requirements of AASHTO M 243 or with aluminum- impregnated caulking compound.

When specified on the project plans, the vertical diameter of round, flexible conduit shall be increased five percent by shop elongation.

Any pipe which is not in true alignment or which shows undue settlement after laying or is damaged shall be removed. The trench shall be prepared as hereinbefore specified and the pipe shall be installed again. Any pipe which, in the opinion of the Engineer, is damaged so that it cannot be used shall be replaced.

Paved or partially lined flexible pipe shall be installed so that the longitudinal center line of the paved segment coincides with the flow line. Elliptical and elliptically reinforced rigid pipe shall be installed with the major axis within five (5) degrees of a vertical plane through the longitudinal axis of the pipe.

The interior of all pipes shall be free of dirt and foreign material as the work progresses and all pipes shall be left clean at the time of final acceptance.

Connections to new or existing pipes or structures shall be made in accordance with the details shown on the project plans or as may be ordered by the Engineer in order to complete the work specified.

(B) Full Circle Corrugated Metal Pipe:

(1) General:

Field joints for each type of corrugated steel pipe shall provide circumferential and longitudinal strength to maintain the pipe alignment, prevent separation of the pipe, prevent infiltration of side fill material, and prevent leakage of water into the surrounding soil.

Corrugations in the coupling bands shall have the same dimensions as the corrugations in the pipe being connected. The use of bands with projections (dimples) shall be limited to end sections, pipe with dissimilar ends, and pipe laid on grades under ten (10) percent.

Pipe fabricated with helical corrugations shall have the ends re-rolled to circumferential corrugations to facilitate coupling to other corrugated pipe, except for the end of an existing in-place helical pipe which is to be extended.

Where bands with projections (dimples) are used to join pipe, the projections shall conform substantially to the shape and depth of the pipe corrugations and shall be in circumferential rows with one projection for each corrugation of helically corrugated pipe. Bands with projections for pipe diameters to seventy-two (72) inches,

inclusive, shall be at least ten and one-half (10 1/2) inches wide and shall have two (2) circumferential rows of projections. Rows of projections shall be spaced to provide equal contact on each side of the pipe being joined.

When bands with projections (dimples) are used, the joints shall be sealed with a continuous sponge rubber strip. When bands without projections are used, the joints shall be sealed with a resilient sealant material, a continuous sponge rubber strip or a rubber "O"-ring gasket. The strip shall conform to the minimum requirements of ASTM D-1056, Grade 2A1 and shall be at least seven (7) inches wide and one-half (1/2) inch thick. The rubber "O"-ring gaskets shall be installed one (1) on each side of the joint and shall conform to AASHTO M-198 with diameters according to AASHTO M-36, Section 9.3 of these specifications for depth of corrugation.

Where existing pipes are to be extended, the ends of the existing pipe shall be in such a condition that the new pipe can be firmly joined to form an acceptable joint. All existing pipe ends that are damaged or are out of shape such that they cannot be joined in an acceptable manner shall be repaired.

Damaged galvanized coating shall be cleaned by a wire brush and the end painted with at least one (1) full coat of Paint No. four (4). If the Engineer determines that the end of an existing pipe is damaged to the extent that it cannot be joined properly to the new pipe, he will order the Subcontractor to remove the damaged portion.

Where prefabricated pipe fittings are to be installed in existing pipes, a portion of the existing pipe shall be removed in order to accommodate the fitting.

(2) Watertight and Water Resistant Joints:

Watertight joints shall be provided for syphon and irrigation pipe installation and when specified in the special provisions, standard drawings, or shown on the project plans. Watertight joints, unless otherwise specified, will not be required for storm drains, culverts, or other drainage pipe, however, joints for these pipes shall be water resistant.

Watertight and water resistant joints shall conform to the requirements of Subsection 1010-2.01 of these specifications. When watertight joints are shown on the project plans or specified in the special provisions, the assembled joint shall pass a performance test, as specified herein or as approved by the Engineer, without significant leakage at the joint:

(a) A hydrostatic pressure test on a joint shall be made on an assembly of two (2) sections of pipe, properly connected in accordance with the joint design. At the option of the

Subcontractor, suitable bulkheads shall be provided within the pipe adjacent to and on either side of the joint, or the outer ends of the two (2) joined pipe sections shall be bulkheaded. No mortar or concrete coatings, fillings, or packings in addition to that normally required for the joint shall be placed prior to watertightness tests. After the pipe sections are fitted together with the gasket or gaskets in place, the assembly shall be subjected to a pressure resulting from a head of ten (10) feet of water above the crown of the pipe for ten (10) minutes. Moisture of beads of water appearing on the surface of the joint will not be considered as leakage. The tests on individual joints may be performed at the fabricator's facility or at the job site.

The joint watertightness test shall be performed on pipe sections in straight alignment and on pipe sections deflected from straight alignment. When testing pipe sections not on straight alignment, the pipe sections shall be positioned to create a gap on one (1) side of the outside perimeter of the pipe that is one-half (1/2) inch wider than the gap for pipe sections in straight alignment. When coupling bands are used to test pipe sections not on straight alignment and the maximum gap on one side of the outside perimeter of the pipe is less than one-half (1/2) inch wider than that for pipe sections in straight alignment, said coupling band pipe sections shall be positioned to provide maximum gap.

(b) Joints, other than watertight joints, which employ rubber gaskets, whether flat or "O" Rings, will be considered water resistant. No testing will be required to establish that condition.

The Subcontractor shall furnish to the Engineer a Certificate of Compliance, in accordance with the provisions in Section 105 of these specifications, that the material being furnished conforms to the joint property requirements as described herein. Field tests may be required by the Engineer whenever there is a question regarding compliance with these requirements.

(C) Slotted Pipe:

Slotted pipe shall be joined with coupling bands as shown on the project plans and the joint shall be made water resistant. Prior to attaching the coupling band, sealant material shall be placed between the coupling band and the periphery of the pipe section ends.

Prior to backfilling and paving operations, the slot shall be covered to prevent infiltration of material into the pipe. Heavy

tape, roofing paper, timber or other material may be used. Coverings shall be removed when the paving operations have been completed.

Slotted pipe shall be backfilled with grout in accordance with the details shown on the project plans. The grout shall conform to the requirements of Subsection 803-2.04 of these specifications. Grout shall not be placed when a descending air temperature falls below forty (40) degrees F. or until an ascending air temperature exceeds thirty-five (35) degrees F. Temperatures shall be taken in the shade and away from artificial heat. The grout shall be kept continuously moist for at least seven (7) days, beginning immediately after finishing, by means of either a water spray or fog system capable of being applied continuously or by liquid membrane-forming compound or by polyethylene sheeting conforming to the requirements specified in ASTM C 171.

If polyethylene sheeting is used, it shall be white opaque and adjoining sheets shall overlap at least twelve (12) inches and the laps secured to provide an airtight and windproof joint. If liquid membrane-forming compound is used it shall be Type I conforming to the requirements of ASTM C 309 and the application rate shall be one-hundred (100) square feet per gallon.

(D) Precast Concrete Pipe:

Pipe sections shall be jointed such that the inner surfaces are reasonably flush and even, and the ends are centered as required.

Unless a particular type of joint is specified on the project plans, joints shall be made with portland cement mortar, portland cement grout, rubber gaskets, plastic sealing compound, or any other type approved by the Engineer.

"Self-centering" tongue and groove mortar joints shall be finished smooth on the inside. For diapered joints, diapers shall be used to retain the poured grout. Joints shall be thoroughly wetted before mortar or grout is applied.

When portland cement mixtures are used, the completed joints shall be protected against rapid drying by means of an approved curing method. No joint shall be grouted until the following two (2) sections of pipe are laid.

Flexible watertight gasketed joints,when required,shall be installed on the pipe in accordance with the requirements of AASHTO M 198, Paragraph 5.1.

(E) Spiral Rib Corrugated Metal Pipe:

Spiral rib corrugated metal pipe shall be installed in accordance with the requirements specified in Subsection 501-3.03(B) of these specifications for full circle corrugated metal pipe, except as otherwise specified herein. Special care shall be taken during placement of the pipe and backfilling to avoid damage to the pipe.

Lateral field connections between metal pipes shall be welded and any galvanizing damaged by welding shall be repaired in accordance with the requirements of Subsection 1010-2(A) of these specifications. Coupling bands shall be supplied in accordance with Section 1010-2.03(C) of these specifications.

The coupling bands used to connect spiral rib pipe sections shall be hugger-type bands, made from the same material as the pipe, or other approved design, and shall be fitted with gaskets or "O" rings fabricated from neoprene or butyl rubber or other durable, resilient material approved by the Engineer, and assembled in such a manner as to form a sealed joint. "O" ring gaskets required for watertight joints shall be composed of rubber as specified in ASTM C-361, Section 6.9, and shall be placed in the first corrugation of each pipe end and shall be compressed by tightening the coupling band, in accordance with the manufacturer's installation instructions.

(F) High Density Polyethylene Pipe (HDPP):

Smooth interior polyethylene pipe shall be assembled and installed in accordance with the manufacturer's instructions. Pipe segments shall be joined by corrugated couplings formed with four (4) corrugations that are spaced to provide nesting in the first two (2) corrugations of each pipe end.

A six (6) inch by eighteen (18) inch strip of magnetic tape shall be placed in the trench at the crown of each length of installed pipe.

Special care shall be taken in the handling and installation of polyethylene pipe to prevent damage and to assure that proper line and grade are maintained through the backfilling operation.

501-3.04 Backfilling and Compacting:

(A) Backfill Material:

(1) Pipe Backfill:

Pipe backfill material shall be selected from excavation or from a source selected by the Subcontractor. It shall not contain frozen lumps, stones larger than three (3) inches in diameter, chunks of clay or other objectionable material. Backfill material to be used for pipes, pipe-arches or arches made of metal shall have a value of

resistivity not less than two-thousand (2,000) ohm-cm or the value shown on the project plans. When resistivity is not shown on the project plans, the backfill material shall have a value of resistivity not less than that of the existing in-place material or two-thousand (2,000) ohm-cm, whichever is less. Backfill material shall have a pH value between 6.0 and 9.0, inclusive, for all metal pipe installations. Backfill material shall have a pH value between 6.0 and 12.0 for all concrete or plastic pipe installations. Tests for pH and resistivity shall be in accordance with the requirements of Arizona Test Method 236.

Pipe backfill material shall conform to the requirements of structural backfill Section 203-5.03 of these specifications.

As an alternate, pipe backfill may conform to the material requirements listed for bedding material as specified in Subsection 501-3.02(A), of these specifications for standard aggregate bedding material or cement-treated slurry bedding material.

When spiral rib pipe culverts or spiral rib storm drains thirty-six (36) inches in diameter or greater are placed in a trench condition the pipe backfill material shall be a cement-treated slurry bedding material as specified in Subsection 501-3.02(A) of these specifications.

(2) Trench Backfill:

Trench backfill material shall not contain organic material, rubbish, debris and other deleterious material and shall not contain solid material which exceeds eight (8) inches in greatest dimension and shall be soil selected from excavation or from a source selected by the Subcontractor.

As an alternate, trench backfill may conform to the material requirements listed for bedding material as specified in Subsection 501-3.02(A) of these specifications for standard aggregate bedding material or cement-treated slurry bedding material.

(3) Slope Plating:

The roadway slope at the inlet ends of pipe culverts shall be plated with an impervious material. The plating material shall be a fine-grained, cohesive material with at least fifty (50) percent of it passing the No. forty (40) sieve and with a plasticity index of at least ten (10) and shall be placed as shown on the project plans. The plasticity index will be determined in accordance with the requirements of AASHTO T 90.

(B) Placement of Backfill Material:

(1) General:

All trash, forms, sheeting, bracing, and loose rock or loose earth shall be removed from the areas to be backfilled before backfill material is placed.

Backfill compacted by pneumatic or mechanical tamping devices, shall be placed in layers not more than eight (8) inches in depth before compaction.

Pipe backfill shall be brought up evenly on both sides of the pipe for the full length to an elevation one (1) foot above the top of the pipe.

Trench backfill shall be placed from one (1) foot above the top of the pipe to the elevation at which base or surfacing materials are to be placed or to the top of the trench.

In case of backfill compaction on culvert pipe wing walls or headwalls, proper precautions shall be taken so that the road embankment shall not be disturbed. If any portion of the roadway embankment is disturbed, that portion, along with the above said pipe backfill, shall be recompacted as specified herein and approved by the Engineer.

(2) Standard Aggregate Slurry:

Pipe backfill or trench backfill mixed as a standard aggregate slurry shall be placed in uniform horizontal layers not exceeding four (4) feet in depth. The slurry shall be compacted with internal vibrators in accordance with the requirements of Subsection 601-3.03(D) of these specifications.

(3) Cement-Treated Slurry:

Cement-treated slurry pipe backfill placement above spring line shall not commence within twenty-four (24) hours of the placement of the underlying cement-treated bedding material below spring line. Cement-treated pipe backfill shall be placed in a uniform manner that will prevent voids in or segregation of the backfill to an elevation one (1) foot above the top of the pipe. No backfilling above the cement-treated slurry pipe backfill shall be commenced until twenty-four (24) hours after the cement-treated slurry has been placed.

If cement-treated slurry bedding material is used for trench backfill, it shall not be disturbed or loaded in any manner within twenty-four (24) hours of placement as above.

(C) Compaction of Backfill Material:

Backfill material shall be compacted to a density of not less than ninety-five (95) percent of maximum dry density at a moisture content within one (1) percent below and to four (4) percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

Ponding or jetting will not be allowed in any case.

If trench backfill or pipe backfill is placed as an aggregate slurry, the Subcontractor shall excavate holes in the compacted slurry to the depths and at the locations designated by the Engineer. These holes shall be of such size as to allow the required density tests to be performed in a safe manner. Upon completion of the tests, the Subcontractor shall refill the excavated areas and compact the material to the required density in a manner satisfactory to the Engineer.

Cement-treated slurry bedding material for pipe backfill shall not require additional compaction after placement up to an elevation one (1) foot above the top of pipe if it meets the material requirements of Subsection 501-3.02(A) of these specifications and is placed and compacted as outlined in Subsection 501-3.04(B) and (C) of these specifications. No density tests will be required in the cement-treated slurry bedding material when it is utilized for pipe backfill to an elevation one (1) foot above the top of pipe.

Cement-treated slurry bedding material used for trench backfill shall meet the requirements listed above for pipe backfill up to the elevation which it is placed.

501-3.05 Filter Material:

When shown on the project plans or specified in the special provisions, filter material shall be carefully placed around perforated pipe.

Filter material shall conform to the grading requirements for fine aggregate in Section 1006 of these specifications and shall be placed in accordance with the details shown on the project plans.

501-3.06 Encasement of Pipe:

When shown on the project plans, pipe shall be encased in Class B concrete. Portland cement concrete shall conform to the requirements of Section 1006 of these specifications.

501-3.07 Ductile Iron Pipe:

Ductile iron pipe shall be installed in accordance with AWWA C-600.

A. Installation:

The polyethylene tubing shall be cut into lengths approximately two (2) feet longer than the pipe sections. With the pipe suspended from the center, the tube shall be slipped over the spigot end and bunched up between the point of support and the spigot end. After the pipe is installed into the bell of the adjacent pipe, the pipe shall be lowered to the trench bottom and the supporting sling removed from the center of the pipe. The pipe shall then be raised at the bell end enough to allow the tube to be slipped along the full length of the barrel with enough left at each end to overlap the adjoining pipe about one (1) foot. A shallow bell hole must be made at each joint to facilitate installation of the polywrap.

Pull the bunched-up polywrap from the preceding length of pipe, slip it over the end of the new length of pipe, and secure in place with one (1) circumferential turn of tape plus enough overlap to assure firm adhesion. Then slip the end of the polywrap from the new pipe section over the end of the first wrap until it overlaps the joint at the end of the preceding length of pipe. Tape it in place.

The loose wrapping on the barrel of the pipe shall be pulled snugly around the barrel of the pipe, and excess material folded over the top of the pipe and the folds held in place by means of short strips of adhesive tape, at about eight (8) foot intervals along the pipe.

Repair any rips, punctures or other damage to the tube with the adhesive tape or pieces of tube material secured with tape.

Bends and reducers in the line shall be covered with polyethylene in the same manner as the pipe.

Valves, tees, crosses and outlets shall be wrapped with flat sheets of the same material. The sheets shall be passes under valves and brought up around the body to the stem. Edges shall be brought together, folded twice and secured with the adhesive tape.

B. Valve Installation:

Valves shall be installed in accordance with AWWA C-600 or AWWA C-603 modified as follows:

Just before installation in the trench, valves shall be fully opened and closed to check the action, and a record made of the number of turns required to fully open or close the valve.

Valves twelve (12) inches or smaller in size shall be supported by concrete blocks, in accordance with standard details.

Concrete supports shall be provided under valves in vaults and manholes, and shall be constructed an inch low, then grouted with non-shrink grout. Adjustable pipe supports shall be as indicated on the project plans. Buried valves shall be supported on concrete blocks as detailed in the project plans.

Valve boxes shall be installed over all buried valves in accordance with standard details.

Standard couplings or matching joints shall be used when more than one (1) length of pipe is required, or when two (2) or more pieces are joined, to form the valve box riser. Install extension stems on all valves where the operating nut is five (5) feet or more below grade.

501-4 Method of Measurement:

Pipe will be measured by the linear foot parallel to the central axis of the pipeline, and shall include the length of fittings and structure/excavation and structure backfill.

Tees, wyes and other branches will be measured as pipe along the central axis of the pipes to the point of intersection of said central axes. Pipe reducers will be measured as pipe of the larger diameter along the central axis.

The end of pipe in closed structures will be considered to be at the intersection of the central axis and the inside face of the wall and for masonry and concrete headwalls it will be considered to be at the intersection of the central axis and the face of the headwall.

No separate measurement or payment will be made for excavating trenches and for furnishing, placing and compacting bedding and backfill material as described and specified herein and on the project plans, the cost thereof being considered as included in the contract unit price per foot of pipe.

Flared end sections shall be included in the contract unit price per foot of pipe.

SECTION 502 SLOTTED DRAIN

502-1 Description:

Slotted drain pipe shall conform to the requirements of Section 501 and 1010 and shall be constructed at the locations shown on the project plans.

502-2 Method of Measurement:

Slotted drain will be measured as per Section 501 of these specifications.

SECTION 503 CONCRETE CATCH BASINS

503-1 Description:

The work under this section shall consist of furnishing all materials and constructing or reconstructing concrete catch basins, including excavation, concrete removal and backfill. Work shall be done at the locations designated on the project plans and in accordance with the details shown on the project plans and the requirements of these specifications.

503-2 Materials:

503-2.01 Concrete:

Portland cement concrete shall conform to the requirements of Section 1006 for Class B concrete.

503-2.02 Reinforcing Steel:

Reinforcing steel bars or mesh shall conform to the requirements of Section 1003.

503-2.03 Masonry Mortar:

Masonry mortar shall be composed by volume of one part portland cement, two parts fine aggregate, one-fifth part hydrated lime and sufficient water to provide a plastic mixture. The lime shall be considered as an addition to and not as replacing any cement.

Fine aggregate shall conform to the requirements of ASTM C 144. Portland cement and water shall conform to the requirements of Section 1006. Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

Mortar that has been mixed more than one hour shall not be used. Retempering of mortar will not be permitted.

503-2.04 Structural Steel:

Structural steel parts shall conform to the requirements of Section 1004.

503-3 Construction Requirements:

503-3.01 Catch Basins:

Excavation and backfill for the catch basin shall be performed in accordance with the requirements of Subsection 203-5.

Catch basins shall be cast-in-place or, at the option of the subcontractor, may be precast units. A list of approved precast units will be found in Subsection 601-1 of these specifications.

Cast-in-place catch basins shall be constructed in accordance with the requirements of Section 601 and reinforced where called for on the project plans in accordance with the requirements of Section 605 in reasonably close conformity to the lines and grades shown on the project plans and shall meet adjacent sidewalk, curb or gutter surfaces with no appreciable offsets. The catch basin grates and frames shall be fabricated and installed so that the bearing surfaces of the grates shall rest securely on the bearing surfaces of the grate frames.

Proper equipment shall be provided for lowering the precast sections to position. The tongue end of the section shall be placed in contact with the base structure unless otherwise directed. Not more than two holes shall be cast or drilled in the shell of each section for the purpose of handling and placing. If such holes are provided, they shall be filled and finished with mortar after placing the catch basins. Immediately before joining precast sections, mortar shall be placed continuously around the circumference of the receiving section's contact surface. Any precast section damaged during handling or placing shall be repaired or replaced at the option of the Engineer and at the subcontractor's expense.

When specified on the project plans, aprons shall be constructed in accordance with the details shown on the project plans. Aprons shall be constructed from portland cement concrete or from asphaltic concrete.

When specified on the project plans or ordered by the Engineer, corrugated metal pipe shall be installed as a temporary drain for the roadway. The pipes shall be subsequently filled with concrete.

Backfilling of the completed structure shall be in accordance with the requirements of Subsection 203-5.

Preformed bituminous joint filler shall be installed where the catch basin concrete will meet new or existing concrete curb or pavement.

503-4 Method of Measurement:

Catch basins will be measured as a unit for each catch basin, including frame and grate.

SECTION 504 FLAP GATES:

504-1 Description:

The work in this section shall consist of furnishing all materials and installing flap gates at the locations designated on the project plans and the requirements of these specifications.

504-2 Materials/Products:

The Subcontractor shall furnish and install the following material/products of Waterman Industries, Lubbock, TX, or approved equal.

F25 Moderate Duty Drainage Flap Gate components are as below:

Frame and Cover - Cast Iron per ASTM A-126, Class B.
Pivot Lug - Ductile Iron per ASTM A-536, Gr. 65-45-12.
Hinge Link - Structural Steel per ASTM A-36, galvanized per ASTM A-123.
Bronze Bushings and Washers - Commercial Bronze
Assembly Hardware and Pins - 18-8 Stainless Steel (Type 304)

504-3 Construction Requirements:

The Subcontractor shall furnish and install a flap gate with a frame of cast-iron of flatback or spigotback design, with machined seating surface inclined from vertical at a minimum of 2 1/2° to assure positive closure. For flatback gates mounted to thimbles, the gate flange shall be machined and drilled to match thimble.

The cover shall be cast iron, cast in one (1) piece, with reinforcing ribs or domed construction, designed to withstand the seating head as shown on the project plans. An integral cast on lifting eye shall be provided.

Seating surfaces for frame and cover shall be:

1. machined iron

or

2. bronze seats securely mounted and attached to frame and cover

or

3. a bronze seat securely mounted and attached to frame with neoprene seat bonded into dovetail groove in cover to cushion cover on closing

All machined seats shall have a minimum sixty-three (63) microinch finish.

The Subcontractor shall make sure that the gates are provided with an adjustable, double-pivoted hinge linkage so designed to permit complete seating, full opening, and with stops or other arrangement to prevent the cover from rotating sufficiently to become wedged in the open position. Pivot lugs mounted to frame shall be adjustable to allow adjustment of hinge links without having to remove cover from gate. The hinge links shall be bronze bushed, structural steel (high-strength malleable iron, cast manganese bronze, or wrought stainless steel).

All assembly hardware shall be type 18-8 stainless steel.

504-3.01 Finish:

All cast iron shall be painted with manufacturer's standard shopcoat paint (special paint). Painting shall meet the requirements of Sections 610 and 1002 of these specifications. Structural steel hinge arms shall be galvanized. All bronze and stainless steel parts do not require further finish.

504-4 Submittals:

At least fifteen (15) days prior to the flap gate purchase and installation, the Subcontractor shall submit six (6) copies of the following drawings and specifications:

> Moderate Duty Drainage Flap Gate consisting of frame and cover, pivot lug, hinge link, bronze bushings and washers including all associated complete hardware and installation procedures.

The Subcontractor shall not begin the work until after the drawings are approved.

504-5 Method of Measurement:

Flap gates will be measured as a unit for each flap gate, complete in place.

SECTION 506 STORM WATER PUMP STATION

506-1 Description:

The work under this section consists of furnishing and installing a pump station, complete with the wetwell, pumps with associated cables and controls, piping, valves, connections to inlet and outlet pipes, and other appurtances in accordance with the details shown on the project plans and requirements of these specifications.

506-2 Materials:

506-2.01 General:

The Subcontractor shall provide the storm water pump station system which includes two submersible non-clog wastewater pumps; check, gate, and flush valves; internal piping, external piping, and fittings as shown on the pump station drawing along with control panel with specified appurtenances; and all internal wiring.

The wetwell shall be constructed of sections of pre-cast reinforced concrete pipe, ASTM C-76, D Load 1320 and cast-in-place reinforced concrete slabs. The wetwell shall include a maintenance hoist base and duplex access frame and cover.

506-2.02 Pump Design:

The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two (2) guide bars extending from the top of the station to the discharge connection. There shall be no regular need for personnel to enter the wetwell. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor.

506-2.03 Pump Construction:

Major pump components shall be of grey cast iron, ASTM 4-48, Class thirty (30) with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI Type 304 stainless steel or brass construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of alkyd primer with a chlorinated rubber paint finish on the exterior of the pump.

Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight

sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two (2) planes and O-ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds elliptical O-rings, grease, or other devices shall be used.

506-2.04 Cooling System:

The Subcontractor shall provide each pump unit with an adequately designed cooling system. The water jacket shall encircle the stator housing, thus providing heat dissipation for the motor regardless of the type of installation. Impeller back vanes shall provide the necessary circulation of the cooling liquid through the water jacket. The cooling media channels and ports shall be non-clogging by virtue of their dimensions. Provisions for external cooling and seal flushing shall also be provided. The Subcontractor shall make sure while selecting and providing a cooling system which shall provide continuous pump operation in liquid temperature of up to one-hundred-four (104) degrees F only and restrictions below this temperature shall not be acceptable.

506-2.05 Motor:

The Subcontractor shall provide, install, and make operable a pump motor which shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber, NEMA B type. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rate for three-hundred-eleven (311) degrees F (one-hundred-fifty-five (155) degrees C). The stator shall be dipped and based three (3) times in Class F varnish and shall be of heat-shrink fitted into the stator housing. The use of bolts, pins, or other fastening devices requiring penetration of the stator housing is not acceptable. The motor shall be designed for continuous duty handling pumped media of one-hundred-four (104) degrees F (forty (40) degrees C) and capable of up to fifteen (15) evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at two-hundred-sixty (260) degrees F (one-hundred-twenty-five (125) degrees C) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber, containing the terminal board, shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board. Wire

nuts or crimping type connection devices are not acceptable. The motor and pump shall be designed and assembled by the same manufacturer.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus ten (10) percent. The motor shall be designed for operation up to one-hundred-four (104) degrees F (forty (40) degrees C). A performance chart shall be provided showing curves for torque, current, power factor, input/output KW and efficiency. This chart shall also include data on starting and no-load characteristics.

The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be neoprene. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of sixty-five (65) feet.

The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

506-2.06 Cable Entry Seal:

The cable entry seal design shall preclude specific torque requirements to ensure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. <u>Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable</u>.

506-2.07 Bearings:

The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The calculated B10 bearing life rating shall be forty-thousand (40,000) hours minimum. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two (2) row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.

506-2.08 Mechanical Seal:

Each pump shall be provided with a tandem mechanical shaft seal system consisting of two (2) totally independent seal assemblies. The seals shall operate in an oil reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the oil chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the oil chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating carbon seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. For special applications, other seal face materials shall be available.

<u>The following seal types shall not be considered acceptable nor equal to the dual independent seal specified</u>: Shaft seals without positively driven rotating members, or conventional couple mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. Cartridge type systems will not be acceptable. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed to prevent overfilling and to provide oil expansion capacity. The drain and inspection plug, with positive anti-leak seal, shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load.

506-2.09 Pump & Motor Shaft:

Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be C1035 Carbon Steel and shall be completely isolated from the pumped liquid.

506-2.10 Impeller:

The impeller(s) shall be of gray cast iron, Class thirty (30), dynamically balanced, double shrouded non-clogging design having a long throughlet with acute turns. The impeller(s) shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Whenever possible, a full vaned, not vortex, impeller shall be used for maximum hydraulic efficiency, thus reducing operating costs. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request.

Impeller(s) shall be retained with an Allen head bolt and shall be capable of passing a minimum four (4) inch diameter solid. All impellers shall be coated with alkyd resin primer.

506-2.11 Wear Rings:

A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a brass, or nitrile rubber coated steel ring insert that is drive fitted to the volute inlet.

506-2.12 Volute:

Pump volute(s) shall be single-piece grey cast iron, Class thirty (30), non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified.

506-2.13 Protection:

All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At two-hundred-sixty (260) degrees F (one-hundred-twenty-five (125) degrees C) the thermal switches shall open, stop the motor, and activate an alarm.

506-2.14 Mix-Flush Valve (Hydraulic):

One pump in each sump shall be equipped with a valve to provide mixing within the sump at the time of start-up of the pump.

The valve is to be mounted directly on the pump volute to direct part of the pumped discharge to flush solids into suspension at the start of each pumping cycle. The valve shall be positioned on the pump volute to provide a non-clogging flow operation.

The valve shall be open at the beginning of each pumping cycle and close under full pump discharge pressure for one minute. The valve shall be operated by the liquid being pumped through a self-contained hydraulic system. No external power source should be required to operate the valve. Units using electrical input will not be acceptable.

A means of adjustment should be provided to achieve a 30-second flushing period for different head and flow conditions.

506-2.15 HDL Ball Check Valve:

Furnish and install two (2) Flygt HDL Ball Check Valves, Type 5087, or approved equal, size eight (8) inch. The valve shall consist of just three components: body, cover, and ball (one moving part). The design of the valve shall be such that it keeps solids, stringy

material, grit, rags, etc., moving without the need for back flushing. In the operating mode, the ball shall not impede flow through the valve. The operating flow area shall be equal to the nominal size of the valve. The ball shall clear the waterway providing "full flow" equal to the nominal size. It shall be non-clog. There shall not be outside levers, weights, springs, dash pots or other accessories required for a swing (clapper type) check valve. The ball shall be hollow steel with an exterior of nitrile rubber. It shall be resistant to grease, petroleum products, animal and vegetable fats, diluted concentrations of acids and alkalines (pH 4-10), tearing and abrasion. The body and cover shall be of gray cast iron, Class thirty-five (35). Flange drilling shall be according to ANSI B16.1, Class one-hundred-twenty-five (125).

506-2.16 Piping:

Pipe shall be Class fifty-two (52), restrained joint, ductile iron pipe. The gate valves shall be bronze fitted with double-discs.

506-2.17 Access Frame and Cover:

Furnish and install one (1) duplex access frame in aluminum material, rated three-hundred (300) lb/sq. ft., complete with upper guide holder. Frame shall be securely placed, mounted above the pump(s). Lower guide bar holders shall be integral with the pump discharge connection. Guide bars (by others) shall be of at least standard weight galvanized steel pipe of the size indicated on drawings. The guide bars shall not support any portion of the weight of the pump. Doors shall be of skid proof design and provided with stainless steel hinges and stainless steel fasteners. The doors open to ninety (90) degrees and lock automatically in that position, with a stainless steel positive locking arm and a stainless steel release handle. Doors are provided with a stainless steel lifting handle and stainless steel locking bar. The aluminum access frames and covers shall carry a guarantee of ten (10) years against defects in material and/or workmanship. Size forty-eight by seventy-two inch (48 x 72) double door.

506-3 Operating Conditions:

(1) The Subcontractor shall furnish and install and make operable two submersible non-clog wastewater pumps which shall be capable of delivering one-thousand-two-hundred (1,200) gallons per minute (gpm) at fifty-three (53) feet total dynamic head (TDH) along with an additional point which shall be one-thousand-six-hundred (1,600) gpm at thirty-three (33) TDH on the same pump performance curve. The shut-off head shall be minimum 1.5 feet.

(2) The Subcontractor has option to furnish, install, and make operable FLYGT pump (Model #3170 along with impeller #443) or equivalent make meeting the requirement of this section.

Each pump shall be equipped with thirty (30) HP, submersible electric motor connected for operation of four-hundred-sixty (460) volts, three (3) phase, sixty (60) hertz four (4) wire service, with forty (40) feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and also meet with P-MSHA approval. The pump shall be supplied with a mating cast iron eight (8) inch discharge connection. Each pump shall be fitted with fifteen (15) feet of lifting chain or stainless steel cable. The working load of the lifting system shall be fifty (50) percent greater than the pump unit weight.

506-4 Controls:

The Subcontractor shall furnish and install and make operable one (1) Flygt Model 3000 Automatic Pump Control Center or approved equal in a lockable, weatherproof NEMA 4 enclosure for four-hundred-sixty (460) volts, three (3) phase, sixty (60) hertz four (4) wire power supply. Panel shall include door in door construction featuring a hinged inner door. For each pump motor, there shall be included: a combination circuit breaker/overload unit providing overload protection, short-circuit protection, resert and disconnect for all phases; across-the-line magnetic contactors; hands/off/auto pump operations selector switch; overload device to be precalibrated to match motor characteristics, and factory sealed to ensure trip setting is tamperproof; one-hundred-twenty (120) volt control panel pilot circuitry. A twenty-four (24) volt control circuit transformer with disconnect circuit breaker and overload protection, for external pilot circuitry shall be included with an automatic electric alternator for two (2) pump stations (providing alternating operation of pumps under normal conditions, or in cases of high level, allowing both pumps to operate simultaneously). Terminal boards for connection of line, pump, and level sensors shall be provided.

The following shall be included with the panel:

1. High level alarm light, to be mounted on the top of the control panel. Once triggered, the light must remain on until deactivated manually by a reset button within the panel. The alarm shall also include an unpowered contact (dry contact).

2. Condensation heater.

3. Running time meter for each pump.

4. Pump run lights.

5. Mounting brackets.

6. Power monitor.

7. A grounding type convenience duplex outlet shall be provided on the side of the cabinet for operation of one-hundred-fifteen (115) volt AC devices.

8. An automatic alternator with manual "on-off" switch shall be provided to change the sequence of operation of the pumps on the completion of each pumping cycle. Provisions shall also be made for the pumps to operate in parallel, should the water level in the wetwell reach the "lag pump on" switch.

9. Controls and timers to "exercise" and run both pumps for twenty (20) seconds every month during dry periods.

The Contractor shall furnish, install, and connect a main disconnect on the side of the control panel. The disconnect shall be housed within a NEMA-3R enclosure.

The Contractor shall prepare complete power and control wiring diagrams for all the station components. These diagrams shall be submitted to the Engineer for approval as per the contract requirements for shop drawing submittal and review.

506-4.01 Liquid Level Sensors:

Furnish and install four (4) Flygt Model ENH-10 Liquid Level Sensors, or approved equal, with forty (40) feet of electrical cable. Level Sensors shall be a non-floating, displacement type. Level Sensors shall be rated for operation at milliwatt levels. Floats or restrained floats shall not be considered as equal.

506-5 Pump Test:

The pump manufacturer shall perform the following inspections and tests on each pump before shipment from the factory:

1. Impeller, motor rating, and electrical connections shall first be checked for compliance to the customer's purchase order.

2. A motor cable insulation test for moisture content or insulation defects shall be made.

3. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.

4. The pump shall be run submerged in water to a minimum of six (6) feet.

5. After Operational Test No. 4, the Insulation Test (No. 2) is to be performed again.

A written certified report stating that the foregoing steps have been done shall be supplied with each pump at the time of shipment.

506-6 Submittals:

At least four weeks prior to ordering the storm water pump station system equipment and structure, the Subcontractor shall submit the six (6) copies of the following in accordance with Section 105 of these specifications:

1. Manufacturers' operation and maintenance manuals

2. Dimensions and descriptive data on all manufactured items

3. Performance curves and dimension data for each pump

4. Shop drawings showing detailed dimension drawings of the pump station locating all equipment but not limited to piping, valves, control panel, along with supports all electrical, conduit, junction boxes, etc. complete.

5. Wiring diagrams for the control panel

6. Shop drawings of fabricated equipment

7. Wet well structure reinforcing bar lists and bending diagrams

The Pump Station Supplier's representative shall train the Subcontractor, the Engineer, and the appropriate maintenance personnel in the operation and maintenance of the pumping station, during three (3) heavy runoff storms.

506-7 Pump Warranty and Services:

506-7.01 Pump Warranty:

The pump manufacturer shall warrant the units being supplied to the Owner against defects in workmanship and material for a period of five (5) years or ten-thousand (10,000) hours under the Municipal Wastewater - Permanent Installation Warranty Policy under normal use, operation, and service. The warranty shall cover parts and labor and shall be in printed form and apply to all similar units.

506-7.02 Factory Service:

Factory-approved service facilities including factory trained mechanics shall be available for emergency and routine service to the project site which is about fifty (50) miles northwest of the City of Phoenix.

506-7.03 Experience Clause:

The pump manufacturer shall have a minimum of ten-thousand (10,000) units of similar type pumps, installed and operating for no less than five (5) years in the United States.

506-8 Operation and Maintenance Manuals:

The Supplier shall provide complete and detailed Installation, Operation, and Maintenance Manuals. These manuals shall cover, in addition to installation and general operating procedures, the operation, maintenance, and servicing procedures of the major individual components provided with the pump station, complete bills of material and parts lists.

506-9 Method of Measurement:

Measurement will be on a lump sum basis.

SECTION 508 DIVERSION CHANNEL

508-1 Description:

The work under this section shall consist of all operations necessary to excavate a Diversion Channel as designated on the project plans, as specified in Section 203 and 802 of these specifications, directed by the Engineer and specified herein.

508-2 Blank:

508-3 Construction Requirements:

The construction requirements shall be as designated in Section 203 and 802 of these specifications.

508-4 Method of Measurement:

Refer to Sections 203 and 802 of these specifications for measurement.

SECTION 601 CONCRETE STRUCTURES

601-1 Description:

The work under this section shall consist of furnishing all materials and constructing structures such as underpasses or parts of structures to the forms, shapes and dimensions shown on the project plans and to the lines and grades established by the Engineer and in accordance with the requirements of these specifications. When the structures or parts of structures are precast, the work shall also include transporting and erecting the units.

Concrete structures such as catch basins, headwalls, wing walls and other small miscellaneous structures of sizes which can readily be precast as units and furnished and installed in place are hereby defined as minor structures. Minor structures, at the option of the Subcontractor, may be either constructed of cast-in-place concrete or furnished and installed as precast units providing they are fabricated in accordance with drawings submitted and approved in accordance with requirements which may be found herein.

601-2 Materials:

Portland cement concrete shall conform to the requirements of Section 1006 of these specifications for Class S or Class B concrete as shown on the project plans.

Where a strength is shown on the project plans but a class of concrete is not indicated, it shall be construed to mean Class S concrete having the required minimum compressive strength shown at twenty-eight (28) days.

Liquid membrane-forming compound shall conform to the requirements of Subsection 1006-2.05 of these specifications.

Materials furnished for expansion joint filler and joint seal shall conform to the requirements of Section 1011 of these specifications.

Materials furnished for water stops shall conform to the requirements of Section 1011 of these specifications.

Preformed bearing pads and elastomeric bearing pads shall conform to the requirements of Section 1011 of these specifications.

Reinforcing steel shall conform to the requirements of Section 1003 of these specifications.

601-3 Construction Requirements:

601-3.01 Foundations:

Foundations for structures shall be placed on suitable earth or rock bearing, on a concrete foundation seal, as shown on the project plans. Excavation and backfill shall be in accordance with the requirements of Subsection 203-5 of these specifications. Except where tremie concrete is specified, no concrete shall be placed under water or against water-bearing strata.

601-3.02 Falsework and Forms:

(A) Design and Drawings:

The Subcontractor shall be responsible for designing and constructing safe and adequate falsework and forms which provide the necessary rigidity, support the loads imposed, and produce in the finished structure the lines, grades, and dimensions shown on the project plans and established by the Engineer.

Forms shall be any system of structural elements which provides horizontal support or restraint to the lateral pressure of concrete.

Falsework shall be any system of structural elements that provides temporary support for loads from plastic concrete, forms, reinforcing steel, structural steel, loads from placement operations or other related loads, and continues to provide support until the concrete has attained adequate strength and the structure is capable of self-support.

The design load for falsework shall consist of the sum of dead and live vertical loads, and an assumed horizontal load. The minimum total design load for any falsework shall be not less than one-hundred (100) pounds per square foot for the combined live and dead load regardless of slab thickness.

Dead loads shall include the weight of concrete, reinforcing steel, forms and falsework. The weight of concrete, reinforcing steel and forms shall be assumed to be not less than one-hundred-sixty (160) pounds per cubic foot for normal concrete and not less than one-hundred-thirty (130) pounds per cubic foot for lightweight concrete.

Live loads shall consist of the actual weight of any equipment to be supported by falsework applied as concentrated loads at the points of contact and a uniform load of not less than fifty (50) pounds per square foot applied over the area supported.

The assumed horizontal load to be resisted by the falsework bracing system shall be the sum of the actual horizontal loads due to equipment, construction sequence or other causes and an allowance for wind, but in no case shall the assumed horizontal load to be resisted in any direction be less than two (2) percent of the total dead load. The falsework shall be designed so that it will have sufficient rigidity to resist the assumed horizontal load without considering the weight of the concrete.

Falsework shall be designed by the working stress design method, and stresses under all loads shall not exceed the maximum allowable stresses provided for in the current edition of AASHTO Standard Specifications for Highway Bridges. The maximum allowable stresses provided for in the National Design Specification for wood construction (NDS) may be used as an alternate to the AASHTO specifications for timber design. The maximum allowable horizontal shear stress in timber shall not exceed one-hundred-twenty-five (125) pounds per square inch after all applicable modification factors have been applied.

Unless otherwise specified on the project plans, deflection of the falsework span due to the weight of concrete only shall not exceed 1/240 of the falsework beam span irrespective of the fact that the deflection may be compensated for by camber strips.

The vertical load used for the design of falsework posts, but not footings, which support the portion of the falsework over openings, shall be increased to not less than one-hundred-fifty (150) percent of the design load calculated in accordance with the provisions for design load previously specified.

Each falsework post adjacent to roadways shall be mechanically connected to its supporting footing at its base, or otherwise laterally restrained, so as to withstand a force of not less than two-thousand (2,000) pounds applied at the base of the post in any direction except toward the roadway. Such posts also shall be mechanically connected to the falsework cap or stringer. Such mechanical connection shall be capable of resisting a load in any horizontal direction of not less than one-thousand (1,000) pounds.

For falsework spans over roadways, all exterior falsework stringers and stringers adjacent to the ends of discontinuous caps, the stringer or stringers over points of minimum vertical clearance and every fifth remaining stringer, shall be mechanically connected to the falsework cap or framing. Such mechanical connections shall be capable of resisting a load in any direction, including uplift on the stringer, of not less than five-hundred (500) pounds. Such connections shall be installed before traffic is allowed to pass beneath the span.

The falsework shall be located so that falsework footings or piles are at least three (3) inches clear of railing posts and barriers and all other falsework members are at least one (1) foot clear of railing members and barriers.

Falsework design will require written approval by the Engineer prior to commencing work and shall be in accordance with the requirements of Subsection 106 of these specifications.

The drawings shall be complete and fully-detailed working drawings showing the dimensions and material for all parts, arrangement, spacing, and connections, and all provisions for adjustment and for measuring displacement. The data may be presented as convenient either on the drawings or in the design summary, which shall also describe the assumptions and types of calculations used in the design and the stresses and deflections found for critical points. For any embankments used, the equivalent of the above drawings and data shall be submitted, and in addition the source, classification, and compaction requirements for the material and the results of any tests performed on the material. In no case shall the embankment be compacted to less than ninety (90) percent compaction, and the top three (3) feet shall be compacted to a density of not less than ninety-five (95) percent of maximum dry density at a moisture content within one (1) percent below and two (2) percent above optimum moisture content as determined in accordance with the requirements of ASTM 1556 for density and AASHTO T 217 or AASHTO T 26 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor). The embankment shall be topped with a lean concrete waste slab screeded to the required grades.

The supports for deck falsework, forming or screed supports shall not be welded to steel girders, shear connectors, slab ties or girder stirrups.

(B) Falsework Construction:

The falsework shall be constructed to conform to the falsework drawings. The materials used in the falsework construction shall be of the quality necessary to sustain the stresses required by the falsework design. The workmanship used in falsework construction shall be of such quality that the falsework will support the loads imposed on the falsework.

Falsework shall be founded on a solid footing safe against undermining and capable of supporting the loads imposed.

No concrete shall be placed in any forms supported by falsework until the Subcontractor's professional Engineer has inspected the completed falsework and has issued a properly signed and sealed

certificate that the falsework has been constructed according to the approved falsework drawings.

Wedges, screws or jacks shall be used in connection with falsework to set the forms to required grade and uniform bearing prior to placing concrete.

All wedges shall be in pairs to insure uniform bearing. Laminated sections will not be permitted. If additional material is required under wedges, either single blocks or thicker wedges will be required. A sufficient number of wedges shall be used to cover the entire bearing area.

The Subcontractor shall provide tell-tales attached to the soffit forms and readable from the ground in enough systematically placed locations to determine the total settlement of the entire portion of the structure where concrete is being placed.

If any weakness develops during the placing of the concrete or the falsework shows any undue settlement or distortion, the work shall be stopped and the falsework corrected and strengthened.

(C) Forms Construction:

(1) General Requirements:

Forms shall be of wood, metal or other suitable material conforming to the requirements specified herein.

The forms shall be mortar-tight and shall be designed, constructed, braced and maintained so that the finished concrete will be true to line and elevation and will conform to the required dimensions and contours. They shall be designed to withstand the pressure of concrete with consideration given to rate of concrete placement, temperature of the concrete, use of set-retarding admixtures or pozzolanic materials in the concrete, the effects of vibration as the concrete is being placed and all loads incidental to the construction operations, without distortion or displacement.

Stay-in-place forming shall not be used unless specified on the plans or approved by the Engineer. Expanded metal meshes may be used to form construction joints providing: (1) three (3) inch edge cover is maintained, and (2) use in bridge decks is prohibited.

Forms reused shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity, watertightness and smoothness of surface. Forms or form lumber unsatisfactory in any respect shall not be used.

Forms shall be constructed so that portions may be removed without disturbing forms that are to remain. Forms to be used when a Class

II finish or ornamental work is required shall be constructed of metal, fiberglass coated panels, or plywood. All form joints shall be taped or caulked in an acceptable manner. Forms for this work shall be equivalent to first-class pattern work.

Forms shall be filleted three-quarter (3/4) inch at all exposed, sharp corners of the concrete.

All forms shall be treated with an approved form release agent before concrete is placed. Any material which will adhere to or discolor the concrete shall not be used.

Forms shall be cleaned of all dirt, sawdust, water and other foreign material prior to placing concrete in the forms.

For narrow walls and columns where the bottom of the form is inaccessible, provisions shall be made for cleaning out extraneous material immediately before placing the concrete.

(2) Wood Forms:

All lumber used for forms shall be free from defects affecting the accuracy of shape, strength, rigidity, watertightness and smoothness of the surface. All lumber for forms above stream bed shall be plywood. All form lumber shall be securely fastened to the studding so that cupping cannot occur. Chamfer strips shall be of selected material dressed to true line and uniform dimensions. The interior surfaces of all forms in contact with concrete surfaces which will be exposed in the finished work shall be smooth and even. No uneven or offset joints or single boards projecting so that their impressions are left in the concrete will be allowed. Forms, as far as practicable, shall be so constructed that the form marks will conform to the general lines of the structure. In general, grain of the lumber and direction of side joints shall be horizontal on wide faces and walls and vertical on narrow faces. If varying widths of panels are used, the wider panels shall be placed on the bottom and the narrower ones near the top. Panel end joints shall be staggered not less than three (3) feet. Spreaders made of wood shall not be left in the concrete.

(3) Metal, Fiberglass and Other Forms:

The same provisions as specified under wood forms shall apply to metal and fiberglass forms and, in addition, the following shall apply:

All bolts and rivet heads shall be countersunk. Clamps, rods, pins or other connecting devices shall be designed to hold the forms rigidly together and allow removal without injury to the concrete. Forms which do not present a smooth surface or are not properly aligned shall not be used.

Care shall be exercised to keep the forms free of dust, grease or other foreign matter which will tend to discolor the concrete.

Metal forms shall be used for the casting of precast I-beams, box beams, and voided or flat slabs where the contract number of units combined dictates production runs equal to or longer than the precasting bed length. A limited number of units, having a total combined length at least one unit length less than bed length, may be cast with alternate forms, as approved by the Engineer. Dimensional tolerances using alternate forms shall conform with 601-4.02(B) of these specifications.

(D) Removal of Falsework and Forms:

No falsework or forms shall be relieved of load and no forms shall be removed without approval of the Engineer.

Falsework for cast-in-place non-prestressed structures or composite superstructures shall not be removed until either:

(1) At least ten (10) days after the last concrete has been placed in each continuous span and until the compressive strength of all placed concrete has attained at least seventy (70) percent of the required twenty-eight (28) day compressive strength.

(2) At least five days after the last concrete has been placed in each continuous span and until the concrete has attained the required twenty-eight (28) day compressive strength.

Side forms for footings, beams, girders, box culverts, columns, railings, curbs or other members wherein the forms do not resist dead load bending may be removed after the concrete has set and the Subcontractor shall cure and protect the concrete thus exposed in accordance with the requirements of Section 1006. The Subcontractor shall assume all risks and responsibility resulting from such removals. Forms for cast-in-place concrete, unless otherwise specified herein, shall not be removed until at least seven (7) days after concrete has been placed in the forms, without the approval of the Engineer.

Placement of backfill material shall be in accordance with Subsection 203-5.03(B) of these specifications. Where backfill is to be placed against both sides of a structural element, the backfill elevations on one (1) side of the element shall not exceed the backfill elevations on the opposite side of the element by more than five (5) feet.

Forms for precast concrete shall stay in place a minimum of fifteen (15) hours.

The period of time between the placement of concrete in the top slab of a standard concrete box culvert (twelve (12) foot span or less) and the removal of the slab support forms may be reduced to forty-eight (48) hours if the top slab remains supported along the center line of the culvert span by a continuous beam and line of posts erected as a part of the original slab form, arid which will remain in place, undisturbed, a minimum of seven days.

If the Engineer allows the removal of forms before the specified curing period has elapsed, the Subcontractor shall cure the concrete for the remaining required curing time by one of the methods specified in Section 1006 of these specifications.

Forms for cast-in-place concrete that require a Class II finish may be removed after the concrete has set, providing the required surface finishing of the concrete is completed within four (4) days. If finishing cannot be completed within four (4) days, the forms shall remain in place for seven (7) days.

Care shall be taken in removing falsework and forms so as not to deface or damage the structure. Methods of removal likely to damage or cause overstressing of the concrete shall not be used.

All falsework shall be removed from underpass superstructures prior to opening the structure to traffic. Falsework shall be removed in such a manner that excessive stresses are not induced into the structure. Holes or blockouts shall not be drilled or cast into the structure to facilitate removal of the falsework.

601-3.03 Placing Concrete:

(A) General Requirements:

No concrete shall be placed in any structure until the placement of reinforcing steel and the adequacy of the forms and falsework have been approved by the Engineer.

Adequate time shall be given to the Engineer to check all form dimensions, embedded items, and placement of reinforcing steel. Concrete shall not be placed until all necessary corrections have been made by the Subcontractor and all work required for the proposed pour has been completed.

Reinforcing steel shall be placed in accordance with the requirements of Section 605 of these specifications and the project plans.

The sequence of concrete placement shall be as shown on the project plans or as approved by the Engineer when not shown on the project plans.

Concrete shall be placed and consolidated by methods that will not cause harmful segregation and will result in a dense homogeneous concrete free of honeycomb or voids.

Concrete shall be placed in horizontal layers not over twenty-four (24) inches in depth unless otherwise approved by the Engineer.

Concrete shall be placed as nearly as possible in its final position and the use of vibrators for shifting the mass of fresh concrete will not be permitted. Dropping the concrete more than eight feet without the use of approved pipes or tubes will not be allowed.

Care shall be taken to fill all areas within the forms and to force the concrete under and around the reinforcement without displacing the reinforcement or other embedded items.

Conveying equipment shall be capable of providing a supply of concrete to the point of placement without segregation, or interruptions sufficient to permit loss of plasticity between successive increments.

Concrete placed in slabs and floors other than bridge decks shall be struck off by means of a screed. The screed may be self-propelled screed equipment or the type specified under Subsection 401-3.04(D) of these specifications, Fixed Form-Manual Methods.

No concrete that has partially hardened or been contaminated by foreign materials shall be deposited in the structure.

The rate of concrete placement and consolidation shall be such that the formation of cold joints within monolithic sections of any structure will not occur. Any portion of any structure displaying apparent cold joints will be rejected, unless the Subcontractor, at his expense, can submit evidence that will indicate that either a cold joint does not exist or that a cold joint is not detrimental to the structure. The Engineer shall be the sole judge in determining the existence of a cold joint and whether its existence is detrimental to the structure. The rate of concrete placement for major structures shall not be less than thirty-five (35) cubic yards per hour unless otherwise specified or approved in writing by the Engineer.

The rate of concrete placement for the bottom slabs and girder walls of cast-in-place box girder superstructures shall not be less

than sixty (60) cubic yards per hour when the volume of concrete to be placed exceeds three-hundred (300) cubic yards.

(B) Pumping Concrete:

Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be of suitable type and shall have adequate capacity for the work. The concrete shall not flow either over or through any piping, fittings or equipment which is fabricated of aluminum or aluminum alloys. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. Excessive segregation due to high velocity discharge of the concrete will not be permitted. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or segregation of the ingredients. Standby equipment shall be readily available to replace initial pumping equipment should breakdown occur.

(C) Vibrating Concrete:

All concrete in structures shall be consolidated by means of approved vibrators together with any other equipment necessary to perform the work as specified herein. The minimum frequency of the internal vibrators shall be eight-thousand (8,000) vibration cycles per minute.

Vibration shall be applied in the area of the freshly deposited concrete. Vibrators shall penetrate to the bottom of the concrete layer and at least six (6) inches into the preceding layer. The vibration shall be of sufficient duration and intensity to consolidate the concrete thoroughly within fifteen (15) minutes after it has been deposited in the forms.

Vibration shall not be continued at any one point to the extent that localized areas of grout are formed. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

Revibration of concrete may be required at any time as directed by the Engineer.

The Subcontractor shall provide sufficient equipment to insure uninterrupted and continuous vibration of concrete.

601-3.05 Finishing Concrete:

(A) General Requirements:

The appropriate finish, as specified herein, shall be applied to each surface of all concrete structures.

All formed surfaces will require a Class I Finish. Formed surfaces shall be finished immediately after the removal of forms in accordance with the requirements specified herein. If rock pockets or honeycomb are of such an extent and character as to affect the strength of the structure and to endanger the steel reinforcement, the Engineer may declare the concrete defective and require the removal and replacement of that portion of the structure affected at the expense of the Subcontractor.

Formed surfaces normally in view of vehicular or pedestrian traffic, or not covered by fill material shall present a pleasing appearance of uniform color and texture commonly achieved by the use of clean, smooth plywood forms joined tightly or taped at the joints, preformed metal forms, paper tubing forms, or specially-coated forms. If a pleasing appearance has not been achieved, either in the formed surface or at the joints, the Engineer will order that the surface be finished in accordance with the requirements for a Class II Finish.

(B) Class I Finish:

All bolts, wires, snap-ties, and rods shall be clipped and recessed one (1) inch below the surface of the concrete. All holes, honeycomb, rock pockets and other surface imperfections shall be cleaned to sound concrete, thoroughly moistened and carefully patched with mortar.

Mortar shall be composed of one part cement, two parts of fine sand, water and an adhesive of a type approved by the Engineer. A portion of the required cement shall be white as required to match the color of the surrounding concrete. Small voids due to entrapped air and water in precast members need not be patched.

(C) Class II Finish:

The surface shall be patched and pointed as specified herein for Class I finish. When the mortar used in patching and pointing has set sufficiently, the surface shall be rubbed with cork, wood, or rubber floats, polystyrene, or a mechanical carborundum stone. During the rubbing process, a thin mortar, matching the color of surrounding concrete, may be used to facilitate producing a satisfactory lather. The mortar used to produce a lather shall not be used in quantities sufficient to cause a plaster coating to be left on the finished surface. Rubbing shall continue until irregularities are removed and there is no excess material. At the time a light dust appears, the surface shall be brushed or sacked. Brushing or sacking shall be carried in one direction so as to produce a uniform texture and color.

601-3.06 Curing Concrete:

Curing cast-in-place concrete and curing precast concrete members shall be in accordance with the requirements of Subsection 1006 of these specifications.

601-3.08 Backfilling:

Structure backfill shall be placed in accordance with the requirements of Subsection 203 of these specifications.

(A) Precast Concrete Structures:

(1) General:

Precast units that do not comply with the dimensional tolerances specified herein will be rejected. Precast units that show evidence of cracks, pop outs, voids or other evidence of structural inadequacy or imperfections that will reduce the aesthetics of the unit after final placement will be rejected.

(2) Precast Minor Structures:

The maximum allowable tolerances or deviations from the dimensions shown on the drawings shall be as follows:

(a) Overall dimensions of member: one-quarter (1/4) inch per ten (10) feet, maximum of ± three-quarter (3/4) inch

(b) Cross-sectional dimensions: Sections six (6) inches or less ± one-eighth (1/8) inch

Sections eighteen (18) inches or less and over six (6) inches ± three-sixteenth (3/16) inch

Sections thirty-six (36) inches or less and over eighteen (18) inches ± one-quarter (1/4) inch

Sections over thirty-six (36) inches ± three-eighths (3/8) inch

(c) Deviations from straight line:
Not more than one-quarter (1/4) inch per ten (10) feet

All exposed, sharp corners of the concrete shall be filleted three-quarter (3/4) inch with a maximum allowable deviation of ±-one-eighth (1/8) inch

601-4 Tests on Finished Structures:

601-4.01 Surface Texture:

The grooves for decks exposed directly to traffic shall be one-sixteenth (1/16) to one-eighth (1/8) inch in width and three-thirty-seconds (3/32) to six-thirty-seconds (6/32) inch in depth. The textured groove depth will be measured in accordance with the requirements of Arizona Test Method 310. The center spacing of the grooves shall be one-half (1/2) inch to one (1) inch.

601-4.02 Dimensional Tolerances:

(A) Cast-in-Place Concrete:

The maximum allowable tolerances or deviations from dimensions shown on the approved shop drawings shall be as follows:

(1) Variation from plumb in the lines and surfaces of columns, piers, abutment and walls:

In any ten (10) foot or less length: 3/8 inch
Maximum for the entire length: 1 inch

(2) Variation in cross-sectional dimensions of columns, piers and in the thickness of slabs and walls:

+ 1/4 inch
- 1/8 inch

(3) Variation in footing cross-sectional dimensions in project plans:

+ 2 inch
- 1/2 inch

(4) Variation in footing thickness:

*Greater than specified - No Limit

Less than specified - five (5) percent of specified thickness up to a maximum of one (1) inch

*Does not apply to reinforcing steel placement.

(5) Subgrade Tolerances:

Slab poured on subgrade excepting footing thickness:

+ 1/4 inch
- 3/4 inch

601-4.03 Compressive Strength and Acceptance:

Sampling and testing for compressive strength and acceptance for compressive strength will be in accordance with the requirements of Subsection 1006-7 of these specifications.

601-4.04 Opening to Traffic:

No vehicular traffic will be allowed on the structure until at least ten days after the last concrete has been placed in each continuous portion of a structure and until the compressive strength of all placed concrete has reached the required twenty-eight (28) day compressive strength on structures in which cast-in-place concrete has been used.

601-5 Submittals:

At least two (2) weeks prior to the concrete structures construction, the Subcontractor shall submit six (6) copies of the following:

1. Precast minor structures:

   The precast minor structures shall consist of catch basins, headwalls, wingwalls and other miscellaneous structures.

   The "H" dimension as shown on the project plans or Standard Drawings for catch basins shall be determined in the field prior to casting. The Subcontractor is advised to acquaint himself with conditions peculiar to the project which might limit the use of precast items.

   If corrections are required, one set of drawings will be returned with the required revisions noted thereon. After corrections have been made, six (6) sets of corrected drawings must be re-submitted. Upon approval, the manufacturer will be notified in writing and the precast item will be listed as an approved alternate.

2. Liquid membrane forming compound.

3. Expansion joint filler and joint seal.

4. Preformed bearing pads and elastomeric bearing pads.

5. Falsework structural elements layout plan with calculations.

6. Concrete placing methods and equipment used.

7. Field test results.

601-6 Method of Measurement:

When concrete is to be paid for by the cubic yard, measurement will be made in accordance with the dimensions shown on the project plans or such other dimensions as may be ordered in writing by the Engineer. No deduction will be made for the volume occupied by reinforcing steel or structural steel.

The quantity of precast, prestressed structural members to be measured for payment will be the actual number of members, except piling, of the various types and sizes, installed in place, complete and accepted. Each member shall include the concrete, steel reinforcement and anchorages, plates, nuts, and such other materials contained within or attached to the unit.

SECTION 602 CONCRETE UNDERPASSES AND BOX CULVERTS

602-1 Description:

The work under this section shall consist of furnishing all materials and constructing reinforced concrete underpasses and reinforced concrete box culverts to the forms, shapes and dimensions shown on the project plans and to the lines and grades established by the Engineer and in accordance with the requirements of Sections 601, 605, 1003 and 1006 of these specifications.

602-2 Materials:

Portland cement concrete shall conform to the requirements of Section 601 and 1006 of these specifications for Class S as shown on the project plans.

Reinforcing steel shall conform to the requirements of Section 605 and 1003 of these specifications.

602-3 Construction Requirements:

The work shall conform to the requirements of Section 601 of these specifications.

For the underpasses, wall backfill and top slab overburden shall be placed at least twenty-one (21) days but not more than twenty-eight (28) days after the top slab falsework is removed.

602-4 Submittals:

Submittals shall conform to the requirements of Section 105 of these specifications.

602-5 Method of Measurement:

Concrete underpasses and box culverts measurement shall conform to the requirements of Sections 601 and 605 of these specifications.

SECTION 603 ANCHOR SLAB (for PCCP):

603-1 Description:

The work under this item shall consist of furnishing all labor, equipment and materials required for installing the anchors for Portland Cement Concrete Pavement at the locations and in accordance with the details shown on the project plans and the requirements of these specifications.

603-2 Materials:

Preformed cellular plastic filler shall conform to the requirements of ASTM D 3204 and as approved by the Engineer.

Joint sealant shall conform to the requirements of ASTM D 3406.

Concrete shall be Class S (F'c = 3,000) conforming to the requirements of Section 1006 of these specification.

Dowel bars shall be plain round bars, one and a quarter (1-1/4) inches in diameter and eighteen (18) inches in length and shall conform to the requirements of AASHTO M 254 with Type H coating. Type B coating shall be an approved epoxy.

The dowel core material shall conform to the requirements of AASHTO M 227, Grade fifty (50).

603-3 Construction Requirements:

The dowel bars shall be uniformly coated with a thin film of heavy waterproof grease for the full length of the dowel immediately prior to concrete placement.

Dowels shall be secured in place before concrete placement begins, by approved methods of assemblies that will hold the dowels in position without disruption throughout construction.

Dowels shall be placed at the mid-depth of the slab and centered about the weakened plane joint. Dowels shall be spaced at twenty-five (25) inches center to center, but shall not be placed within fifteen (15) inches of the pavement edge or within four (4) inches of a longitudinal joint.

Dowels bars shall be placed to a vertical and a horizontal tolerance of ± one-half (1/2) of an inch of the specified depth, centering and spacing.

Dowels bars shall be placed parallel to the pavement center line and pavement surface within a tolerance of ± three-eighths (3/8) of an inch of the full dowel length.

603-4 Submittals:

Submittals shall conform to the requirements of Section 105 of these specifications.

603-5 Method of Measurement:

Anchors will be measured by the unit, each, complete as shown on the project plans.

SECTION 605 STEEL REINFORCEMENT

605-1 Description:

The work under this section shall consist of fabricating, furnishing, and placing steel reinforcement of the quality, coating, type, size, shape and quantity designated, all in accordance with the details shown on the project plans and the requirements of these specifications.

605-2 Materials:

Steel reinforcing bars, wire, and welded wire fabric shall conform to the requirements of Section 1003 of these specifications.

605-3 Construction Requirements

605-3.01 General:

When the project plans show a bar list and bending diagram, the Subcontractor shall carefully check the schedule against the details in advance of ordering materials.

When bar bending diagrams are not shown on the project plans, shop drawings and lists showing the bending of reinforcement bars shall be submitted by the Subcontractor to the Engineer for approval, but such approval shall not relieve the Subcontractor of responsibility for the correctness of such drawings and lists.

Any discrepancy or error found by the Subcontractor in checking a bar list or bending diagram shown on the project plans or in preparing shop drawings or lists shall be reported immediately to the Engineer, and the discrepancy or error shall be corrected in advance of fabrication and delivery of materials.

Steel reinforcement shall be protected at all times from damage. When placed in the work, all reinforcement shall be free of dirt, oil, paint and grease. Rust, surface irregularities or mill scale shall not be cause for rejection, provided the weight, dimensions, cross-sectional area and tensile properties of a manually wire brushed test specimen are not less than the requirements of these specifications.

When bending is required, it shall be done without the use of heat, and bars having cracks or splits at the bends will be rejected. Grade forty (40) bars which are No. eight (8) and larger and all sizes of Grade sixty (60) bars shall not be rebent at the same location. Grade forty (40) which are size No. seven (7) and smaller may be rebent once at the same location.

Reinforcement shall be accurately fabricated and placed as shown on the project plans and shall be firmly held in place by wire ties at all intersections and splices with sixteen (16) gauge or heavier tie wires and with precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires or other approved supports at the spacing necessary to maintain the specified clearance of the reinforcing steel. The use of pebbles, broken stone, concrete masonry blocks, brick, metal pipe or wood blocks will not be permitted for the purpose of spacing or support. Where reinforcement spacing is less than twelve (12) inches in each direction alternate intersections may be tied. Tack welding of reinforcement will not be permitted unless approved in writing by the Engineer. If tack welding of reinforcement is approved the reinforcement shall be deformed and shall conform to the requirements of ASTM A 706.

Before placing the pier column and superstructure reinforcement, the Subcontractor shall insure that the vertical reinforcing steel will not interfere with the horizontal cap reinforcing steel and tendon ducts. Reinforcing steel shall not be cut to facilitate installation.

The following tolerances will be allowed when placing, tying, and supporting reinforcing steel:

> In slabs and beams, horizontal bars shall be within one-quarter (1/4) inch, measured vertically, of the position indicated on the project plans.
>
> In vertical walls, columns, wings, and similar members, clearance from the forms shall be within one-fourth (1/4) inch of the clearance shown on the project plans.
>
> In slabs or walls, long runs of bars may vary up to two (2) inches in spacing; however, the specified number of bars shall be placed.

No concrete shall be placed until reinforcement in the member has been inspected and approved by the Engineer. Reinforcement which does not conform to the above tolerances shall be adjusted or repaired prior to concrete placement.

When required by the project plans, all reinforcement and all other steel elements to be encased in the concrete of a bridge deck or bridge barriers shall be epoxy coated. Reinforcement that is to be partially within these concrete elements, but extends into other structural elements, will not require coating on that part which is to be outside the bridge deck or bridge barrier concrete.

605-3.02 Splicing and Lapping:

All reinforcement shall be furnished in the full lengths indicated on the project plans. Splicing of bars, except as shown on the project plans, will not be permitted without the Engineer's approval. Splices shall be staggered as far as possible. The type and method of splices or connections shall be approved by the Engineer.

The Subcontractor may use either lap splices, full welded splices or mechanical connections for reinforcement bars up to and including bar size No. eleven (11). Where the bar size exceeds No. eleven (11), full welded splices or mechanical connections shall be used. Welded splices shall not be used on epoxy-coated bars, and no welding shall be performed close enough to epoxy-coated bars to cause any heating of the coating. All exterior surfaces of positive connectors for epoxy-coated bars shall have the same coating as the bar.

In lapped splices, the bars shall be placed in contact with one another and wired together in such a manner as to maintain a clearance of not less than the minimum clear distance to other bars and the minimum distance to the surface of the concrete, as specified in the AASHTO Standard Specifications for Highway Bridges. Lap lengths shall be as shown on the project plans.

A full welded splice is one in which the bars are butted and welded to develop, in tension, at least one-twenty-five (125) percent of the specified yield strength of the bar. Test requirements shall be as specified in AWS D 1.4.

Welding shall be performed in accordance with the requirements of Subsection 604-3.06 of the ADOT specifications.

A mechanical connection is one in which the bars are connected to develop an ultimate strength, in tension or compression as required, of at least one-hundred-twenty-five (125) percent of the specified yield strength of the bar.

Except as otherwise specified, mechanical splices shall be made in accordance with the manufacturer's recommendations as approved by the Engineer. As a condition of approval, the Subcontractor shall make three (3) test splices in the presence of the Engineer of each size he intends to splice. Two (2) of the test splices shall be tension tested to one-hundred-twenty-five (125) percent of the specified yield strength of the bar and one splice shall be tested to destruction by an approved laboratory and certified reports of the tests shall be submitted to the Engineer for approval. Field splices shall be subject to visual inspection and physical testing. A minimum of two (2) percent of the field splices chosen at random by the Engineer shall be removed and tested to one-hundred-twenty-

five (125) percent of specified yield strength by the Engineer. Samples shall be at least forty-two (42) inches long with the splice at mid-length.

Sheets of welded wire fabric or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one mesh width.

605-3.03 Epoxy-Coated Reinforcement:

(A) General:

The requirements of this subsection for epoxy-coated reinforcement are in addition to the previous requirements which apply to un-coated reinforcement.

(B) Field Operations - Epoxy-coated Bar Reinforcement:

All handling systems for coated bars shall have padded contact areas for the bars wherever possible. All bundling bands shall be padded and all bundles shall be lifted with a strong back, multiple supports or a platform bridge so as to prevent bar to bar abrasion from sags in the bar bundle. The bars or bundles shall not be dropped or dragged.

All hardware that will remain permanently in concrete using epoxy coated reinforcement shall be made of or coated with a dielectric material. Such hardware includes reinforcement chairs, tie wires, screed rail supports, or any other item that would be a potential source of corrosion. The specific hardware that the Subcontractor proposes to use shall be approved by the Engineer.

The Subcontractor shall be required to field repair damaged areas of the coating, and to replace items exhibiting severely damaged coatings. The material used for field repair shall be that supplied by the coating applicator.

Field repair shall be required wherever the area of coating damage exceeds two percent of the surface area of the bar in a one foot length and the damaged spot is larger than one-quarter (1/4) inch by one-quarter (1/4) inch.

Field repair will not be allowed on bars which have severely damaged coatings. A severely damaged coating is defined as a coating which has a total damaged area greater than five (5) percent of the surface area of the reinforcing bar. The Engineer shall be the sole determiner of the severity of damaged area for purposes of repair or replacement. A reinforcing bar having a coating determined by the Engineer to be severely damaged shall not be incorporated in the work and it shall be removed from the work

site. All such bars shall be replaced in kind by the Subcontractor at no additional cost to the Engineer.

605-3.04 Dowel Placement:

Dowel placement shall consist of drilling or coring dowel holes, furnishing and placing setting materials and placing metal dowels in accordance with the details shown on the project plans and the requirements of the specifications.

The diameter of dowel holes shall be one-quarter (1/4) inch larger than the diameter of the dowels to be placed and the depth of the holes shall be as shown on the project plans.

Setting materials shall be an approved epoxy adhesive unless otherwise specified on the project plans.

The minimum tensile pull out strength of the dowel anchorage shall be as specified on the project plans.

If required by the Engineer, the Subcontractor shall submit details of the anchorage system to the Engineer prior to dowel placement.

605-4 Method of Measurement:

605-4.01 General:

No measurement for payment will be made for steel reinforcement, whether coated or uncoated as required, which is included in a precast concrete item which is listed in the bidding schedule as a unit to be paid for at a lump sum price.

Except for that contained in a precast concrete item to be measured as a unit, steel reinforcement will be measured as a lump sum item or by the pound, as listed in the bidding schedule. Epoxy-coated reinforcement will be measured separate from uncoated reinforcement.

Dowel placement will be measured by the unit each.

605-4.02 Pound Basis:

Reinforcing Steel will be measured in pounds based on the total computed weight for the size and lengths of bars, wire or welded wire fabric as shown on the project plans or authorized.

The weight of bars will be calculated from weights shown in Table 605-1.

TABLE 605-1

Deformed Bar Designation Number	Weight - Pounds Per Linear foot	Nominal Diameter, Inches
3	0.376	0.375
4	0.668	0.500
5	1.043	0.625
6	1.502	0.750
7	2.044	0.875
8	2.670	1.000
9	3.400	1.128
10	4.303	1.270
11	5.313	1.410
14	7.650	1.693
18	13.600	2.257

Note: The nominal diameter of a deformed bar is equivalent to the diameter of a plain round bar having the same weight per foot as the deformed bar. Bar numbers are based on the number of eighths of an inch included in the nominal diameter of the bars.

The weight of welded wire fabric will be computed from the theoretical weight of plain wire of the corresponding gauge. If the weight per square foot is shown on the project plans, that weight will be used.

In measurement of the weight of epoxy-coated steel reinforcement, no addition to or deduction from the weights shown in Table 605-1 will be made because of additional requirements for blast cleaning and epoxy coating.

When laps are made for splices other than those shown on the project plans for the convenience of the Subcontractor, the extra steel will not be included in the measurement for payment.

The measurement of samples for testing will be the weight in pounds of the samples selected by the Engineer or the weight in pounds of the full length of reinforcing steel bars supplied for sampling purposes when sampling is done at the construction site.

SECTION 607 ROADSIDE SIGN SUPPORTS

607-1 Description:

The work under this section shall consist of furnishing and installing roadside sign supports in accordance with the details shown on the project plans and the requirements of these specifications.

Sign supports shall consist of breakaway, perforated and U-channel sign posts. The type, size and installation location of the sign posts will be shown on the project plans.

607-2 Materials:

607-2.01 General:

Certificates of Analysis conforming to the requirements of Subsection 106.05 shall be submitted for all structural steel.

607-2.02 Breakaway Sign Post Shapes:

Posts shall be fabricated from structural steel conforming to the requirements of ASTM A 441. ASTM A 572 Grade 50 or ASTM A 588 may be substituted for ASTM A 441 at the option of the Subcontractor. Base plates for the breakaway connections and friction fuse plates and back plates for the post hinge assembly shall be fabricated from the same type structural steel selected for the sign posts.

All plate holes shall be drilled and all plate notches shall be saw cut, except that flame cutting will be permitted provided all edges are ground. Flange holes shall be drilled or sub-punched and reamed. The posts shall be saw cut for the hinge and bolted as detailed on the project plans.

Bolts, nuts and washers shall conform to the requirements of ASTM A 325.

Posts and plates shall be galvanized after fabrication in accordance with the requirements of ASTM A 123. Bolts, nuts and washers shall be cadmium plated in accordance with the requirements of ASTM A 165, or zinc plated in accordance with the requirements of ASTM B 633.

607-2.03 Perforated Sign Posts:

Single and telescoping perforated posts shall be square tube fabricated from 0.105 inch U.S.S. gauge cold-rolled sheet carbon steel conforming to the requirements of ASTM A 366. Posts shall be welded directly in the corner by high frequency resistance welding or equal. The posts shall be externally scarfed to agree with std.

corner radii of five-thirty-seconds (5/32) inch ± one-sixty-forth (1/64) inch. Bolts, nuts and washers shall conform to the requirements of ASTM A 307, Grade A.

Perforated posts shall be galvanized after fabrication in accordance with the requirements of ASTM A 525, Coating Designation G-90. Bolts, nuts and washers shall be zinc coated in accordance with the requirements of ASTM A 153 or cadmium plated in accordance with the requirements of ASTM A 165.

607-2.04 U-Channel Sign Posts:

Unchannel posts shall be fabricated from rerolled rail steel conforming to the requirements of ASTM A 499 or hot-rolled carbon steel bars.

Prior to rerolling the rail steel, the rail nominal weight shall be ninety-one (91) pounds per yard and shall meet the requirements of ASTM A 1 pertaining to quality assurance.

Yield Point of the steel shall be 80,000 PSI (Min.).

The cast heat analysis of the steel shall conform to the following requirements:

Element	Composition (Percent)
Carbon	0.67 - 0.82
Manganese	0.70 - 1.10
Phosphorus, max.	.04
Sulphur, max.	.05
Silicon	0.10 - 0.25

Posts shall be a uniform, modified, flanged channel section as shown in the project plans. Weight of the posts shall be three (3) pounds per lineal foot, plus or minus five (5) percent. The post shall be punched with continuous three-eighths (3/8) inch diameter holes on one (1) inch centers. The first hole shall be one (1) inch from top and bottom of post.

The post shall consist of two parts, a sign post and a base post. The sign post lengths shall be supplied in six (6) inch increments up to twelve (12) feet as required for the installation location. The base posts shall be forty-two (42) inches in length and pointed at one end and have at least eighteen (18) holes in the base post, starting one (1) inch from the top and continuing at one (1) inch increments.

Posts shall be machine straightened to have a smooth uniform finish, free from defects affecting their strength, durability, or appearance. All holes and rough edges shall be free from burrs.

The permissible tolerance for straightness shall be within one-sixteenth (1/16) inch in three (3) feet.

Posts shall be galvanized after fabrication in accordance with the requirements of ASTM A 123. Bolts, nuts, washers and spacers shall be cadmium plated in accordance with the requirements of ASTM A 165 or zinc plated in accordance with the requirements of ASTM B 633.

For shipment, the posts shall be nested and fastened in such a manner that they will not slip. Care shall be taken during shipping to minimize the rubbing of posts together resulting in damage to the galvanized finished surface. Excessive damage to the finish of the posts during shipping or handling will result in rejection of the damaged posts. Posts shall be bundled in groups of no more than one-hundred (100).

Unchannel base posts shall be driven into the ground to a depth of thirty-eight (38) inches. Where rock is encountered, the rock shall be cored, drilled or removed to a minimum diameter of eight (8) inches and to a depth sufficient to place portland cement concrete two (2) inches below the bottom of the base post and fill the hole to within one (1) inch of the top. Solid rock coring or drilling is not required to continue beyond twenty-four (24) inches in depth regardless of the depth at which the rock is encountered. The base post may be cut at the bottom prior to being set in portland cement concrete where rock does not permit use of full length base post.

607-2.05 Concrete:

Concrete for breakaway sign post foundations shall be Class B, except that utility concrete may be used for foundations using stub post sizes S 3 x 5.7 and S 4 x 7.7. Class B concrete shall conform to the requirements of Section 1006 and utility concrete to the requirements herein. Concrete for perforated sign posts foundations and U-channel sign post foundations, when required, shall conform to the requirements herein.

Portland cement, water, admixture, fine aggregate and coarse aggregate shall conform to the requirements of Section 1006. The coarse aggregate size designation shall be chosen by the Subcontractor and approved by the Engineer and shall conform to the size designation and gradation requirements of AASHTO M 43.

The Engineer will inspect and approve the facilities, materials and methods for producing the concrete to ensure that concrete of the quality suitable for use in the work will be obtained. Mixing and placing of the concrete shall conform to the requirements of recognized practice. Concrete may be mixed in mobile mixers upon approval of the Engineer.

Mixing and placing concrete in cold weather shall conform to the requirements of Subsection 1006-5.03. There is no maximum temperature limitation for the concrete mixture immediately prior to placement.

The minimum cement content per cubic yard of concrete shall be four-hundred-seventy (470) pounds.

All exposed concrete shall be finished to a smooth surface.

Foundation stub posts shall be fabricated from the same type of steel selected for the appropriate sign posts. Breakaway stub posts shall be galvanized a minimum of twelve (12) inches down from the top of the stub. Galvanizing shall be in accordance with the requirements of ASTM A 123.

Reinforcing steel bars for breakaway sign post foundations shall conform to the requirements of ASTM A 615, Grade forty (40). Reinforcing steel wire shall conform to the requirements of ASTM A 82.

607-3 Construction Requirements:

Fabrication of the breakaway sign posts, stub posts and base plates shall conform to the requirements of Subsection 604- 3.02, except that shop drawings will not be required.

Breakaway sign post lengths will be determined by the Engineer at the time of construction staking and will be furnished to the Subcontractor prior to ordering fabrication of the sign posts.

Perforated and U-channel sign post lengths shall be determined by the Subcontractor at the time of construction staking. Posts shall be cut to the proper lengths in the field. Splicing will be permitted for single perforated posts; however, splices will be limited to one (1) per each post installation and the splicing shall be accomplished in accordance with the details shown on the project plans. The minimum length of any spliced piece of post shall be two (2) feet.

Foundations for the breakaway sign posts, perforated sign posts and when required, U-channel posts shall be constructed to the details and dimensions shown on the project plans. Concrete shall be placed in accordance with the requirements of Section 601 or Subsection 607-2.05, as the case may be. Excavation shall conform to the requirements of Subsection 203-5.03(A) of these specifications.

Sign posts shall be erected plumb and shall be bolted to the foundation stub or base posts in accordance with the procedure specified on the project plans.

607-4 Method of Measurement:

Breakaway sign posts will be measured for each installation regardless of the number of posts at the location shown on the project plans for each size of post furnished and erected.

Perforated sign posts will be measured for each installation regardless of the number of posts at the locations shown on the project plans for each type of post furnished and installed. Telescoping post members will be considered as one post after installation and will not be measured separately. U-channel posts will be measured as each.

Foundations for signposts will be considered as part of the post.

SECTION 608 SIGN PANELS

608-1 Description:

The work under this section shall consist of furnishing and installing sign panels in accordance with the details shown on the project plans and the requirements of these specifications.

The sign panels shall be of the following types:

- Extruded Aluminum With High Reflectivity Sheeting and Demountable Characters
- Flat Sheet Aluminum With Demountable Characters
- Flat Sheet Aluminum With Direct Applied or Silk Screened Characters
- Warning, Marker, and Regulatory With Standard Reflectivity Sheeting

Sign panels shall be installed on Roadside Sign Supports as provided in Section 607 of these specifications.

608-2 Materials:

608-2.01 General:

Certificates of Compliance conforming to the requirements of Section 105 of these specifications for all materials, including reflective sheeting, required for fabricating sign panels shall be submitted.

Shipment, storage, and handling of sign panels shall conform to the recommendations of the manufacturers of the sign panel components. Fabricated signs and overlay sheets shall be shipped on edge. Damage to the sign panel or legend resulting from banding, crating or stacking may be cause for rejection of the signs.

608-2.02 Extruded Aluminum With High Reflectivity Sheeting and Demountable Characters:

Panels shall be fabricated from 12-inch wide aluminum extrusions formed from Aluminum Alloy 6063-T6 conforming to the requirements of ASTM B 221 and fastened together by bolt connections as shown on the project plans.

Panel facing shall be reflectorized with high reflectivity sheeting of the color specified on the project plans. The reflective sheeting and color shall conform to the requirements of Section 1007 of these specifications.

The letters, numerals, symbols, borders and other features of the sign message shall consist of embossed aluminum frames, porcelain enameled white in which prismatic reflectors are installed or, called for in the project plans, porcelain enameled black with no reflectors.

Panel surfaces to be covered with reflective sheeting shall be prepared in accordance with the recommendations of the sheeting manufacturer. Panel surfaces not covered with sheeting shall be etched in accordance with the recommendations of the extrusion manufacturer to reduce glare from reflected sunlight.

After all fabrication has been completed, including the cutting and punching of holes except holes for demountable letters, numerals symbols and borders, the aluminum extrusions shall be degreased and the reflective sheeting shall be applied.

Aluminum extrusions shall be flat with a 1/4-inch tolerance allowed on an eight-foot length, with proportionally greater tolerances permitted on lengths greater than eight feet. Flatness tolerance across the face of each extrusion shall be 0.005 inch per inch of width.

Aluminum extrusions shall be bolted together on 12 inch centers with a maximum allowable gap of 1/32 inch between extrusions.

Shop fabricated sub-assemblies shall be rigidly braced for transportation and erection. Hardware utilized to fasten panels to supports shall conform to the panel manufacturer's recommendations.

Each completed sign panel shall be provided with a side trim molding fabricated from extruded Aluminum Alloy 6063-T6 conforming to the requirements of ASTM B 221. The trim molding shall be fastened to each individual 12-inch aluminum extrusion with two, 5/32-inch diameter, self-plugging aluminum blind rivets 2-1/2 inches from either edge. The exposed surface of the side trim molding shall be treated by etching as recommended by the manufacturer to reduce glare from reflected sunlight.

608-2.03 Flat Sheet Aluminum With Demountable Characters:

Panels shall be fabricated from one piece 0.125 inch thick, 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B 209.

Panel facing shall be prepared and covered with high reflectivity sheeting in accordance with the recommendations of the sheeting manufacturer. Color will be specified on the project plans.

All surfaces not covered shall be etched to reduce glare from reflected sunlight.

The reflective sheeting and color shall conform to the requirements of Section 1007 of these specifications. Splicing of reflective sheeting shall not be allowed on sign panels having a minimum dimension up to and including four feet.

The letters, numerals, symbols, borders and other features of the sign message shall consist of embossed aluminum frames, porcelain enameled white in which prismatic reflectors are installed or, if called for in the project plans, porcelain enameled black with no reflectors.

608-2.04 Flat Sheet Aluminum With Direct Applied or Silk Screened Characters:

Panels shall be fabricated from 0.125 inch thick, 5052-H38 Aluminum Alloy conforming to the requirements of ASTM B 209.

Panel facing shall be prepared and covered with high or standard type reflectivity sheeting in accordance with the recommendations of the sheeting manufacturer. Color and type of sheeting will be specified on the project plans.

All surfaces not covered shall be etched to reduce glare from reflected sunlight.

The reflective sheeting and color shall conform to the requirements of Section 1007 of these specifications. Splicing of reflective sheeting shall not be allowed on sign panels having a minimum dimension up to and including four feet.

Characters on these sign panels shall be reflectorized white, or, if called for in the project plans, opaque black and produced by silk-screening or direct applied lettering.

The letters, numerals, symbols, borders and other features of the sign message shall consist of embossed aluminum frames, porcelain enameled white in which prismatic reflectors are installed or, if called for in the project plans, porcelain enameled black with no reflectors.

Panels shall be attached to the posts as shown in the project plans.

608-2.05 Warning, Marker and Regulatory With Standard Reflectivity Sheeting:

Panels to be installed on Roadside Sign Supports shall be fabricated from flat sheet aluminum and shall be reflectorized as specified herein.

Panels shall be fabricated in one piece from 0.125 inch thick, 5052-H38 or 6061-T6 Aluminum Alloy conforming to the requirements of ASTM B 209 except Panels three feet or less in the largest dimension shall be fabricated in one piece from 0.063 inch thick, 5052-H38 or 6061-T6 Aluminum conforming to the measurements of ASTM B 209.

All surfaces of panels to be covered with reflective sheeting shall be prepared in accordance with the recommendations of the sheeting manufacturer. Surfaces not covered shall be etched to reduce glare from reflected sunlight.

Warning signs except No Passing Zone pennant signs shall be reflectorized with yellow standard reflectivity sheeting. No Passing Zone pennant signs shall be reflectorized with yellow high reflectivity sheeting.

Regulatory signs shall be reflectorized with silver white standard reflectivity sheeting.

Reflectorized red signs shall be reflectorized with silver-white standard reflectivity sheeting. The red color shall be reverse silk-screened.

Regulatory signs with reflectorized red circles and slashes shall be reflectorized with silver-white standard reflectivity sheeting as background. The red color shall be reverse silk-screened.

Splicing of reflective sheeting shall not be allowed on sign panels having the minimum dimension up to and including four feet.

608-2.06 Reflective Sheeting:

Reflective sheeting shall be either standard reflectivity or light reflectivity sheeting and shall conform to the requirements of Section 1007 of these specifications.

The colors specified for reflective sheeting shall match visually and be within the color tolerance limits shown on the appropriate Highway Color Tolerance Charts issued by the Federal Highway Administration.

608-2.07 Demountable Characters:

The letters, numerals, symbols, borders, and other features of the sign message shall consist of embossed aluminum frames in which prismatic retroreflectors are installed so as to be an integral part of the character or otherwise affixed to prevent their displacement in handling or service. Retroreflectors that are held in the frames by means of tape or adhesive will not be accepted. All items shall be fabricated from 0.040-inch-sheet Aluminum Alloy

3003-HI4, conforming to ASTM B 209. Mounting holes shall be provided within frames to permit the use of screws, rivets, or other common fasteners. The size and spacing of retroreflector holes shall be such as to afford maximum night legibility and visibility to the finished cut-out figure.

The retroreflectors shall conform to the requirements of Section 1008 of these specifications. The embossed aluminum frames shall be porcelain enameled white or, if called for in the project plans, black and shall conform to the requirements of the Porcelain Enamel Institute. No prismatic reflectors shall be installed in black frames.

Letter design of the upper case and lower case letters and numerals shall be Series E of the Standard Alphabets for Highway Signs, modified by widening the stroke width to approximately one-fifth of the letter or numeral height. The uppercase letter shall be one and one-third times the loop height of the lower case letters.

Letter design of the capital letters shall be Series 0 of the Standard Alphabets for Highway Signs modified by widening the stroke width to approximately one-fifth of the letter or numeral height.

Self-plugging aluminum blind rivets or round-head wood screws, when used in black frames, shall be anodized black. All rivets used shall be 5/32 inch in diameter, self-plugging aluminum blind rivets. The length of the rivets placed in the characters shall be at least 3/4 inch. All rivets shall extend through the panel face and set tight.

608-2.08 Silk Screened and Direct Applied Characters:

Silk screened letters, numerals, arrows, symbols, and borders, shall be applied on the retroreflective sheeting background of the sign by direct or reverse screen process. Messages and borders of a color darker than the background shall be applied to the paint or the retroreflective sheeting by direct process. Messages and borders of a color lighter than sign background shall be produced by the reverse screen process.

Opaque or transparent colors, inks, and paints used in the screen process shall be of the type and quality recommended by the manufacturer of the retroreflective sheeting.

The screening shall be done in a manner that results in a uniform color and tone, with sharply defined edges of legends and borders and without blemishes on the sign background that will affect intended use.

Signs after screening shall be air dried or baked in accordance with manufacturer's recommendations to provide a smooth hard finish. Any signs on which blisters appear during the drying process will be rejected.

Direct Applied letters, numerals, symbols, borders, and other features of the sign message shall be cut from black opaque or standard or high retroreflective sheeting of the color specified and applied to the retroreflective sheeting of the sign background in accordance with instructions of the manufacturer of retroreflective sheeting.

The retroreflective sheeting shall have the minimum SIA specified in the applicable tables of Section 1007 of these specifications.

608-3 Construction Requirements:

608-3.01 Fabrication:

Fabrication of the sign panels shall be in accordance with the details shown on the project plans and the requirements of these specifications. If additional details for sign panel fabrication are required, the subcontractor shall submit shop drawings in accordance with the requirements of Section 105 of these specifications.

Panels shall be cut to size and shape and shall be free of buckles, warp, dents, cockles, burrs and defects resulting from fabrication.

Fabricated signs and overlay sheets shall be stored indoors and kept dry during storage. If packaged signs become wet, all packaging material shall be removed immediately and the signs allowed to dry. The signs may be repackaged using new dry materials. If outdoor storage is necessary, all packaging materials shall be removed. Signs shall be stored on edge, above ground, in an area where dirt and water will not contact the sign face. Materials used to support stored signs shall not contact sign faces.

608-3.02 Installation of Sign Panels:

The sign panels shall be installed on roadside sign supports in accordance with the details shown on the project plans and in accordance with the recommendations of the manufacturers of the sign panel components.

Minor scratches and abrasions resulting from fabrication, shipping and installation of panels may be patched; however, patching shall be limited to one patch per 50 square feet of sign area with the total patched area being less than five percent of the sign area. Panels requiring more patching than the specified limit will be

rejected. Patches shall be edge sealed by a method approved by the reflective sheeting manufacturer.

Face of bolts and nylon washers on panel face shall be painted to match the background or legend color in which they are placed. The sign manufacturer's name and date of installation shall be placed on the back of each sign in black, one-inch block letters. Use of felt markers for this purpose will not be permitted.

608-3.03 Inspection:

An inspection of the completely installed sign panels will be made by the Engineer during the daytime and at night for proper appearance, visibility, color, specular gloss and proper installation.

Each sign panel face shall be cleaned thoroughly just prior to the inspection as recommended by the manufacturer. The cleaning solvent and cleaning material shall in no way scratch, deface or have any adverse effect on the sign panel components.

All apparent defects disclosed by the inspection shall be corrected by the subcontractor at his expense. If color variations or blemishes between aluminum extruded sign panel increments are visible from a distance of 50 feet either during the day or at night, the panels shall be removed and replaced at the subcontractor's expense.

608-4 Method of Measurement:

Sign panels will be measured by the square foot of sign panel furnished and installed. The area of each sign panel, except for warning, regulatory and marker sign panels, will be measured to the nearest 0.1 of a square foot.

For warning, regulatory and marker sign panels, the area of each sign panel will be measured to the nearest square foot and the areas will be determined as follows:

The area of each rectangular, square or triangular sign panel will be determined from the dimensions shown on the project plans.

The area of irregular shaped signs, such as stop signs and route markers, will be determined by multiplying the maximum height in feet by the maximum width in feet, using the dimensions shown on the project plans.

SECTION 610 PAINTING:

610-1 Description:

The work under this section shall consist of furnishing paint and other materials and painting metal structures or other surfaces where shown on the project plans in accordance with the requirements of these specifications. The work shall include preparation of the surfaces to be painted, the protection and drying of the paint coatings and the protection of pedestrian, vehicular or other traffic near or under the work from paint spatter and disfigurement.

610-2 Materials:

Paint shall conform to the requirements of Section 1002, unless otherwise specified.

610-3 Construction Requirements:

610-3.01 Weather Conditions:

Paint shall be applied only on thoroughly dry surfaces and only when the atmospheric temperature is at or above forty (40) degrees Fahrenheit. Paint shall not be applied when the air is misty or when weather conditions exist which might damage the work. If fresh paint is damaged by the elements, it shall be replaced or repaired by the Subcontractor at his expense. The Subcontractor may provide suitable enclosures to permit painting during inclement weather.

610-3.02 Surface Cleaning:

(A) General:

All surfaces of structural steel or other metals, except galvanized surfaces, shall be cleaned prior to painting.

All surfaces of new structural steel or other metals which are to be painted shall be blast cleaned to a near-white finish in accordance with SSPC-SP10, unless otherwise specified or approved in writing by the Engineer.

(B) Blast Cleaning:

All dirt, rust, old paint, mill scale and other foreign material shall be removed from steel or other metal surfaces with an approved blast cleaning apparatus. Blast cleaning shall be sufficient to give the surface the appearance of unpolished sand-cast aluminum and shall leave all surfaces with a dense, uniform

anchor pattern or profile of 1.0 mils to 4.0 mils, as measured with an approved surface profile comparator.

Abrasives used for blast cleaning shall be clean, dry sand, mineral grit, steel shot, or steel grit and shall be graded to produce satisfactory results. The use of other abrasives will not be permitted unless approved in writing by the Engineer.

When blast cleaning is being performed near machinery, all journals, bearings, motors and moving parts shall be sealed against entry of abrasive dust.

Blast cleaned surfaces shall be primed or treated the same day blast cleaning is done, unless otherwise authorized by the Engineer. If cleaned surfaces rust or are contaminated with foreign material before painting is accomplished, they shall be recleaned by the Subcontractor at his expense.

(C) Steam Cleaning:

All dirt, grease, loose chalky paint or other foreign material which has accumulated on previously painted surfaces shall be removed with a steam cleaning apparatus prior to all other phases of cleaning. It is not intended that sound paint be removed by this process. After steam cleaning, any paint which has become loose, curled, lifted or loses its bond to the preceding coat or coats shall be removed to sound paint or metal surface by the Subcontractor at his expense.

A detergent shall be added to the feed water of the steam generator or applied to the surface to be cleaned. The detergent shall be of such composition and shall be added in such quantity that the specified cleaning is accomplished.

Any residue, detergent or other foreign material which may accumulate on cleaned surfaces shall be removed by flushing with fresh water.

Steam cleaning shall not be performed more than two (2) weeks prior to starting painting operations or other phases of cleaning.

Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than twenty-four (24) hours after cleaning.

(D) Hand Cleaning:

Manual or powered wire brushes, hand scraping tools, power grinders or sandpaper shall be used to remove all dirt, loose rust, mill scale, or paint which is not firmly bonded to the surfaces.

(E) Water Blast Cleaning:

Water blast cleaning shall be done in accordance with NACE Standard RP-01-72 with normal water. No additives to the water will be allowed. All areas of oil and grease on surfaces to be coated shall be hand cleaned with clean petroleum solvents. The solution of solvent and contaminates shall be wiped clean and the surfaces allowed to air dry prior to the water blast cleaning. The Subcontractor shall not use power spray equipment or similar methods to apply the solvent. All the surfaces to be coated shall be power washed with a water pressure of not less than two-thousand (2,000) PSI and not greater than five-thousand (5,000) PSI. The water blasting equipment shall have a minimum water usage of five (5) gallons/minute.

Water blast cleaning shall be performed no more than two (2) weeks prior to the start of painting operations or other phases of cleaning.

Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case less than twenty-four (24) hours after cleaning.

610-3.03 Application:

The Subcontractor shall notify the Engineer, in writing, at least one week prior to beginning cleaning and painting operations including shop painting.

Painting shall be accomplished in a neat and workmanlike manner. Paint shall be applied with hand brushes, by spray, or roller, or by a combination thereof, except that Paint No. three (3), Aluminum, shall be applied by spraying.

Each application of paint shall be smoothly and uniformly spread so that no excess paint will collect at any point. Any skips, holidays, thin areas or other deficiencies shall be corrected before the succeeding paint application. The surface of the paint being covered shall be free of moisture, dust, grease or any other deleterious materials which would prevent the bond of the succeeding applications.

When paint brushes are used, they shall have a sufficient body and length of bristle to spread the paint in a uniform film.

Surfaces which are inaccessible shall be painted with daubers or by other means approved by the Engineer.

When rollers are used, they shall be of a type which will not leave a stippled texture in the paint film.

When sprayers are used, a water trap, approved by the Engineer, shall be furnished and installed at each spray pot.

Prior to application, paint shall be mixed with mechanical mixers for a sufficient length of time to thoroughly mix the pigment and the vehicle together and it shall be kept thoroughly agitated during its application.

The handling and the application of paints shall be done in accordance with all applicable occupational, safety and health standards, rules and regulations.

610-3.04 Protection Against Damage:

The Subcontractor shall provide protective devices as necessary to prevent damage to the work and to other property or persons from all cleaning and painting operations.

Paint or paint stains which result in an unsightly appearance on surfaces not designated to be painted shall be removed or obliterated as approved by the Engineer.

All painted surfaces that are marred or damaged as a result of the 's operations shall be repaired with materials and to a condition equal to that of the paint coating specified herein.

Upon completion of all painting operations and of any other work, the painted surfaces shall be thoroughly cleaned.

610-3.05 Painting Structural Steel:

(A) Paint Coats:

(1) General:

All surfaces of new metals shall be painted with one (1) shop coat (prime coat) and two (2) field coats (first field coat and finish coat), unless otherwise specified.

The dry film thickness of the paint will be measured in place with a calibrated magnetic film thickness gauge in accordance with SSPC-PA2.

If the minimum dry film thickness is exceeded, it shall be limited to that which will result in uniform drying throughout the paint film.

(2) Pre-Treatment:

If directed by the Engineer, a wash primer conforming to the requirements of Subsection 1002-3.05 shall be applied to freshly

blast cleaned steel surfaces prior to the application of the first undercoat of paint. All blast cleaned surfaces shall be coated with pre-treatment wash within four (4) hours of cleaning. Treatment shall be applied sooner if, in the opinion of the Engineer, atmospheric conditions are such that corrosive products form on freshly blast cleaned surfaces in less than four (4) hours.

Pre-treatment washes shall be applied by spraying to produce a uniform wet film on the surface.

During the application of the pre-treatment wash, no blast cleaning will be permitted adjacent to the areas being treated.

No paint shall be applied until after the treated surfaces have thoroughly dried.

The first coat of paint shall be applied to the treated surfaces the same day that cleaning and pre-treatment have been done.

(3) Prime Coat:

The prime coat shall conform to the requirements of Subsection 1002-3 and, when applied, the dry film thickness of the paint shall not be less than two (2) mils, and sufficient to adequately cover the blast profile pattern. A deep profile pattern from steel shot blasting may require two applications of prime coat to obtain sufficient coating of the steel surface.

(4) First Field Coat:

The first field coat shall be appropriately tinted to contrast with the prime coat and shall conform to the requirements of Subsection 1002-3. When applied, the dry film thickness shall be not less than 1.5 mils.

(5) Finish Coat:

The finish coat shall be an aluminum pigmented paint. This paint shall conform to the requirements of Subsection 1002-3. When applied, the dry film thickness shall not be less than 1.0 mil.

(B) Shop Painting:

After structural steel has been fabricated, blast cleaned and accepted by the Engineer, all surfaces except metal surfaces which are to be embedded in concrete, or within three (3) inches of a high strength bolted connection, shall be painted with a prime coat.

Structural steel which is to be welded shall not be painted before welding is complete. If it is to be welded only in the fabricating shop and subsequently erected by bolting, it shall receive one prime coat after the shop welding is completed. Areas of structural steel to be field welded shall be masked and the remainder of the steel shall be given one (1) prime coat.

As soon as practicable after being accepted by the Engineer and prior to removal from the shop, machine-finished surfaces shall be prime coated with a rust inhibitor which can easily be removed.

Erection marks for field identification of steel members and weight marks shall be painted upon surface areas previously painted with the shop coat.

Surfaces of milled or finished iron and steel castings shall be given one (1) shop coat of paint.

(C) Field Painting:

After erection of steel structures has been completed, including all riveting, welding, bolting and any straightening of bent metal, all adhering rust, scale, dirt, grease and other foreign material shall be removed as specified under Subsection 610-3.02. All areas where the prime coat is damaged or deteriorated shall be thoroughly cleaned and spot painted with the same type of paint used for the shop coat and to the specified dry film thickness.

When the spot painting coat is thoroughly dry, the first field coat and the finish coat shall be applied. In no case shall a succeeding coat be applied until the previous coat has dried throughout the full thickness of the paint film.

All small cracks and cavities which have not become sealed in a watertight manner by the first field coat shall be filled before the finish coat is applied.

At the option of the , the two (2) field coats may be applied in the shop. When finished coats are applied in the shop, the Subcontractor shall repaint all damaged or deteriorated areas in the field as directed by the Engineer.

610-3.06 Painting Damaged Galvanized Coating:

Areas of galvanized coating damaged due to welding after fabrication or due to handling, shall be roughened by sanding or acid and the roughened areas shall be painted with at least one (1) full coat of Paint Number four (4) - Zinc, conforming to the requirements of Subsection 1002-3.

610-3.07 Painting of Miscellaneous Steel Items:

All miscellaneous steel items that are not elements of bridges, cantilever sign supports, or bridge truss sign structures, may be hand cleaned and have the required field paint coats applied in the shop.

610-4 Blank:

610-5 Basis of Payment:

No measurement of direct payment will be made for painting as described and specified herein and on the project plans, the cost being considered as included in the prices paid for the various contract items of work involving painting.

SECTION 703 MARKERS

703-1 Description:

The work under this section shall consist of furnishing and installing reference markers and object markers in conformance with the details shown on the project plans and in accordance with the requirements of these specifications.

The types of markers to be installed and the locations will be shown on the project plans.

703-2 Materials:

703-2.01 General:

Certificates of Compliance conforming to the requirements of Section 105 shall be submitted.

703-2.02 Metal Posts:

Posts for all markers shall conform to the details shown in the project plans.

703-2.03 Metal Plates:

Metal plates for the various types of object markers shall conform to the details shown on the project plans and shall be fabricated in one piece from 0.063 inch thick aluminum-alloy sheet 3003-H 14, 5052-H 38 or 6061-T 6, all conforming to the requirements of ASTM B 209.

703-2.04 Paint:

Paint for use on the metal plates shall conform to the requirements of Section 1002 for the type and color of paint specified on the project plans.

703-2.05 Retroreflective Sheeting:

Retroreflective sheeting for markers shall conform to the requirements of Section 1007.

The type of retroreflective sheeting to be applied shall specified on the project plans.

703-2.07 Hardware:

Steel bolts and nuts of the types shown on the project plans shall be galvanized in accordance with the requirements of ASTM A 153 or

shall be cadmium plated in accordance with the requirements of ASTM A 165.

703-3 Construction Requirements:

Metal posts shall be cut and perforated to the sizes and shape shown on the project plans. The finished posts shall be straight with a permissible tolerance in straightness of 1/16 inch per three feet of post length.

Posts on which galvanizing has been damaged in transporting, handling or erecting shall be repaired by the subcontractor at his expense in accordance with the requirements of Subsection 610-3.06.

Metal plates shall be cut to size and shape and the holes punched for mounting all in accordance with the details shown on the project plans. The surfaces and edges of the plates shall be free of buckles, warps, dents, cockles, burrs and defects resulting from fabrication.

Posts shall be set vertically to line at the locations designated on the project plans. Posts shall be set firmly in the ground by a method that will not bend the post or deface the top of the post. If ground conditions are such that the posts cannot be driven without damaging the posts, pilot holes shall be required. Metal plates shall be installed after the posts have been set in place.

Posts shall be placed in the ground to the depth shown on the project plans.

703-4 Method of Measurement:

Markers will be measured by the unit for each type of marker furnished and installed.

SECTION 706 RAISED PAVEMENT MARKERS

706-1 Description:

The work under this section shall consist of cleaning and preparing the pavement surface, furnishing all materials, equipment, tools and labor and placing raised pavement markers of the type specified at the locations and in accordance with the details shown on the project plans and the requirements of these specifications.

706-2 Materials:

706-2.01 General:

Certificates conforming to the requirements of Subsection 106.05 may be submitted in lieu of samples of markers and adhesive proposed for use by the Subcontractor. If samples are submitted for testing, they shall be submitted to the Engineer at least ten days prior to their being used. Markers and adhesive will be tested in accordance with ADOT test methods on file in the ADOT Materials Section.

The base of the pavement markers shall be free from glass glaze or from substances which may reduce its bond to the adhesive. The base shall be flat and it's deviation from a flat surface shall not exceed 0.05 of an inch.

706-2.02 Reflective Pavement Markers:

Reflective pavement markers shall be of the following type:

Type G	Clear, one-way

Reflective pavement markers shall be of the prismatic reflector type consisting of a molded methyl methacrylate shell conforming to Federal Specification L-P-380 2, Type I, Class 3, filled with a mixture of an inert thermosetting compound and filler material. The exterior surface of the shell shall be smooth and shall contain one or two methyl methacrylate prismatic reflector faces of the color specified.

When illuminated by an automobile headlight, the color of the reflectors shall be an approved clear as designated. Reflectors not meeting the required color may be rejected.

Reflective pavement markers will be tested for compressive strength and for abrasion resistance..

The strength by compressive loading shall be at least two-thousand (2,000) pounds.

After the lens surface has been abraded the specific intensity of each clear reflecting surface shall be not less than the following:

Reflectance	**Specific Intensity**
	Clear
0 Degrees Incidence	3.0
20 Degrees Incidence	1.2

706-2.03 Non-reflective Pavement Markers:

Non-reflective pavement markers shall be of the following types:

Type A white

Non-reflective pavement markers shall consist of a heat-fired, vitreous ceramic base and a heat-fired, opaque glazed surface which will produce the required properties. Markers shall be produced from any suitable combination of intimately mixed clays, shales, flints, feldspars, or other inorganic material which will meet the properties herein required. Markers shall be thoroughly and evenly matured and free from defects which will affect appearance or serviceability.

The top surface of the marker shall be in reasonably close conformity with the configuration shown on the project plans. Markers shall be convex and the radius of curvature shall be between three and one-half (3 1/2) and six (6) inches, except that the radius of the one-half (1/2) inch nearest the edge may be less. All edges shall be rounded and any change in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentations, air bubbles, or other objectionable marks or discolorations.

Non-reflective pavement markers shall meet the following requirements:

Glaze Thickness, minimum	.005 inch
Moh Hardness, minimum	6
Directional Reflectance (White Only), minimum	
Glazed Surface	75
Body of Marker	70
Yellowness Index (White Only), maximum	
Glazed Surface	0.07
Body of Marker	0.12
Color (Yellow Only)	
Purity, percent, range	75-96
Dominant Wave Length, mu, range	579-585
Total Lummous Reflectance (Y valve), min.	0.41
Compressive Strength, pounds, minimum	1,500
Water Absorption, percent, maximum	2.0
Autoclave	Glaze shall not

spall, craze or peel

706-2.05 Bituminous Adhesive:

The bituminous adhesive for pavement markers shall be a hot-melt adhesive manufactured by one (1) of the following approved manufactures:

Signal Products Division
Amerace Corporation
7542 N. Natchez Avenue
Niles, Illinois 60648

or

CRAFCO, Incorporated
P.O. Box 20133
Phoenix, Arizona 85036

Materials by manufacturers other than those listed above may be used but must be approved by the Engineer prior to use.

706-3 Construction Requirements:

The portion of the pavement to which the markers are to be attached shall be free of dirt, existing painted lines, curing compound, grease, oil, moisture, loose or unsound layers and any other material which could adversely affect the bond of the adhesive. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. Newly placed asphaltic concrete pavement need not be sandblasted unless, in the opinion of the Engineer, the surface is contaminated with materials that would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the cleaned pavement surface in an amount sufficient to result in complete coverage of the area of contact of the markers, with no voids present and with a slight excess after the markers have been placed. The markers shall be placed in position and pressure applied until firm contact is made with the pavement. The markers shall be protected against impact until the adhesive has set to the degree acceptable to the Engineer.

Excess adhesive on the pavement and on the exposed surfaces of the markers shall be immediately removed. Thinners or solvents which may be detrimental to either the markers or the bond provided by the adhesive shall not be used in removing excess adhesive.

Markers shall not be installed when the temperature of the pavement surface or the atmosphere is less than forty (40) degrees

Fahrenheit, when the relative humidity is eighty (80) percent or higher or when the pavement surface is not dry.

All markers shall be installed to the line approved by the Engineer and in such manner that the reflective face of the markers is perpendicular to a line parallel to the roadway centerline. No pavement markers shall be installed over longitudinal or transverse joints of the pavement surface.

706-4 Method of Measurement:

Pavement markers will be measured as a unit for each marker furnished and placed.

SECTION 708 PERMANENT PAVEMENT MARKINGS:

708-1 Description:

The work under this section shall consist of cleaning and preparing the pavement surface, furnishing all materials and applying white or yellow fast-dry traffic paint and reflective glass beads at the locations and in accordance with the details shown on the project plans, MUTCD, the requirements of these specifications, or as directed by the Engineer.

708-2 Materials:

708-2.01 Chlorinated Rubber Pavement Marking Paint:

(A) General:

All material used in the formulation of chlorinated rubber pavement marking paint shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

(B) Composition Requirements:

The chlorinated rubber permanent pavement marking paint shall consist of the following components with all percentages specified being by weight:

(1) Pigment Composition: percent by weight of total pigment	White	Yellow
Titanium Dioxide, Rutile (ASTM D 476, Type II 92% min.)	24.0-26.0	7.0-9.0
Medium Chrome Yellow (ASTM D 211, Type III 87% min.)		15.0-17.0
Zinc Oxide (ASTM D 79 American Process Type)	7.5-9.5	7.0-9.0
Magnesium Silicate (ASTM D 605)	36.0-38.0	35.0-37.0
Calcium Carbonate (ASTM D 1199, Type GC, Grade I or II)	28.0-30.0	31.0-33.0
Antisettling Agency (Bentone 34 or Claytone 40) See Note 1		

(2) Vehicle Composition: percent by weight	White and Yellow
Alkyd Resin Solution - See Note 2	21.3 min.
Chlorinated Rubber (Parlon S20 or Alloprene X20)	16.4 min.
Chlorinated Paraffin (Fed. Spec. Mil-C 429C, Type I)	11.3-13.3
Lead Drier 24% (ASTM D 600 Class B)	0.2-0.4
Cobalt Drier 6% (ASTM D 600 Class B)	0.05-0.25
Antiskinning Agent (Exkin or Equivalent) See Note 3	0.45-0.55
Stabilizer (Propylene Oxide) See Note 4	
Toluene (ASTM D 362)	26.1 max.
Heptane (Technical Grade)	6.5-8.5
Methyl Ethyl Ketone (ASTM D 740)	14.7 min.
Methanol (ASTM D 1152)	0.2-0.4

Note 1. Sufficient dispersing and suspending agent shall be added to prevent excessive settling.

Note 2. Alkyd Resin Solution: The medium oil soya-modified alkyd resin shall be supplied as 59 to 61 percent non-volatile solids in VM & P Naphtha (TT-N-95b, Type I). The resin solids shall contain an oil acid content of 48 to 55 percent, a phthalic anhydride content of 33 to 37 percent and an acid number of 8 maximum. The alkyd resin solution shall have a maximum of 9 (Gardner). The alkyd resin solution, reduced to 45 percent solids with VM & P Naphtha,shall have a viscosity of D to G (Gardner-Holdt). No rosin will be permitted. The oil fatty acids shall be of vegetable origin, either alkali refined soya bean oil or the fatty acids of soya bean oil having a minimum iodine number of 115. No recovered oil marine or soya food fatty acid derivatives shall be used. The alkyd resin solution must tolerate a 500 percent by weight dilution with VM & P Naphtha. A solution

containing alkyd resin solution, chlorinated rubber, methyl ethyl ketone, toluene and heptane in the proportions given in the vehicle composition shall be clear, transparent and show no separation after storage of 24 hours in a three-quarter full test tube at 26.7 degrees ± 2.8 degrees Celsius (80 degrees ± 5 degrees Fahrenheit).

Note 3. Sufficient antiskinning agent shall be used to prevent skinning. Material shall be added at the proper time during the manufacturing of the paint so as to minimize losses due to volatilization and maximize retention in the packaged product.

Note 4. Other approved Stabilizers: Styrene Oxide - 3 pounds per 100 gallons of paint; Thermolite 813 - 0.5 pounds per 100 gallons of paint.

(C) Manufacturing Formulations:

The typical formula which may serve as a guide for the paint manufacturer is as follows: (Yield is approximately 100 gallons).

	POUNDS	
	White	Yellow
Titanium Dioxide	150	50
Medium Chrome Yellow		100
Zinc Oxide	50	50
Magnesium Silicate	224	224
Calcium Carbonate	175	200
Antisettling Agent (Claytone)	5	5
Methanol	2	2
Alkyd Resin Solution (60% non-volatile)	130	130
Chlorinated Rubber (93% non-volatile)	100	100
Chlorinated Paraffin	75	75
24% Lead Drier	2	2
6% Cobalt Drier	1	1
Antiskinning Agent (Exkin)	3	3
Stabilizer (Propylene Oxide)	3	3
Toluene	160	160
Heptane	45	45
Methyl Ethyl Ketone	90	90
	1215	1240

(D) Quantitative Requirements of Mixed Paint:

	White	Yellow
Pigment: percent by weight-See Note 5	48.9-50.6	49.9-51.6
Total Solids: percent by weight	69.4 min.	70.0 min.
Non-volatile Vehicle: percent by weight vehicle	38.9 min.	38.9 min.
Viscosity: K.U. at 77° F	76 ± 8	76 ± 8
Weight per Gallon: pounds	12.0 ± 0.2	12.4 ± 0.2
Fineness of Grind: Hegman gauge, North Standard Scale	3 min.	3 min.
Drying Time: minutes	1 - 4	1 - 4
Directional Reflectance:	80 min.	50 min.
Uncombined Water: percent by weight of paint	1.0 max.	1.0 max.
Coarse Particles and Skins: retained on a No. 325 mesh sieve, percent by weight of pigment	1.0 max.	1.0 max.

Note 5. The extracted pigment, upon analysis, shall conform to the quantitative compositional requirements.

(E) Qualitative Requirements:

(1) Color of Yellow paint:

The color of the yellow paint shall visually match color chip No. 33538 of Fed. Std. 595 (Note 6). In case of dispute, the color shall be within the green and red tolerance limits when compared with the standard color chips of "Highway Yellow Color Tolerance Chart" U.S. Department of Commerce, Bureau of Public Roads PR Color No. 1, June 1965.

(2) Condition in Container:

The paint shall not show excessive settling in freshly-opened full can and shall be easily redispersed with a paddle to a smooth homogeneous state. The paint shall show no curdling, livering, caking, gelling or thixotropic properties, lumps, skins or color separation.

(3) Skinning:

The paint shall not skin within 48 hours in a three-quarter filled, tightly closed container.

(4) Storage Stability:

The paint shall show a viscosity increase of not more than five (5) Krebs units above the original viscosity and the degree of settling shall have a rating of six (6) or better (Note 7). When stored for twelve (12) months the paint must be usable, the drying time shall be as specified and the consistency range shall be 68 to 84 Krebs units.

(5) Flexibility and Adhesion:

The paint shall show no cracking, flaking or loss of adhesion when tested as specified. Apply a wet film thickness of 0.005 inches with a film applicator to a 3 by 5 inch tin panel weighing 0.39 to 0.51 lbs. per sq. ft., previously cleaned with a Hydrocarbon Solvent and lightly buffed with steel wool. Dry the paint film at 70 degrees to 80 degrees Fahrenheit in a horizontal position for 18 hours, then bake in an oven at 122 degrees ± 4 degrees Fahrenheit (47.8 degrees Celsius to 52.2 degrees Celsius) for two hours, cool to room temperature for at least 1/2 hour and bend over a 1/2 inch diameter rod and examine, without magnification.

(6) Water Resistance:

The paint shall show no softening, blistering, loss of adhesion or other evidence of deterioration other than a slight loss in gloss when tested as specified. Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Let dry in a horizontal position at room temperature (70 degrees to 80 degrees Fahrenheit) for 72 hours. Immerse one-half the painted plate in distilled water at room temperature for 18 hours as specified in method 6011 of Fed. Test Method Std. No. 141, allow to dry for two hours and examine.

(7) Dilution Stability:

The thinned paint shall be uniform and show no separation, curdling or precipitation after reduction in the properties of eight parts

by volume of the package material with not more than one part by volume of the appropriate thinner for each type of paint.

(8) Spraying Properties:

The paint as received or diluted no more than specified above, shall have satisfactory spraying properties when applied (and held in a horizontal position) to tinplate or aluminum surfaces at a wet film thickness of approximately 0.015 inch. The sprayed film shall dry to a smooth uniform finish, free from roughness, grit, unevenness and other surface imperfections. The paint shall show no streaking or separation when placed on clean glass.

(9) Bleeding:

The bleeding characteristics shall be determined in accordance with ASTM D 969. The test panels shall be evaluated according to ASTM D 868, and the degree of resistance to bleeding shall have a numerical rating of six (6).

Note 6. Apply a wet film of 0.015 inches to a tin panel; let dry for 24 hours and compare color.

Note 7. Storage stability shall be determined in accordance with ASTM D 1309 Settling Properties of Traffic Paints During Storage; ASTM D 869 Evaluating Degree of Settling; and Consistency, Krebs-Standard Method 4281 of Federal Test Method Std. No. 141.

(F) Manufacturing Requirements:

(1) Inspection:

The manufacturer shall advise the Engineer when paint is to be manufactured and shall furnish the Engineer free access to all parts of the plant and shall furnish every reasonable facility for sampling both the paint and the raw materials during the process of manufacturing.

All materials used in formulation shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

(2) Testing:

All tests will be conducted in accordance with the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141 , and methods in use by Materials Services, Highways Division, and the Arizona Department of Transportation. Where both an ASTM and Federal Test Method is

available for new materials or the finished product, the ASTM test method will prevail.

Evidence of adulteration or improper formulation shall be cause for rejection.

(3) Packaging:

The finished paint shall be homogeneous, free of dirt, water and other foreign matter. The paints shall be strained immediately prior to canning.

All shipping containers must comply with Federal Interstate shipping standards of the Department of Transportation, and be stamped 17-H in accordance with the standards. The containers must be lined so as to prevent attack by the paint. The lining must not come off the container as skins.

All containers of paint shall be labeled with weatherproof markings showing the color, manufacturer's name, date of manufacture, tare, weight, net weight, gross weight and manufacturer's batch number on the side of drum and also on the lid.

708-2.02 Reflective Glass Beads (Spheres):

(A) General:

The term "glass bead" shall be synonymous with the term "glass sphere" as used herein.

The beads shall be manufactured from glass of a composition designated to be highly resistant to traffic wear and to the effects of weathering.

The glass beads shall be moisture-proof, contain less than 1/4 of one percent moisture by weight, and be free of trash, dirt, or other deleterious materials.

Beads shall be essentially free of sharp angular particles showing milkiness or surface scoring or scratching. Beads shall be water white in color.

(B) Physical Requirements:

(1) Gradation:

When tested by the method provided in ASTM D 1214 (by use of US Standard Sieves) the grade sizes of the beads shall be as follows:

Size of Sieve	Percent Passing
No. 30	100
No. 50	15 - 35
No. 70	0 - 15
No. 100	0 - 5

(2) Roundness:

When tested by the method provided in ASTM D-1155 (Procedure B except paragraphs (F) and (G) are deleted) beads retained on any screen specified in the gradation requirements shall contain a minimum of 70% true spheres.

(3) Index of Refraction:

When tested by a liquid immersion method at a temperature of 25 degrees Celsius, the beads shall have an index of refraction of 1.50 to 1.57.

(4) Specific Gravity:

The specific gravity of the beads shall be in the range 2.40-2.60 when tested in accordance with the following procedures:

Place 100 grams in an oven at 100 Celsius for 1 hour.

Remove beads and place in a desiccator until the sample is cool.

Remove approximately 60 grams of beads from the desiccator and weigh the sample accurately.

Pour the beads slowly in a clean 100 ml graduated cylinder containing 50 ml of isopropyl alcohol. Make certain that air is not entrapped among the beads.

The total volume, minus 50, will give the volume of the beads.

Calculate the specific gravity as follows:

$$\text{Specific Gravity} = \frac{\text{Weight of the sample}}{\text{Volume of the sample}}$$

(5) Chemical Stability:

Beads which show any tendency toward decomposition, including surface etching, when exposed to atmospheric conditions, moisture, dilute acids, or alkalies or paint film constituents, may be required to demonstrate satisfactory reflectance behavior, prior to acceptance, under such tests as may be prescribed.

(C) Moisture Proofing:

All glass beads shall have a moisture-proof overlay consisting of water repellent material applied during the process of bead manufacture. The beads so treated shall not absorb moisture in storage and shall remain free of clusters and lumps and shall flow freely from dispensing and testing equipment.

The beads shall pass the test for water repellency and free flow using the following equipment:

(1) Test bag:

The bag used is approximately 10 1/2 inches x 17 1/2 inches after sewing. The material used in the construction of the bags is unbleached cotton sheeting with a thread count of 48 x 48. The material before sewing is approximately 18 inches x 22 inches. The cloth is folded in half lengthwise and stitched in the shape of an "L" with the short side left open at the top. The material can be obtained from selected manufacturers of cloth and paper packaging. The finished bag may also be obtained from the manufacturer of the glass beads.

Newly fabricated bags must be thoroughly washed with hot water and detergent and rinsed before use to remove the sizing which may be present in the cloth. Subsequent to the initial washing, the bags need only be rinsed clean of beads from previous tests and dried thoroughly before use.

(2) Funnel:

The funnel used is a standard laboratory funnel with a top opening diameter of 125 mm. and 150 mm. stem length. The inside diameter of the stem is between 9 and 10 mm. This funnel is available from most laboratory glassware supply houses. Corning No. 6100 or equal.

(3) Ring Stand and Clamp.

(4) Balance accurate to 0.1 grams.

(5) Distilled water.

MOISTURE TESTING PROCEDURE:

Glass beads shall be tested for compliance to specification requirements . Testing shall be conducted at standard conditions of temperature (25 ± 1 degree Celsius) and humidity (50 ± 5 percent R.H.) and shall consist of the following procedure or an approved alternate:

Weigh 900.0 grams of glass beads into a clean, dry, flat-bottomed pan.

Dry beads at 150 degrees Celsius for two hours.

Cool beads to room temperature (25 ± 1 degree Celsius) in a desiccator.

Using the clean, prewashed bag described under apparatus section, turn the bag inside-out so that the sewn seam and seam-allowance are on the outside.

Quantitatively transfer the beads into the inverted cotton bag.

Grasp the gathered top of the bag with one hand and lower the bag into a container of distilled water until the beads are approximately one inch below the water level. The container shall be of such dimensions that the bag does not contact the bottom or sides during immersion. Each bag shall be immersed individually. Do not allow one bag to contact another if multiple tests are run.

Remove the bag after 30 seconds of immersion time.

Cradle the bottom of the bag uniformly in the palm of one hand and twist the top neck of the bag until the twisted bag is compressed firmly against the beads. Twist until excess water no longer drips from the bag.

After the excess water has been squeezed from the bag, allow the bag to unwind.

Gather the top of the bag and clamp. Suspending the bag on a ring stand or other support such that the bottom or sides of bag do not contact the support.

After a standing time of 2 hours at room temperature (25 degrees ± 1 degree Celsius), remove bag from support. Mix sample thoroughly by holding the bottom seam allowance in one hand and gathered neck of the bag in the other, invert bag and shake up and down 5 times.

Transfer the sample into a clean, dry funnel of the type described under apparatus. If consecutive tests are run, be sure the funnel is clean, dry and free of beads from prior tests.

The entire sample shall flow through the funnel without stoppage.

At the start of the test only, it is permissible to lightly tap the stem of the funnel to initiate flow.

Small quantities of beads which have adhered to the side of the funnel or stem shall not be cause for failure.

708-2.03 Chlorinated Ethylene Vinyl Acetate (Hypalon) Pavement Marking Paint:

(A) General:

Chlorinated ethylene vinyl acetate (Hypalon) pavement marking paint may be used as an equal alternate to the chlorinated rubber pavement marking paint. All material used in the formulation of chlorinated ethylene vinyl acetate (Hypalon) pavement marking paint shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

After the selection is made, one type of pavement marking paint shall be used for the entire project.

(B) Composition Requirements:

The chlorinated ethylene vinyl acetate (Hypalon) pavement marking paint shall consist of the following components with all percentages specified by weight:

(1) Pigment Composition: percent by weight of total pigment	White	Yellow
Titanium Dioxide, Rutile (ASTM D 476, Type III or IV)	23.0-25.0	7.5-9.5
Medium Chrome Yellow (ASTM D 211, Type III 87% min.)		15.0-17.0
Zinc Oxide (ASTM D 79 American Process Type)	7.0-9.0	7.0-9.0
Magnesium Silicate (ASTM D 605)	34.0-36.0	34.0-36.0
Calcium Carbonate (ASTM D 1199, Type GC, Grade I or II)	33.0-35.0	34.0-36.0
Antisettling Agency (Bentone 34 or Claytone 40) See Note 1		

Note 1: Sufficient dispersing and suspending agent shall be added to prevent excessive settling.

(2) Vehicle Composition: percent by weight of vehicle	White and Yellow
Alkyd Resin Solution - See Note 2	20.5 min.
Chlorinated Ethylene Vinyl Acetate (Hypalon 173)	16.0 min.
Chlorinated Paraffin (Fed. Spec. Mil-C 429C, Type I)	4.0-6.0
Chlorinated Paraffin (Mil-C 429C, Type II)	5.0-7.0
Lead Drier 36% (ASTM D 600 Class B)	0.2-0.4
Cobalt Drier 12% (ASTM D 600 Class B)	0.02-0.15
Antiskinning Agent (Exkin or Equivalent) See Note 3	0.45-0.55
Stabilizer (Epoxidized Bisphenol A) See Note 4	0.45-0.55
Toluene (ASTM D 362)	10.0 max.
Heptane (Technical Grade)	20.0-22.0
Methyl Ethyl Ketone (ASTM D 740)	21.0 min.
Methanol (ASTM D 1152)	0.2-0.4

Note 2. Alkyd Resin Solution: The medium oil soya-modified alkyd resin shall be supplied as 59 to 61 percent nonvolatile solids in Vm & P Naphtha (TT-N-95b, Type I). The resin solids shall contain an oil acid content of 48 to 55 percent, phthalic anhydride content of 33 to 37 percent and an acid number of 8 maximum. The alkyd resin solution shall have a maximum of 9 (Gardner). The alkyd resin solution, reduced to 45 percent solids with VM & P Naphtha, shall have a viscosity of D to G (Gardner-Holdt). Alkyd resin containing other dibasic acids such as maleic or fumaric or modifying agents such as urea, melamine, phenolic resin, or styrene will not be permitted. The oil fatty acids shall be of vegetable origin, either alkali refined soya bean oil or the fatty acids of soya bean oil having a minimum iodine number of

115. No recovered oil marine or soya food fatty acid derivatives shall be used. The alkyd resin solution must tolerate a 500 percent by weight dilution with VM & P Naphtha. A solution containing alkyd resin solution, chlorinated ethylene vinyl acetate, methyl ethyl ketone, toluene and heptane in the proportions given in the vehicle composition shall be clear, transparent and show no separation after storage of 24 hours in a three-quarter full test tube at 26.7 degrees ± 2.8 degrees Celsius (80 degrees ± 5 degrees Fahrenheit).

Note 3. Sufficient antiskinning agent shall be used to prevent skinning. Material shall be added at the proper time during the manufacturing of the paint so as to minimize losses due to volatilization and maximize retention in the packaged product.

Note 4. Other approved Stabilizers: Propylene Oxide - 3 pounds per 100 gallons of paint; Thermolite 813 - 0.5 pounds per 100 gallons of paint.

(C) Manufacturing Formulations:

The typical formulas which may serve as a guide for the paint manufacturer are as follows (Yield is approximately 100 gallons):

	POUNDS	
	White	Yellow
Titanium Dioxide	150	50
Medium Chrome Yellow		100
Zinc Oxide	50	50
Magnesium Silicate	225	225
Calcium Carbonate	215	230
Antisettling Agent (Claytone)	5	5
Methanol	2	2
Soya Lecithin	3	3
Alkyd Resin Solution (60% Non-Volatile)	130	130
Chlorinated Ethylene Vinyl Acetate (Hypalon 173)	100	100
Chlorinated Paraffin 40%	30	30
Chlorinated Paraffin 70%	35	35
36% Lead Drier	1.5	1.5
12% Cobalt Drier	0.5	0.5
Antiskinning Agent (Exkin)	2	2
Stabilizer (Epoxidized Bisphenol A)	3	3
Toluene	60	60
Heptane	125	125

Methyl Ethyl Ketone	131	131
	1268	1283

(D) Quantitative Requirements of Mixed Paint:

	White	Yellow
Pigment: percent by weight-See Note 5	49.0-52.0	50.0-53.0
Total Solids: percent by weight	68.9 min.	69.5 min.
Non-volatile Vehicle: percent by weight vehicle	38.9 min.	38.9 min.
Viscosity: K.U. at 77° F	70 - 84	70 - 84
Weight per Gallon: pounds	12.0 ± 0.2	12.4 ± 0.2
Fineness of Grind: Hegman gauge, North Standard Scale	3 min.	3 min.
Drying Time: minutes	4 max.	4 max.
Directional Reflectance:	80 min.	50 min.
Uncombined Water: percent by weight of paint	1.0 max.	1.0 max.
Coarse Particles and Skins: retained on a No. 325 mesh sieve, percent by weight of pigment	1.0 max.	1.0 max.

Note 5. The extracted pigment, upon analysis, shall conform to the quantitative compositional requirements described previously.

(E) Qualitative Requirements:

(1) Color of Yellow paint:

The color of the yellow paint shall visually match color chip No. 33538 of Fed. Std. 595 (Note 6). In case of dispute, the color shall be within the green and red tolerance limits when compared with the standard color chips of "Highway Yellow Color Tolerance Chart" U.S. Department of Commerce, Bureau of Public Roads PR Color No. 1, June 1965.

(2) Condition in Container:

The paint shall not show excessive settling in freshly-opened full can and shall be easily redispersed with a paddle to a smooth, homogeneous state. The paint shall show no curdling, livering, caking, gelling or thixotropic properties, lumps, skins or color separation.

(3) Skinning:

The paint shall not skin within 48 hours in a three-quarter filled, tightly closed container.

(4) Storage Stability:

The paint shall show a viscosity increase of not more than five (5) Krebs units above the original viscosity and the degree of settling shall have a rating of six (6) or better (Note 7). When stored for twelve (12) months the paint must be usable, the drying time shall be as specified and the consistency range shall be 70 to 85 Krebs units.

(5) Flexibility and Adhesion:

The paint shall show no cracking, flaking or loss of adhesion when tested as follows:

Apply a wet film thickness of 0.005 inches with a film applicator to a 3 by 5 inch tin panel weighing 0.39 to 0.51 lbs. per sq. ft., previously cleaned with a Hydrocarbon Solvent and lightly buffed with steel wool. Dry the paint film at 70 degrees to 80 degrees Fahrenheit in a horizontal position for 18 hours, then bake in an oven at 122 degrees ± 4 degrees Fahrenheit (47.8 degrees Celsius to 52.2 degrees Celsius) for two hours, cool to room temperature for a least 1/2 hour and bend over a 1/2-inch diameter rod and examine, without magnification.

(6) Water Resistance:

The paint shall show no softening, blistering, loss of adhesion or other evidence of deterioration other than a slight loss in gloss when tested as follows:

Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Let dry in a horizontal position at room temperature (70 degrees to 80 degrees Fahrenheit) for 72 hours. Immerse one-half of the painted plate in distilled water at room temperature for 18 hours as specified in method 6011 of Fed. Test Method Std. No. 141a, allow to dry for two hours and examine.

(7) Dilution Stability:

The thinned paint shall be uniform and show no separation, curdling or precipitation after reduction in the proportions of eight parts by volume of the package material with not more than one part by volume of the appropriate thinner for each type of paint.

(8) Spraying Properties:

The paint as received or diluted no more than specified above shall have satisfactory spraying properties when applied (and held in a horizontal position) to tinplate or aluminum surfaces at a wet film thickness of approximately 0.015 inch. The sprayed film shall dry to a smooth uniform finish, free from roughness, grit unevenness and other surface imperfections. The paint shall show no streaking or separation when placed on clean glass.

(9) Bleeding:

The bleeding characteristics shall be determined in accordance with ASTM D969. The test panels shall be evaluated according to ASTM D868, and the degree of resistance to bleeding shall have a numerical rating of six (6).

Note 6. Apply a wet film of 0.015 inches to a tin panel; let dry for 24 hours and compare colors.

Note 7. Storage stability shall be determined in accordance with ASTM D1309, Settling Properties of Traffic Paints During Storage; ASTM D869 Evaluating Degree of Settling; and Consistency, Krebs-Standard Method 4281 of Federal Test Method Std. No. 141a.

(F) Manufacturing Requirements:

(1) Inspection:

The manufacturer shall advise the Engineer when paint is to be manufactured and shall furnish the Engineer free access to all parts of the plant and shall furnish every reasonable facility for sampling both the paint and the raw materials during the process of manufacturing.

All materials used in formulation shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Engineer.

(2) Testing:

All tests will be conducted in accordance with the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141a, and methods in use by the Materials Section, Highways Division, and the Arizona Department of Transportation. Where both an ASTM and Federal Test Method is available for new materials or the finished product, the ASTM test method will prevail, unless otherwise indicated herein.

Evidence of adulteration or improper formulation shall be cause for rejection.

(3) Packaging:

The finished paint shall be homogeneous, free of dirt, water and other foreign matter. The paints shall be strained immediately prior to canning.

All shipping containers must comply with Federal Interstate shipping standards of the Department of Transportation, and be stamped 17-H in accordance with the standards. The containers must be lined so as to prevent attack by the paint. The lining must not come off the container as skins.

All containers of paint shall be labeled with weatherproof markings, showing the color, manufacturer's name, date of manufacture, tare weight, net weight, gross weight and manufacturer's batch number on the side of drum and also on the lid.

708-3 Construction Requirements:

708-3.01 Equipment:

The traffic paint and beads shall be placed on the pavement by a spray-type, self-propelled pavement marking machine except that

temporary striping during construction may be placed with other equipment designed for application of paint and beads.

The application equipment to be used on roadway installation shall have, as a minimum, the following characteristic and/or apparatus:

The machine shall be capable of applying a clear-cut 2-inch line or lines.

The machines shall be equipped with a mechanical device capable of placing a broken reflectorized line with a 10-foot painted segment and a 30-foot gap, 2-foot painted segment and a 4-foot gap, and 26-foot painted segment and a 40-foot gap.

The machine shall be equipped with an air-operated glass bead drop-in dispenser controlled by the spray gun mechanism.

A glass bead dispenser which is capable of placing the glass beads into the paint line as the paint is applied to the pavement shall be utilized. This dispenser shall provide satisfactory marking and delineation.

708-3.02 Application:

Pavement markings shall be applied when the pavement surface is dry and the weather is not foggy, rainy, or otherwise adverse to the application of markings. The surface shall be free from excess asphalt or other deleterious substances before traffic paint, beads or primer are applied. The subcontractor shall remove dirt, debris, grease, oil, rocks or chips from the pavement surface before applying markings. The method of cleaning the pavement surface and removal of detrimental material is subject to approval by the Engineer and shall include sweeping and the use of high-pressure air spray. The placing of traffic markings shall be done only by personnel who are experienced in this work.

The volume of paint in place shall be determined by measuring the paint tank with a calibrated rod. At the option of the Engineer, if the striping machine is equipped with air-atomized spray units (not airless) and paint gauges, the volume of paint may be determined by utilizing said gauges.

The quantity of glass reflectorizing beads in place shall be determined by measuring the glass reflectorizing bead tank with a calibrated rod.

The subcontractor shall provide the necessary personnel and equipment to divert traffic from the installation area where the work is in progress and during drying time when, in the opinion of the Engineer, such diversion of traffic is necessary.

Tolerances for Placing Paint, Beads, and Primer:

The length of painted segment and gap shall not vary more than 6 inches in a 40-foot cycle.

The finished line shall be smooth, aesthetically acceptable and free from undue waviness.

Painted lines shall be 2, 4, 6, 8, or 12 inches wide as shown on the project plans with a tolerance of plus or minus 1/8 inch and shall be placed at a minimum rate of 16 gallons per mile for a solid 4-inch line and 4 gallons per mile for a broken 4-inch line, based on a 10-foot stripe and a 30-foot gap (40-foot cycle aggregate).

Glass reflectorizing beads shall be applied on the wet paint at a minimum rate of 6 pounds to each gallon of paint.

Wet mil thickness shall not be less than 15 mils.

708-4 Method of Measurement:

Pavement marking paint will be measured by the linear foot along the centerline of the pavement stripe. Skips in dashed lines will not be included in the measurement. Length of pavement markings will be based on four inch wide stripe. Measurement for striping with a plan width greater or less than the basic four inches as shown on the project plans or directed by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

SECTION 730 GENERAL REQUIREMENTS FOR LOOP DETECTORS:

730-1 Description:

It is the purpose of this section to provide general information necessary for completion of the work on loop detector systems in accordance with the details shown on the project plans and requirements of these specifications.

All electrical systems and appurtenances shall be complete, functional and in operating condition at the time of acceptance. For additional Electrical and Conduit requirements, see Division XII.

730-2 Definitions:

The words defined in the following subsection shall for the purpose of these specifications have the meanings ascribed to them pertaining to loop detectors.

730-2.01 Detector:
A device for indicating the passage or presence of vehicles or pedestrians.

(A) Inductive Loop Detector:

A detector capable of sensing the passage or presence of a vehicle by a change in the inductance characteristics of the wire loop.

730-2.02 Vehicle:

Any motor vehicle normally licensed for highway use.

730-3 Regulations and Codes:

All electrical equipment shall conform to the current standards of National Electrical Manufacturers Association (NEMA), National Electric Safety Code (NESC), Underwriters' Laboratory Inc. (UL), or the Electronic Industries Association (EIA), when applicable. All materials and workmanship shall conform to the requirements of the National Electric Code (NEC), Illumination Engineers Society (IES), Standards of the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), requirements of the plans, these specifications, and the special provisions, and to any other codes, standards, or ordinances which may apply. Whenever reference is made to any of the standards mentioned, the reference shall be construed to mean the code, ordinance, or standard that is in effect at the time of the bid advertisement.

730-4 Equipment List and Drawings:

The subcontractor shall note that approval by the Engineer is required before ordering or installing any material that is to be used on the project.

The subcontractor shall submit six copies of a complete project material submittal for approval at the preconstruction conference which shall conform to these specifications. The project material submittal shall state all relevant information regarding materials and equipment to allow for the procurement of exact replacements of any or all items on the project. To be acceptable, the material submittal shall be complete and contain all items supplied on the project by the subcontractor. The Engineer reserves the right to reject an incomplete or unclear material submittal.

The materials on the submittal shall be identified by the contract project number, bid item numbers, catalog part numbers, catalog cuts, shop drawings, trade names, schedules for other pertinent information. The materials from any catalog cuts shall be clearly indicated by the subcontractor. Any material designations used in the contract documents shall be so noted on the materials list. If requested by the Engineer, the contractor shall submit manufacturer shop drawings for review and approval and shall furnish Certificates of Compliance conforming to the requirements of Section 105.

There shall be no substitutions for any of the materials on the list without prior written approval by the Engineer. Changes to the approved materials list shall be submitted in writing to the Engineer. If requested by the Engineer, the subcontractor shall submit samples of the proposed materials for inspections, testing, and approval by the Engineer. The Owner will not be liable for any electrical materials procured or any labor performed prior to approval.

730-5 Warranties & Guaranties:

Manufacturer's warranties and guaranties, furnished for materials and equipment used in the work, shall be delivered to the Engineer prior to acceptance of the project. Warranties and guaranties shall conform to the requirements of Subsection 106.13.

SECTION 732 ELECTRICAL UNDERGROUND MATERIAL FOR LOOP DETECTORS

732-1 Description:

The work in this section shall consist of furnishing and installing electrical conduit, conductors and pull boxes for loop detectors, including excavating, backfilling and compacting at the locations designated on the project plans and in accordance with the details shown on the project plans and the requirements of these specifications.

732-2 Materials:

732-2.01 Electrical Conductors for Loop Detectors:

Electrical conductors shall be stranded thermoplastic insulated electrical wire. Conductors shall conform to the specifications of the NEC, UL and other applicable industry standards.

All single conductors, except detector lead-in cables, shall have plain, distinctive and permanent markings on the outer surface throughout the entire length showing the manufacturer's name or trademark, insulation type letter designation, conductor size, voltage rating and the number of conductors in the cable.

The wire shall be annealed copper and shall be uncoated unless otherwise specified. The wire shall be solid for number 10 AWG and smaller, conforming to the requirements of ASTM B 3 for annealed bare copper wire. Conductors for sizes number 8 AWG and larger shall be stranded and shall conform to ASTM B 8 for Class B stranding, unless otherwise specified, the conductors shall be insulated with THW grade thermoplastic compound and shall meet the requirements of UL 83. Insulation colors shall be permanent and an integral part of the insulation and shall not be applied as a surface treatment of coating. The insulation thickness shall conform to the requirements of the NEC. Conductor insulation shall be a solid color as specified in the conductor table unless otherwise specified. The color shall be continuous over the entire length of the conductor.

(A) Loop Detector Conductors:

Conductors used for loop detector systems shall conform to the requirements of the following table. The minimum conductor sizes shall be as shown in the following table unless otherwise specified.

CONDUCTOR TABLE

CIRCUIT	SIGNAL PHASE OR FUNCTION	INSULATION COLOR	INSULATION TYPE	CONDUCTOR MIN THK (MILS)	CONDUCTOR MIN GAUGE SIZE (AWG)	CONDUCTOR TYPE
Detec-tion	Detector Loops	Rdwy. Black Orange	THWN in PVC Tubing	15 31	14	

(1) Roadway Loop Detector Wire:

Roadway loop detector wire shall be a factory assembled combination of PVC tubing and wire. Loop detector wire shall be UL listed stranded number 14 AWG copper, rated at 600 volts with THWN insulation. The wire shall be enclosed in a factory extruded PVC flexible tubing by the wire manufacturer. Subcontractor assembly of the wire in the flexible tubing will not be acceptable.

(2) Wire Marking Tags:

See Division XII.

732-2.02 Electrical Conduit and Warning Tape:

See Division XII.

732-2.03 Pull Boxes:

Precast reinforced concrete pull boxes, covers and extensions shall be installed and located as shown on the project plans and shall be the size specified.

Chipped or cracked pull boxes, covers and extensions will not be accepted.

Portland cement concrete shall conform to the requirements of Section 1006 for Class B concrete. When requested by the Engineer, pull boxes, covers and extensions shall be furnished for testing at the subcontractor's expense.

Covers shall be marked as follows:

"ELECTRICAL HIGH VOLTAGE"

Markings shall be clearly defined and uniform in depth and shall be placed parallel to the long side of the cover. Letters shall be one inch high.

732-3 Construction Requirements:

732-3.01 Installation of Electrical conduit and Pull Boxes for Loop Detectors:

For conduit installation, see Division XII.

Excavation and backfill shall be in accordance with the requirements of Subsection 203-5.

Conduit entering pull boxes shall terminate a minimum of three inches inside the box wall. The conduit shall be between two inches and four inches above the bottom of the pull box and shall be sloped to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall be located near the sides and ends in order to leave the major interior portion clear. At all outlets, conduits shall enter from the direction of the run and allow for expansion and contraction.

Conduit ends shall be capped with conduit end cap fittings until wiring is started. When end caps are removed, PVC ends shall be provided with an approved conduit end bell. End bells shall be installed prior to the installation of the conductors. Approved insulated grounding bushings shall be used on steel conduit ends.

732-3.02 Wiring Procedures:

(A) General:

Wiring shall conform to the regulations and codes listed in Division XII and of the NEC, and shall be UL listed and bear the UL labels and the following requirements:

> The conductors shall be pulled into runs in a smooth continuous manner, avoiding contact with sharp objects that might damage the insulation. Approved lubricants shall be used for inserting conductors in conduit. Before installation, conductor ends shall be taped for moisture protection until connections are made. Conductors shall be spliced only in pull boxes, terminal compartments, pedestals or cabinets.

Conductors shall have a minimum of 36 inches of slack from the conduit end bell in the pull box.

(B) Tagging:

All conductors shall be tagged to identify their lane number or function with wire marking tags. The tags shall be furnished and

installed by the subcontractor. Each tag shall be wrapped entirely around the conductor twice.

732-4 Method of Measurement:

See Division XII for conduit.

Pull boxes will be measured as a unit for each pull box.

SECTION 735 LOOP DETECTORS

735-1 Description:

The work under this section shall consist of furnishing and installing vehicular detectors at the locations shown on the project plans and in accordance with the details shown on the project plans and the requirements of these specifications.

735-2 Materials:

735-2.01 Vehicle Detectors:

(A) General:

Loop detectors shall conform to the minimum acceptable design and operating requirements of these specifications for detecting the presence and passage of vehicles.

(B) Loop Detectors:

The detector loop dimensions shall be as specified on the project plans.

The conductors for the inductive loop detector shall be as specified in Section 732-2.01(A)(1) of these specifications.

735-2.04 Saw Cut Sealant:

Saw cut sealants shall be a flexible encapsulant intended for sealing and protecting vehicle detector loop wires installed in saw cuts.

(A) Emulsified Crack Filler Sealant for Asphaltic Concrete:

Emulsified crack filler sealant may be used to seal saw cuts in asphaltic concrete and lean concrete base. The emulsified crack filler sealant shall conform to the requirements of the following table:

Emulsion (For Crack Filling)

Test on Emulsion	ASTM Test Method Except As Shown	Requirements
Viscosity, Saybolt Furol, 25 degrees C., Seconds, Range	D244	25-150
Retained on No. 20 Sieve, percent, maximum	D244 (1)	0.10
Particle Charge	D244	Positive

Emulsion (For Crack Filling)

Test on Emulsion	ASTM Test Method Except As Shown	Requirements
Pumping Stability	(2)	Passes
Settlement, 5 days percent, maximum	D244	5.0
Residue, percent minimum	D244 (3)	60.0
TEST ON RESIDUE		
Viscosity, 60 degrees F. centistokes, range	D2170	100-9500
Maltene Distribution, ration, range	D 2006-70 (4)	0.7-1.4
PC/S, ration, minimum	D 2006-70 (4)	0.50
Asphaltenes, percent maximum	D 2006-70	11.0

(1) Distilled water will be used instead of the two percent sodium oleate solution.

(2) 450 ml. of emulsion will be charged into a one liter beaker and circulated through a gear pump (Roper 29 B 22621) having a 1/4-inch inlet and outlet. The pumping

stability is acceptable if there is no significant oil separation after a circulation of minutes.

(3) ASTM D 244 is modified by heating a 50-gram sample to 149 degrees until foaming ceases, then cooling it immediately.

(4) PC + Polar Compounds; A Sub 1 = First Acidaffins; S Saturated Hydrocarbons; A Sub 2 = Second Acidaffins. Maltene Distribution = ratio of PC + A Sub 1 to S + A Sub 2.

The emulsified crack sealant shall remain homogeneous within 30 days of delivery and shall be homogeneous after thorough mixing. The emulsified crack sealant shall be freeze stabilized and if freezing has occurred a homogeneous mixture shall be obtained when the material has thawed and been thoroughly mixed.

(B) One Part Elastomeric Sealant:

One part elastomeric sealant may be used to seal saw cuts in portland cement concrete pavement and lean concrete base.

The sealant shall provide compressive yield strength to withstand normal vehicular traffic as well as sufficient flexibility to withstand normal movement in concrete pavements, while protecting the loop wire from moisture penetration.

The encapsulant shall be a one-part elastomeric compound requiring no mixing, measuring or application of heat prior to or during its installation.

The encapsulant shall, within its stated shelf life in original undamaged packaging, cure only in the presence of moisture. The rate of cure will, therefore, depend upon temperature and relative humidity at the time of installation. Cool dry weather will slow curing whereas warm, humid weather will accelerate curing.

The encapsulant shall be designed to enable vehicular traffic to pass over the properly filled saw cut immediately after installation without tracking or stringing of the material. The encapsulant shall form a surface skin allowing exposure to vehicular traffic within 30 minutes at 75 degrees F. and completely cure to a tough, rubber-like consistency in two to seven days after installation.

Properly installed and cured encapsulant shall exhibit resistance to effects of weather, vehicular abrasion, motor oils, gasoline, anti-freeze solution, brake fluid, deicing chemicals and salt normally encountered, in such a manner that the performance of the vehicle detector loop wire is not adversely affected.

The cured encapsulant shall be temperature stable and exhibit no degradation in performance throughout the ambient pavement temperature ranges experienced within the State of Arizona.

The encapsulant shall exhibit minimal shrinkage during or after its installation, and in no manner affect the performance characteristics of the material.

The encapsulant shall be designed to permit clean-up of material and application equipment with non-flammable solvents such as 1,1,1 trichloroethane or Scotch-Grip Brand Solvent No. 4 (Prior to curing of encapsulant). Should any encapsulant material be allowed to cure in the application nozzle, it shall be able to be pulled out as a solid plug.

The encapsulant shall have a minimum 12-month shelf life in undamaged original containers when stored in a cool, dry environment.

The encapsulant shall be designed for roadway installation when the surface temperature is between 40 degrees F. and 140 degrees F.

The encapsulant shall have the following physical properties in its uncured and cured states.

Physical properties of the uncured (wet) encapsulant:

Property	**Requirement**	**Test Procedures**
Weight	10.1 lbs/gal +/- 0.3 lbs	A. Weight/Gallon
Total Solids by Weight	75 - 85%	B. Determination of No-Volatile Content
Viscosity	10,000-85,000 CPS	C. Viscosity
Drying Time	Touch:24 hrs. max. Complete: 30 hrs. max.	D. Tack-Free Time

Physical properties of the cured encapsulant:

Property	**Requirement**	**Test Procedure**
Hardness (Indentation)	65-85	E. Rex hardness
TensileStrength	500 psi min.	F. Tensile & Elongation

Elongation	300% min.	F. Tensile & Elongation

(C) Hot Applied Rubberized Sealant:

Hot applied rubberized sealant may be used to seal saw cuts in asphaltic concrete and in lean concrete base. Hot rubberized asphalt sealant shall be formulated specifically to be flexible. It shall be suitable for use as a sealant for traffic loop saw cuts and be nontracking under traffic. At application temperatures, the traffic loop sealant shall be a thin, free flowing fluid which penetrates saw cuts and self-levels permitting uniform application. The sealant shall be melted and applied to pavements using a pressurized application unit. The sealant shall be a relatively stiff sealant but shall remain flexible at low pavement surface temperatures. The test results shall conform to the following specifications for the loop detector sealant.

Test	**Specification**
Penetration, 77 F	25 - 35 max.
Flow, 140 F	0 mm - 5 mm max.
Resilience, 77 F	40% min.
Softening Point	180 F min.
Ductility, 77 F	30 cm min.
Mandrel Bend, 0 F, 180 deg., 5s, 1/2" dia.	
Rec. Pour Temp	380 F.
Safe Heating Temp.	410 F.
375 F Viscosity	30 Poise
Unit Weight	10.0 lbs/gallon
Coverage, 1/2" x 1/2" crack	13.0 lbs per 100 ft.

735-3 Construction Requirements:

735-3.01 Detector Installation:

(A) General:

Detectors shall be installed as shown on the project plans, as shown in the Standard Drawings, and as directed by the Engineer.

The installation of the detectors shall be such that the operation shall not be affected by temperature changes, water, ice, rain, snow, chemicals, or electromagnetic noise.

(B) Hold Down Tabs:

Hold down tabs shall be installed in the saw cut on top of the wire every two feet. The tabs shall be installed after the loop wire installation and prior to the sealant installation. The tabs shall be individual sections of PVC tubing one inch in length which shall be bent and wedged tightly into the saw cut channel.

(C) Saw Cut Sealants:

Saw cuts shall be sealed with an approved sealant. All slots cut in the pavement shall be blown out and dried before installing conductors. After the conductors are installed in the slots, the slots shall be filled to within 1/8 inch of the pavement surface with the sealant. Before the sealant sets up, the surplus sealant shall be removed from the road surface without the use of solvents. The handling of the sealant and the filling of the saw cut shall be in accordance with the directions of the manufacturer. Sand blotter shall be applied as directed by the Engineer.

(D) Splices:

The detector sensor conductors shall be spliced to the detector lead-in cable in the adjacent pull box.

(E) Detector Loop Installation Field Tests:

Before and after the saw cut sealant has been installed, the subcontractor shall perform an insulation resistance-to-ground test. The insulation resistance-to-ground shall be at least 50 megohms when measured at a voltage between 400 volts and 600 volts D.C.

Any loop detector that does not meet the above requirement or cannot be tuned to the Engineer's satisfaction shall be replaced by the subcontractor at no cost to the Engineer.

735-3.02 Blank

735-4 Method of Measurement:

Loop detectors will be measured as a unit for each type of detector furnished and installed.

SECTION 801 EROSION CONTROL

801-1 Description:

The work in this section shall consist of seeding, soil cement channel and riprap and is further described in sections 802, 803 and 805 of these specifications and on the project plans.

801-2 Materials:

Materials shall be as specified in sections 802, 803 and 805 of these specifications.

801-3 Construction Requirements:

Construction requirements shall be as specified in sections 802, 803 and 805 of these specifications.

801-4 Method of Measurement:

Measurement requirements shall be as specified in sections 802, 803 and 805 of these specifications.

SECTION 802 SOIL-CEMENT:

802-1 Description:

The work under this section shall consist of furnishing all materials and constructing soil-cement channel (bottom and slopes), dip crossings and linings and at the locations in accordance with the details shown on the project plans and the requirements of these specifications. The work shall include toe trench excavation, backfill, and dewatering.

802-2 Materials:

802-2.01 Portland Cement:

Portland cement shall conform to the requirements of ASTM C 150 for Type II.

802-2.03 Water:

Water shall conform to the requirements of Subsection 1006-2.02 of these specifications.

802-2.04 Aggregate:

The soil used in the soil-cement mix shall not contain any material retained on a one and one-half (1-1/2) inch sieve, nor any deleterious material. Soil for soil-cement shall be obtained from the required excavations or from borrow areas specified on the project plans or approved by the Engineer and stockpiled on the job site as specified herein. The Subcontractor shall be responsible for providing all the soil required for soil-cement production. Soil, meeting the gradation requirements specified herein, shall be obtained from the project excavations and/or from borrow areas specified on the project plans or obtained by the Subcontractor. Soil suitable for soil-cement shall be obtained from the required excavations, as shown on the project plans, before any borrow material is allowed to be used for this purpose. The actual soil to be incorporated into the soil-cement shall be analyzed by laboratory tests in order to determine the mix proportions to be used on the project. The distribution and gradation of materials in the soil-cement lining shall not result in lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from surrounding material. Soil shall conform to the following gradation:

Sieve Size	Percent Passing (Dry Weight)
1-1/2"	100%
#4	60% - 90%
#200	5% - 45%

The Plasticity Index shall be a maximum of 10.

Clay and silt lumps larger than one-half (1/2) inch shall be unacceptable.

802-2.05 Design Procedures:

The design requirements for the soil-cement shall be such that it has the compressive strength of seven-hundred-fifty (750) psi, at seven (7) days. Compressive strength tests will be run after twenty-four (24) hours during production. The results of the twenty-four (24) hour test will be used to monitor the daily output of the central plant. Final acceptance, however, shall be based on the compressive strength results of the seven (7) day samples. The quantity of cementitious material established through the mix design procedures shall be monitored throughout the life of the project with modifications, as required, to account for varying field conditions.

The cementitious portion of the soil-cement mix shall consist of one hundred percent portland cement.

The Subcontractor shall use the soil aggregate, cementitious material content, and moisture content determined by laboratory tests. During the course of the work, the Subcontractor may adjust the mix proportions, whenever necessary, in order to assure that the required minimum compressive strength is being attained, but not excessively exceeded. Changes in the amount of cementitious material required in the soil cement mixture shall be made promptly by the Subcontractor when the result of laboratory testing indicates the need or when directed by the Engineer.

For bidding purposes only, the estimated content of cementitious material in the soil-cement mix shall be as specified herein.

The percent of cementitious material to be used in the mix has been estimated to be eight (8) percent calculated by dividing the total weight of cementitious material by the total weight of the dry compacted soil-cement. Testing shall be conducted in accordance with the ADOT's test procedure, "Determination of Cement Content Required for Soil-Cement Mixtures" a modification of Arizona Test Method 220.

802-3 Construction Details:

802-3.01 Equipment:

Soil-cement may be constructed with any combination of machines and/or equipment, except as noted herein, that will produce a completed soil-cement lining meeting the requirements for soil pulverization, cementitious material content and moisture content, mixing, transporting, placing, compacting, finishing and curing as provided in these specifications.

802-3.02 Required Subcontractor Submittals:

Prior to the start of construction, the Subcontractor shall submit, in writing for approval, the following items:

(1) The approximate length of soil cement channel or area of soil cement lining to be placed prior to starting compaction operations.

(2) The type of compaction equipment to be used.

(3) The number and type of watering equipment to be used.

(4) The method used to keep surfaces continuously moist until subsequent layers of soil cement are placed.

(5) The method used to cure permanently exposed surfaces.

(6) The proposed source of soil, if other than required excavations.

(7) The proposed source of portland cement.

Such approval shall not relieve the Subcontractor of the responsibility for achieving the desired result of constructing sound soil cement, free from defects, according to the specifications and project plans, or as directed by the Engineer. Changes in the source of cement will not be permitted without the prior approval of the Engineer.

802-3.03 Preparation:

Before soil-cement processing begins, the area to be lined shall be graded and shaped to the lines and grades shown on the project plans or as directed by the Engineer. The subgrade shall be compacted to a minimum of ninety (90) percent of maximum dry density at a moisture content within one (1) percent below and two (2) percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the

Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

Immediately prior to placement of the soil-cement mixture, the underlying material shall be moistened if necessary. Soft or yielding native material shall be corrected and made stable in accordance with the requirements of Subsection 203-5.03 (A).

802-3.04 Stockpiling of Soil Aggregate:

In the event the Subcontractor elects to stockpile soil aggregate, the stockpile(s) shall be constructed on level, firm ground free of brush, trees, stumps, roots, rubbish, debris and other objectionable or deleterious material and shall be located so as to provide a distance of not less than fifteen (15) feet from the outside bottom edge of any other existing stockpile. The stockpile shall be constructed in layers; each layer no exceeding two (2) feet in thickness. Ramps formed for stockpile construction shall be of the same material as that being stockpiled, and will be considered a part of the stockpile. Before steepening a ramp, any contaminated surface material shall be removed.

Stockpiled material should be thoroughly mixed throughout its depth, width, and length before utilization. The material shall be homogenous and uniform in color, graduation and moisture throughout.

The Subcontractor shall be solely responsible for the construction of the stockpile(s), including monitoring for quality and uniformity of the material placed therein. To assure conformance with the requirements of this Subsection and Subsection 802-2.04 of these specifications, the Engineer, at random intervals during construction of the stockpile, will sample and test the material being placed therein. Results from these tests shall be compared against the test results obtained by the Subcontractor to assure compliance with the requirements of Subsection 802-2.04 of these specifications.

802-3.06 Mixing Plant:

Soil-cement shall be mixed in an approved central-type plant having a stationary twin shaft pugmill mixer of the continuous-mixing type or an approved batch-type pugmill. The Subcontractor may submit to the Engineer alternative equipment and procedures, along with evidence of its successful use. The Engineer may permit alternatives at his discretion. The mixing plant shall be designed, coordinated and operated to produce a soil-cement mixture of the proportions specified within the required tolerances. Twin shaft pugmills shall also be equipped with a positive means for maintaining a constant speed of rotation of the shafts. Mixing plants shall be equipped with screening, feeding and weighing,

metering or volumetric measuring devices that will add the soil, cementitious material and water into the mixer in the specified quantities. The blades of twin shaft continuous pugmill mixers shall be adjustable for angular position on the shaft and reversible to retard the flow of the mix.

When the quantity of water is controlled by metering, provisions shall be made by the Subcontractor whereby the quantity of water delivered through the meter can be readily converted to weight. A water storage tank may be required to prevent the adverse effects created by surge drawdown.

When a continuous mixing plant with a fixed soil aggregate feed rate system is used, the belt shall travel at a constant speed. The feed system shall continuously deliver aggregate to the mixer at a constant feed rate, calculated on a dry weight basis, at any locked gate setting. The feed system shall be mechanically interlocked with all other feed devices. The soil aggregate feed monitoring system shall provide the rate of and total quantity of soil aggregate fed into the mixture.

The plant shall be equipped with a hydraulically or mechanically operated discharge holding bin having a minimum capacity of twenty (20) tons.

Mixing shall be sufficient to secure a homogenous, intimate, uniform mixture of the soil, cement, and water within the specified tolerances. Soil and cementitious material shall be mixed sufficiently to prevent cementitious balls from forming when water is added.

Mixing shall not proceed when the soil aggregate or the area on which the soil-cement is to be placed is frozen. Soil-cement shall not be mixed or placed when the air temperature is below 45°F (7°C), unless the air temperature is at least 40°F (5°C) and rising.

Free and safe access to the mixing equipment must be provided to the Engineer at all times for inspection of operation, and for sampling the soil-cement mixture and its components.

802-3.07 Measuring Devices:

Weighing, metering or volumetric measuring devices used with mixing equipment shall display current calibrations.

Measuring devices shall be calibrated, at the Subcontractor's expense and approved by the Engineer.

Each measuring device shall be calibrated to an accuracy of plus/minus two (2) percent and shall be inspected and calibrated as often as the Engineer deems necessary to assure their accuracy.

802-3.08 Required Moisture:

The moisture content of the mix shall be adjusted as needed to achieve the compressive strength and compaction requirements specified herein.

802-3.09 Handling:

The soil-cement mixture shall be transported from the mixing area to the embankment in clean equipment. Hauling equipment shall be outfitted with suitable covers to protect the mixture in unfavorable weather. The total elapsed time between the addition of water to the mixture and the start of compaction shall be the minimum possible. In no case should the total elapsed time exceed thirty (30) minutes. This time may be reduced by the Engineer when the air temperature exceeds 90°F, or when there is a breeze or wind which promotes rapid drying of the soil-cement mixture.

802-3.10 Placing:

The mixture shall be placed on the moistened subgrade embankment, or previously completed soil-cement with spreading equipment that will produce layers of such widths and thicknesses as are necessary for compaction to the required dimensions of the completed soil-cement layers. The compacted layers of soil-cement shall not exceed eight (8) inches, nor be less than (4) inches in thickness.

Each successive layer shall be placed as soon as practicable after the preceding layer is completed and certified.

All soil-cement surfaces that will be in contact with succeeding layers of soil-cement shall be kept continuously moist by fog spraying until placement of the subsequent layer, provided that the Subcontractor will not be required to keep such surfaces continuously most for a period longer than seven (7) days.

The Subcontractor shall take all necessary precautions to avoid damage to the completed soil-cement by equipment, and to avoid the deposition of raw earth or foreign materials between layers of soil-cement. Where ramps are constructed over soil-cement that is not to grade, all foreign materials and the uppermost one (1) inch of the previously placed soil-cement mixture must be removed prior to continuation of the soil-cement construction.

802-3.11 Compaction:

Soil-cement shall be uniformly compacted to a minimum of ninety-eight (98) percent of maximum density as determined by field density tests taken in accordance with the procedures of Arizona Test Method 230 or 231. Optimum moisture and maximum density shall be determined in accordance with Arizona Test Method 221, 222b and 223 procedures. Wheel rolling with only hauling equipment shall not be an acceptable method of compaction.

At the start of compaction, the mixture shall be in a uniform, loose condition throughout its full depth. Its moisture content shall be such that the required compaction can be achieved with a minimum of effort and manipulation of the mix. No section shall be left undisturbed for longer than thirty (30) minutes during compaction operations. Compaction of each layer shall be conducted in such a manner as to produce a dense surface, free of compaction planes in not longer than one (1) hour from the time water is added to the mixture. Whenever the Subcontractor's operation is interrupted for more than two (2) hours, the top surface of the completed layer, if smooth, shall be scarified to a depth of at least one (1) inch with a spike tooth instrument, or by other means acceptable to the Engineer, prior to placement of the next layer. The spacing of striations, produced by scarifying, shall not exceed eighteen (18) inches measured perpendicular to the length of the soil-cement being placed. The surface, after said scarifying, shall be swept using a power broom, or other method approved by the Engineer, to completely free the surface of all loose material prior to placement of the next layer of soil-cement.

802-3.12 Finishing:

After compaction, the soil-cement shall be further shaped to the required lines, grades, and cross sections and rolled to a reasonably smooth surface. Shaping of the face of the soil-cement shall be conducted daily, at the completion of each day's production.

802-3.13 Curing:

Temporarily exposed surfaces shall be kept moist as directed by the Engineer.

Care must be exercised to ensure that no curing material, other than water, is applied to the surfaces that will be in contact with succeeding layers.

Permanently exposed surfaces shall be kept in a moist condition for seven (7) days, or they may be covered with a suitable curing material, subject to the Engineer's approval. Any damage to the

protective covering within seven (7) days shall be repaired to the satisfaction of the Engineer.

When a curing material, other than water is used, the permanently exposed surfaces shall be kept moist until the curing material is applied. The curing material is to be applied as soon as practicable, with a maximum time limit of twenty-four (24) hours between the finishing of the surface and the application of the protective cover or membrane.

When necessary, the soil-cement shall be protected from freezing for seven (7) days after its construction by a covering of loose earth, straw, or other suitable material approved by the Engineer.

802-3.14 Construction Joints:

At the end of each day's work, or whenever construction operations are interrupted for more than two (2) hours, a 15° minimum skew, transverse construction joint shall be formed by cutting back into the completed work to form a vertical face for the full depth of the soil cement layer, as directed by the Engineer.

802-3.15 Maintenance:

The Subcontractor shall be required, within the limits of his Contract, to maintain the soil-cement in good condition until all work is completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done by the Subcontractor at his own expense and repeated as often as necessary. Faulty work shall be replaced for the full depth of the layer.

802-3.16 Inspection and Testing:

The Engineer, with the assistance and cooperation of the Subcontractor, shall make such inspections and tests as he deems necessary to assure the work conforms to the Contract documents. These inspections and tests may include, but shall not be limited to: (1) the taking of test samples of the soil-cement and its individual components at all stages of processing and after completion, and (2) the close observation of the operation of all equipment and methods used on the work. Only those materials and methods achieving the requirements specified herein shall be acceptable.

All testing of soil-cement, its individual components, or the mix design unless otherwise provided specifically in the plans or herein, shall be in accordance with the latest applicable Agency specifications in effect as of the date of advertisement for bids on the project.

Testing for proper compaction shall be done on at least every other layer of compacted soil-cement, at any location chosen by the testing personnel. If the layer being tested does not achieve the minimum density requirements, as specified in Subsection 802-3.11 or these specifications, it must be reworked until it meets the requirement or be removed at the Subcontractor's expense. The Subcontractor shall not be permitted to continue placing subsequent layers of soil-cement on any layer which has failed to achieve the required compaction until such time as the deficient layer has been reworked, retested, and found to meet the density requirements specified.

The initial acceptance of the soil-cement shall in no way preclude further examination and/or testing at any time during the course of construction or the warranty period that the Engineer suspects that the material is not properly represented by the sample(s) obtained to date. The acceptance, at any time, of material incorporated into the work shall not bar its future rejection if it is subsequently found to be defective in quality or uniformity.

802-4 Method of Measurement:

The work shall be measured: (1) in cubic yards of soil-cement, as determined by the specified lines, grades, and cross sections shown on the project plans and verified during placement and (2) in tons of cementitious material (i.e., portland cement) incorporated into the soil-cement used as indicated herein or in accordance with the instructions of the Engineer.

Cementitious material shall be computed in accordance with the example herein provided. Any waste of cementitious material and/or soil-cement material by the Subcontractor during the handling, mixing, placing, etc., operations shall not be paid for.

802-4.01 Example Calculation For The Measurement of Cementitious Material Incorporated Into The Soil-cement.

Cementitious Material (Tons) = A x B x C

where:

A = Volume of soil-cement as determined one (1) from the specified lines, grades and cross-sections indicated on the project plans, verified during placement, multiplied by "B", the average in-place dry density.

B = Average in-place dry density as determined from the compaction test results obtained through the course of construction.

C = Average content of cementitious material as determined from the plant scale readings, verified by delivery

receipts, and calculated by dividing the total weight of cementitious material by the total weight of dry aggregate and cementitious material.

Thus, if: A = ten-thousand (10,000) cubic yards; B = one-hundred-thirty-five (135) pounds per cubic foot or 1.8225 tons per cubic yard; and C = 8.0%; the quantity of cementitious material, for the purpose of measurement, would be one-thousand-four-hundred-fifty-eight (1,458) tons.

SECTION 803 RIPRAP:

803-1 Description:

The work under this section shall consist of furnishing all materials and constructing riprap in accordance with the details shown on the project plans and the requirements of these specifications.

Riprap shall be dumped or grouted riprap and shall be constructed at the locations and to the details as shown on the project plans.

803-2 Materials:

803-2.01 Rock:

(A) General:

Rock shall be sound and durable, free from clay or shale seams, cracks or other structural defects. The Bulk Specific Gravity (SSD) shall be determined in accordance with the requirements of AASHTO T-85 and shall be a minimum of 2.4. Rock used to construct dumped riprap shall be angular in shape. Rock used to construct other types of bank protection may be rounded stones or boulders. Rock shall have a least dimension not less than one-third (1/3) of its greatest dimension and a gradation in reasonable conformity with that shown herein for the various types of bank protection. Control of the gradation will be by visual inspection.

The source from which the stone will be obtained shall be selected well in advance of the time when it will be required in the work. The acceptability of the stone will be determined by the Engineer. If testing is required, suitable samples of stone shall be taken in the presence of the Engineer at least twenty-five (25) days in advance of the time when its use is expected to begin. The approval of some rock fragments from a particular quarry site shall not be construed as constituting the approval of all rock fragments taken from that quarry.

(B) Dumped Riprap:

Gradation of the rock for dumped riprap shall be as shown below:

Gradation of the rock referenced to the fifty (50) percent size (D_{50} = 10") for twenty (20) inches riprap shall be as follows:

Size of Rocks	Percent Range of Total Load Smaller than the Given Size
D_{50} = 10"	
20"	100
15"	80-100
10"	40-60
6"	20-40
4"	0-5

Gradation of the rock referenced to the fifty (50) percent size (D_{50} = 8") for sixteen (16) inches riprap shall be as follows:

Size of Rocks	Percent Range of Total Load Smaller than the Given Size
D_{50} = 8"	
16"	100
12"	80-100
8"	40-60
6"	20-40
4"	0-5

Gradation of the rock referenced to the fifty (50) percent size (D_{50} = 6") for twelve (12) inches riprap shall be as follows:

Size of Rocks	Percent Range of Total Load Smaller than the Given Size
D_{50} = 6"	
12"	100
9"	80-100
6"	40-60
4"	20-40
2"	0-5

Each load of riprap shall be properly well-graded from the smallest to the maximum size specified. Rocks smaller than the specified five (5) percent size and spalls will not be permitted in an amount exceeding ten (10) percent of each load.

(C) Grouted Riprap:

Gradation of the rock for grouted riprap shall be as shown below:

Gradation of the rock referenced to the fifty (50) percent size (D_{50} = 10") for twenty (20) inches riprap shall be as follows:

Size of Rocks	Percent Range of Total Load Smaller than the Given Size
D_{50} = 10"	
20"	100
15"	80-100
10"	40-60
6"	20-40
4"	0-5

Gradation of the rock referenced to the fifty (50) percent size (D_{50} = 8") for sixteen (16) inches riprap shall be as follows:

Size of Rocks	Percent Range of Total Load Smaller than the Given Size
D_{50} = 8"	
16"	100
12"	80-100
8"	40-60
6"	20-40
4"	0-5

Gradation of the rock referenced to the fifty (50) percent size (D_{50} = 6") for twelve (12) inches riprap shall be as follows:

Size of Rocks	Percent Range of Total Load Smaller than the Given Size
D_{50} = 6"	
12"	100
9"	80-100
6"	40-60
4"	20-40
2"	0-5

Each load of riprap shall be properly well-graded from the smallest to the maximum size specified. Rocks smaller than the specified five (5) percent size and spalls will not be permitted in an amount exceeding ten (10) percent of each load.

803-2.03 Bedding Material:

Bedding material shall consist of granular material having a maximum dimension of two (2) inches and shall be free of clay or organic material.

803-2.04 Grout:

Grout shall consist of one (1) part portland cement, three (3) parts fine aggregate and one-fifth (1/5) part hydrated lime, by volume. These materials shall be thoroughly dry mixed and sufficient water shall be added to provide a mixture of thick, workable consistency.

Portland cement, fine aggregate and water shall conform to the requirements of Section 1006 of these specifications. Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

Grout that has been mixed more than one (1) hour shall not be used. Retempering of grout will not be permitted.

803-2.05 Filter Fabric:

Filter fabric shall be supplied in accordance with and conform to the material requirements of Subsections 803-4. Special attention shall be given to the required survivability of the filter fabric.

The identification, packaging, handling, and storage of the geotextile fabric shall be in accordance with ASTM D4873. Fabric rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labelled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Rolls will be stored on the site or at another identified storage location in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof, light colored, opaque cover. At no time, shall the fabric be exposed to sunlight for a period exceeding fourteen (14) days.

Geotextile fabric to be used behind rip rap as called out on the project plans shall be a woven monofilament or non-woven fabric consisting only of long chain polymeric filaments such as

polypropylene or polyester formed or woven into a stable network such that the filaments retain their relative position to each other. The fabric shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties. The physical requirements for the bank protection fabric shall be as specified below:

803-2.06 High Survivability Fabric:

High survivability geotextile fabrics shall meet the following minimum average roll values:

Property	Requirement	Test Method
Grab Tensile Strength, lbs.	200	ASTM D4632-86
Grab Elongation at Break, %	15 min. 115 max.	ASTM D4632-86
Puncture Strength, psi	80	ASTM D3787
Burst Strength, lbs.	320	ASTM D3786
Trapezoidal Tear, lbs.	50	ASTM D4533-85
Permitivity, sec -1	.10	ASTM D4491-85
Apparent Opening Size, U.S. Standard Sieve Size	30-100	ASTM D4751-87
Ultraviolet Stability, %	70	ASTM D4355-84

Minimum average roll values represent the average test results for a lot in the weaker direction when sampled according to ASTM D4354 and tested according to the test method specified above.

803-3 Construction Requirements:

803-3.01 General:

Areas on which riprap is to be constructed shall be cleared, grubbed, and excavated or backfilled in accordance with the requirements of the appropriate sections of Division II to produce a ground surface in reasonable conformance with the lines and grades shown on the project plans or established by the Engineer.

Placement through water will not be permitted unless otherwise approved by the Engineer.

803-3.02 Filter Fabric:

When filter fabric is required, it shall be placed in the manner and at the locations shown on the project plans. The surface to receive the fabric shall be free of obstructions, depressions and debris. The filter shall be loosely laid and not placed in a stretched condition.

The strips shall be placed to provide a minimum twenty-four (24) inches of overlap for each joint. On horizontal joints, the uphill strip shall overlap the downhill strip. On vertical joints, the upstream strip shall overlap the downstream strip. The fabric shall be protected at all times during construction from extensive exposure to sunlight.

When the maximum size of the rock to be placed on filter fabric exceeds eighteen (18) inches, the fabric shall be protected during the placement of the rock by a layer of bedding material . The bedding material shall be spread uniformly on the fabric to a depth of four (4) inches and shall be free of mounds, dips or windrows. Compaction of the bedding material will not be required.

Rock shall be carefully placed on the bedding material and filter fabric in such a manner as not to damage the fabric. If, in the opinion of the Engineer, the fabric is damaged or displaced to the extent that it cannot function as intended, the Subcontractor shall remove the rock, regrade the area if necessary, and replace the filter fabric.

803-3.03 Dumped Riprap:

The rock shall be placed to its specified thickness in one (1) operation and in a manner which will produce a reasonably well graded mass with a minimum amount of voids and with the larger rock evenly distributed throughout the mass.

No method of placing the rock that will cause segregation will be allowed. Hand placing or rearranging of individual rock may be necessary to obtain the specified results.

803-3.04 Grouted Riprap:

Rock for grouted riprap shall be placed in accordance with the requirements of Subsection 803-3.03 of these specifications. The stones shall be thoroughly moistened and any excess of fines shall be sluiced to the underside of the stone blanket before grouting.

(A) Grout:

The grout may be delivered to the place of final deposit by any means that will ensure uniformity and prevent segregation of the grout. If penetration of grout is not obtained by gravity flow into the interstices, the grout shall be spaded or rodded to completely fill the voids in the stone blanket. Pressure grouting shall not unseat the stones; and during placing by this method, the grout shall be spaded or rodded into the voids.

Penetration of the grout shall be to the depth specified on the project plans. Rough surface is specified, stone shall be brushed

until from one-fourth (1/4) to one-half (1/2) of the depth of the maximum size stone is exposed.

Grout shall not be placed when the descending air temperature falls below forty (40) degrees Fahrenheit nor until the ascending air temperature rises above thirty-five (35) degrees Fahrenheit. Temperatures shall be taken in the shade away from artificial heat.

Grout surfaces shall be kept continuously moist for at least seven days, beginning immediately after finishing, by means of either a water spray or fog system capable of being applied continuously or by liquid membrane-forming compound or by polyethylene sheeting conforming to the requirements specified in ASTM C 171.

If polyethylene sheeting is used, it shall be white opaque and adjoining sheets shall overlap at least twelve (12) inches and the laps secured to provide an airtight and windproof joint. If liquid membrane-forming compound is used it shall be Type I conforming to the requirements of ASTM C 309 and the application rate shall be one-hundred (100) square feet per gallon.

803-4 Submittals:

803-4.01 Riprap Rock Samples:

The Subcontractor shall provide two samples of rock of at least five (5) tons each, meeting the gradation specified above. The sample at the construction site may be a part of the finished riprap covering. The other sample shall be provided at the quarry. These samples shall be used as a frequent reference for judging the gradation of the riprap supplied. Any difference of opinion between the Engineer and the Subcontractor shall be resolved by dumping and checking the gradation of two random truck loads of stone.

Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Subcontractor at no additional cost to the Engineer.

803-4.02 Geosynthetic Materials:

(A) Certificate of Compliance:

Certificates of Compliance shall be submitted to the Engineer by the Subcontractor upon delivery of geosynthetic materials. If the delivered materials have not been evaluated and preapproved as noted below, it will be necessary for a Certificate of Analysis to be submitted to the Engineer along with the supporting documentation before the material may be considered for use on the project. Each geosynthetic material lot or shipment must be

approved by the Engineer before the materials may be incorporated in the work.

(B) Certificate of Analysis:

Certificates of Analysis, conforming to the requirements of Section 105, may be submitted, along with a representative sample of appropriate size for testing, by the supplier or manufacturer of any geosynthetic material. Testing methods and results shown in the Certificate of Analysis shall conform to the referenced specifications for the proposed geosynthetic use.

(C) Manufacturer Data:

The Subcontractor shall provide product information sheets, installation procedures and recommendations, recommended use, and project references shall also be submitted by the supplier or manufacturer as part of product evaluation and preapproval.

(D) Products Packaging & Shipment:

Geosynthetic materials shall be furnished in protective covers capable of protecting the materials from harmful environmental conditions such as ultraviolet rays, abrasion, extreme heat and water. Storage of the materials will be in a manner to prevent damage, contamination, or deterioration of the materials.

803-5 Method of Measurement:

Dumped and grouted riprap will be measured by the cubic yard of protection constructed by computing the surface area measured parallel to the protection surface and the total thickness of the riprap measured normal to the protection surface.

No separate measurement will be made for geotextile fabric.

SECTION 804 GEOTEXTILE FABRIC

804-1 Description:

The work under this section shall consist of furnishing and placing a permeable geotextile fabric. The fabric shall be placed in accordance with the details shown on the project plans, the requirements of Section 803 of these specifications and as specified herein.

804-2 Materials:

The geotextile fabric shall be supplied and approved by the Engineer in accordance with and conform to the material requirements of Sections 803-2.05 and 803-4 respectively of these specifications.

804-3 Construction Requirements:

Construction requirements shall be in accordance with Section 803-3 of these specifications.

804-4 Method of Measurement:

No separate measurement will be made for geotextile fabric.

SECTION 805 SEEDING

805-1 Description:

The work under this section shall consist of furnishing and applying chemical all materials but not limited to fertilizer; furnishing and planting grass and shrub seed; and furnishing, applying and affixing mulch for Seeding, Class II. The areas to be seeded are disturbed or unvegetated areas as designated by the Engineer.

Seeding (Class II) shall consist of furnishing and planting range grass seed, flower seed and/or shrub seed, including mulch.

805-2 Materials:

805-2.1 Seed:

Seed shall consist of Atriplex canescens (four-winged saltbush/dewinged), Baileya multradiata (desert marigold), Encelia farinosa (brittlebush), Escholtzia californica (california poppy), Franseria deltoides (triangle leaf bursage), Larrea tridentata (creosote bush), Lupinus arizonicus (desert lupine), Plantago insularis (indian wheat), and Schismus barbatus (mediterranean grass).

Application rates of seed as specified are for Pure Live Seed (PLS). PLS is determined by multiplying the sum of the germination and hard or dormant seed by the purity.

Weed content of seed shall not exceed 0.5%

No substitution of species, strain or origin of seed will be allowed unless evidence is submitted in writing by the Subcontractor to the Engineer showing that the specified materials are not reasonably available during the contract period. The substitution of species, strains or origins shall be made only with the written approval of the Engineer, prior to making said substitution.

The seed shall be delivered to the project site in standard, sealed, undamaged containers. Each container shall be labeled in accordance with Arizona Revised Statutes and the U.S. Department of Agriculture rules and regulations under the Federal Seed Act. Labels shall indicate the variety or strain of seed, the percentage of germination, purity and weed content, and the date of analysis which shall not be more than nine (9) months prior to the delivery date.

Legume seed shall be inoculated with appropriate bacteria cultures approved by the Engineer, in accordance with the culture manufacturers' instructions.

805-2.2 Emulsified Asphalt:

Emulsified asphalt shall be type SS-1 or CSS-1 and shall conform to the requirements of Subsection 1005-3.04 of these specifications.

805-2.3 Binder:

Binder shall be free-flowing, noncorrosive powder produced from natural plant gum marketed under M-Binder, M145 Binder, AZ-TAC or approved equal.

805-2.4 Wood Fiber Mulch:

Wood fiber mulch shall consist of a specially prepared wood fiber processed to contain no growth germination inhibiting factors. The mulch shall be from virgin wood and be manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form a homogenous slurry.

805-2.5 Chemical Fertilizer

Chemical fertilizer shall be Ammonium Phosphate. Chemical fertilizer shall be furnished in standard containers with the name, weight and guaranteed analysis of the contents clearly marked. When a mixed fertilizer is specified, such as five-ten five (5-10-5), the first number shall represent the minimum percent of soluble nitrogen, the second number shall represent the minimum percent of available phosphoric acid and the third number shall represent the minimum percent of water soluble potash.

805-2.6 Straw Mulch:

Straw mulch shall conform to the requirements of this Subsection shall be from the current season's crop. A letter of certification from the supplier shall be required to the effect that the straw was baled less than twelve (12) months from the delivery date.

Straw shall be from oats, wheat, rye or other grain crops of current season as approved by the Engineer and shall be free of noxious weeds, mold or other objectionable material. Straw mulch shall be from the current season's crop and shall be in an air-dry condition and suitable for placing with mulch blower equipment.

805-2.7 Water:

Water shall be free of oil, acid, salts or other substances which are harmful to plants. The source shall be as approved by the Engineer prior to use.

805-3 Construction Requirements:

805-3.1 General:

The Subcontractor shall notify the Engineer at least two (2) days prior to commencing seeding operations.

Seeding shall be accomplished as soon as possible after the slopes and those portions of the right-of-way that have been disturbed have been finished in accordance with the requirements of the applicable portions of Section 203 of these specifications.

Seeding operations shall not be performed when wind would prevent uniform application of materials or would carry seeding materials into areas not designated to be seeded.

Preparation of areas for seeding shall be as specified herein and in the special provisions.

The equipment and methods used to distribute seeding materials shall be such as to provide an even and uniform application of seed, mulch and/or other materials at the specified rates.

Unless specified otherwise herein, seeding operations shall not be performed on undisturbed soil outside the clearing and grubbing limits of the project or on steep rock cuts.

All disturbed areas shall be seeded.

805-3.2 Tillage:

All areas to be seeded shall have the following chemical fertilizers uniformly applied to the surface at the rate specified and tilled into a minimum of the top three (3) inches of the surfaces:

Type of Fertilizer	Pounds per Acre
Ammonium Phosphate	200

Tillage shall be accomplished with a disc harrow, chiseling tool or with other equipment which will provide an even mixture of fertilizer into the soil.

Tillage shall be performed across the slope when practical. No work shall be done when the moisture content of the soils is unfavorable or the ground is otherwise in a condition inimical to tillage.

In areas which, in the opinion of the Engineer, are too rocky to till without drastically disturbing the completed sections, the Engineer will approve a reduction of tillage accordingly. Tillage depth shall be at least one-half (1/2) inch deep to break up the compacted surface and provide material for seed coverage.

All competitive vegetation shall be uprooted during the tillage operation and the soil shall be left in a smooth, firm surface free of clods, large stones over four (4) inches in any dimension and other foreign material that would interfere with the seeding operation.

805-3.3 Planting:

After the tillage is completed and accepted by the Engineer, seed shall be planted by drill, except that on slopes too steep or rocky, seed may be broadcast provided that it is covered by dragging, hand raking or other approved methods. Hyroseeding is an acceptable method for seed distribution in areas where drilling is not practical, provided fifty (50) pounds per acre of binder and two-hundred (200) pounds per acre of wood fiber are included in the slurry with the seed. Seed shall not be in the slurry more than thirty (30) minutes. Seed planted by this method will not require covering.

The type of seed and the pure live seed rate are as follows:

S P E C I E S	Pounds per Acre
Atriplex canescens four-winged saltbush/dewinged	3
Baileya multradiata desert marigold	2
Encelia farinosa brittlebush	2
Escholtzia californica california poppy	3
Franseria deltoides triangle leaf bursage	2
Larrea tridentata creosote bush	3
Lupinus arizonicus desert lupine	2
Plantago insularis indian wheat	4
Schismus barbatus mediterranean grass	1

Seed shall be planted approximately one-quarter (1/4) inch deep, with a maximum depth of one-half (1/2) inch. The distance between the drilled furrows shall not be more than eight (8) inches. If the furrow openers on the drill exceed eight (8) inches, the area shall be drilled twice. Seeding shall be done with grass seeding equipment with double disc openers, depth bands, packer wheels or drag chains, rate control attachments, seed boxes with agitators and separate boxes for small seed. Seed of different sizes shall be sowed from at least two (2) separate boxes adjusted or set to provide the planting rate as specified.

On cut and fill slopes the operations shall be conducted in such a manner as to form minor ridges thereon to assist in retarding erosion and favor germination of the seed.

Care shall be taken during the seeding operations to prevent damage to existing trees and shrubs in the seeding area in accordance with the requirements of Subsection 107.06. Seed shall be drilled, broadcast or otherwise planted in the manner and at the rate specified herein.

Mulch material which is placed upon trees and shrubs, roadways, structures and upon any areas where mulching is not specified or which is placed in excessive depths on mulching areas shall be removed as directed. Mulch materials which are deposited in a matted condition shall be loosened and uniformly spread, to the specified depth, over the mulching areas.

During seeding and mulching operations, care shall be exercised to prevent drift and displacement of materials. Any unevenness in materials shall be immediately corrected by the Subcontractor.

Mulch shall be immediately affixed by either crimping or tacking after application. No mulch shall be applied to seeding areas which can not be crimped or tacked by the end of each day. Any drifting or displacement of mulch before crimping or tacking shall be corrected by the Subcontractor, at the Subcontractor's expense.

Prior to the application of a tacking agent, protective covering shall be placed on all structures and objects where stains would be objectionable. All necessary precautions shall be taken to protect the traveling public and vehicles from damage due to drifting spray.

Class II seeding areas shall not be watered after planting.

805-3.4 Applying Mulch:

Mulch shall be immediately affixed by either crimping or tacking. The Engineer shall determine which areas are not conducive to

anchoring by crimping and will direct the Subcontractor to anchor such mulch by tacking.

Within twenty-four (24) hours after each area is planted, straw mulch shall be uniformly applied at the rate of approximately two and one-half (2 1/2) tons per acre for crimped areas and one and three-quarter (1 3/4) tons per acre for tacked areas.

805-3.5 Anchorage by Crimping:

Mulch shall be anchored into the soil with a heavy disc with flat, serrate discs at least one-quarter (1/4) inch thick having dull edges and spaced no more than nine (9) inches apart. Mulch shall be anchored to a depth of at least two (2) inches and shall not be covered with an excessive amount of soil. Anchoring operations shall be across the slopes where practical with no more than two (2) passes of the anchoring equipment.

805-3.6 Anchorage by Tacking:

Mulch shall be anchored by tacking using either emulsified asphalt uniformly applied at the rate of approximately four-hundred (400) gallons per acre or a slurry consisting of one-hundred (100) pounds of binder, three-hundred (300) pounds of wood fiber mulch and seven-hundred (700) gallons of water per acre.

805-3.7 Preservation of Seeded Areas:

The Subcontractor shall protect seeded areas from damage by traffic or construction equipment. Surfaces which are eroded or otherwise damaged following seeding and prior to final acceptance shall be repaired by regrading, reseeding and remulching as directed by the Engineer.

805-4 Submittals:

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

805-5 Method of Measurement:

Seeding Class II will be measured by the acre to the nearest hundredth acre, measured along the ground surface for the areas which have been planted and mulched, as determined by the Engineer.

SECTION 904 POLE MOUNTED CONVEX MIRROR:

904-1 Description:

The work under this section shall consist of furnishing and installing a pole mounted convex mirror including, but not limited to, pole foundation and other accessories required and as shown on project plans.

904-2 Materials:

904-2.01 Mirror Frame:

The mirror shall be of 36 inch diameter, outdoor, light weight shatterproof plexiglass lense with weatherproof painted hardboard backs including an adjustable swivel aluminum, and weather resistant frame. The mirror #CV-36 shall be supplied by Industrial Safety and Security Co., Lima, Ohio [(414)227-6030] or approved equal.

904-2.02 Pole:

The pole shall be made of one piece, spun, tapered tube of aluminum alloy 6063-T6, with embedded pedestal anchor base and single member (SM) arm including all accessories and as manufactured by HapCo [(703)628-7171] or approved equal.

904-3 Construction Requirements:

The subcontractor shall construct a foundation for the pole with class "S" concrete as per Section 601 and Section 1006 of these specifications.

The steel plate and anchor bolts shall be installed per the manufacturer's requirements.

The subcontractor shall install the pole, single member arm, plexiglass mirror lense mounted on aluminum frame, per the instructions of the manufacturer and as shown on the project plans.

904-4 Submittal:

At least two weeks prior to ordering the pole mounted convex mirror, the subcontractor shall submit six (6) copies of the following drawings in accordance with Section 105 of these specifications.

1. Mirror and frame

2. Pole with single member with all required accessories.

3. Concrete foundation details and calculations.

904-5 Method of Measurement:

Pole mounted convex mirror complete unit shall be measured as a per unit, each basis.

SECTION 905 GUARD RAIL

905-1 Description:

The work under this section shall consist of furnishing all materials and constructing new guard rail, temporary removable guard rail, all at the locations shown on the project plans and in accordance with the details shown on the project plans and the requirements of these specifications.

905-2 Materials:

Materials for guard rail shall conform to the requirements of Section 1012 of these specifications.

905-3 Construction Requirements:

905-3.01 General:

The construction of the various types of guard rail shall include the assembly and erection of all component parts complete at the locations shown on the project plans or as directed by the Engineer. All materials shall be new.

The various types of guard rail shall be constructed as specified on the project plans. The same type of post shall be used in any one continuous length of guard rail.

All metal work shall be fabricated in the shop. No punching, drilling, cutting or welding shall be done in the field. All metal cut in the field shall be cleaned and painted with two (2) coats of Paint No. 4.

Where a post is to be set in concrete, the concrete shall be placed against undisturbed material in the excavated hole. Before the post is set in the hole, a one-half (1/2) inch thickness of polystyrene material shall be placed to cover all sides and corners of the embedded portion of the post for the full depth of the concrete. The polystyrene material shall not be nailed or clipped to the post, but shall be held against the post in a manner approved by the Engineer.

All bolts shall extend beyond the nuts a minimum of two (2) threads, except that all bolts on posts adjacent to pedestrian traffic shall be cut off flush to the nut.

Bolts extending more than two inches beyond the nut shall be cut off less than one-half (1/2) inch beyond the nut.

Unless otherwise shown on the project plans, bolts shall be torqued as follows:

Diameter of Bolt, Inches	Torque, Foot - Pounds
5/8	45- 50
3/4	70- 75
7/8 and larger	120-125

All bolts, other than those specified to be torqued, shall be securely tightened.

Guard rail elements shall be spliced by lapping in the direction of traffic in the nearest adjacent lane.

Reflectorized tabs shall be installed on posts at the locations shown on the project plans. The slotted part of the tab shall be installed under the mounting bolt head so that the reflectorized surface of the tab faces oncoming traffic. The exposed ends of the slotted part of the tab shall be bent up against and then over the top of the bolt head. Silver faced tabs shall be installed on the right hand side of all roadways and in addition, yellow faced tabs shall be installed on the left hand side of one-way roadways and ramps.

When guard rail is being constructed, the Subcontractor shall conduct his operations so as to constitute the least hazard to the public. All guard rail work shall be performed in the direction of traffic flow.

905-3.02 Roadway Guard Rail:

Guard rail posts shall be set to the line and grade established by the Engineer and spaced as shown on the project plans.

Steel posts shall either be driven, or placed in manually or mechanically dug holes; however, driven posts will not be permitted at locations where damage to the curb, gutter, sidewalk, buried items, shoulders or pavement might occur. The Engineer will be the sole judge as to whether driving of posts will be allowed. Driving of posts shall be accomplished in a manner which will prevent battering, burring, separation of the galvanizing from the steel or distortion of the post. Any post which is bent or otherwise damaged to the extent it is unfit for use in the finished work, as determined by the Engineer, shall be removed and replaced at the Subcontractor's expense.

Prepunched pilot holes may be required where wood posts are driven. Pilot holes will not be required where steel posts are driven.

Where pavement is disturbed in the construction of guard rail, the damaged surfacing shall be repaired as approved by the Engineer. Where the top surface of a culvert or other item is at an elevation which would interfere with full depth post placement, the post

shall be placed and anchored in accordance with the requirements of Subsection 905-3.06 of these specifications.

Except where a concrete foundation for a post is required, the space around and under the posts placed in manually or mechanically dug holes shall be backfilled with moist soils placed in compacted lifts as approved by the Engineer.

Rail elements shall be spliced at twenty-five (25) foot intervals or less, except that rail elements used to construct breakaway cable terminals shall not be spliced within 12.5 feet of the terminal post of the breakaway cable terminals. Rail elements shall be spliced at posts unless otherwise shown on the project plans. Where steel posts and blocks are used, back-up plates shall be installed at each post, except at posts where splices are made. Rail elements at joints shall have full bearing. When the radius of curvature is one-hundred-fifty (150) feet or less, the rail elements shall be shop curved.

905-3.03 Breakaway Cable Terminal or Guard Rail Anchor Assembly:

Installation of either breakaway cable terminals (BCT's) shall be as shown on the project plans. Concrete footings shall be poured against moist, undisturbed earth. The top of all footings shall be flush with the ground line and shall be steel troweled to a smooth finish with a slope to drain away from the post.

Immediately after placing concrete footings, at least four inches of loose moistened earth which is free of clods or gravel shall be placed over the footing or the footing shall be sprayed with an approved liquid membrane curing compound. After the footing has cured, this material and any excess excavated material shall be removed and disposed of as approved by the Engineer.

All guard rail components requiring removal shall be removed in such a manner as to prevent damage to and minimize the loss of the components.

If any materials designated for reconstruction are deemed by the Engineer to be unsuitable for reuse or if the quantities of existing materials are insufficient to complete the work, the Subcontractor shall furnish new materials in sufficient quantities to complete the work.

Where new bolt holes in rail elements are required, the holes shall be made by drilling or punching. Flame-cut bolt holes will not be permitted.

905-3.06 Buried and Bolted Guard Rail Anchors:

Buried guard rail anchors shall consist of two (2) W-beam elements bolted to the buried portion of the guard rail posts and buried in a trench as shown on the project plans. The trench shall be carefully excavated so as to avoid overexcavation. Backfill material may be either uncontaminated material removed from the trench or other material approved by the Engineer. Surfacing material removed during trench excavation shall be replaced with the same type of material in a manner approved by the Engineer.

Buried guard rail elements which require bituminous coating shall be coated with material conforming to the requirements of AASHTO M 190.

Bolted guard rail anchors shall consist of bolting two (2) steel brackets to the shortened post and to the box culvert roof as shown on the project plans.

Where the elevation of the top surface of a culvert or other similar installation prevents the placement of a post of the specified length, the posts shall be shortened and anchored in accordance with the details shown on the project plans.

905-3.07 Installation of Sleeve for Heavy Removable Guardrail:

After placement of Aggregate Base Course (ABC) and prior to placement of Asphaltic Concrete (AC), steel sleeves shall be installed at the position shown on the project plans. Sleeves shall be driven by approved methods to the depth and at the angle shown on the project plans. Augering holes for sleeve placement shall not be permitted.

At the Subcontractor's option, the top of the sleeve may be cut off flush with the finished ABC surface after installation. If the sleeve is cut off, measures shall be taken during paving operations to prevent placement of AC within the twelve (12) inch diameter space above the sleeve.

If the sleeve is not cut off flush with the ABC surface, care shall be taken to assure full compaction of the AC around the sleeve during paving operations.

The top of the steel sleeve shall not extend higher than 1.5" below the finished AC surface after AC placement is complete.l

Before the placement of the guard rail post, the earth inside of the sleeve shall be cleaned. The cleanup procedure shall be such that it shall not disturb or damage any materials around the sleeve.

905-3.08 Shop Drawings:

Shop drawings of guard rail shall be submitted for Engineer's approval prior to start of fabrication. Shop drawings shall reflect the actual field conditions.

905-4 Submittals:

The Subcontractor shall submit a planned method for installation of Heavy Removable Guardrail for approval prior to beginning sleeve installation.

905-5 Method of Measurement:

The limits of measurement for the various guard rail items are shown on the project plans. Guard rail, of the type shown on the project plans, will be measured by the linear foot along the face of the rail element from center to center of end posts, exclusive of breakaway cable terminals.

Breakaway cable terminals will be measured by the unit each.

SECTION 908 CONCRETE CURB AND GUTTER:

908-1 Description:

The work under this section shall consist of furnishing all materials and constructing portland cement concrete curb, precast safety curb, curb and gutter, and valley gutters at the locations shown on the project plans in accordance with the details shown on the project plans and the requirements of these specifications.

908-2 Materials:

908-2.01 Concrete:

Concrete shall be Class B concrete conforming to the requirements of Section 1006.

908-2.02 Expansion Joint Filler:

Expansion joint filler shall be one-half (1/2) inch bituminous or nonbituminous preformed strips conforming to the requirements of Subsection 1011-6.

908-2.03 Concrete Curing Compound:

Curing compound shall be liquid membrane-forming compound conforming to the requirements of AASHTO M 148, Type I, Class A.

908-3 Construction Requirements:

The subgrade shall be constructed in reasonably close conformity to the lines and grades established or shown on the project plans.

Prior to placing concrete curb, curb and gutter, or valley gutter, the material on which they are to be placed shall be compacted to a depth of at least six (6) inches to a density of not less than ninety-five (95) percent of maximum dry density at a moisture content within one (1) percent below and to four (4) percent above optimum moisture content as determined in accordance with the requirements of ASTM D 1556 for density and AASHTO T 217 or AASHTO T 265 for moisture as approved by the Engineer. Maximum dry density and optimum moisture content shall be established in accordance with ASTM D 1557 (Modified Proctor).

All soft or unsuitable material shall be removed to a depth of not less than six (6) inches below subgrade and replaced with material approved by the Engineer.

Curb and gutter shall be constructed either by the use of conventional fixed forms or by slip-form curb and sidewalk placing machines.

Weather and temperature limitations for the placement of concrete shall be in accordance with the requirements of Subsection 1006-5.

Forms shall be maintained at all times in good condition as to accuracy of shape, strength, rigidity and smoothness of surface. The depth of face forms for concrete curbs shall be equal to the full face height of the curb.

All other forms shall be set to form the full depth of all edges not formed by adjacent concrete. Forms unsatisfactory in any respect shall not be used.

Forms shall be set in reasonably close conformity to the dimensions, lines and grades shown on the project plans or established by the Engineer and be securely staked in position. Clamps, spreaders, and braces shall be used where required to ensure rigid forms.

When the roadway section slopes away from the gutter, the slope of the gutter shall be formed to match the roadway cross slope.

The subgrade and forms shall be watered immediately in advance of placing concrete. Concrete shall be placed in the forms and thoroughly consolidated. The concrete shall be consolidated by means of approved mechanical vibrators or by tamping or spading by hand. The fresh concrete shall be struck off so the surface will be at the proper elevation when the concrete is consolidated. Concrete shall be thoroughly worked so that the coarse aggregate is below the surface. The surface shall then be finished to grade and cross-section with a float, troweled smooth and then given a final fine brush finish.

The exposed edges shall be tooled to a one-quarter (1/4) inch radius unless a larger radius is indicated on the project plans. When concrete placed in curb has set sufficiently so that it will not slump, the front face form shall be removed. The gutter, front face, and top of curb shall be troweled smooth and then given a final fine brush finish with brush strokes parallel to the lines of curb and gutter. The exposed edges shall be tooled to a one-quarter (1/4) inch radius.

Expansion joints shall be constructed at tangent points of curb returns, at structures, and at a maximum of sixty (60) foot intervals. Joint filler shall be placed vertically and extend full depth beginning three-sixteenth (3/16) inch below the surface of the concrete being placed. During the placing and tamping of concrete, the filler shall be restrained in its proper position.

Edges of the concrete at expansion joints shall be tooled to a one-quarter (1/4) inch radius.

Contraction joints (weakened-plane joints) shall be constructed at a maximum of fifteen (15) foot intervals in curb and gutter.

Scoring lines, where required, shall have a minimum depth of one-quarter (1/4) inch and a radius of one-eighth (1/8) inch. Where longitudinal scoring lines are required, they shall be parallel to, or concentric with, the lines of the work.

Forms shall be thoroughly cleaned each time they are used and shall be coated with a light oil as required to prevent the concrete from adhering to them.

If slip-form equipment is used to construct curb and gutter, such equipment shall be designed specifically for the work. The results shall be equal to or better than that produced by the use of fixed forms. If the results are not satisfactory to the Engineer, the use of the equipment shall be discontinued. All applicable requirements of construction by use of fixed forms shall apply to the use of slip-form equipment.

The slip-form equipment shall be controlled as to line and grade by means of automatic sensing and control devices such that the machine automatically senses and follows either a taut guide line or other reference, performing any necessary corrective maneuvers in order to establish the correct grade and alignment. The Subcontractor shall set the guide line.

Immediately following the required finishing operations, one or more applications of curing compound shall be applied to all exposed surfaces.

The curing compound shall be applied at the rate of not less than one gallon per one-hundred-fifty (150) square feet of surface area, and in such manner as to entirely cover and seal all exposed surfaces of concrete with a uniform film.

The face, top, back, and flow line of the curb and gutter shall be tested with a ten (10) foot straightedge or curve template, longitudinally along the surface.

Any deviation in excess of one-quarter (1/4) of an inch shall be corrected at no additional expense to the Engineer.

Before acceptance of the work, all curb and gutter shall be cleaned of all discolorations resulting from the Subcontractor's operations, including, but not limited to, dirt, stains, bitumens, and equipment tire marks. Cleaning may be by abrasive blast methods or by other methods approved by the Engineer.

908-4 Method of Measurement:

Concrete curb and gutter will be measured by the linear foot along the flow line. Lengths occupied by catch basins will be excluded from the measurement.

Concrete valley gutter will be measured by the square foot of area constructed. Areas occupied by catch basins will be excluded from the measurement.

Concrete precast safety curb will be measured per each six (6) foot long unit.

SECTION 910 RAINWATER CATCHMENT UNIT:

910-1 Description:

The work under this section shall consist of furnishing all materials, equipment and associated accessories and transportation necessary for installation and construction of complete, rainwater catchment unit in accordance with the project plans.

910-2 Materials/Products:

The Subcontractor shall furnish, install and construct, the following materials/products:

910-2.01 Corrugated PVC:

Corrugated, Phase-2 PVC panels of H & F Manufacturing Co. or approved equal. The panel's corrugation configuration shall be four and one-half (4-1/2) inch times one and one-sixteenth (1-1/16) inch and the thickness a minimum of one-eighth (1/8) inch. The panels shall be camel tan or equal in color to blend with the desert environment.

910-2.02 Fiberglass Tank:

One (1) 2,550 gallon fiberglass, aboveground water tanks of Desert Sun Fiberglass Systems Ltd or approved equal, shall be installed at each site shown on the project plans for a total of four (4). Each tank shall be supplied with a cover, four lifting lugs, one twenty-four (24) inch open man-way on top of tank and one (1) two (2) inch outlet on the end at the bottom of the tank. The tank inside coating shall be an FDA approved gel-coat and the exterior coating shall be gel-coat in camel brown coloring. Four (4), fifteen inches times forty-five inches (15 x 45) saddles shall be prefabricated with a bolt tab to bolt the tank to concrete footings as shown on the project plans.

910-2.03 Fiberglass Drinker Trough:

Four fiberglass drinking troughs of Desert Sun Fiberglass Systems Ltd, or approved equal shall be installed in camel brown color. The sloped portion of the troughs shall be embedded with crushed rock or gravel to form a non-slip walking surface. A hood, as shown on the project plans, shall be bolted to the trough or prefabricated as part of the trough.

910-2.04 Valves:

Each rainwater catchment unit shall be equipped with a Golden Anderson (Figure 69), one (1) inch float valve or approved equal as shown on the project plans. Valves shall be installed to maintain

the normal water surface indicated on the project plans with a minimum three (3) inch freeboard.

910-2.05 PVC 1" Diameter Pipe:

The one (1) inch diameter pipeline shall be constructed of PVC schedule forty (40) pipe in accordance with ASTM-1785 except where specified as galvanized metal pipe on the project plans. The PVC joints shall be solvent cement. All exposed piping shall be protected by a coat of vinyl based paint in a tan color.

910-2.06 Roof Deck & Connections:

Roof deck connections to be one-eighth (1/8) inch thick corrugated PVC, watertight, with a minimum No. eight (8) self drilling screws with neoprene washers. The connections shall be made to joint at each side of the seam at alternate deck flutes and minimum eighteen (18) inches on center.

910-2.07 Structural Steel, Bolts and Welds:

The structural steel, bolts and welds shall conform to AISC codes, ASTM A-30, AWS D 1.3 and per Section 904 of these specifications.

910.3 Construction Requirements:

910-3.01 Trench Excavation:

The trench excavation, backfilling and compaction shall be done in accordance with Section 203 of these specifications.

910-3.02 Waterline Construction:

The waterline construction shall be done in accordance with AWWA C-900.

910-3.03 Concrete Foundation:

The concrete foundations shall be constructed conforming to ACI 301, ASTM C 33, ASTM C 150, and ASTM C 618, Type F, and in accordance with Section 601 of these specifications.

910-3.04 Structural Steel, Bolts and Welds:

The subcontractor shall install and construct the structural steel, bolts and welds conforming to Section 906 of these specifications.

910-3.05 Wood Members:

All wood construction shall comply with Uniform Building Code Standards.

910-3.06 Road Construction and Grading:

The subcontractor shall clear and grade roads to provide access to each rainwater catchment sites from the nearest permanent access or maintenance road. These roads shall be approved by the Engineer prior to start of construction.

910-3.07 Location of Rainwater Catchment Sites:

The subcontractor shall coordinate with Mr. Eric Swanson of the Arizona Game and Fish Department (602-942-3000) when a construction road to the general area of Rainwater Catchment Site No. 1 has been completed to make a final determination of the rainwater catchment site location. In addition, the subcontractor shall coordinate with Mr. Swanson prior to construction and installation of Rainwater Catchment Sites No. 2,3, and 4 to make a final determination of the rainwater catchment site location. Mr. Swanson will choose the specific site location based on the available vegetation, local wash conditions, and accessibility of the site at each of these locations.

910-3.08 Drinking Troughs:

The subcontractor shall coordinate with Mr. Eric Swanson of the Arizona Game and Fish Department (602-942-3000) when locating the drinking troughs at each of the rainwater catchment sites. The project plans show general directions about the locations of the troughs and Mr. Swanson will choose the specific location based on the available vegetation and small game requirements at each site.

910-3.09 Grading:

The subcontractor shall install above ground storage tanks on sites that have been cleared and grubbed and uniformly graded. The storage tanks are allowed to be placed on sites that have been sloped in the direction of the drinking trough with a maximum slope of 0.02 ft per ft. The tanks shall not be placed on fill sites unless the area has been filled and compacted per Section 203 of these specifications. Clearing and grubbing shall be done prior to grading work, conforming to Section 201 of these specifications. Structural excavation and backfill shall be done, conforming to Section 203 of these specifications.

910-4 Submittals:

At least four weeks prior to ordering any items for rainwater catchment unit, the subcontractor shall submit the six (6) copies of the following in accordance with Section 105 of these specifications.

(1) Shop drawings showing fiberglass aboveground water tank. The subcontractor shall design and construct prefabricated saddles with anchors to the concrete footings as shown on the project plans. Design calculations for the tank, saddles and anchors shall be submitted.

(2) Shop drawings for corrugated PVC roof decking with strap and solid binding straps and supports as shown on the project plans.

(3) Fiberglass drinking trough with piping and float and valve as shown on the project plans.

910-5 Method of Measurement:

Rainwater Catchment Unit will be measured as a unit for each rainwater catchment unit complete in place including grading access to the site and restoration of channels.

SECTION 916 EMBANKMENT CURB:

916-1 Description:

The work under this section shall consist of furnishing all materials and constructing portland cement concrete embankment curbs at the locations shown on the project plans or otherwise designated in accordance with the details shown on the project plans and the requirements of these specifications.

916-2 Materials:

Portland cement, water and admixtures shall conform to the requirements of Section 1006 for Class B concrete.

Fine aggregate and coarse aggregate shall conform to the requirements of Subsection 1006-2.03. The designated size of coarse aggregate shall be No. 7, No. 67 or No. 57. At the option of the subcontractor, aggregate conforming to the requirements for Aggregate Base, Class 1 as shown in Table 303-1 of the ADOT Standard Specifications may be furnished.

The subcontractor may add additional fine aggregate to the aggregate for the curb in order to facilitate finishing. Fine aggregate for this purpose shall be nonplastic and shall conform to the following grading requirements:

Passing No. 4 sieve	100 percent
Passing No. 200 sieve	0-10.0 percent

Fine aggregate added for this purpose shall not exceed 25 percent of the total aggregate for the concrete curb.

Liquid membrane-forming compound shall conform to the requirements of AASHTO M 148, Type I, Class A.

916-3 Construction Requirements:

The subcontractor shall be responsible for furnishing the various ingredients and for proportioning and mixing them; however, approval of the proposed materials and proportioning and mixing shall be obtained prior to any concrete operations.

The minimum cement content per cubic yard of concrete shall be 470 pounds.

No field tests will be required on the concrete mixture.

The requirements for mixing and placing concrete in cold weather shall conform to the requirements of Subsection 1006-5.03. There is no maximum temperature limitation on the concrete mixture immediately before placement.

Embankment curb shall be constructed either by the use of conventional fixed forms or by slip-form curb placing machines. The surface on which the curbs are to be placed shall be cleaned of all loose dirt and debris prior to placing. The work shall be performed so as not to mar the roadway surface.

If slip-form equipment is used to construct embankment curb, such equipment shall be designed specifically for the work. The slip-form machine shall be capable of producing curb equal to or better than that produced by the use of fixed forms. If the curb produced by such machines is not acceptable, the use of such machines shall be terminated.

Curbs shall present a neat appearance. The finish normally associated with the use of slip-form curb placing machines, including the use of moveable forms, will be considered as acceptable for the finishing of concrete embankment curb. When bituminous material is being applied to the adjacent roadway, curbs shall be protected so that they are not spattered or discolored.

Embankment curb shall be cured by the application of liquid membrane-forming compound. The time at which it is to be applied and the rate of application shall be approved by the Engineer.

916-4 Method of Measurement:

Embankment curb will be measured by the linear foot of curb placed. Lengths occupied by spillway inlets will be excluded from the measurement.

SECTION 917 EMBANKMENT SPILLWAYS, INLETS AND OUTLETS:

917-1 Description:

The work under this section shall consist of furnishing all materials and constructing embankment spillways, inlets and outlets at the locations designated on the project plans and in accordance with the details shown on the project plans and the requirements of these specifications.

917-2 Materials:

Certificates of Compliance conforming to the requirements of subsection 105 shall be submitted.

Concrete shall be Class B portland cement concrete conforming to the requirements of Section 1006.

Welded wire fabric and wire ties shall conform to the requirements of Section 1003.

Steel bars for reinforcing, anchor stakes and trash racks shall conform to the requirements of Section 1003.

Performed bituminous joint filler shall conform to the requirements of Subsection 1011-7.01.

917-3 Construction Requirements:

917-3.01 General:

Embankment slopes and existing ground at outlets shall be excavated in reasonably close conformity to the lines, and grades shown on the project plans or established by the Engineer

Backfill shall be placed and compacted in accordance with the requirements of Subsection 203-10 for embankment.

917-3.02 Concrete:

Concrete spillways, inlets and outlets shall be constructed in accordance with the requirements of Section 601. Reinforcing with wire mesh or steel bars where shown on the plans shall be placed in accordance with the requirements of Section 605.

Concrete surfaces shall be protected from discoloration.

917-4 Method of Measurement:

917-4.01 Embankment Spillways and Embankment Down-drains:

Embankment spillways will be measured by the linear foot along the slope at the center line of the spillway.

917-4.02 Inlets and Outlets:

Inlets and outlets will be measured as a unit for each installation of the type specified.

Trash racks will not be measured for separate payment, but will be considered as included in the price bid for inlets.

SECTION 922 UTILITY CONCRETE FOR MISCELLANEOUS CONSTRUCTION

922-1 Description:

The work under this section shall consist of furnishing all materials, mixing and placing portland cement concrete for post foundations and anchors for barrier fences, line fences, chain link fences and miscellaneous signs; concrete foundations for depth gauges at fords; concrete for markers and survey monuments; concrete rings at ground surface for irrigation valves and gates; concrete fill at the base of electrical pull boxes; and for similar uses as specified on the project plans or in the special provisions.

922-2 Materials:

Portland cement, water, admixture, fine aggregate and coarse aggregate shall conform to the requirements of Section 1006. The coarse aggregate size designation shall be chosen by the subcontractor and be approved by the Engineer and shall conform to the size designation and gradation requirements of AASHTO M 43.

922-3 Construction Requirements:

The Engineer will inspect and approve the facilities, materials, and methods for producing the concrete to insure that concrete of the quality suitable for use in the work will be obtained. Mixing and placing of the concrete shall conform to the requirements of recognized practice. Concrete may be mixed in mobile mixers upon approval of the Engineer.

Mixing and placing concrete in cold weather shall conform to the requirements of Subsection 1006-5.03. There is no maximum temperature limitation for the concrete mixture immediately prior to placement.

The minimum cement content per cubic yard of concrete shall be 470 pounds.

All exposed concrete shall be finished to a smooth surface.

922-4 Method of Measurement:

No measurement will be made of the concrete used.

No measurement will be made for furnishing and placing utility concrete. The cost will be considered as included in the price bid for the item of work in which the concrete is incorporated.

SECTION 928 FORMED RUMBLE STRIP (Shoulder Grooving)

928-1 Description:

The work under this section shall consist of forming rumble strips in the asphaltic concrete roadway shoulders at the locations shown and in accordance with the details on the project plans and the requirements of these specifications.

928-2 Construction Requirements:

Rumble Strips shall be formed in the asphaltic concrete by making indentations a minimum of 1 1/4 inches deep by two feet in length and spaced at centers of approximately eight inches, in accordance with the details shown on the project plans.

The indentations shall be formed by rolling the asphaltic concrete, while still hot, with a tandem roller weighing not less than 12 tons. The roller shall have segments of 2-inch diameter pipe welded to the driving roller drum.

The pipe segments shall be 2 feet long, cut longitudinally to provide a half segment, and capped on the ends. The pipe segments shall be welded to the roller drum at approximately 8-inch centers, with the rounded side of the pipe away from the drum.

If the rear tires are pneumatic, they shall have a smooth or slick tread design. The roller shall be equipped with an approved water system which will moisten the drums and tires so that the bituminous material will not be picked up. The roller shall also be equipped with an approved guide that extends in front of the roller and is clearly visible to the operator so that proper alignment of the strips will be obtained.

The equipment used shall be positioned by using planking, or by other approved means, so that the asphaltic concrete is indented only at those locations specified on the project plans and to the dimensions specified herein and on the project plans.

The forming of the Rumble Strips shall be accomplished in one pass of the equipment. The surface surrounding the indentations shall be smooth and not deformed.

The asphaltic concrete shall be compacted to the degree specified in the appropriate section of the Standard Specifications.

928-3 Method of Measurement:

Formed rumble strips will be measured by the linear foot longitudinally along the edge of the Marginal Strip on which the rumble strips are formed. Individual strips will not be measured for payment.

SECTION 930 CABLE BARRICADE:

930-1 Description:

The work under this section shall consist of furnishing all materials and constructing a cable barricade with "Do Not Enter" signs at these locations and in accordance with the details shown, and in accordance with the requirements of the project plans and these specifications.

930-2 Materials:

The wire rope (cable) shall conform to the requirements of AASHTO M 30, Class B, Type II. U-bolt and clamp bar and cable clamp assembly shall be in accordance with the details shown in Standard Drawing, C-12.30.

Foundation concrete shall be Class S portland cement concrete conforming to the requirements of Section 1006 of these specifications.

Posts shall be round pipe, roll formed and shall conform to the nominal dimensional requirements shown on the project plans. The subcontractor shall have the option to furnish zinc-coated or aluminum coated steel pipe posts, the same shall be used for the entire project, conforming to the requirements of ASTM A 53, Type E or S, with a minimum weight of 3.65 pounds per foot for line posts.

The option used shall be the same for the entire project.

930-3 Construction Requirements:

The cable barricade shall be constructed at the location shown on the project plans and to the lines and grades established by the subcontractor with the approval of the Engineer. The cable barricade shall follow the contours of the finished steep grade facility.

930-4 Submittals:

Fourteen days prior to ordering the materials, the subcontractor shall submit the six copies of the following for approval:

A. The wire rope sample and Certificate of Compliance.

B. Vendor drawing of post and foundation.

Submittals shall meet the requirements of Section 105 of these specifications.

930-5 Method of Measurement:

Cable barricade will be measured by the linear foot complete, in place and the payment shall include the material and labor for installing the "Do Not Enter" signs.

SECTION 1001 MATERIAL SOURCES

1001-1 Description:

The work under this section shall consist of the procuring of borrow, base, and surfacing materials specified for use from sources either designated on the project plans or in the special provisions or from other sources.

1001-2 General:

The subcontractor shall determine for himself the type of equipment and work required to produce a material meeting the specifications.

Unless otherwise specified, pits and quarries shall be so excavated that water will not collect and stand therein. Sites from which material has been removed shall, upon completion of the work, be left in a neat and presentable condition.

1001-2.01 Definitions:

All material sources shall fall into one of the following categories:

Owner-Furnished Source
Subcontractor-Furnished Source
Commercial Source

An Owner-furnished source shall be defined as a material source for which the Engineer has prospected, taken samples, tested, prepared an Environmental Analysis, secured the rights for its use, including ingress and egress, and which is provided for the subcontractor's use on a specific project.

A subcontractor-furnished source shall be defined as a material source which is neither an Engineer-furnished source nor a commercial source, as herein defined.

A commercial source shall be defined as a material source in which the owner or producer has been for at least one year regularly engaged during regular business hours on a regular basis in the processing and selling of sand, rock, ready mixed portland cement concrete, asphaltic concrete and other similar products normally produced and sold to all parties. The company shall have an Arizona retail sales tax license.

1001-2 Owner-Furnished Sources:

1001-2.01 General:

The subcontractor shall make all arrangements.

1001-2.02 Information Available:

The information contained on the borrow pit drawing and project plan shall be considered at most as only a starting point for those prospective bidders choosing to use the source.

It shall be the responsibility of prospective bidders to conduct any necessary on-site investigations and/or explorations, and to satisfy themselves that the quantity and/or quality of material exists in the source will meet satisfactorily all the project total earthwork quantities. Whether a source will in fact yield material of sufficient quantity or quality to meet the specific requirements may not have been determined.

1001-2.03 Usage of Materials:

Except as hereinafter provided, materials removed from Engineer-furnished sources shall be used only for the specific project and purpose for which the source was obtained.

Should the subcontractor require using material from the commercial source in addition to that specified for use, prior special approval by means of a supplemental borrow pits agreement shall be obtained. The subcontractor shall furnish the Engineer with evidence that the owner of the source has agreed to such use. The Engineer reserves the right to disapprove any request when it is considered to be in the best interest of the Engineer to conserve such material for future use.

If the Engineer approves the removal and use of such material, the quantity of the material removed and the quantity of any waste material resulting from its removal will be deducted from the estimated quantity of material shown to be available.

1001-2.04 Deficiency of Material:

An estimated quantity of the material available at each Engineer-furnished source will be shown on the drawings. This quantity may be considered correct provided that the pit operations are conducted in accordance with the requirements of this section.

If the Engineer determines that the subcontractor, after having worked the source in accordance with the requirements of this section, is not able to produce acceptable material in the amount shown to be available, he will order the subcontractor to move his equipment to another commercial source.

1001-2.05 Testing:

Testing done by the engineer at the designated borrow pits are available for subcontractor review.

1001-3 Subcontractor-Proposed Source:

The subcontractor shall promptly advise the Engineer as to the source that he proposes to use.

The use of a subcontractor-proposed commercial source will require written approval by the Engineer. No approval will be given until the subcontractor has complied with the following conditions:

(1) The subcontractor has submitted an Environmental Analysis of the source proposed for use and the Engineer has reviewed the analysis and satisfied itself that the use of such source will not have an adverse social, economic or environmental impact.

(2) The subcontractor has furnished the Engineer with evidence that he has secured the rights to the source, including ingress and egress.

(3) The sampling and testing herein specified has been satisfactorily completed and the Engineer has determined that the material from the proposed subcontractor-furnished source not only meets the requirements but it also compatible with the established project design criteria developed by the Materials Section and based on the soil support value of the embankment.

The subcontractor shall furnish equipment and personnel and shall obtain representative samples of the material under the supervision of the Engineer. The material shall be tested by a testing laboratory approved by the Engineer.

If testing is performed by a testing laboratory, the subcontractor shall arrange for the samples to be delivered to the testing laboratory. Tests shall be performed using appropriate test procedures referred to in the sections of the specifications in which the specific material requirements are described.

The subcontractor shall make the arrangements necessary to see that the testing laboratory samples are submitted to the Quality Assurance Manager. He shall submit to the Quality Assurance Section sufficient material from the samples taken so that the Engineer may test the materials and verify the results.

The cost of all sampling and testing, including the cost of supervision by the Engineer, shall be borne by the subcontractor until the testing has been satisfactorily completed.

Every effort will be made by the Engineer to advise the subcontractor as quickly as possible that the source he proposes to

use has been either approved or disapproved. The contract time will not be adjusted and no schedule delay shall be considered because of any time required by either the subcontractor or the Engineer to sample and test the material and to determine the quality of the material.

1001-4 Commercial Source:

The subcontractor shall advise the Engineer promptly as to the source that he proposes to use.

The use of a commercial source will require written approval by the Engineer. No approval shall be assumed, nor will it be made, until the Engineer has determined that the material not only meets the specified requirements, but is also compatible with the established project design criteria and soil support value of the embankment materials and the structural coefficients of the base and surfacing materials mentioned in the project geotechnical report.

The securing of necessary samples, the testing of the samples and the costs associated with such work shall conform to the requirements specified hereinbefore under Subsection 1001-4 of these specifications.

Every effort will be made by the Engineer to advise the subcontractor as quickly as possible that the source he proposes to use has been either approved or disapproved. The contract time will not be adjusted because of any time required by either the subcontractor or the Engineer to sample and test the material and to determine the quality of the material.

1001-5 Operations at Source:

1001-5.01 Clearing and Stripping:

Before beginning stripping, the contractor shall clear and grub the source as necessary to prevent the contamination of materials to be used in the work. Clearing and grubbing shall be in accordance with the requirements of Section 201, except that the resulting surface need not be leveled and vegetable matter need not be separated from any overburden which the Engineer determines to be unsuitable for any future use and which is to be wasted.

In the disposal of all tree trunks, stumps, brush, limbs, roots, vegetation and other debris removed, the contractor shall comply with the requirements of Title 36 - Public Health and Safety, Chapter 6; Article 8, Air Pollution, of the Arizona Revised Statutes and with the Rules and Regulations for Air Pollution Control, Article 7, adopted by the Arizona Department of Environmental Quality pursuant to the authority granted by the Statutes.

Burning will be permitted only after the contractor has obtained a permit from the Arizona Department of Environmental Quality, and from any other Federal, State, County or City Agency that may be involved.

When stripping is required, overburden shall be removed to the extent necessary to remove all undesirable materials and shall, at all times, be kept stripped at least five feet beyond the working face of the area being excavated.

1001-5.02 Extraction of Materials:

Materials shall be removed from the source in a workmanlike manner. In order to produce acceptable material in the amount and gradation required, it may be necessary for the contractor to do any or all of the following, along with any other similar operations usually associated with the extraction, processing and production of the particular material being produced:

- Move materials from one area to another
- Perform additional screening
- Remove, wash and waste material
- Blend materials
- Revise crushing methods
- Remove deleterious materials such as clay balls, roots, and sticks

If the Engineer determines that the material in a source is stratified, all material except borrow shall be removed for the full depth in such a manner as to produce a uniform blend of the material. Placing the material from different areas and depths into a surge pile and removing material from the surge pile by cutting through the pile will be acceptable provided that a uniformly blended material is obtained.

Material sources located in drainage channels such as washes, river beds, etc., may experience seasonal variations in the depth of ground water.

1001-6 Cleaning Up:

The requirements of this subsection shall apply to subcontractor-furnished sources to the extent that they are required by the Environmental Analysis and by the owner.

All overburden and other undesirable materials removed and all piles of waste materials resulting from operations in Engineer-furnished sources shall be deposited within the excavated area of the source and the material shall be leveled as directed. In the event that the Department-furnished source contains material needed for future use, the placement of such materials within the

excavated area shall be as directed. All debris shall be removed and disposed of and, if directed, all open test holes shall be filled. The sides of Engineer-furnished sources shall be sloped and smoothed so that livestock can enter and leave the excavated area safely. Unless otherwise specified, all haul roads constructed to Engineer-furnished sources shall be obliterated and, as far as practicable, the ground left in as good condition as it was prior to hauling. All disturbed areas shall be seeded.

1001-7 Method of Measurement:

Except as may be otherwise specifically provided for in this section or elsewhere, no measurement or direct payment will be made for any costs involved in the procuring of materials. Such costs shall be considered as included in the cost of contract items.

SECTION 1002 PAINT

1002-1 General Requirements:

All paints furnished shall be ready mixed at the manufacturer's plant, except for Paint No. 4 and Paint No. 5, which shall be mixed at the project site or fabricator just prior to application. All paints shall be standard paint products of the manufacturer with published product data sheets.

Ready-mixed paint shall be homogeneous, free of contaminants, and shall be of a consistency suitable for the use for which it is specified. The pigment shall be finely ground and properly dispersed in the vehicle, according to the requirements for the type of paint, and this dispersion shall be such that the pigment does not settle appreciably, does not cake or thicken in the paint container, and does not become granular, jelled or curdled. Any settlement of pigment in the paint shall be easily dispersed with a paddle so as to produce a smooth, uniform paint of the proper consistency. The manufacturer shall include in the paints the necessary additives for control of sagging, pigment settling, leveling, drying, drier absorption and skinning.

Paint shall be furnished in new, unopened air-tight containers, clearly labeled with the exact title of the paint, Federal Specification number when applicable, name and address of manufacturer, date of paint manufacture and the lot or batch number. The containers shall meet U.S. Department of Transportation Hazardous Material Shipping Regulations.

Precautions concerning the handling and the application of the paint shall be shown on the label of paint containers.

When painting structural steel, the supplier or manufacturer of the prime, intermediate, and finish coats of paint shall be the same and the paint coats shall be compatible with each other, forming a complete paint system. Only approved paint systems will be allowed for use on structural steel. A list of these approved paint systems will be kept on file at the ADOT Materials Section, Room 127-A, (602)255-8200. Approved paint systems will be removed from the list if it is determined through long term performance testing or by their performance in the field that they are unacceptable.

The subcontractor shall submit to the Engineer six copies of a Certificate of Analysis for each lot or batch of paint supplied, in accordance with Section 105, prior to the use of any materials which require that such certificates be furnished. Submissions shall be made in accordance with the requirements of the Materials Testing Manual. In addition, product data sheets listing the paint constituents and their proportions, as well as materials safety

data sheets, are required for each paint material supplied which is not on the approved paint system list.

1002-2 Sampling and Testing:

Paint will be tested in accordance with the requirements of the latest applicable test methods of Federal Test Method, Standard Number 141, the American Society for Testing and Materials, and current methods used by the Engineer.

Paint which is accepted by the Owner for use on a project will be identified with a green sticker affixed to it showing project number and lot or batch number. For paint supplied by an out-of-state manufacturer to be applied out-of-state, acceptance will be done by letter identifying the project number and lot or batch number. The acceptance letter will be sent to the manufacturer, supplier and applicator of the paint.

Paint will be tested on a lot or batch basis.

At least one sample per batch or lot, not less than one quart in size, will be taken and tested. Random samples may be taken at the discretion of the Engineer.

1002-3 Paints:

All paint vehicles and varnishes, shall be tested in accordance with the requirements of ASTM D 2621.

Lead, lead compounds, soluble barium compounds, or hexavalent chromium compounds shall not be used as raw materials in the paint formulas specified under this Section. Lead, lead compounds, soluble barium compounds or hexavalent chromium compounds shall not be added to any paint formulas specified under this Section.

Raw materials used in paint formulas shall conform to the specifications designated by ASTM or by Federal or Military serial classifications hereinafter specified. Subsequent amendments to the specifications quoted shall apply to all raw materials and finished products. No "or equal" substitutions for any specified material shall be made without written consent of the Engineer.

The volatile portion of the vehicle shall conform to the following requirements by volume:

(A) Solvents with an olefinic or cyclo-olefinic type of unsaturation shall not exceed 5 percent.

(B) The total of aromatic compounds with eight or more carbon atoms in the molecule, except ethylbenzene shall not exceed 8 percent.

(C) The total of ethylbenzene, toluene, and branched-chain ketones shall not exceed 20 percent.

(D) A solvent which may be classified into more than one of the above groups shall be considered a member of the group having the lowest allowable concentration.

(E) The total of (A), (B), and (C) shall not exceed 20 percent.

(F) The volatile solvents shall contain no benzene or halogenated compounds.

(G) All paints shall be completely miscible with mineral spirits conforming to Grade II of Federal Specification TT-T-291.

(H) Mineral spirits, conforming to Grade 11, of Federal Specification TT-T-291 shall be the preferred thinner for all paints specified in this Subsection. If necessary, other paint thinners conforming to the requirements of (A) through (F) above may be used.

(I) Only alkyd-modified phenolic varnishes that require mineral spirits as the sole solvent shall be used. Unmodified para-phenolic varnishes that require aromatic and polar solvents shall not be used.

Alkyd-phenolic spar varnish shall conform to the following requirements:

Type	Oleoresinous Alkyd
Solids by Weight (%)	49 to 51
Viscosity (G-H)	D to F
Weight per Gallon (lbs.)	7.34 - 7.55
Color (G)	12 Maximum
Kauri Reduction (Complete with driers)	Passes 120%
Type of Oil	Tung, Soya
Type of Resin	Phthalic Alkyd-Phenolic
Type of Solvent	Mineral Spirits
Mineral Spirits Tolerance	Over 1000%
Solids by Volume	42%
Air Drying Time @ 77°F	
Set to Touch	1 to 1-1/2 hours
Dry Hard	5 to 6 hours

1002-3.01 Paint Number I - Alkyd Primer

This paint shall meet or exceed in performance the requirements of Steel Structures Painting Council (SSPC) Paint Specification No. 11 except that it shall contain no lead compounds or zinc chromate. The color shall be gray, Federal Chip No. 36373, or as specified on the standard details or project plans.

The following material requirements will be tested for compliance to the manufacturer's own tolerance requirements for paint constituents and proportions as well as to the general acceptance requirements listed as follows:

MATERIAL PROPERTY	REQUIREMENT	TEST METHOD
Composition	Infra-red scan on non-volatile vehicle must match a previously-submitted, approved material of the manufacturer or supplier.	ASTM D 2621
Weight	Pounds per U.S. gallon, 11.5 Min.	ASTM D 1475
Viscosity	Shear rate of 200 rpm, 150 to 250 grams, or 72 to 89 Krebs Units.	ASTM D 562
Drying Time	Tack Free - Max. 10 hours Dry Hard - Max. 24 hours	Federal Std #141, Test Method 4061
Pigment	By Weight - Total Composition 44% - 52%	ASTM D 4451 or ASTM D 2371 Mod.
Volatiles	By Weight - Total Composition 35% Max.	ASTM D 2369
Non-Volatile Vehicle	By Weight - Total Composition Calculated by Difference 17% Minimum	Federal Std #141, Test Method 4053

1002-3.02 Paint Number 2 - Alkyd:

This paint shall conform to the requirements of SSPC Paint Specifications No. 104, Type I. The color shall be white or

off-white, or must be distinguishable from Paint Number 1 and Paint Number 3.

The following material requirements will be tested for acceptance:

MATERIAL PROPERTY	REQUIREMENT	TEST METHOD
Composition	Infra-red scan on non-volatile vehicle must match a previously-submitted, approved material of the manufacturer or supplier.	ASTM D 2621
Weight	Pounds per U.S. gallon, 11.2 Min.	ASTM D 1475
Viscosity	Shear rate of 200 rpm, 65 to 85 Krebs Units.	ASTM D 562
Drying Time	Dry Hard - Max. 18 hours	Federal Std #141, Test Method 4061
Pigment	By Weight - Total Composition 45% - 50%	ASTM D 4451
Volatiles	By Weight - Total Composition 30% Max.	ASTM D 2369
Non-Volatile Vehicle	By Weight - Total Composition Calculated by Difference 23.5% Minimum	Federal Std #141, Test Method 4053

1002-3.03 Paint Number 3 - Silicone Alkyd:

This paint shall conform to the requirements of SSPC Paint Specification No. 21, Silicone Alkyd Paints, Type I, High Gloss. The color shall be a visual match to Federal Standard 595A, Color Chip No. 10318, unless otherwise indicated on the project plans.

The following material requirements will be tested for acceptance:

MATERIAL PROPERTY	REQUIREMENT	TEST METHOD
Composition	Infra-red scan on non-volatile vehicle must match a previously-submitted, approved material of the manufacturer or supplier.	ASTM D 2621
Viscosity	Shear rate of 200 rpm, 125-175 grams or 67-77 Krebs Units.	ASTM D 562
Drying Time	Set to Touch - Max. 2 hours, Dry Hard - Max. 8 hours.	ASTM D 1640
Total Solids	By Weight - Total Composition 59% Min.	ASTM D 2369
Total Volatiles	By Weight - Total Composition 41% Max.	ASTM D 2369
Pigment Solids	By Weight - Total Composition 23% - 33%	ASTM D 2371-85 (Mod.)
Vehicle Solids	By Weight - Total Composition 36% Min.	ASTM D 2371-85 (Mod.)
Silica Solids	By Weight of Vehicle Solids 14% Min.	ASTM D 2698, ASTM D 2369, ASTM D 4451 (Modified to 800°C)

1002-3.04 Paint Number 4 - Zinc:

This paint shall be a zinc-dust, zinc-oxide primer conforming to the requirements of Federal Specification TT-P-64IG and shall be one of the following types:

Type I Zinc-dust, zinc-oxide linseed oil primer

Type II Zinc-dust, zinc-oxide phthalic alkyd resin primer

Type III Zinc-dust, zinc-oxide phenolic resin primer modified to conform to requirements (A) through (I) of Subsection 1002-3.

If modified colors are required, pigments which do not contain lead, lead compounds, soluble barium compounds or hexavalent chromium compounds shall be used in amounts not exceeding 10 percent of the total pigment weight and replacing an equal weight of zinc oxide.

1002-3.05 Paint Number 5 - Aluminum:

This paint shall conform to the requirements of AASHTO M 69, for Type I Aluminum Paint, and may be utilized for the final coat when the aluminum color is specified on the plans. It must be compatible with the underlying paint coats. The quantity of this paint mixed during any one day shall be limited to the quantity to be used during that day.

1002-4 Enamels:

The following enamels shall conform to the requirements of Federal Specification TT-E-489-G (Enamel, Alkyd, Gloss), and may be utilized for the final coat when specified on the plans. It must be compatible with the underlying paint coats. The color of enamel specified shall be a visual match to the standard color chip in Federal Standard No. 595A, Colors. The color match shall be made with non-lead containing materials. The class and composition of the enamels shall be Class A-Air Drying and Composition G-General Use:

.01 Dull Black Enamel	(Color Chip No. 37038)
.02 Gloss Black Enamel	(Color Chip No. 17038)
.03 White Enamel	(Color Chip No. 17875)
.04 Yellow Enamel	(Color Chip No. 13538)
.05 Dark Olive Green Enamel	(Color Chip No. 14087)
.06 Light Gray Enamel	(Color Chip No. 16187)
.07 Buff Enamel	(Color Chip No. 30257)
.08 Green Enamel	(Color Chip No. 34108)
.09 Tan Enamel	(Color Chip No. 20318)
.10 Dark Gray Enamel	(Color Chip No. 26081)
.11 Light Brown (Sandstone)	(Color Chip No. 20252)
.12 Medium Brown (Sandstone)	(Color Chip No. 20233)
.13 Dark Tan	(Color Chip No. 20227)

SECTION 1003 REINFORCING STEEL

1003-1 General Requirements:

Reinforcing steel shall be furnished in the sizes, shapes and lengths shown on the project plans and in conformance with the requirements of this Section. Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

When reinforcing steel is delivered to the site of the work, the subcontractor shall furnish the Engineer with four (4) copies of all shipping documents. Each shipping document shall show the sizes, lengths and weights of the reinforcing steel separately for each structure.

1003-2 Reinforcing Bars:

Except when used for wire ties or spirals, steel bars used as reinforcement in concrete shall be deformed and shall conform to the requirements of AASHTO M 31 (ASTM A 615).

Where shown on the project plans, the bars shall be Grade 60.

Where Grade 60 is not specified on the project plans, Grade 40 shall be used if it is immediately available. If Grade 40 is not immediately available, Grade 60 may be used exclusively or in combination with Grade 40 provided that the conditions under which the grades are used in combination are acceptable to the Engineer and further provided that there is no additional cost to the owner.

1003-3 Wire:

Steel wire used as spirals or ties for reinforcement in concrete shall conform to the requirements of AASHTO M 32.

1003-4 Welded Wire Fabric:

Welded wire fabric used as reinforcement in concrete and mortar shall conform to the requirements of AASHTO M 55.

1003-5 Epoxy Coated Reinforcing Bars:

1003-5.01 Steel:

Steel reinforcing bars shall conform to the requirements of Subsection 1003-2.

1003-5.02 Epoxy for Coating:

A list of powdered epoxy resins which have passed prequalification tests and may be used if the material is applied and cured in the same manner as that used to coat the test bars in the original powder prequalification test may be found herein.

The powdered epoxy resin selected by the subcontractor and furnished by the manufacturer shall be of the same material and quality as the resins listed below.

The following powdered epoxy resins have passed prequalification tests and may be used if the material is applied and cured in the same manner as that used to coat the test bars in the original powder prequalification test:

Scotchkote 202, 213, 215
3M Company
PO Box 2963
Austin, Texas 78769-2963

Micron 650-Blue Epoxy
Republic Steel Corp.
Cleveland, Ohio

LSU 431 - Formula 907-2-5
Ciba - Geigy Corp.
Ardsley, New York

Flintflex 531-6020, 531-6080
531-6068, 531-6085
Dupont Company
Wilmington, Delaware

Greenbar
Lilly Powder Coating, Inc.
North Kansas City, Missouri 64116

Oxyplast EL-704-P-9
Fuller O'Brien
South San Francisco, California

Corvel Green 10-6071
ECA-1440-3383
Morton Thiokol, Inc.
Powder Coatings Group
Reading, PA 19612-5240

Mobilox 1004-R-2
Mobil Chemical Company
Cleveland, Ohio

Nap - Guard 7-2000
Napco Corporation
Houston, Texas

Hysol DK-23-0548, DK-23-0679
DK-23-0602
Dexter - Hysol Corporation
Oleans, New York 14760

Corflex CF 4650 Green
Carboline, Ferro Powder Coating
St. Louis, Missouri 63144

Interpon HD 33, HD 34
International Paint Co.
Houston, Texas 77292

The approved powders are based on specific reinforcing steel preparation and powder application and curing methods and these identical methods shall be followed during fabrication.

The coating manufacturer shall supply the purchaser with a certification which properly identifies the batch and/or lot number, material, quantity of batch, date of manufacture, name and

address of manufacturer and a statement that the material is the same composition as the initial sample prequalified for use. A statement shall also be submitted regarding the fact that production bars and prequalification bars have been identically prepared and applied with epoxy powders.

Patching or repair material, compatible with the coating and inert in concrete, shall be made available by the epoxy coating manufacturer. This material shall be suitable for repairs made by the subcontractor of areas of the coating damaged during fabrication and/or handling in the field.

1003-5.03 Application of Coating:

The coating applicators facilities shall be subject to approval by the Engineer. Applications for approval of facilities shall be made to the Engineer by the coating applicator.

The surface to be coated shall be blast-cleaned in accordance with the requirements of the Steel Structures Painting Council-Surface Preparation Specification No. 10 (SSPC-SP10), Near White Blast Cleaning. After blasting, the cleaned surface shall be defined by ASTM D 2200 to be equal to or better than A Sa 2 1/2 or B Sa 2 1/2, as applicable.

The powdered epoxy resin coating shall be applied to the cleaned surface as soon as possible after cleaning and before visible oxidation occurs. In no case shall more than eight hours elapse between cleaning and coating.

The protective epoxy coatings shall be applied by the electrostatic spray method or the electrostatic fluidized bed method in accordance with the recommendations of the coating manufacturer. The epoxy coating may be applied before or after fabrication of the reinforcing.

The epoxy coating shall be applied as a smooth, uniform coat. After curing, the coating thickness shall be 7 ± 2 mils. Coating thickness shall be controlled by taking measurements on a representative number of bars from each production lot. Coating thickness measurements shall be conducted by the method outlined in ASTM G 12.

The coating shall be check visually after cure for continuity. It shall be free from holes, voids, contamination, cracks and damaged areas.

The coating shall not have more than two holidays (pinholes not visible to the naked eye) in any linear foot of the coated item. A holiday detector shall be used, in accordance with the manufacturer's instructions, to check the coating for holidays.

The flexibility of the coating shall be evaluated on a representative number of bars selected from each production lot. The coated bar shall be bent 120 degrees (after rebound) around a six-inch diameter mandrel. The bend shall be done at a uniform rate and may take up to one minute to complete. the test specimens shall be at thermal equilibrium between 20 and 30 degrees Celsius (68-85 Fahrenheit) at the time of testing. No cracking of the coating shall be visible to the naked eye on the outside radius of the bent bar.

The subcontractor shall furnish a Certificate of Compliance from the coating applicator, in accordance with the requirements of Subsection 106.05 with each shipment of coated steel. The Certificate of Compliance shall:

1. Verify that the coated items and coating material have been tested in accordance with the requirements of these specifications.

2. State the actual test results for each requirement.

3. State that the test results comply with the requirements.

4. State that the entire lot is in a fully-cured condition.

The coating applicator shall be responsible for performing quality control and tests. This will include inspection for compliance with the requirements of coating thickness, continuity of coating and coating cure and the testing required under Flexibility of Coating, in accordance with the requirements of this subsection.

The Engineer reserves the right to have its authorized representative observe the preparation, coating and testing of the reinforcement bars. The representative shall have free access to the plant, and any work done when access has been denied will be automatically rejected.

If the representative elects, lengths of coated bars may be taken from the production run on a random basis for test, evaluation and check purposes by the Engineer.

1003-5.04 Shop Repair:

Epoxy coated reinforcement bars which do not meet the requirements for coating thickness, continuity of coating, coating cure or flexibility of coating shall not be repaired.

Reinforcement bars with these defects shall be replaced or, alternately, stripped of epoxy coating, recleaned and recoated in accordance with the requirements of this specification.

Coating breaks due to fabrication and handling shall be repaired with patching material if the defective area exceeds two percent of the surface area of the bar in a one-foot length and the damaged spot is larger than 1/4 inch by 1/4 inch.

The repair of coating breaks shall be limited to bars on which the total of the defective coating areas does not exceed five percent of the surface area of the reinforcement bar. Bars with greater than five percent damage shall be replaced or, alternately, stripped of epoxy coating, recleaned and recoated in accordance with the requirements of this specification.

SECTION 1005 BITUMINOUS MATERIALS FOR SURFACING

1005-1 General Requirements:

Bituminous materials shall conform, when tested in accordance with the tests hereinafter enumerated, to the following requirements, as applicable, for the types and grades designated and used.

Certificate of Compliance conforming to the requirements of Subsection 106.05 of these specifications shall be submitted.

1005-2 Sampling of Bituminous Material:

Sampling of bituminous material shall conform to the requirements of AASHTO T 40. Samples shall be taken by the Subcontractor and witnessed by the Engineer. The point of sampling and the number of samples will be specified by the Engineer.

The Subcontractor shall provide convenient facilities for obtaining accurate samples of bituminous material.

1005-3 Bituminous Material Requirements:

1005-3.01 Asphalt Cement:

Asphalt cement shall conform either to the requirements of Table 1005-1 or to the requirements of Table 1005-1A of these specifications.

When any reference is made in the Specifications to Table 1005-1, the reference shall also include Table 1005-1A of these specifications as an alternate.

The Subcontractor shall inform the Engineer as to which table will be used and the Subcontractor shall use the selected table throughout the duration of the contract.

Should test results indicate that the asphalt cement does not meet the specified requirements, the Subcontractor shall, upon request by the Engineer, supply an Engineering analysis of the expected performance of the material in which the asphalt cement is incorporated if the material is permitted to remain in place. The Engineering analysis shall detail any proposed corrective action and the anticipated effect of such corrective action on the performance.

1005-3.02 Liquid Asphalt:

Liquid asphalt shall conform to the requirements of AASHTO M 82, Cut-back Asphalt (Medium Curing Type).

1005-3.03 Emulsified Asphalt:

Emulsified asphalt shall conform to the requirements of Table 1005-2 of these specifications for Anionic Rapid Set (RS-1, RS-2), Anionic Slow Set (SS-1), Cationic Rapid Set (CRS-1, CRS-2) and Cationic Slow Set (CSS-1). Emulsified asphalt with polymer shall conform to requirements of Table 1005-3.

Emulsified asphalts shall be homogeneous. If emulsified asphalt has separated, it shall be thoroughly mixed to insure homogeneity. If emulsified asphalt has separated due to freezing, it shall not be used. Emulsified asphalt shall not be used after thirty (30) days from delivery.

1005-3.04 Emulsified Asphalt (Special Type):

Emulsified asphalt (special type) shall consist of Type SS-1 or CSS-1 diluted with water to provide an asphalt content not less than twenty-six (26) percent. The material may be diluted in the field.

1005-3.05 Recycling Agents:

Recycling agents shall conform to the requirements of Table 1005-3 of these specifications.

1005-3.06 Emulsified Recycling Agents:

Emulsified recycling agents shall conform to the requirements of Table 1005-4 of these specifications.

1005-3.07 Other Requirements:

Other requirements for bituminous materials shall conform to the requirements of Table 1005-5 of these specifications.

TABLE 1005-1
ASPHALT CEMENTS

TEST ON ASPHALT CEMENT	AASHTO TEST METHOD	AC-5	AC-10	AC-20	AC-30	AC-40
Viscosity, 140 degrees F., Poises, range	T202	400 600	800 1200	1600 2400	2400 3600	3200 4800
Viscosity, 275 degrees F., centistokes, minimum	T201	110	150	210	250	300
Penetration, 77 degrees F., 100 grams, 5 seconds, minimum	T49	120	70	40	30	20
Flash Point, Pensky-Martens closed tester, degrees F., minimum	T73	350	425	450	450	450
Solubility in Trichloro-ethylene, percent, minimum	T44	99	99	99	99	99
TEST ON AGED ASPHALT CEMENT						
Viscosity, 140 degrees F., poises, maximum	T202	2000	4000	8000	12000	16000
Ductility, 77 degrees F., centimeters, minimum	T51	100	100	75	60	45

Note (1) Aged asphalt cement will be obtained in accordance with the requirements of AASHTO T 240.

TABLE 1005-1A
ASPHALT CEMENTS

TEST ON ASPHALT CEMENT	AASHTO TEST METHOD	AC-5	AC-10	AC-20	AC-30	AC-40
Viscosity, 140 degrees F., Poises, range	T202	400 600	800 1200	1600 2400	2400 3600	3200 4800
Viscosity, 275 degrees F., centistokes, minimum	T201	110	150	210	250	300
Penetration, 77 degrees F., 100 grams, 5 seconds, minimum	T49	140	80	60	50	40
Flash Point, Pensky-Martens closed tester, degrees F., minimum	T73	350	425	450	450	450
Solubility in Trichloro-ethylene, percent, minimum	T44	99	99	99	99	99
TEST ON AGED ASPHALT CEMENT						
Viscosity, 140 degrees F., poises, maximum	T202	2500	5000	10000	15000	20000
Ductility, 77 degrees F., centimeters, minimum	T51	100	100	75	75	75

Note (1) Aged asphalt cement will be obtained in accordance with the requirements of AASHTO T 240.

TABLE 1005-2
EMULSIFIED ASPHALTS

TEST ON EMULSIONS	TEST METHOD*	RS-1	CRS-1	RS-2	CRS-2	SS-1	CSS-1
Viscosity, Saybolt Furol, secs., range	T59						
77° F.	T59	20-100				20-100	20-100
122° F.	T59		20-100	50-400	50-400		
Settlement, 5 days, percent, maximum	T59	5	5	5	5	5	5
Sieve, Retained on No. 20, percent, maximum	T59 (1)	0.10	0.10	0.10		0.10	0.10
Particle Charge	T59		Positive		Positive		Positive (2)
Demulsi-ability, 35 ml., 0.02 N calcium chloride, percent, min.	T59	60		60			
Classification, Uncoated particles, percent, min.	Ariz. 502				55		
Residue (3) Residue, percent, min. (4)		55	60	63	65	57	57

* T 59 is AASHTO

Note (1) Distilled water will be used instead of the two percent sodium oleate solution.

Note (2) If the Particle Charge Test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

Note (3) Residue will be obtained in accordance with the requirements of Arizona Test Method 504 and shall conform to all the requirements of Table 1005-1 of these specifications for AC-20, except that for CRS-2 the viscosity at 140 degrees Fahrenheit shall be between 1800 and 2200 poises.

Note (4) Residue by evaporation may be determined in accordance with the requirements of Arizona Test Method 512; however, in case of dispute, AASHTO T 59 will be used.

TABLE 1005-5 OTHER REQUIREMENTS

Grade of Asphalt Specification Designation	Range of Temperatures for Application by Spraying degrees F.	Range of and Maximum Temperature of Aggregate for Plant Mixing degrees F.	Basis of Conversion Average Number of Gallons Per Ton at 60 degrees F.
Paving Asphalt	275-400	-----	235
Liquid Asphalt			
MC- 70	105-175	90-155	253
MC-250	140-225	125-200	249
MC-800	175-255	160-225	245
MC-3000	215-290	200-260	241
Emulsified Asphalt			
RS-1	70-140	-----	240
CRS-1	125-185	-----	240
RS-2	125-185	-----	240
CRS-2	125-185	-----	240
SS-1	70-160	-----	240
CSS-1	70-160	-----	240
Emulsified Asphalt (Special Type)	70-160	-----	240
Recycling Agent			
RA-1	-----	-----	240
RA-5	-----	-----	240
RA-25	-----	-----	240
RA-75	-----	-----	240
Emulsified Recycling Agent			
ERA-1	70-160	-----	240
ERA-5	70-160	-----	240
ERA-25	70-160	-----	240
ERA-75	70-160	-----	240

TABLE 1005-3 EMULSIFIED ASPHALT WITH POLYMER

Product Name: CRS-2P

Test Description	Test Method	Typical Test	Shipping Min.	Shipping Max.	Guaranteed Min.	Guaranteed Max.
Test on Emulsion						
Viscosity, SFS @ 122F	D244	125	100	375	75	400
Settlement, 5 Days, %	D244	0.4		3		5
Storage Stability 1 Day, %	D244	0.2		1		1
Classification, Uncoated Par	A502	70	65		60	
Particle Charge Test	D244	+		+		+
Sieve Test, %	D244	0.20		0.25		0.30
Oil Distillate,% of Emulsion	D244	0.5		3		3
Residue by Distillation, %	D244	68	66		65	
Tests on Residue by Vacume Recovery A512						
Viscosity,ABS,Poise @ 140F	D2171	2229	2000		1600	2400
Pen @ 77F, 100g/5sec, Dmm	D5	67	45	65	40	90
Ductility, 77F,5cm/min.Cm	D113	110+	40		40	
Solubility in TCE, %	D2042	99.8	97.5	97	97.5	
Toughness, inch-pounds	(1)	330	170		150	
Tenacity, inch-pounds	(1)	270	130		110	
Polymer Content (solids wt.)	CAL-401	2.5	2.5		2.5	
Test on RTFO Residue						
Aging Ratio, absolute viscosities						
Viscosity, ABS, Poise @ 140F	D2171	4470				25
Polymer Requirement						
Melt Flow Rate, dg/min 190 C	D1238					45

Notes

(1) Benson method of toughness and tenacity: Scott tester, inch-pounds @ 77 F, twenty (20) inches per minute pull, Tension head seven-eighth (7/8) inches in diameter.

(2) Upon standing undisturbed for a period of twenty-four (24) hours, the emulsion shall show no white milky film upon the surface.

(3) The base asphalt shall be modified prior to emulsification. Modifiers that are in latex form are not allowed.

(4) The emulsion shall be precertified prior to use. A one (1) quart sample each of the base asphalt and polymer shall be supplied to the agency ten (10) days in advance of the project start.

(5) Certificates of analysis from an approved Laboratory showing compliance with specifications shall accompany each load of emulsion to the project site.

(6) Field testing is required and will be performed at the discretion of the Engineer by the supplier at the suppliers expense. Testing will consist of field Vialet plates per the University of Nevada Test Method. Testing will be performed at least once per day consisting of three (3) Vialet plates. A report will be submitted at the completion of the job.

SECTION 1006 PORTLAND CEMENT CONCRETE

1006-1 General Requirements:

Portland cement concrete shall consist of a mixture of hydraulic cement, fine aggregate, coarse aggregate, water and admixtures.

The Subcontractor shall submit and get approval of concrete mix design and shall furnish concrete which conforms to the requirements of these specifications. All concrete shall be sufficiently workable, at the slump proposed by the Subcontractor within the specified range, to allow proper placement of the concrete without harmful segregation, bleeding, or incomplete consolidation. It shall be the responsibility of the Subcontractor to proportion, mix, place, finish, and cure the concrete properly in accordance with the requirements of these specifications.

1006-2 Materials:

1006-2.01 Hydraulic Cement:

Hydraulic cement shall consist of either portland cement or portland-pozzolan cement.

Portland cement shall conform to the requirements of ASTM C 150 for Type II or Type III.

Portland-pozzolan cement shall conform to the requirements of ASTM C 595 for Type IP (MS).

Hydraulic cement shall not contain more than 0.60 percent total alkali. The word alkali as used in these specifications shall be taken as the sum of sodium oxide and potassium oxide calculated as sodium oxide.

Certificates of Compliance conforming to the requirements of Section 106 shall be submitted.

Unless otherwise permitted by the Engineer, all cement used for any individual structure shall be of the same brand and manufactured at the same mill. Cement of different types or brands shall not be intermingled or used in the same batch. The Subcontractor shall provide suitable means for storing and protecting the cement against dampness. Cement which for any reason has become partially set or which contains caked lumps shall not be used.

The use of either sacked cement or bulk cement is permissible. The use of fractional bags of sacked cement will not be permitted unless the Subcontractor elects to weigh the cement into each batch.

1006-2.02 Water:

The water used shall be free from injurious amounts of oil, acid, alkali, clay, vegetable matter, silt or other harmful matter. Water shall contain not more than one-thousand (1,000) parts per million of chlorides as C1 or of sulphates as SO 4.

Water shall be sampled and tested in accordance with the requirements of AASHTO T 26. Potable water obtained from public utility distribution lines will be acceptable.

1006-2.03 Aggregates:

(A) General Requirements:

Mill tailings or material from mine dumps shall not be used in the production of fine or coarse aggregate.

The handling and storage of concrete aggregate shall be such as to minimize segregation or the intermixing and contamination with foreign materials. The Engineer may require that aggregates be stored separately. Different sizes of aggregate shall be separated by bulkheads or stored in separate stockpiles sufficiently removed from each other to prevent the material from becoming intermixed.

When aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and level. The bottom one (1) foot layer of aggregate shall not be disturbed or used.

The handling and storage of concrete aggregate for Class P concrete at the job site shall be such as to minimize segregation. Stockpiles shall be neat and regular in form and shall occupy as small an area as possible. Stockpiles shall be constructed by first distributing the aggregate over the entire base and then building upward in successive layers not more than five feet in depth. Aggregate shall not be dumped or spilled over the side of the pile. When a conveyor is used to stockpile aggregate, it shall be equipped with an adequate rock tremie or rock ladder to reduce segregation and it shall be moved continuously across the stockpile. The distance the material drops from the tremie shall not exceed ten feet. Aggregate shall be distributed over the stockpile so that the formation of conical piles higher than 10 feet is prevented.

Contamination of concrete aggregate for Class P concrete by contact with the ground at the job site shall be positively prevented. The Subcontractor shall take the necessary measures to prevent such contamination. Such preventive measures shall include, but not necessarily be limited to, placing aggregate on hardened surfaces consisting of portland cement concrete, asphaltic concrete, or cement treated material.

The contractor shall maintain at least two (2) full days worth of production of fine and coarse aggregate stockpiled at the batch plant for Class P concrete prior to starting and throughout the duration of portland cement concrete paving operations. This requirement is waived for the last two (2) days of production.

(B) Fine Aggregate:

Fine aggregate shall be a natural sand or other approved inert material with similar characteristics composed of clean, hard, strong, durable, uncoated particles. Fine aggregate shall be free from deleterious amounts of soft or flaky particles, loam, caliche, ice, frost, organic matter or clay lumps.

The grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	95-100
No. 16	45- 80
No. 50	0- 30
No. 100	0- 10
No. 200	0- 4

Fine aggregate shall have an average sand equivalent value of not less than seventy-five (75) when tested in accordance with the requirements of AASHTO T 176.

Fine aggregate shall be of such quality that, when made into mortar and subjected to the test for mortar-making properties in accordance with the requirements of AASHTO T 71, the mortar shall develop a compressive strength at seven (7) and twenty-eight (28) days of not less than ninety (90) percent of that developed by a mortar prepared in the same manner with the same Type II cement and graded Ottawa sand having a fineness modulus of 2.40 plus or minus 0.10.

(C) Coarse Aggregate:

Coarse aggregate shall consist of crushed stone, gravel, or other approved inert material of similar characteristics, including cinders when specified, having hard, strong and durable pieces free of clay and other deleterious substances. The aggregate shall be washed.

The coarse aggregate gradation shall conform to the appropriate size designation of AASHTO M 43 when tested in accordance with the requirements of Arizona Test Method 201, Section 12 (3), except the

amount of material passing the No. two-hundred (200) sieve shall not exceed 1.0 percent.

The percent of wear of coarse aggregate at five-hundred (500) revolutions, when tested in accordance with the requirements of AASHTO T 96, shall not exceed forty (40).

1006-2.04 Admixtures:

(A) General Requirements:

The Subcontractor shall furnish Certificates of Compliance conforming to the requirements of Subsection 106.05 for each type of admixture furnished. Admixtures containing chlorides will not be acceptable for concrete containing uncoated reinforcing steel or embedded metal items.

All concrete admixtures shall be stored in suitable containers in accordance with the manufacturer's recommendations. All liquid admixtures shall be protected from freezing. Liquid admixtures that have frozen shall not be used.

(B) Air-Entraining Admixtures:

Air-entraining admixtures shall conform to the requirements of AASHTO M 154.

(C) Chemical Admixtures:

Chemical admixtures shall conform to the requirements of AASHTO M 194.

(D) Fly Ash:

Fly ash shall conform to the requirements of ASTM C 618 for Class C or F mineral admixture, except that the loss on ignition shall not exceed 3.0 percent.

Fly ash, when used as a replacement for portland cement, shall have an R factor less than 2.5. The R factor is defined as (C-5%)/F, where C is the calcium oxide content expressed as a percentage and F is the ferric oxide content expressed as a percentage. The R factor requirement may be waived if the Subcontractor furnishes documented test results that the soil in contact with the portland cement concrete contains less than 0.10 percent water soluble sulfate (as S04) and/or the water in contact with the portland cement concrete contains less than one-hundred-fifty (150) milligrams per liter sulfate (as S04). The tests for sulfates shall be performed in accordance with the requirements of California Department of Transportation Test Method No. 417.

Calcium and ferric oxide content shall be determined in accordance with the requirements of ASTM C 311.

1006-2.05 Concrete Curing Materials:

Liquid membrane forming compound shall conform to the requirements of AASHTO M 148. Type two (2) compound with either a Class A or Class B vehicle shall be used for concrete pavement, bridge decks, and approach slabs. Type I compound with either a Class A or Class B vehicle shall be used for other concrete items.

Certificates of Compliance conforming to the requirements of Section 105 shall be submitted.

1006-3 Design of Mixtures:

1006-3.01 Design Criteria:

Portland cement concrete shall conform to the requirements specified in Table 1006-A for each of the Classes listed therein.

Unless otherwise shown in Table 1006-A, the proposed slump shall be chosen by the Subcontractor. Concrete at the proposed slumps shall be sufficiently workable to allow proper placement without harmful segregation, bleeding, or incomplete consolidation.

For elevations below three-thousand (3,000) feet, air-entraining admixtures may be used at the option of the Subcontractor and the amount of entrained air in the concrete shall not exceed seven percent by volume.

Concrete that fails to conform to the entrained air content requirements listed above for the respective elevation as determined by the Engineer, shall be rejected prior to placement.

Unless specifically required, water reducing admixtures may be used at the option of the Subcontractor.

TABLE 1006-A

Class of Concrete	Hydraulic Cement Lbs per Cu Yd Minimum-Maximum	Slump Range, Inches	28-Day Compressive Strength Required, psi
P	564 -	0-4.5	4,000
S	564 - 752	-----	-----
B	517 - 658	-----	2,500

The minimum and maximum weights of hydraulic cement required are shown on Table 1006-A for each class of concrete. A fly ash admixture may be used at the option of the Subcontractor only when portland cement is used. A maximum of fifteen (15) percent of the required weight of portland cement may be replaced with a fly ash admixture. A minimum of 1 .2 pounds of fly ash shall replace each 1.0 pound of portland cement removed.

Class S concrete shall have a compressive strength not less than that shown on the project plans. Unless otherwise shown on the project plans, the minimum required twenty-eight (28) day compressive strength of Class S concrete shall be f'c = three-thousand (3000) psi. Class B and Class P concrete shall have minimum strengths of not less than that shown in Table 1006-A at twenty-eight (28) days when tested in accordance with the requirements of AASHTO T 22.

The coarse aggregate size designation for Class S and Class B concrete shall be chosen by the Subcontractor and approved by the Engineer and shall conform to the size designation and grading requirements of AASHTO M 43. In choosing the size designation, the maximum size of coarse aggregate shall not be larger than one-fifth (1/5) of the narrowest dimension between sides of adjacent forms, or two-thirds (2/3) of the minimum clear spacing between reinforcing bars, or one-third (1/3) the depth of the slab, whichever is least.

Coarse aggregate for Class P concrete used to construct portland concrete pavement without load transfer dowels shall be separated into two (2) sizes meeting the requirements of size designation No. fifty-seven (57) and No. four (4) except that the percent passing the one (1) inch sieve shall be ten (10) to fifty-five (55).

The percent of fractured particles for Class P concrete for each aggregate size shall be at least thirty (30) when tested in accordance with the requirements of Arizona Test Method 212. At the time of proportioning for mixing, the aggregate in each stockpile shall be measured by weight and proportioned so that the resulting mixture of coarse aggregate meets the requirements for size designation No. four-hundred-sixty-seven (467).

Coarse aggregate for Class P concrete used to construct portland cement concrete pavement with load transfer dowels and adjacent shoulders shall meet the requirements for size designation No. fifty-seven (57). The percent of fractured particles shall be at least thirty (30) when tested in accordance with the requirements of Arizona Test Method 212.

Coarse aggregate for Class P concrete placed in pavement ramp tapers not exceeding a width of ten feet and in pavement gore areas may be size designation No. fifty-seven (57). The use of size

designation No. fifty-seven (57) coarse aggregate may be used in concrete placed in other inaccessible pavement areas when approved in writing by the Engineer.

Concrete to be placed under water, tremie concrete, shall conform to the requirements for the class required except that the minimum hydraulic cement content shall be increased by forty-seven (47) pounds per cubic yard of concrete.

1006-3.02 Design Procedures:

The Subcontractor shall substantiate each mix design by furnishing test data and providing all details of the mixtures proposed for use.

The complete solid volume mix designs submitted for approval shall include all weights and volumes of all ingredients. The brand, type, and source of hydraulic cement and admixtures, the coarse aggregate size number designation, source of aggregates, the specific gravities of all ingredients, the proposed slump, a code number to identify the mix design, and the intended use of each mix design shall be an integral part of each mix design.

No changes in the approved mix designs or code numbers shall be made by the Subcontractor except by approval of the Engineer. A new mix design shall be submitted for approval any time the Subcontractor requests a change in materials or proportioning of the materials from that given in each approved mix design. In no case shall the approval of a mix design relieve the Subcontractor of the responsibility for the results obtained by the use of such approved mix design.

Mix designs from previous or concurrent projects may be submitted for approval. The Engineer may waive trial batches at any time.

Prequalification of new mix designs by testing of trial batches will be required. For each trial batch, the materials, mixing equipment, procedures, and size of batch shall be the same as that to be used in the work.

The number of trial batches required will be determined by the Engineer. Samples for testing will be taken by the Engineer. A new mix design shall be submitted for approval any time the test results of an approved mix design indicate that the concrete will not meet the required twenty-eight (28) day compressive strength.

When approved by the Engineer, concrete from trial batches may be used in the work at locations where concrete of a lower strength is required and such concrete will meet the requirements of the class of concrete at that location. The basis of payment for such

concrete shall be that which applies to the concrete required at that location.

1006-4 Concrete Production:

1006-4.01 General Requirements:

The Subcontractor may obtain concrete for each Class of concrete and for each strength of Class S concrete from an approved commercial source in lieu of establishing a batch plant at the project site.

For each class of concrete and each strength of Class S concrete, except for Class P concrete produced in a batch plant at the site and used exclusively for Class P work, the Subcontractor shall furnish an invoice for each batch of concrete. The minimum information to be shown on each invoice shall be the date, time batched, truck identification number, name or identification of batch plant, name of Subcontractor, name and location of project, the volume of concrete, the batch weights or mix design code number, the estimated percent of free moisture in the coarse and fine aggregates, the amount of any water withheld during batching, and the number of revolutions that the concrete has been mixed at mixing speed in a truck mixer. An authorized representative of the Subcontractor shall be responsible for each invoice and shall sign each invoice accepting the Subcontractor's responsibility for the concrete as the concrete is being placed. He shall immediately furnish the invoice to the Engineer.

1006-4.01(A) Contractor Quality Control:

(1) General Requirements:

It shall be the responsibility of the contractor to administer a Quality Control Plan, hereinafter referred to as the "Plan", sufficient to assure a product meeting the requirements of these specifications. The Plan shall be administered whenever Class S or Class P concrete is being used for project construction, with the exception of pre-cast, pre-stressed units constructed at a central plant in Arizona. The Plan shall meet the requirements of Subsection 106.04(B) and the requirements specified below. The Plan may be operated wholly or in part by a second tier Subcontractor or an independent organization; however, the Plan's administration, including compliance with the Plan and its modification shall remain the responsibility of the Subcontractor.

(2) Elements of The Plan:

The Plan shall address all elements which affect product qualities including, but not limited to the following:

(a) Mix Design(s)

(b) Aggregate Production

(c) Quality of Components

(d) Stockpile Management

(e) Proportioning, including added water

(f) Mixing and Transportation, including time from batching to completion of delivery

(g) Initial Mix Properties, including Temperature, Air Content, and Consistency

(h) Placement and Consolidation

(i) Compressive Strength

(j) Finishing and Curing

(3) Requirements:

The Plan shall include the use of Operations Technicians, including the following:

(a) Process Control Technician (PCT). This person will be expected to utilize laboratory test results and other quality control practices to assure the quality of aggregates and other mix components and control and adjust mix proportioning to meet the mix design(s). The Plan shall detail the frequency of each type of test, when and how corrective actions are to be taken, and the means of documentation. The PCT shall be responsible for periodically inspecting all equipment utilized in proportioning and mixing to assure its proper operating condition and to assure that proportioning and mixing is in conformance with the mix design and other requirements. The Plan shall set forth how these duties and responsibilities will be accomplished and documented.

If more than one individual is required to accomplish these requirements, the Plan shall so note. Included also shall be the criteria utilized by the PCT to correct or reject unsatisfactory materials.

(b) Quality Control Technician (QCT). This person will be expected to perform and utilize quality control tests at the job site in assuring that delivered materials meet

the requirements of the specifications and the mix design, including temperature, slump and air content. In addition, this person shall be responsible for periodically inspecting all equipment utilized in placing, consolidating, joint construction and finishing to assure its proper operating condition and to assure placing, consolidation, joint construction and finishing in conformance with the specifications. The Plan shall detail the frequency of each type of test, when and how corrective actions are to be taken, and the means of documentation. If more than one individual is required to accomplish these requirements, the Plan shall so note. Included also shall be the criteria utilized by the QCT to reject unsatisfactory materials.

(c) The Plan shall set forth the coordination of the activities of the PCT and the QCT.

(d) The Engineer reserves the right to check the records of the PCT and QCT at any time. The Engineer may take and test samples at any time to confirm the effectiveness of the activities of the PCT and QCT.

1006-4.02 Proportioning:

(A) Cement:

Separate scales, positioned so as to be easily visible to the Engineer and accurate to ±0.2 percent of scale capacity, shall be provided to weigh all hydraulic cement. The batching accuracy shall be within ±1.0 percent of the required weight. Dial scales or a load cell providing a digital printed readout will be required to weigh all hydraulic cement.

The cement shall be conveyed by means of an enclosed conveying system and the weighing hopper shall be equipped with one or more vibrators as required to insure the complete discharge of all cement from the hopper after each batch is weighed.

(B) Water:

Water shall be measured by volume or by weight. Measurement by volume will be by metering.

Scales shall be accurate within ±0.2 percent of scale capacity. Volumetric measuring devices shall have an accuracy of ±1.5 percent. The batching devices shall be capable of routinely batching water within ±1.5 percent.

(C) Aggregates:

All aggregates shall be proportioned by weight.

Suitable dial scales shall be provided by the Subcontractor to weigh each size of aggregate, The scales shall be positioned so as to be easily visible to the Engineer and accurate to ±0.2 percent of scale capacity. The weighing equipment shall have a batching accuracy of ± two (2) percent of the required weight. The weighing equipment shall be arranged so as to permit the convenient removal of excess material from the weighing hopper and the equipment shall be arranged to enable the operator to have convenient access to all controls, The scales shall be so equipped and the dials so graduated that the weights of materials being weighed can be accurately determined. Every expedient shall be used to obtain and preserve uniform moisture content in the coarse and fine aggregates. The moisture content shall not vary more than three percent during any day's production. The estimated percent of free moisture in each of the coarse and fine aggregates shall be determined by the Subcontractor using acceptable test methods.

The moisture content of the aggregate shall be such that no free drainage of water from the aggregate will be visible during transportation from the stockpile to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until it is sufficiently dry to meet the above requirement.

In the event that either the coarse or fine aggregate has a moisture absorption rate of more than 1.5 percent, the materials shall be thoroughly prewetted and allowed to drain in advance of use until the moisture content is stable.

(D) Admixtures:

The equipment and the procedures used to measure admixtures and dispense them into the concrete batch shall be approved by the Engineer prior to use.

Dry admixtures shall be measured by weight, with a separate dial scale positioned so as to be easily visible to the Engineer and accurate to within ±1.0 percent of the amount being weighed. Paste or liquid admixtures shall be measured either by weight or by volume. Only mechanical dispensing equipment shall be used for adding admixtures. Dosage rates shall conform to the manufacturer's recommendations or approved rates, or as determined from field trial batches.

Dispensers for admixtures shall have sufficient capacity to measure at one time the full quantity required for each batch. Unless liquid admixtures are added to premeasured water for the batch, their discharge into the batch shall be arranged to flow into the

stream of water or on the fine aggregate. The amount of liquid admixtures shall not vary from the required amount by more than ±5.0 percent.

Equipment for measurement shall be designed for convenient confirmation of measurement accuracy. If more than one liquid admixture is used, each admixture shall be dispensed by separate equipment unless otherwise permitted in writing by the Engineer.

Separate dial scales, positioned so as to be easily visible to the Engineer and accurate to ±0.2 percent of scale capacity, shall be provided to weigh all fly ash admixtures. The batching accuracy shall be within ±1.0 percent of the required weight.

Weighing of a fly ash admixture may be accomplished by the use of the hydraulic cement scales if proposed by the Subcontractor and approved in writing by the Engineer.

The fly ash admixture shall be conveyed by means of an enclosed conveying system and the weighing hopper shall be equipped with one or more vibrators as required to insure the complete discharge of all fly ash from the hopper after each batch is weighed.

1006-4.03 Mixing:

(A) General Requirements:

The concrete may be mixed in a stationary mixer, either at a central mixing plant or at the site or it may be mixed in a truck mixer, either at a central mixing plant or at the site. Concrete may be mixed in a mobile mixer at the site for Class S and Class B concrete, provided written permission of the Engineer is granted.

Each mixer shall meet the specified requirements for type and size and shall have attached in a prominent place a manufacturer's plate showing the gross volume of the mixer and the recommended speeds of the mixer for mixing and for agitating.

Each batch plant shall be equipped to control the time when the water enters the mixer during the mixing cycle. Batch and mixing time shall be from the time hydraulic cement is combined with water.

Mixers shall be cleaned at suitable intervals. Water used for cleaning the mixer shall be discharged prior to further batching.

Equipment having components made of aluminum or magnesium alloys, which would have contact with plastic concrete during mixing and transporting, shall not be used.

All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement.

(B) Mixing in a Stationary Mixer:

After measurement is made of the materials in the required proportions and amounts, the batch of concrete materials shall be placed in the mixer. The flow of water into the mixer shall be uniform with a portion of the water entering in advance of the cement and aggregates and all of the water entering within the first fifteen (15) seconds of the mixing time.

The volume of concrete mixed per batch shall not exceed the capacity of the mixer as shown on the manufacturer's plate. No spillage of concrete will be allowed during the process of mixing.

While mixing, the mixer shall be operated at the speed shown on the manufacturer's plate as the mixing speed.

The mixing time shall not be less than sixty (60) seconds per batch on Class P concrete and the mixing time shall be increased if directed by the Engineer. The mixing time shall be not less than sixty (60) seconds for one (1) cubic yard and shall be increased fifteen (15) seconds for each additional cubic yard or fraction thereof for Class S and Class B concrete.

The mixers shall have an automatic timing device which locks the discharge equipment until the required mixing time has been completed. The mixer shall be operating at mixing speed at the time that all ingredients enter the mixer to insure the immediate beginning of the mixing cycle. Mixing time shall end when the discharge chute opens. The contents of the mixer shall be completely discharged before the succeeding batch is placed in the mixer.

Any concrete discharged before the mixing time is completed shall be disposed of by the Subcontractor at his expense.

Stationary mixers shall be equipped with automatic batch meters for counting the batches for Class P concrete. The Subcontractor shall furnish the batch count daily to the Engineer.

Mixed concrete shall be transported in truck mixers, truck agitators or in nonagitating trucks having special bodies.

When truck mixers or truck agitators are used, the concrete shall be continuously agitated from the time of loading until the time of discharge. Agitation shall be by rotation of the drum at the speed shown on the manufacturer's plate as agitating speed.

The truck mixer or truck agitator shall be loaded and operated within a capacity not to exceed eighty (80) percent of the gross volume of the drum. The rate of discharge shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully opened.

Discharge from the truck mixer or truck agitator shall be completed within ninety (90) minutes from the time batched.

Bodies of nonagitating trucks shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. If discharge of concrete is accomplished by tilting the body, the surface of the load shall be retarded by a suitable baffle. Covers shall be provided when needed for protection.

Discharge from nonagitating trucks shall be completed within forty-five (45) minutes from the time concrete is batched. Concrete hauled in open-top vehicles shall be protected against access of rain, or exposure to the sun for more than thirty (30) minutes when the ambient temperature exceeds eighty-five (85) degrees Fahrenheit.

(C) Mixing in Truck mixers:

Truck-mixed concrete shall be mixed entirely in the truck mixer and shall be mixed at the batch plant or at the site.

Truck mixers shall be operated within a capacity not to exceed sixty-three (63) percent of the gross volume of the drum and at speeds shown on the manufacturer's plate as mixing and agitating speeds.

Each batch of concrete shall be mixed for not less than seventy (70) nor more than one-hundred (100) revolutions of the drum at mixing speed after all materials have been loaded into the drum, except that when approved by the Engineer, the maximum of one-hundred (100) revolutions may be increased. Any revolving of the drum beyond the maximum number of revolutions shall be at the agitating speed. Mixing shall begin within ten (10) minutes after the cement has been combined with either the aggregate or water.

The truck mixer shall be equipped with an electrically or mechanically activated revolution counter by which the number of drum revolutions may be verified. The counter shall be of the "continuous registering" type, which accurately registers the number of revolutions. It shall be mounted on the truck mixer or just inside the truck cab, so that it may be safely and conveniently read from beside the truck. The revolution counter shall be reset to zero after all materials have been loaded into the drum.

Discharge from the truck mixer shall be completed within ninety (90) minutes from the time batched.

If additional mixing water is required to maintain the specified slump, the concrete shall be mixed by a minimum of twenty (20) revolutions of the drum at mixing speed after the water has been added, prior to discharge of any concrete for placement. Any additional mixing water and required mixing revolutions shall be recorded on the invoice specified in Section 1006-4.01. This additional mixing may be in excess of the maximum revolutions previously specified.

(D) Mixing in Mobile Mixers:

Concrete mixing in mobile mixers for Class S and Class B concrete shall be performed in accordance with the requirements of AASHTO M 241.

1006-4.04 Consistency:

The Subcontractor shall furnish Class P Concrete having a slump within the range specified in Table 1006-1.

The Subcontractor shall furnish Class S and Class B concrete having the slump shown on the approved mix designs with a permissible variation of ±1 inch; however, the permissible variation will be ±2 inches when an approved high range water reducer conforming to type F or G requirements of AASHTO M 194 is used.

Concrete that fails to conform to the consistency requirements will be rejected.

When concrete is pumped, samples for consistency will be taken both as the concrete leaves the mixer and at the pump hose discharge. If the Engineer determines that there is a good correlation between the results of consistency tests on samples obtained from the mixer and from the pump hose, the Engineer may discontinue sampling from one of the sources; however, the Engineer may take periodic samples from both sources to verify the correlation of test results.

1006-5 Submittals:

At least two weeks prior to the appropriate concreting operation, the Subcontractor shall furnish a mix design for each class of concrete and each strength of Class S concrete for review and approval. More than one mix design for each class of concrete and each strength of Class S concrete may be submitted for approval, provided specific items and locations of intended uses accompany the mix design. The Subcontractor shall substantiate each mix design by furnishing test data and providing all details of the mixtures proposed for use.

The Subcontractor shall submit the following items in addition to a concrete mix design.

1006-5.01 Equipment:

Detailed descriptions of intended equipment and methods for conveying, placing, consolidating, preliminary finishing and curing of concrete.

1006-5.02 Trial Concrete Mix Designs.

1006-5.03 Concrete Delivery Tickets.

1006-5.04 Concrete in Hot Weather:

Proposals for concrete placement in hot weather, showing conformance to ACI 305R.

1006-5.05 Concrete Protection:

Detailed description of proposed methods for protecting fresh concrete from inclement weather and extremes of temperature.

1006-5.06 Concrete Placement:

Locations of concrete placements with scheduled dates, intended rate of placing, and mix classes.

1006-5.07 Curing Compound:

Manufacturer's technical data and directions for use.

1006-5.08 Test Cylinders:

Upon request of the Engineer, furnish concrete and labor assistance for compression test cylinders and slump tests at delivery points.

1006-5.09 Tests:

Test data, as required by the Engineer.

1006-6 Weather Limitation:

1006-6.01 General Requirements:

Under rainy conditions, placing of concrete shall be stopped before the quantity of surface water is sufficient to cause a flow or wash of the concrete surface or have a detrimental effect on the finished concrete and acceptance parameters.

Placing of concrete shall immediately cease if the hauling vehicles or any equipment or pedestrian traffic tracks mud on the prepared base or changes the allowable subgrade dimensional tolerances for Class P concrete and slabs placed on subgrade for Class S and Class B concrete.

1006-6.02 Hot Weather Concreting:

The temperature of the concrete mixture immediately before placement shall not exceed ninety (90) degrees Fahrenheit.

Concrete that fails to conform to the maximum temperature requirement in hot weather when the air temperature is above ninety (90) degrees Fahrenheit and rising, shall be rejected prior to placement.

Forms, subgrade and reinforcing steel, shall be sprinkled with cool water just prior to placement of concrete.

1006-6.03 Cold Weather Concreting:

The temperature of the mixed concrete shall not be less than fifty (50) degrees Fahrenheit.

Concrete that fails to conform to the minimum temperature requirement in cold weather when the air temperature is below fifty (50) degrees Fahrenheit and lowering, shall be rejected prior to placement.

Concrete shall not be placed on or against ice-coated forms, reinforcing steel, structural steel, conduits or construction joints, nor on or against snow, ice, or frozen earth materials.

Concrete operations shall be discontinued when a descending air temperature in the shade and away from artificial heat falls below forty (40) degrees Fahrenheit, nor shall concrete operations be resumed until an ascending air temperature in the shade and away from artificial heat reaches thirty-five (35) degrees Fahrenheit unless otherwise approved by the Engineer.

Mixing and placing concrete shall continue no later in any day than that time which will allow sufficient time to place and protect the concrete already poured before the air temperature drops to thirty-five (35) degrees Fahrenheit.

Concrete operations may be allowed although the air temperature at any time during the cure period in the shade and away from artificial heat is below the limit permitted above. Where concrete operations are thus allowed, the Subcontractor shall use equipment to heat the aggregates or water, or both, prior to mixing. if aggregates are heated, the minimum temperature shall be sixty (60)

degrees Fahrenheit and the aggregates shall have no chunks of ice or frozen aggregate present. Equipment used to heat the aggregates shall be such that consistent temperatures are obtained throughout the aggregate within each batch and from one batch to another. Water shall not be heated in excess of one-hundred-fifty (150) degrees Fahrenheit unless the water is mixed with the aggregate prior to the addition of cement to the batch.

When concreting operations are allowed when the air temperature falls below the limits permitted in the shade and away from artificial heat, the Subcontractor shall provide adequate insulation or heat, or both, to protect the concrete after placement. This protection shall be to the extent required to maintain a concrete surface temperature of not less than fifty (50) degrees Fahrenheit for a period of seventy-two (72) hours after placement and at not less than forty (40) degrees Fahrenheit for an additional ninety-six (96) hours. When artificial heating is required, the heating units shall not locally heat or dry the surface of the concrete. A written outline of the proposed protection method shall be submitted to the Engineer for approval.

The placing of concrete will not be permitted until the Engineer is satisfied that all the necessary protection equipment and materials are on hand at the site and in satisfactory working condition.

Concrete requiring cold weather protection shall have such protection removed at the end of the required period in a manner that will permit a gradual drop in the concrete temperature.

1006-7 Curing Concrete:

1006-7.01 Curing Cast-in-Place Concrete:

(A) General Requirements:

All cast-in-place concrete shall be cured by one or by a combination of more than one (1) of the methods specified herein and curing shall begin immediately after completion of machine or hand finishing of the fresh concrete.

Curing shall be continued for a period of at least seven days after placing if either Type II portland cement or portland pozzolan cement has been used, or for at least three (3) days if Type III portland cement has been used.

Surfaces requiring a Class II finish shall not be cured by the Liquid-Membrane Forming Compound Method until after the finishing operations are completed.

No traffic, hauling, storing of material or other work shall be allowed on any concrete surface during the required curing periods.

(B) Water Curing Method:

All surfaces not covered by reasonably waterproof forms shall be kept damp by applying water with a nozzle that so atomizes the flow of the water that a fog mist and not a spray is formed until the surface of the concrete is covered with a curing medium or sprinkling of the surface is permitted. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

If a curing medium is used, the concrete shall be kept continuously wet by sprinkling with water for the entire curing period. Burlap, rugs, carpets, or earth or sand blankets may be used as a curing medium to retain the moisture during the curing period. Application of the curing medium shall not begin until such time that placement can be made without marring the surfaces of the concrete.

If a curing medium is not used, the entire surface of the concrete shall be kept damp by the application of water with an atomizing nozzle as specified above until the concrete has set, after which the entire surface of the concrete shall be sprinkled continuously with water for the entire curing period.

In no case shall curing be interrupted by more than one (1) hour during the curing period.

(C) Liquid-Membrane Forming Compound Method:

All surfaces not covered by reasonably waterproof forms shall be cured by the liquid-membrane forming compound method. The curing compound shall be applied to the concrete immediately following the surface finishing operation in one or more applications totaling a rate of not less than one gallon per one-hundred (100) square feet.

The curing compound shall form a continuous unbroken surface.

If the membrane film is broken during the curing period, the broken area shall be given a new application of compound at the rate of one gallon per two-hundred (200) square feet.

In no case shall curing be interrupted by more than one (1) hour during the curing period.

(D) Forms in Place Method:

Formed surfaces of concrete may be cured by retaining the forms in place. The forms shall remain in place for the entire curing period.

All joints in the forms and the joints between the end of forms and concrete shall be kept moisture-tight during the curing period.

Cracks in the forms and cracks between the forms and the concrete shall be resealed by methods approved by the Engineer.

1006-7.02 Curing Precast Concrete:

(A) General Requirements:

The Subcontractor may cure precast concrete in accordance with the requirements specified above for curing cast-in-place concrete or if he elects, the curing of precast concrete may be performed by external heating. This may be accomplished by the use of low-pressure steam or radiant heat with moisture.

If curing of the concrete is accomplished by low-pressure steam or radiant heat with moisture, curing will be considered completed after termination of steam or radiant heat curing. Rapid temperature changes in the concrete shall be avoided during the cooling period.

If curing of the concrete is accomplished by the water curing method, the liquid-membrane forming compound method, or the forms-in-place method, such curing shall be continued for a period of at least seven (7) days after placement of the concrete. The curing time may be reduced to a minimum of three (3) days when a Type III portland cement has been used.

(B) Low-Pressure Steam Curing:

After placement of the concrete, precast items shall be held for a minimum two (2) hour presteaming period. If the ambient air temperature is below fifty (50) degrees Fahrenheit, steam shall be applied during the presteaming period to hold the air surrounding the precast item at a temperature between fifty (50) and ninety (90) degrees Fahrenheit.

To prevent moisture loss on exposed surfaces during the presteaming period, precast items shall be covered as soon as possible after casting or the exposed surfaces shall be kept wet by fog spray or wet blankets.

Enclosures for steam curing shall allow free circulation of steam about the member and shall be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar flexible covers will be permitted, provided they are kept in good repair and secured in such a manner to prevent the loss of steam and moisture.

Steam at the jets shall be low pressure and in a saturated condition. Steam jets shall not impinge directly on the concrete, test cylinders or forms. During application of the steam, the ambient air temperature rise within the enclosure shall not exceed forty (40) degrees Fahrenheit per hour. The average curing temperature throughout the enclosure shall not exceed one-hundred-sixty (160) degrees Fahrenheit and shall be maintained at a constant level for a sufficient length of time so as to ensure the development of the required compressive strength by the age of twenty-eight (28) days in concrete items which are not to be prestressed. For items which are to be prestressed, the constant temperature shall be maintained for sufficient time necessary to develop the concrete compressive strength required for prestressing. The ambient curing temperature shall not exceed one-hundred-seventy-five (175) degrees Fahrenheit at any point. Control cylinders shall be covered to prevent moisture loss and shall be placed in a location where temperature is representative of the average temperature of the enclosure.

Temperature recording devices that will provide an accurate continuous permanent record of the ambient curing temperature shall be provided. A minimum of two temperature recording devices or one (1) for every two-hundred (200) feet of continuous bed length will be required for checking temperature.

In the event the side forms are removed before the precast unit has obtained the required release compressive strength. The curing method shall be continuous in maintaining the temperature and moisture level as described above, within the enclosure, as nearly as practical. There shall not be a delay in re-covering the girder or prestress member.

(C) Radiant Heat With Moisture:

Radiant heat shall be applied by means of pipes circulating steam, hot oil or hot water, or by heating elements or electric blankets on the forms. Pipes, blankets or elements shall not be in contact with the concrete surfaces.

Moisture shall be applied in such a manner as to keep the top surface of the precast unit continuously moist during the curing period by fogging or spraying. Moisture shall be maintained by a cover of burlap or cotton matting and further covered by a waterproof tarpaulin with an insulating cover.

Temperature limits and the use of recording thermometers shall be the same as curing with low-pressure steam. Application of the heat cycle may be accelerated to meet climatic conditions upon the approval of the Engineer. A temperature sensing device shall be placed two inches, plus or minus one-half (1/2) inch, from the heated form.

1006-8 Acceptance Sampling and Testing:

1006-8.01 General:

Rejection of concrete will occur due to improper temperature, slump, and/or air content for the concrete mixture delivered to the site. The Engineer at his discretion may allow failed concrete mixture already placed to remain in place subject to acceptance by compressive strength or may require its removal.

Rejection of concrete will also occur due to insufficient compressive strength. Concrete compressive strength requirements consists of the specified strength which the concrete shall attain before various loads or stresses are applied and a minimum strength at twenty-eight (28) days.

Acceptance and penalties for placed concrete which meets the above mixture requirements or is allowed to remain in place shall be determined by the results of the twenty-eight (28) day compressive strength, and additionally in the case of Class P concrete, on the measured thickness of concrete pavement in place according to Section 401. Sampling and testing for compressive strength will be performed on all classes of concrete furnished, including each strength specified on the project plans for Class S concrete.

1006-8.02 Sampling and Testing of Concrete:

A sample of concrete for determination of temperature, slump, and air content of the concrete mixture as well as for fabrication of test cylinders for compressive strength determination at twenty-eight (28) days will be taken at random at the specified sampling frequency for each type of concrete.

Samples of concrete will be taken in accordance with the requirements of AASHTO T141 except that the concrete for Class S or B will be sampled only once during discharge in the middle portion of the batch. That sample shall be of sufficient size to perform all the required tests and fabricate the necessary test cylinders.

If concrete is pumped to facilitate placement, at the discretion of the Engineer, samples may be taken from both the truck and pump hose discharge to determine that the compressive strength specifications are met in the structure, and to correlate temperature, slump and air content results. If the correlation is satisfactory and meets with the approval of the Engineer, sampling may continue from the most convenient location with occasional retesting for correlation. Rejection of concrete due to improper temperature, slump, and air content will only occur due to failing tests for samples obtained at the final point of discharge.

Temperature of the concrete mixture will be determined in accordance with ASTM C1064. Slump of the concrete mixture will be determined in accordance with AASHTO T119. Air content of the concrete mixture will be determined in accordance with AASHTO T152. All compressive strength test cylinders will be fabricated in accordance with the requirements of AASHTO T23. Testing for compressive strength of cylinders will be in accordance with the requirements of AASHTO T22 as modified by Arizona Test Method 314.

A strength test will consist of the average strength of two (2) cylinders or ninety-five (95) percent of the higher strength cylinder, whichever is greater.

1006-8.03 Sampling Frequency for Cast-in-place Concrete:

A sample of concrete for the required tests as specified in Subsection 1006-7.02 will be taken for each fifty (50) cubic yards or fraction thereof of consecutively placed concrete on a daily basis for Class B and for each strength classification of Class S concrete from each batch plant or source. A sample for the required tests on daily placements of twenty (20) cubic yards or less will be taken at the discretion of the Engineer. An additional sample or samples for any of the required tests may be taken at an interval of less than fifty (50) cubic yards at the discretion of the Engineer on any batch or load of concrete. The Engineer will determine the quantity of concrete represented by each sample of concrete for any test performed.

A sample of concrete for the required tests as specified in Subsection 1006-7.02 will be taken four (4) times for each full day's production for Class P concrete placed by the slip-form method. A minimum of one sample per day will be taken for Class P concrete placed by other than the slip-form method from each batch plant or source. An additional sample or samples for any of the required tests may be taken at the discretion of the Engineer on any batch or load of concrete. The Engineer will determine the quantity of concrete represented by each sample of concrete for any test performed.

1006-8.04 Sampling Frequency for Precast Concrete:

A sample of concrete for the required tests as specified in Subsection 1006-7.02 will be taken for either each precast concrete member or for each day's production at the discretion of the Engineer, when the method of measurement is by the unit.

An additional sample or samples for any of the required tests may be taken at the discretion of the Engineer. The Engineer will determine the quantity of concrete represented by each sample of concrete for any test performed.

When a sample of concrete for the required compressive strength test is taken to represent a single day's production and not each precast member, the degree of acceptance for all precast concrete members in that day's production will be established by the results of such compressive strength test.

1006-8.05 Testing for Minor Precast Concrete Structures:

A strength test on each precast unit produced will consist of the average rebound number as determined from readings taken on the precast unit with a rebound hammer. The average rebound number will be determined in accordance with the requirements of ASTM C 805.

The compressive strength of the concrete will be determined from the average rebound number and the calibration chart established for the specific rebound hammer being used. The calibration chart will be established from rebound readings taken on concrete test cylinders fabricated at the precast plant and the actual compressive strength of the cylinders. The test cylinders will be fabricated in accordance with the requirements of AASHTO T 23. The compressive strength of the test cylinders will be determined in accordance with the requirements of AASHTO T 22.

1006-8.06 Acceptance for Compressive Strength:

(A) Class P Concrete:

All concrete represented by a strength test of at least seventy-five (75) percent of the required twenty-eight (28) day compressive strength will be acceptable for Class P concrete, subject to the further requirements of Section 401. All concrete failing to meet this requirement or otherwise rejected in accordance with Section 401 or Subsection 1006-7.01, shall be replaced with concrete meeting the requirements of these specifications.

Concrete rejected wholly, or in part, due to deficiency in strength, may be accepted if the Subcontractor, at his own expense, can submit evidence that the strength test(s) is (are) not representative of the concrete placed. If such evidence consists of cores, the Subcontractor shall obtain three cores from each area represented by a failing test and submit them to the Engineer in time to allow complete testing within forty-two (42) days of placement. All cores shall be obtained and tested in accordance with the requirements of AASHTO T 24. All cores will be tested in the wet condition. Strength test results of the cores will be utilized, along with the provisions of Section 401, to determine acceptability and appropriate pay factor.

(B) Class S and Class B Concrete:

Concrete represented by a strength test of at least ninety-five (95) percent of the required twenty-eight (28) day compressive strength will be acceptable for cast-in-place and precast concrete. All concrete failing to meet this requirement or other requirements listed in Subsection 1006-7.01 will be rejected in accordance with the provisions of Subsection 1006.10 of these specifications unless the Subcontractor, at his own expense, can submit evidence that will indicate to the Engineer that the strength and quality of the concrete is such that the concrete should be considered acceptable.

If such evidence consists of concrete cores, the Subcontractor shall obtain three cores from the concrete represented by the failing strength test and deliver them to the Engineer in time to allow complete testing of such cores within forty-two (42) days after the placement of the concrete. All cores shall be obtained and tested in accordance with the requirements of AASHTO T 24. All cores will be tested in the wet condition. The concrete represented by the cores will be considered acceptable if the numerical average of the three tests is ninety-five (95) percent of the required twenty-eight (28) day compressive strength. If the average compressive strength does not meet this requirement, all concrete so represented shall be removed at the Subcontractor's expense unless permitted to remain in place by the Engineer.

1006-9 Method of Measurement:

The method of measurement will be made under the provisions specified in the various sections of the specifications covering construction requiring the use of concrete.

1006-10 Unacceptable Materials:

Materials not conforming to the requirements of the specifications, whether in place or not, will be rejected and shall be promptly removed from the site of the work, unless otherwise directed by the Engineer. No rejected material, the defects of which have been corrected, shall be returned to the work site until such time as approval for its use has been given by the Engineer.

SECTION 1007 RETROREFLECTIVE SHEETING

1007-1 General Requirements:

Retroreflective sheeting shall consist of a retroreflective system having a smooth outer surface. The sheeting shall have a pre-coated adhesive on the back side protected by an easily removable liner.

Retroreflective sheeting is specified as standard reflectivity enclosed-lens sheeting and high reflectivity encapsulated-lens sheeting. The level of reflectivity and color shall be as specified herein or on the project plans.

Manufacturer's identification marks may be fabricated in, or on, the face of standard grade sheeting. If used, the markings shall be inconspicuously placed on 12-inch maximum centers; shall be visible from a distance not greater than three feet; and the identification codes shall be furnished to the Engineer.

A certificate of compliance, conforming to the requirements of Subsection 106.05, shall be submitted.

1007-2 Color Requirements:

The colors specified for Retroreflective Sheeting shall conform to all criteria established in AASHTO M268 with the following exceptions:

1. Silver is an acceptable color designation for white.

2. Minimum reflectance limit for the color orange in Table 2 shall be 12.

The Engineer may, at his discretion, accept colors by certification or require the subcontractor to furnish laboratory test results.

If testing is required, the test instrument must be one of the following or an approved equal:

1. Gardner Multipurpose Reflectometer or Model XL20 Color Difference Meter.

2. Gardner Model AC-2a Color Difference Meter or Model XL30 Color Difference Meter.

3. Meeco Model V Colormaster.

4. Hunterlab 025 Color Difference Meter.

Test panels shall be mounted according to the manufacturer's recommendations.

1007-3 Specific Intensity Per Unit Area (SIA):

The retroreflective sheeting shall obtain the minimum SIA requirements as described in Tables 1007-1 or 1007-2. Measurement of SIA will be conducted in accordance with Instrumental Photometric Measurements of Retroreflective Materials and Retroreflective Devices, Federal Test Method Standard 370. Tests will be conducted at 50 feet with 1-inch source and 1-inch receiver on a 12-inch square test specimen. Observation and entrance angles shall be in the same plane.

The SIA of the sheeting when totally wet shall not be less than 90 percent of the dry values. Wet performance measurements shall be made on new sheeting in accordance with the standard rainfall test specified in Section 7.10.1 of AASHTO M268.

Table 1007-1

Minimum SIA (Candelas Per Footcandle Per Square Foot)

Standard Reflectivity Enclosed-Lens Sheeting

Observ. Angle	Entrance Angle	White	Red	Orange	Brown	Yellow	Green	Blue
0.2	-4	70	14.5	25.0	1.0	50	9.0	4.0
0.2	+30	30	6.0	7.0	0.3	22	3.5	1.7
0.5	-4	30	7.5	13.5	0.35	25	4.5	2.0
0.5	+30	15	3.0	4.0	0.20	13	2.2	0.8

Table 1007-2

Minimum SIA (Candelas Per Footcandle Per Square Foot)

High Reflectivity Encapsulated Lens Sheeting

Observ. Angle	Entrance Angle	White	Red	Orange	Brown	Yellow	Green	Blue
0.2	-4	250	45	100	12.0	170	45	20.0
0.2	+30	150	25	60	8.5	100	25	11.0
0.5	-4	95	15	30	5.0	62	15	7.5
0.5	+30	65	10	25	3.5	45	10	5.0

1007-4 Specular Gloss:

The retroreflective sheeting shall have an 85 degree specular gloss of not less than 40 for standard reflectivity and not less than 50 for high reflectivity when tested in accordance with the requirements of ASTM D 523.

1007-5 Color Processing

Color processing shall meet all requirements specified in AASHTO M268. Opaque or transparent colors, inks and paints used in sign fabrication shall be of the type and quality as recommended by the manufacturer of the reflective sheeting. Application will be by a screen process which results in uniform color and tone, possessing sharply defined edges of legend and border.

1007-6 Shrinkage:

Shrinkage testing and limits shall be as specified in AASHTO M268 except that the shrinkage of high reflectivity reboundable sheeting shall not be in excess of 0.10 inch in 24 hours in any dimension.

1007-7 Flexibility:

Standard grade retroreflective sheeting shall be applied according to the manufacturer's specifications to a clean, etched 0.020-inch by 2-inch by 8-inch aluminum panel of alloy 6061-T6, conforming to the requirements of ASTM B209 and conditioned a minimum of 48 hours at 72 degrees Fahrenheit and 50 percent relative humidity. Tested at these conditions, the panel shall exhibit no evidence of cracking when bent around a 3/4-inch mandrel.

High reflectivity sheeting, with the liner removed, shall be conditioned for 24 hours at 72 degrees Fahrenheit and 50 percent relative humidity. Tested under these conditions, the sheeting shall exhibit no evidence of cracking when bent slowly around a 1/8-inch mandrel with the adhesive contacting the mandrel. To facilitate testing, talcum powder may be used to prevent the sheeting from sticking to the mandrel. The test specimen shall be 2-3/4 inches by 11 inches.

High reflectivity reboundable sheeting shall be conditioned and tested at 32 degrees Fahrenheit.

1007-8 Adhesive:

The reflective sheeting shall include either a pre-coated, pressure sensitive adhesive backing or a pre-coated, tack-free heat-activated, adhesive backing, either of which can be applied without necessity of additional adhesive coats on either the reflective sheeting or the application surface.

The pre-coated, pressure sensitive, adhesive backing shall be of the aggressive tack type requiring no heat, solvent or other preparation for adhesion to smooth, clean surfaces.

The pre-coated, heat-activated, adhesive backing shall be tack-free, activated by applying heat in excess of 175 degrees Fahrenheit to the material as in the heat-vacuum process of sign fabrication.

The protective liner attached to the adhesive shall be removed by peeling, without soaking either in water or other solvents and without breaking, tearing or removing any adhesive from the backing. The protective liner shall be easily removed following storage for four hours at 160 degrees Fahrenheit under a weight of 2.5 pounds per square inch.

The adhesive backing of the reflective sheeting shall produce a bond to support a 1-3/4 pound weight for five minutes, without the bond peeling, for a distance of more than 2.0 inches (1.0 inch for high reflectivity, reboundable sheeting) when applied to a smooth aluminum surface and tested in accordance with the requirements of AASHTO M268.

1007-9 Impact Resistance:

The impact resistance of standard and high retroreflective sheeting shall conform to the requirements of AASHTO M268, except for high reflectivity, reboundable sheeting which shall utilize a 100-inch pound setting on the test instrument. In addition, high reflectivity, reboundable sheeting shall be conditioned and tested at 32 degrees Fahrenheit.

1007-10 Accelerated Weathering:

When applied in accordance with recommended procedures, the retroreflective sheeting shall be weather resistant and, following cleaning, shall show no appreciable discoloration, cracking, blistering or dimensional change.

Following exposure to accelerated weather testing, the panels shall be washed with a five-percent hydrochloric acid solution for 45 seconds, rinsed thoroughly with clean water, blotted with a soft, clean cloth, brought to equilibrium and standard conditions and tested. Reflective materials tested shall not have SIA values less than specified in Table 1007-3, when subjected to accelerated weathering in accordance with ASTM G23, Type E or EH Weatherometer with the humidifier off.

Table 1007-3

Accelerated Weathering Testing Requirements

Type of Material	Hours Tested	Minimum Specific Intensity Per Unit Area
Standard	1,000	50% of Table 1007-1
High	*2,200	80% of Table 1007-2

*For orange material having glass bead retroreflective elements and for high retroreflective reboundable material, the hours tested shall be 500.

1007-11 Colorfastness

Specimens prepared and subjected to accelerated weathering shall be used to test for colorfastness in accordance with AASHTO M268.

SECTION 1008 PRISMATIC REFLECTORS

1008-1 General Requirements:

The subcontractor shall furnish a Certificate of Compliance in accordance with the requirements of Subsection 106.05. The certificate shall state that the reflectors comply in all respects with the following requirements:

The retroreflectors shall consist of a plastic face (herein referred to as the lens) and an opaque back fused to the lens (under heat and pressure) around the entire perimeter to form a homogeneous unit permanently sealed against dust, water and water vapor. The retroreflector shall be clear (crystal) in color. The lens shall consist of a smooth front surface free from projections or indentations other than for identification and a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

The specific intensity of each acrylic retroreflector shall be equal to or exceed the minimum values in Table 1008-1 with measurements made with retroreflectors spinning.

1008-2 Delineator and Object Marker Retroreflectors:

The retroreflectors shall be either white, yellow, green or red as specified and shall be ready for mounting.

The lens shall have a retroreflective area of not less than 6.5 square inches. Retroreflection shall be provided by the lens prismatic optical elements.

The following test shall be used to determine if a retroreflector is adequately sealed against dust, water or air.

Submerge 50 samples in water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches gauge for 5 minutes. Restore atmospheric pressure and leave samples submerged for 5 minutes, then remove and examine the samples for water intake. Failure of three or more units shall be cause for rejection of the entire lot.

The delineator or object marker device shall consist of an acrylic plastic retroreflector unit mounted in a housing fabricated of 0.063 inch 3003-H-14 or similar aluminum, or of cold rolled, hot dip, galvanized steel, having a thickness of 0.064 inch. Housing dimensions, including assembly and post mounting hardware will be as shown on the project plans or as specified in the contract. Attachment hardware shall permit easy removal with the proper

tools, but that removal is not possible without the use of such tools.

The housing shall be protected against corrosion as recommended by the manufacturer.

1008-3 Cut-Out Letters, Symbols and Accessory Retroreflectors:

The retroreflectors shall be clear and transparent mounted as an integral part of the character. Five retroreflectors shall be submitted for test. Failure of one or more units shall constitute failure of the lot.

The sealed prismatic retroreflector units shall be tested for dust and water intrusion as follow:

- Submerge five retroreflectors in a water bath at room temperature. Subject the submerged units to a vacuum of 5 inches gauge (water) for 5 minutes, then examine them for water intake. Failure of one or more units shall constitute failure of the lot.

- Three reflectors shall be tested for 4 hours in a circulating air oven at 175°F ± 5°. The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test, the retroreflectors shall be removed from the oven and permitted to cool in air to room temperature. The units, after exposure to heat and air cooling, shall show no significant change in shape and general appearance when compared with unexposed control standards. Failure of one or more units shall constitute failure of the lot.

- The assembled cut-out letter, symbol or accessory shall withstand the combined corrosion test set forth in ASTM B 117. No failures permitted.

Table 1008-1

(Candelas per Footcandle per Square Inch)

Minimum Specific Intensity per Unit Area (SIA)

Reflector Units

		Delineators & Object Markers				Cut-Out Letters Symbols & Access.
Observation Angle (Degrees)	Entrance Angle Degrees	*White	Yellow	Green	Red	Colorless
0.1	0	17.7	6.5	4.6	4.6	14.0
0.1	20	6.9	3.8	1.8	1.8	5.6
0.33	0	-	-	-	-	10.0
0.33	20	-	-	-	-	4.0
0.17	0	-	-	-	-	7.0
0.17	20	-	-	-	-	2.8

*Crystal, Clear or Colorless

SECTION 1010 DRAINAGE PIPE:

1010-1 General Requirements:

The subcontractor shall furnish certificates of compliance in accordance with the requirements of Section 105 of these specifications.

1010-2 Metal Pipe:

1010-2.01 Corrugated Metal Pipe:

Type 1A pipe may be used if the shell thickness meets or exceeds the thickness specified on the project plans for Type 1 pipe.

Metallic coated (zinc or aluminum) corrugated iron or steel culverts, underdrains, and spiral rib corrugated steel pipe shall conform to the requirements of AASHTO M 36, except as otherwise noted herein.

Polymer precoated, metallic coated (zinc or aluminum) corrugated steel culverts and underdrains shall conform to the requirements of AASHTO M 245, except as otherwise noted herein.

Bituminous coated corrugated metal (metallic coated steel or aluminum) culverts and underdrains shall conform to the requirements of AASHTO M 190.

Aluminum alloy corrugated metal pipe shall conform to the requirements of AASHTO M 196.

The types of bituminous coating and the type of precoated sheets to be used will be specified on the project plans. In lieu of the Type A bituminous coating, the pipe shall be coated either in the field or at the plant on the outside surface only in accordance with the requirements of AASHTO M 243. Either asphalt mastic or tar base material shall be used.

Coupling bands shall conform to the requirements of AASHTO M 36, M 245, and M 196, except that the use of bands with projections (dimples) will be limited to end sections, to pipe laid on grades under ten percent, and to pipe requiring water resistant joints .

Bands of special design that engage factory reformed ends of corrugated metal pipe may be used.

Bolts and nuts for all types of coupling bands shall conform to the requirements of ASTM A 307.

Coupling band connection hardware consisting of nuts, bolts, rods, bars, and rivets shall be either galvanized after fabrication by

the hot-dip process in accordance with the requirements of ASTM A 153 or coated by the electroplating process in accordance with the requirements of ASTM A 164, Type RS or ASTM A 165, Type TS. Components of bolted assemblies shall be coated separately before assembly.

Special sections, such as elbows and prefabricated end sections, shall conform to the applicable requirements of AASHTO M 36, M 190, M 196 and M245.

Gaskets for all water-resistant joints shall be a continuous band or strip, at least seven inches wide and one half inch thick. Rubber for the gaskets shall conform to the requirements of ASTM D 1056 for the "2A" closed cell expanded grades.

Watertight joints, when specified on the project plans, shall use "O"-ring gaskets, with appropriate diameters as specified under AASHTO M 36, and conforming to the technical requirements of AASHTO M-198. Watertight joints may substitute or be used when water-resistant joints are required.

1010-2.02 Spiral Rib Steel Pipe:

Spiral rib steel shall conform to the requirements specified under Subsection 1010-2.01 of these specifications for corrugated metal pipe, except as modified herein.

(A) Fabrication:

Ribbed steel pipe shall be fabricated with a continuous helical lock seam in accordance with AASHTO M-36, Type 1R or corrugation in accordance with AASHTO M-196, Type 1R. Aluminum rib pipe shall be manufactured in accordance with AASHTO M-196, Type 1R.

Each pipe end shall be fabricated with a minimum of two annular rerolled corrugations for the purposes of joining pipes together with band couplers.

(B) Coatings:

The types of coatings and the type of precoated sheets to be used shall be as specified on the project plans.

(C) Coupling Bands:

Coupling bands for spiral ribbed steel pipe shall be rerolled bands manufactured from 0.064 inch thick metallic coated steel conforming to the requirements specified under Subsection 1010-2.01 of these specifications and shall be two-piece for pipe greater than forty-eight (48) inches in diameter.

Coupling bands shall be a minimum of ten and one half (10-1/2) inches wide, formed with two (2) corrugations that are spaced to provide nesting in the second corrugation of each pipe end and shall be drawn together by a minimum of two (2) one half (1/2) inch diameter galvanized bolts through the uses of a bar and strap suitably welded to the band. Bands may be drawn together by other means, such as angles, as approved by the Engineer.

(D) Fittings:

Fittings for ribbed steel pipe shall conform to the requirements for corrugated steel pipe fittings specified in Subsection 1010-2.01 of these specifications, except the material shall be ribbed steel.

(E) Miscellaneous:

All spiral rib manhole risers twenty-four (24)" in diameter or greater shall be reinforced with a rolled 3" x 3" x 1/4" angle or as approved by the Engineer.

Pipe thickness for spiral rib pipe shall be specified in the pipe summary, but shall not be less than that listed in the following table.

PIPE DIAMETER	MINIMUM THICKNESS	CORRUGATION SIZE
18" - 36"	16 Gage	3/4"x3/4"x7 1/2" or 3/4"x1"x11 1/2"
42" - 72"	14 Gage	3/4"x3/4"x7 1/2" or 3/4"x1"x11 1/2"
72" - 102"	12 Gage	3/4"x3/4"x7 1/2" or 3/4"x1"x11 1/2"

1010-2.03 Concrete-lined

(A) Corrugated Metal Pipe:

Corrugated metal pipe, coupling bands and fittings for concrete-lined pipe shall conform to the requirements of AASHTO M-36 for the specified sectional dimensions and metallic coatings.

Aluminized coating shall conform to AASHTO M-274.

Pipe shall be full circle and shall be fabricated with helical corrugations.

Pipe thickness shall be as specified in the pipe summary, but shall not be less than that listed in the following table:

Pipe Diameter	Minimum Thickness (Gage)	Corrugation Size
30" - 48"	0.064" (16)	2-2/3" x 1/2"
54"	0.079" (14)	2-2/3" x 1/2"
60" - 66"	0.109" (12)	2-2/3" x 1/2"
72" - 78"	0.138" (10)	2-2/3" x 1/2"
54" - 72"	0.064" (16)	3" x 1"
78" - 84"	0.079" (14)	3" x 1"
90" - 102"	0.109" (12)	3" x 1"
108" - 120"	0.138" (10)	3" x 1"

Each pipe end shall be fabricated with a minimum of two annular rerolled corrugations for purposes of joining pipes together with band couplers.

Pipe shall be joined with rerolled bands made from the same material as the pipe. The bands shall be a minimum of sixteen (16) gage (.064). Bands shall be two (2) piece for pipe greater than forty-eight (48) inches in diameter.

Coupling bands shall be a minimum of ten and one half (10-1/2) inches wide, formed with two (2) corrugations that are spaced to provide nesting in the second corrugation of each pipe end and shall be drawn together by a minimum of two (2) one half (1/2) inch diameter galvanized bolts through the use of a bar and strap suitably welded to the band. Bands may be drawn together by other means, such as angles, as approved by the Engineer.

When watertight joints are specified, "O"-ring gasket will be required. "O"-ring gaskets shall be per ASTM C-361 Section 5.9 and shall be placed in the first corrugation of each pipe end and shall be compressed by tightening the coupling band, in accordance with the manufacturer's installation instructions.

(B) Concrete Lining:

(1) Composition:

Concrete for the lining shall be composed of cement, fine aggregate and water that are well mixed and of such consistency as to produce a dense, homogeneous, non-segregating lining.

(2) Cement:

Portland cement shall be in accordance with Subsection 1006-2.01 of these specifications.

(3) Aggregate:

Aggregates shall conform to AASHTO M6, except that the requirements for gradation and uniformity of gradation shall not apply.

(4) Mixture:

The aggregates shall be sized, graded, proportioned and thoroughly mixed with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the pipe will conform to the design requirements of this specification. In no case, however, shall the proportions of Portland cement plus pozzolanic admixture be less than 470 pounds per cubic yard of concrete.

(5) Lining:

The lining shall have a minimum thickness of 3/8 inch above the crest of the corrugations and shall be applied by a machine traveling through a stationary pipe. The rate of travel of the machine and the rate of concrete placement shall be mechanically regulated so as to produce a homogeneous non-segregated lining throughout. The lining shall be applied in a two (2) course application, and shall be mechanically troweled by the lining machine as the unit moves through the pipe. The trowel attachment shall be such that the pressure applied to the lining will be uniform and shall produce a lining that has a uniform thickness and a consistent troweled finish. The vertical diameter anywhere inside the pipe must be 95% of the nominal diameter less acceptable tolerances as stated in AASHTO M36. Pipe not meeting these tolerances will be rejected.

(C) Experience:

The manufacturer shall certify in writing that he has successfully manufactured and furnished corrugated steel pipe with a concrete lining per these specifications on a minimum of fifteen (15) previous projects of a storm sewer nature.

1010-3 Slotted Pipe:

Slotted pipe shall conform to the applicable requirements of AASHTO M36. It shall be the grate slot or angle slot type. Pipe shall be helically or annular corrugated.

Grate assemblies shall be fabricated from steel conforming to the requirements of either ASTM A 36 or ASTM A 576 and shall be galvanized in accordance with the requirements of ASTM A 123. The method of manufacture shall relieve all strain and prevent distortion of the pipe.

When a lockseam joint is used, slotted drain pipe shall be placed in a clamping device and cut the entire length prior to placement of the grate. The grate must be continuous and full depth. The grate shall be welded continuously to the pipe with a 3/16" fillet weld from end to end on both sides.

Bolts and nuts shall be steel conforming to the requirements of ASTM A 307 and shall be galvanized in accordance with the requirements of ASTM A 123.

The butyl rubber joint sealant material shall be an extruded strip or bead compounded from a nondrying, nontoxic, synthetic resin base with butyl rubber and inorganic extenders and be 100 percent solid material with no shrinkage. The sealant material shall have sufficient adhesion so that the strip or bead will adhere to galvanized steel and be soft enough to allow cold flow when compressed during connection of the pipe sections. The sealant material shall not flow or sag at temperatures up to 180 degrees Fahrenheit nor become brittle, crack or lose adhesion at temperatures as low as -30 degrees Fahrenheit and shall contain no migrating components that could leach out or produce any chemical reaction with galvanized steel . The sealant material shall be furnished in 5/8" x 1" strips or in 1" diameter beads on 1" wide release paper and wound into rolls.

An alternative joint sealant or sealing method that will provide a watertight joint may be used if approved by the Engineer.

Materials used for grout shall conform to the requirements of Section 1006. The grout shall be composed by volume of one part portland cement, three parts fine aggregate and one-fifth part hydrated lime. Hydrated lime shall conform to the requirements of ASTM C 207, Type N. To these mixed materials sufficient water shall be added to provide a mixture that will flow readily. Grout that has been mixed more than one hour shall not be used. Retempering of grout will not be permitted.

1010-4 Structural Plate Pipe:

Structural plate (steel) for pipe, pipe-arches and arches and the accessories for connecting the plates shall conform to the requirements of AASHTO M 167.

Structural plate (aluminum alloy) for pipe, pipe arches and arches and the accessories for connecting the plates shall conform to the requirements of AASHTO M 219.

When specified on the project plans structural plates (steel) and structural plates (aluminum alloy) shall be bituminous coated in accordance with the requirements of AASHTO M 243. Unless otherwise specified, the coating shall be applied to the outside only.

Concrete for footings, bottom slabs on paved inverts, and rings on struts shall conform to the requirements of Section 1006 for the strength and class specified on the project plans.

Steel bars, wire, wire fabric, anchor bolts, and structural steel shall conform to the requirements of Section 1003 or Section 1004 of these specifications, as applicable.

1010-5 Nestable Steel Pipe:

Nestable corrugated steel pipe shall conform to the requirements of AASHTO M 36, except that the pipe shall be fabricated in two separate semi-circular sections. The two sections shall be firmly joined together in accordance with the requirements of Military Specification MIL-P-236. At the option of the subcontractor, the longitudinal joint of the nestable pipe sections shall be either Type I, flanged, or Type 11, notched, as specified in MIL-P-236.

1010-6 Reinforced Concrete Pipe:

Reinforced concrete pipe (circular) shall conform to the requirements of AASHTO M 242 for the D-load specified.

Reinforced concrete pipe (circular) shall conform to the requirements of AASHTO M 170 for the class of pipe specified.

Reinforced concrete pipe (elliptical) shall conform to the requirements of AASHTO M 207 for the class of pipe specified.

Reinforced concrete pipe (arch) shall conform to the requirements of AASHTO M 206 for the class of pipe specified.

The subcontractor shall furnish the Engineer a copy of the pipe design when the standard AASHTO tables are exceeded.

Precast, reinforced concrete flared end sections shall conform to the requirements of the previously cited specifications to the extent to which they apply. The area of steel reinforcement per linear foot of the flared end section shall be at least equal to the minimum steel requirement for the reinforcement in that portion of the flared end section which abuts the pipe.

Gaskets for reinforced concrete pipe (circular) joints shall conform to the requirements of AASHTO M 198.

Mortar used to join reinforced concrete pipe shall be composed by volume of one part portland cement, two parts fine aggregate, one-fifth part hydrated lime and sufficient water to provide a plastic mixture. Cement and water shall conform to the requirements of Section 1006 of these specifications.

Fine aggregate shall conform to the grading requirements of ASTM C 144. Hydrated lime shall conform to the requirements of ASTM C 207, Type N. The lime shall be considered as an addition to and not as replacing any cement.

1010-7 Polyvinyl Chloride (PVC):

Plastic pipe and fittings shall conform to the requirements of the National Sanitation Foundation and bear their stamp.

Materials used in the manufacture of PVC pipe and fittings shall conform to the requirements of ASTM D 1784, Class 12454-B.

PVC pipe shall conform to the requirements of ASTM D-2241 for SDR-PR pipe and ASTM D-1785 for Schedule 40 and Schedule 80 pipe.

The pipe classification and the pressure rating will be specified on the project plans or herein.

PVC pipe, unless otherwise specified, shall be plain-end solvent weld or bell-end solvent weld. Bell-end solvent weld pipe shall conform to the requirements of ASTM D 2672.

PVC pipe shall be assembled with solvent weld, socket type fittings.

All PVC fittings shall conform to one or more of the following requirements:

(a) ASTM D 2466 for Schedule 40 socket type fittings.

(b) ASTM D 2467 for Schedule 80 socket type fittings.

1010-8 High Density Polyethylene Pipe (HDPEP):

Corrugated polyethylene pipe, fittings, couplings and ends, where specified, shall be high-density, smooth interior pipe. Twelve (12) to thirty-six (36) inch diameters shall conform to AASHTO M 294. Pipe joints and fittings shall conform to AASHTO M 252 or AASHTO M 294. Material shall conform to ASTM D 3350 and must meet with the approval of the engineer.

Magnetic tape, which is to be placed in the trench with the polyethylene pipe as an aid in location after burial, shall have a minimum overall thickness of 5.5 mils and a minimum tensile strength of 5000 psi.

1010-9 Ductile Iron Pipe:

All ductile iron water pipe shall be in accordance with AWWA C-150 and shall be manufactured in accordance with AWWA C-151.

1010-9.01 Fittings:

Iron fittings shall be either Gray-Iron or Ductile-Iron conforming to AWWA C-110 or AWWA C-153 with a minimum pressure rating of 250 psi. Flanged ends shall conform to AWWA C-110. Push-on and mechanical joints ends shall conform to AWWA C-111.

Fittings shall be cement mortar lined and coal-tar coated in accordance with AWWA C-104.

1010-9.02 Joints:

Mechanical joint restraint for ductile iron pipe shall conform to AWWA C-111 and shall include cast iron glands, synthetic rubber gaskets, and T-head bolts and nuts. The mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1, such as EBAA Megalug or equal.

1010-9.03 Polyethylene Corrosion Protection:

A. General:

Pipe, valves and fittings shall be protected from corrosion by encasement in a polyethylene protective wrapping referred to hereafter as polywrap. Although not intended to be a completely air and water tight enclosure, the polywrap shall provide a continuous barrier between the pipe and surrounding bedding and backfill.

B. Materials:

The polywrap shall be of virgin polyethylene, not less than eight (8) mils in thickness, formed into tubes or sheets as may be required. Naturally pigmented material may be used where exposure to ultra violet light will be less than forty-eight (48) hours. Otherwise the material shall be pigmented with 2 to 2-1/2 percent of well dispersed carbon black with stabilizers.

The polywrap shall be secured as specified below with two (2) inch wide pressure sensitive plastic tape not less than ten (10) mils thick. Tape shall be Scotchrap No. 50, Polyken No. 900, Tapecoat CT, Johns-Manville No. V-10 Trantex, or approved equal.

The minimum tube size for twelve (12) inch pipe diameter shall be as shown below.

1. Cast Iron or Ductile Iron Pipe with push-on joints shall be twenty-nine (29) inches of Polywrap flat tube.

2. Cast Iron or Ductile Iron pipe with mechanical joints shall be thirty (30) inches of Polywrap flat tube.

1010-9.04 Gate Valves:

All valves shall conform to the latest revisions of AWWA C-500 or C-509, supplemented as follows:

Valves shall be iron body resilient seated solid wedge gate valves with a cast iron wedge, designed to work equally well with pressure on either side of the gate. Valves shall be of the non-rising stem type and shall be left hand opening, counter-clockwise.

Bronze for all interior parts of valves shall contain not more than six (6) percent zinc if made from cast bronze, or must conform to Copper Development Association #67600 if made from bar stock material.

All interior ferrous surfaces exposed to fluid flow shall be epoxy coated to a minimum dry film thickness of six (6) mils. Epoxy coatings shall be factory applied by an electrostatic or thermosetting process in accordance with the manufacturer's printed instructions. The epoxy materials used shall be 100% powder epoxy or liquid epoxy that conforms to the requirements of AWWA C550-81, and to the prevailing requirements of the Food and Drug Administration and of the Environmental Protection Agency.

All exterior ferrous surfaces, except finished or bearing surfaces, shall be factory coated with two coats of asphaltic varnish conforming to Federal Specification TT-V-51c, or shall be epoxy coated as required above for interior surfaces.

SECTION 1011 JOINT MATERIALS

1011-1 Rubber Waterstops:

Rubber waterstops shall be either molded or extruded from plain rubber or synthetic rubber, at the option of the subcontractor.

The waterstops shall be formed with an integral cross section which shall be uniform within ± 1/8 inch in width and the web thickness or bulb diameter within ± 1/16 inch and -1/32 inch. No splices will be permitted in straight strips and special connection pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous and free from porosity or other defects. All junctions in the special connection pieces shall be full-molded. During the vulcanizing period the joints shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

Field splices shall be vulcanized; mechanical, using stainless steel parts; or made with a splicing union of the same stock as the waterstop, at the option of the subcontractor. All finished splices shall have a tensile strength of not less than 50 percent of the unspliced material.

Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-1.01 Plain Rubber Waterstops:

Plain rubber waterstops shall be formed from stock composed of a high grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, anti-oxidants and softeners and shall conform to the following requirements:

New Plantation Rubber Content, by volume, percent	Minimum 72
Tensile Strength (ASTM D 412), pounds per square inch	Minimum 3500
Elongation at Breaking (ASTM D 412), percent	Minimum 550
Unit Stresses:	
At 300 percent Elongation, pounds per square inch	Minimum 1100
At 500 percent Elongation, pounds per square inch	Minimum 2800

Shore Durometer (Hardness) (ASTM D 2240)	55 to 65
Tensile Strength and Elongation at Breaking (ASTM D 572), after seven days in air at 158 degrees (± 2 degrees) Fahrenheit, or after 48 hours in oxygen at 158 degrees (± 2 degrees) Fahrenheit, and 300 pounds per square inch = percent of original	Minimum 65

1011-1.02 Synthetic Rubber Waterstops:

Synthetic rubber waterstops shall be formed from a compound made exclusively from neoprene or SBR (styrene butadiene rubber), reinforcing carbon black, zinc oxide, polymerization agents and softeners and shall conform to the following requirements:

Neoprene or SBR Content, by volume, percent	Minimum 70
Tensile Strength (ASTM D 412), pounds per square inch	Minimum 2500
Elongation at Breaking (ASTM D 412), percent	Minimum 425
Shore Durometer (Hardness) (ASTM D 2240)	50 to 70
Tensile Strength at Breaking (ASTM D 572), after seven days in air at 158 degrees (± 2 degrees) Fahrenheit, or after 48 hours in oxygen at 158 degrees (± 2 degrees) Fahrenheit, and 300 pounds per square inch = percent of original	Minimum 65

1011-2 Polyvinyl chloride (PVC) Waterstops:

Polyvinyl chloride waterstops shall be manufactured from virgin polyvinyl chloride conforming to the requirements of the Corps of Engineers Specification Number CRD-C572.

Certificate of Compliance conforming to the requirements of Subsection 106.05 shall be submitted stating that the requirements specified under paragraph 6 of CRD-C572 have been complied with.

Field splices shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. The heat shall be sufficient to melt but not char the plastic.

1011-3 Joint Sealant (Hot-Poured):

Joint sealant material shall be a one component, hot poured type, conforming to the requirements of either ASTM D 3406 or ASTM D 3569.

The following requirement shall be added to paragraphs 5.1 of ASTM D 3406 and 7.1 of ASTM D 3569:

> The minimum ambient temperature during application and ambient temperatures under various storage conditions shall be clearly marked on the container.

1011-4 Joint Sealant (Cold-Application):

Joint sealant shall be cold-application, mastic, single or multiple component type conforming to the requirements of ASTM D 1850.

1011-5 Bridge Deck Joint Seals:

The elastomer for joint seal elements shall be polychloroprene rubber (Neoprene) and shall be compatible with concrete and shall be resistant to abrasion, oxidation, aging and sunlight, and to oils, gasoline, salt and other materials that may be spilled on or applied to the surface.

Joint seals shall be of the cellular compression type or strip type.

One piece of the material supplied shall be at least 18 inches longer than required by the project plans and the additional length will be removed by the Engineer and used for testing by the Materials Section. Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-5.01 Compression Seals:

Compression seals shall consist of a prefabricated, preformed, elastomer joint seal material and shall conform to the requirements of ASTM D 3542.

The seal shall consist of a multi-channel nonporous, homogeneous material furnished in a finished extruded form.

The minimum depth of the seal, measured at the contact surface shall be at least 95 percent of the minimum uncompressed width of the seal as designated by the manufacturer.

The joint seal shall provide a Movement Rating (MR) of not less than that shown on the project plans. The seal shall be so formed that it can be compressed to 40 percent of its original width without damage while simultaneously maintaining the top center of the exposed surface below the top surface of the installed joint.

The top and bottom edges of the joint seal shall maintain continuous contact with the side of the armor over the entire range of joint movement.

The compression seal shall be furnished full-length except as otherwise specified on the project plans and as indicated on Standard Drawing B-24.20.

At all open ends of the seal that would admit water or debris, each cell shall be filled to a depth of 3 inches with commercial quality open cell polyurethane foam or closed by other means subject to the approval of the Engineer.

The seal element shall be installed in strict accordance with the manufacturer's recommendations, subject to these specifications and the approval of the Engineer, using equipment manufactured specifically for the installation of said element. The equipment shall not cause structural damage to either the seal element or the joint armor and shall not twist, distort, or cause other malformations in the installed seal element. Contact surfaces of the seal element shall be cleaned with normal butylacetate, using clean rags or mops, immediately prior to application of lubricant adhesive and sealant. The lubricant adhesive and sealant shall be applied to the seal element and joint armor contact surfaces at the rate recommended by the manufacturer.

If the required joint opening at the time of installation is inadequate to allow for easy installation of the seal element, the compression seals shall be shop-installed into deck joint assemblies to be shipped fully assembled and installed as a unit. Fully assembled units shall have the lubricant adhesive applied to the seal and armor contact surfaces and shall be equipped with shipping and temperature adjustment devices approved by the Engineer.

The lubricant adhesive and sealant shall conform to the provisions of ASTM D 4070.

The lubricant adhesive and sealant shall have a viscosity such that it will perform suitably with installation equipment, remaining fluid from five degrees Fahrenheit to 120 degrees Fahrenheit.

Each lot of lubricant adhesive and sealant shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture. The shipping containers shall also indicate any special precautions or instructions required because of product toxicity, flammability, or other such information pertinent to the proper storage and use of the product.

1011-5.02 Strip Seals:

The elastomer for strip seal elements shall conform to the requirements of ASTM D 3542 modified to exclude the recovery testing.

Strip seals shall be continuous sheets and shall be furnished full-length except as otherwise specified on the project plans.

1011-6 Preformed Expansion Joint Filler:

Preformed expansion joint filler for concrete structures, pavements and incidental items shall conform to the requirements on the project plans. When not specified, one of the following joint fillers may be used.

1011-6.01 Bituminous Joint Filler:

Bituminous joint filler shall conform to the requirements of AASHTO M 213.

1011-6.02 Nonbituminous Joint Filler:

Nonbituminous joint filler shall conform to the requirements of AASHTO M 153, Type II, with the following modifications. The joint filler may be formed as a premolded strip from suitable fibers. The compression test specimen of the premolded fiber joint filler shall recover to at least 65 percent of its thickness before testing.

1011-7 Cellular Plastic Joint Filler:

Cellular plastic joint filler shall conform to the requirements of ASTM D 3204. The lubricant-adhesive shall be furnished by the manufacturer and used according to his recommendations. Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

1011-8 Silicone Joint Sealant:

1011-8.01 Testing:

Silicone joint sealant shall be a low modulus silicone that is specifically formulated to seal Portland Cement Concrete Pavement

joints. Silicone sealant shall be furnished in a one-part formulation which is non-acid curing and shall meet the following physical requirements:

Test Method	Test	Material Requirements
ASTM D 412 (Method A, Die C)	Tensile Stress at 150% Elongation (1)	45 psi maximum
ASTM D 412 (Method A, Die C)	Elongation (1)	700% minimum
ASTM C 603	Extrusion Rate (ASTM C 920, Type S, Grade NS)	25 seconds maximum
ASTM D 792 (Method A)	Specific Gravity	1.15-1.515
ASTM C 679	Tack-Free Time	120 minutes maximum
ASTM D 2240 (Shore A)	Durometer Hardness	25 maximum
ASTM C 719 (Mortar Block)	Movement (2) (3)	+50% and -50% (4) of the joint width

NOTE 1: Sample cured 7 days at 77 degrees Fahrenheit ± 2 degrees Fahrenheit and 50% ± 5% relative humidity.

NOTE 2: Curing of specimens shall be in accordance with Article 7.2; any option or alternate conditions will not be permitted.

NOTE 3: Section 8. Procedure, shall be strictly adhered to through and including Article 8.5. The test procedure will then be considered concluded.

NOTE 4: Adhesive Loss Maximum 15% of surface area and no cohesive failure after 10 cycles at standard conditions.

1011-8.02 Packaging and Marking:

The sealant shall be delivered in the manufacturer's original sealed container. Each container shall have attached, intact, the original manufacturer's label. The label shall be tamper-proof,

non-removable and shall be legibly marked with the manufacturer's name, the trade name of the sealer, the manufacturer's batch or production lot number, and the expiration date of the manufacturer's shelf life warranty. Sealant that has exceeded the shelf life warranty expiration date shall not be used unless it has been retested and recertified for adhesion in conformance with ASTM C719. The sealant may be recertified for a period not exceeding 6 months from the date of retesting. Retesting or replacement of the sealant will be at the subcontractor's option. Retesting will be at the subcontractor's expense. Failure to meet specification requirements shall not be cause for claim or extension of the contract. The subcontractor shall be held liable for all costs incurred in procuring and testing of materials that are found to be outside specification requirements.

1011-8.03 Field Performance:

The manufacturer of the joint sealant shall demonstrate satisfactory field performance in Arizona of less than 1% total failure (either within the material or the adhesive bond to the joint face) after one year of service, before the material shall be used.

1011-8.04 Sampling:

All sealant to be used on the project shall be stockpiled at the site at least forty-five (45) working days prior to use, or at least sixty (60) working days prior to use if stockpiled at the vendor's place of business. This will allow thirty-five (35) days for laboratory testing to determine compliance. Subsequent deliveries shall be placed in separate stockpiles. The Engineer shall be notified when each stockpile has been established and is ready to be sampled. Not less than one random sample of each lot or batch number (minimum of 10 lbs. per sample) shall be taken. No material shall be placed until the Engineer has approved the material for placement.

1011-8.05 Certification:

The subcontractor shall, at his expense, have the previously obtained sample tested by an independent laboratory. The testing laboratory shall be approved by the Engineer, shall be independent of the sealant manufacturer, and shall be under the supervision of a registered professional engineer. The subcontractor shall furnish to the Engineer certification by the approved testing laboratory that the production lot tested meets the specified requirements. A Certificate of Compliance and Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted.

SECTION 1012 GUARD RAIL MATERIALS

1012-1 General Requirements:

Certificates of Compliance conforming to the requirements of Subsection 106.05 of these specifications shall be submitted.

References to American Road and Transportation Builders Associations (ARTBA) in this section shall mean the latest edition and supplements to the publication "A GUIDE TO STANDARDIZED HIGHWAY BARRIER RAIL HARDWARE", ARTBA Technical Bulletin No. 268-B.

1012-2 Fasteners, Elements, and Posts:

Guard rail fasteners shall conform to the requirements of Table 1012-1. Guard rail elements shall conform to the requirements of Table 1012-2. Guard rail posts shall conform to the requirements of Table 1012-3.

All surfaces of guard rail elements which are exposed to traffic shall present a uniform, pleasing appearance and shall be free of scars, stains or corrosion.

1012-3 Miscellaneous Materials:

Nails shall be 16-penny common, galvanized.

Welded wire fabric for the breakaway cable terminals and the guard rail anchor assembly shall be 6x6-W2.9xW2.9 and shall conform to the requirements of AASHTO M 55.

Concrete for the breakaway cable terminals and guard rail anchor assemblies shall conform to the requirements of Section 1006 of these specifications for Class S concrete of the strength shown on the project plans.

Polystyrene filler for the breakaway cable terminals and the guard rail anchor assembly shall be 1/2" thick insulation sheets.

The metal used to manufacture reflector tabs shall be either 3003-HI4 aluminum strip 0.063" ± 0.004 inch thick or steel strip 0.078" ± 0.008 inch thick with a G-90 galvanized coating. The reflector material shall be high-reflectivity sheeting, either silver-white or yellow and shall conform to the requirements of Section 1007 of these specifications. The reflective sheeting shall adhere to the metal tabs.

Nuts, bolts, and washers to be used in installations for which the details are not shown on the project plans nor in the ARTBA publication shall conform to the requirements of ASTM A 307 and be galvanized in accordance with the requirements of ASTM A 153, Class

C, and conform to the dimensional requirements of the American National Standards Institute.

Structural steel shapes, plates, bars and strips used in fabrication of hardware and all miscellaneous steel shall conform to the requirements of ASTM A 36 and shall be galvanized in conformance with the appropriate requirements of AASHTO M 111 and AASHTO M 232. They shall meet the dimensional requirements of The American Institute of Steel Construction.

Round and square structural steel tubing shall conform to the material requirements of either ASTM A 500 or ASTM A 501 and shall be galvanized in accordance with the requirements of AASHTO M 180, Type 1.

The tubular thrie beam shall be fabricated from thrie beam elements conforming to the requirements of ARTBA, RE-63, Class A, Type 1.

Where galvanizing has been damaged, the coating shall be repaired by painting with two coats of Paint No. 4.

TABLE 1012-1
GUARD RAIL FASTENERS

Part Name	ARTBA Drawing No.	Specification
Button Head Bolt (5/8") and Recess Nut	F- 3	
Hex Bolt		ASTM A 307
Heavy Hex Structural Bolt		ASTM A 325, Type I
Hex Nut and Hex Thick Nut		ASTM A 563, Grade A
Heavy Hex Nut		ASTM A 563, Grade DH
Heavy Hex Screw		ASTM A 449
Plain Washer (Type A) and Plain Washer (Wide) (Type A)		ASTM F 436 and ANSI B 27.2
Rectangular Plate Washer	F-12	AASHTO M 180, Class A, Type 1
BCT Sleeve	F-34	
BCT (Timber) Bearing Plate	F-36	
BCT Cable Assembly	F-37	AASHTO M 30, Class C
BCT Cable End Plate	F-38	
BCT (Steel) Tapered Washer	F-40	ASTM F436
BCT (Steel) Bearing Plate	F-41	
Flat Plate Washer	F-43	ASTM F436
High Strength Anchor Bolt (3/4")	F-44	

TABLE 1012-2
GUARD RAIL ELEMENTS

Part Name	ARTBA Drawing No.	AASHTO M180 Designation
W Beam	RE- 3	Class A, Type I
W Beam Back-Up Plate	RE- 4	Class A, Type 1
W Beam End Section (Flared)	RE- 5	Class A, Type 1
W Beam End Section (Buffer)	RE- 7	Class A, Type 1
W Beam Terminal Connector	RE- 8	Class A, Type I
Rub Rail and Splice Plate	RE- 9	
Thrie Beam	RE-63	Class A, Type I
Thrie Beam Back-Up Plate	RE-64	Class A, Type I
BCT Anchor Plate	RE-71	

TABLE 1012-3
GUARD RAIL POSTS

Part Name	ARTBA Drawing No.	Specification
G4 and MB4 Structural Shape Post and Block	P-10	
G4 and MB4 Bent Plate Post and Block (Steel)	P-52	ASTM A 570, Grade 40
G9 and MB9 Structural Shape Post and Block	P-54	
G9 and MB9 Bent Plate Post and Block (Steel)	P-56	ASTM A 570, Grade 40
BCT Terminal Post (Timber)	P-59	ARTBA P-59 (for dimension only)
BCT Terminal Post (Steel)	P-60	ASTM A 500, Grade B
BCT Terminal Post Foundation (Steel)	P-61	

Timber for posts and blocks shall be rough sawn (unplanned) or S4S with the nominal dimensions indicated. Any species or group of woods graded in accordance with the requirements for Timber and Posts of the Western Wood Products Association may be used.

Timber shall be either Select Structural or No. 1 and the stress grade shall be as follows:

6" x 8"	Post and Block	1200 psi
8" x 8"	Post and Block	900 psi
10" x 10"	Post	900 psi

When the project plans show guard rail systems using 8" x 8" timber posts and blocks, the subcontractor may use 8 1/4" x 8 1/4" nominal size posts and blocks with a stress grade of 825 psi.

At the time of installation, the dimensions of timber posts and blocks shall vary no more than plus or minus 1/2 inch from the nominal dimensions as hereinbefore specified.

The size tolerance of rough sawn blocks in the direction of the bolt holes shall vary no more than plus or minus 3/8 inch. Only one type of post and block shall be used for any one continuous length of guard rail.

All timber shall have a preservative treatment in accordance with the requirements of AASHTO M 133.

SECTION 1013 PEA GRAVEL

1013-1 General Requirements:

The pea gravel aggregate utilized for the Vehicle Trap located at the Cornering Course shall conform to the details shown on the Project Plans and the requirements of these specifications. Mill tailings or material from mine dumps shall not be used in production of the pea gravel aggregate.

1013-2 Storage:

When aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and level. The bottom one (1) foot layer of aggregate shall not be disturbed or used.

1013-3 Material:

Pea gravel aggregate shall consist of clean uncrushed,naturally rounded gravel, or other approved inert material of similar characteristics, having hard, strong and durable pieces free of clay and other deleterious substances. The aggregate shall be washed.

The pea gravel aggregate gradation shall conform to the following:

Screen or Sieve Size	% Passing
3/4	100
3/8	70-100
No. 4	45-75
No. 8	30-60
No. 16	20-45
No. 30	10-30
No. 50	0-15
No. 100	0-5

NOTE: Alternate pea gravel gradation may be used with Engineering approval.

The percent of wear of pea gravel aggregate at five-hundred (500) revolutions, when tested in accordance with the requirements of AASHTO T 96, shall not exceed forty (40).

1013-4 Construction Requirements:

The pea gravel vehicle pit aggregate shall be placed and spread, uncompacted to the lines and grades shown on the plans, by equipment and methods approved by the Engineer. To insure that the

pea gravel vehicle pit aggregate remains uncompacted, no equipment or traffic will be permitted on the finish vehicle pit bed, unless otherwise permitted by the Engineer.

1013-5 Method of Measurement:

Pea gravel aggregate shall be measured by the ton installed complete in place.

SECTION 1100 SPECIAL ROADS

1100-1 General:

Special roads designated here consist of the following:

(A) Ride and Vibration Surface Road:

(1) High Speed Track:
- Choppy Road (Type 1 & 3)
- Waved and Repaired Concrete Road
- Waved and Repaired Asphalt Road

(2) Cornering Course:
- Rough Asphalt Road (No. 1, 2 & 3)
- Winding Road (No. 1 & 2)
- Low Friction Road

(3) Loop Road A:
- Chip Seal Surface Road
- Fine Texture Surface Road

(B) Others:

(1) High Speed Track:
- Curve Section
- Tangent Section

(2) Steep Grade

(3) Dirt Track

(4) Rampway and Bank Road

These roads have specific requirements for their construction, material, testing, and tolerance in addition to the requirements specified in the previous sections 401, 404 and 416 of these specifications.

The specific requirements of material and construction for these roads are described herein, and in Appendix A of these specifications. The subcontractor must meet these tolerances or rework shall be made at no additional expense to the Owner.

Proof rolling on subgrade and aggregate base course shall be required for all test tracks except the Dirt track. If any significant deflection is found visually during the rolling, a Benkelman Beam shall be used to check the deflection except the curve section of the High Speed track.

The subcontractor shall submit the construction execution plan for special roads, prior to the start of construction, for Engineer's approval

Quality Control flow diagrams for special roads are specified in Appendix B of these specifications. The flow diagram indicates the quality control procedures for all major items of special roads, the responsible parties for each activity and the required documents to be prepared by the subcontractor. These are above and beyond the Quality Control requirements specified in Section 106 of these specifications.

The subcontractor shall comply with the procedures and prepare the quality control plan.

1100-2 Hold Point Inspection:

Due to the specific purposes, uses, finishes and the strict tolerances involved with the Special Roads, hold point inspections will be held to:

A. Verify the quality of the workmanship of the subcontractor.

B. Review the subcontractor's work procedures.

C. Perform a complete independent verification of the tolerances.

The construction activities will stop for hold point inspections. Construction shall not restart until all action items are satisfactorily resolved by the subcontractor. The subcontractor should allow a three day work stoppage in paving activities for this purpose.

A. High Speed Track Curve Section

1. The first 2600' of the asphaltic concrete layer at the transition section, at two transitions.

2. Location to be specified later pending the subcontractor work schedule.

B. Ride and Vibration Surface Roads

1. Locations to be specified later pending the subcontractor work schedule.

2. The first 300' of asphaltic concrete pavement layer.

3. The first 300' of portland cement concrete pavement layer.

If any nonconformances are identified, the subcontractor shall be directed to change/modify their work procedures. The defective work shall be reworked.

1100-3 Trial Runs:

After the acceptance of portions of the scope or the total scope of work for the special roads, trial runs will be performed by the Owner. The intent of these runs is to verify that the finished product satisfies the intended testing purpose.

After the trial runs, the Engineer may direct the subcontractor to revise the road profile. The special road surfaces requiring a trial run and the schedule of the trial runs are specified in each applicable section.

1100-4 Profile Measurements:

The finished surface elevations, smoothness, matching the specified profiles, etc., are extremely important to achieve acceptable special roads. For this purpose extensive measurement will be taken as described in Appendices A and C of these specifications.

The smoothness of the surfaces shall be measured by 3-meter and 8 meter profilographs. The ride and vibration surface road profiles shall be measured by a profilograph that has fixed feet at both ends, a sliding type measuring wheel and a recording device.

These measurements may be labor intensive. The subcontractor should make allowances for this purpose.

1100-5 Submittals:

The additional quality control submittals for the special surfaces have specific requirements for form and format. These are provided in Appendices A and C of these specifications.

For the ride and vibration surfaces, the submittal should show both the design and as constructed profiles (see example in Appendix C). In addition, numerical values and statistical analysis results should be submitted. The frequency of the measurements are given in Appendix A of these specifications.

These data are also required in electronic form (e.g. floppy disk).

1100-6 Temperature Monitoring:

In order to maintain the design profile after compaction and to achieve the degree of compaction, the subcontractor shall develop and submit for approval a plan which includes temperature monitoring during hauling and placement of asphaltic concrete. This applies to sections 1100, 1103, 1106, 1107, 1108, and 1109 of these specifications. The construction shall not start before the approval of the plan(s).

1100-7 Sample profiles:

The profiles provided as a part of the request for proposal are typical samples. Presently, investigations are being performed to select and process the final data for construction. The numerical data for construction will be finalized in the first quarter of 1992.

1100-8 Proof Rolling

Appendix A defines those special roads that shall be proof rolled by a twenty (20) ton tire roller. The acceptance limits are also given in Appendix A.

SECTION 1101 CHOPPY ROAD

1101-1 Description:

The work under this section shall comply with Section 401 of these specifications and the requirements specified in this section.

Choppy Road consists of three (3) types, Number one (1) & two (2) are located in the High Speed Track as shown on the project plans. Choppy Road number three (3) is located in the cornering course.

Basic characteristics of the profile are random, but it has a continuous similar pattern.

The configuration of the transverse section surface is straight.

1101-2 Material:

Portland cement concrete shall comply with the following requirements in addition to the requirements of Section 401 of these specifications.

Slump tests as specified in ASTM C 143 shall be performed twice a day and variance from the design value shall be less than 1.5 centimeters from the specified mix design value.

Entrained air quantity specified in ASTM C 231 shall be tested twice a day and its variance from the specified mix design value shall be less than one percent.

Flexural strength specified in ASTM C 78 shall be tested once a day and its twenty-eight (28) days strength shall be greater than six-hundred-forty (640) psi.

The Subcontractor can use additives to superplasticize the cement after getting approval from the Engineer.

Each form shall be rigid plywood or steel and its accuracy of cut shall be less than 0.5 mm.

It is recommended that the forms be manufactured by using a numerically controlled router to get the required accuracy.

1101-3 Construction Requirements:

The Subcontractor shall conform to the requirements in Section 401 of these specifications unless otherwise specified herein.

1101-3.01 Forms:

The Subcontractor shall use fixed forms for the pavement at both edges of the lane as specified herein. The forms shall be set with an accuracy of less than 0.5 mm.

1101-3.02 Concrete Placement:

The finished pavement surface shall meet the tolerance of the finish shown in Appendix A of these specifications.

The elevation of the concrete surface shall be surveyed by a micro level that has a 0.1 mm. accuracy.

1101-3.03 Joints:

a) Choppy Roads number one (1) and two (2)

Construction joints and expansion joints shall be placed as required and as shown on the project plans.

b) Choppy Road number three (3)

Construction joints shall be provided every twenty-five (25) feet. (See drawing O.V.-20.0). An expansion joint shall be provided in lieu of a construction joint at or around the middle of the road. (See drawings O.V.-20.0).

1101-3.04 Lot-by-Lot Construction:

The road shall be constructed lot by lot as shown on the project plans. Choppy Road number three (3) is divided into two (2) lots each two-hundred-fifty (250) feet long. After one (1) lot is completed, all quality control requirements specified in the specifications shall be checked for acceptance of the work.

1101-3.05 Trial Run:

A trial run shall be carried out at each lot after curing.

1101-4 Construction Profile Measurement:

The finished surface profile shall be measured by the profilograph on the lines that are 2.5 feet from the center line. Its tolerance, difference between design value and actual value, is specified in Appendix A of these specifications.

SECTION 1102 WAVED AND REPAIRED CONCRETE ROAD:

1102-1 Description:

The work under this section shall comply with Sections 401, 406 and 416 of these specifications and the requirements specified in this section.

The road is located in the High Speed Track as shown on the project plans.

The characteristic of the road is such that it has asphalt concrete patches on the portland cement concrete pavement.

1102-2 Material:

The material shall comply with Sections 401, 404, 406 and 416 of these specifications.

1102-3 Construction Requirements:

The construction shall comply with Sections 401, 404, 406 and 416 of these specifications, unless otherwise specified herein.

After the concrete pavement is completed, the concrete surface shall be scraped two (2) inches deep at specified locations and asphalt concrete shall be used to patch these areas. Tack coat shall be sprayed on the concrete surface, prior to patching. The patches shall be every ten (10) feet, and the size shall be four (4) feet by seven-point-five (7.5) feet.

The tolerance of the patchwork shall be as specified in Appendix A of these specifications.

1102-4 Trial Run:

All of these patches will be checked by trial runs of the test car.

1102-5 Demonstration Patch Pattern:

The Subcontractor shall construct a demonstration patch pattern to be provided later on a designated asphalt concrete road before the patching work starts.

The patches shall be placed on the road surface and shall not require scraping.

The demonstration area shall be five-hundred (500) feet long.

Patched asphalt concrete shall be removed from the demonstration

area after the evaluation is finished.

The evaluation will be done by a trial run by the Owner.

SECTION 1103 WAVED AND REPAIRED ASPHALT ROAD:

1103-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications and the requirements specified in this section.

The road is located in the High Speed Track as shown on the project plans.

The road profile characteristics are random shaped along the longitudinal section and straight along the transverse section. The surface has small waves longitudinally.

1103-2 Materials:

The materials for the work shall comply with Sections 404, 406 and 416 of these specifications and the following requirements.

The degree of compaction of the asphalt concrete shall be checked by the nuclear method specified in AASHTO T238. For the purpose of calibration a comparison shall be made between a core sample test and the nuclear method. The core shall be taken one foot inside of the inner line of the low speed lane.

1103-3 Construction Requirements:

Subgrade and Aggregate Base Course (ABC) shall be constructed without undulation to follow the surface profile. All asphaltic concrete courses shall be paved by the designated paver and manually.

Manual work will be required to make small waves and depression before compaction.

Shot blasting, sand blasting or a similar method shall be used for surface finishing to meet the surface roughness specified in Appendix A.

1103-3.01 Lot by Lot Construction:

The road shall be constructed lot by lot as shown on the project plans.

An inspection to check required tolerances shall take place after completion of the second lift and after completion of the surface asphaltic concrete lift in the first lot and the completion of the finished surface in the second lot.

1103-3.02 Trial Run:

A trial run will be carried out on the above area.

1103-3.03 Profile Measurement:

The finished surface of each AC pavement shall be measured by the Profilograph on the lines that are 2.5 feet from the center line of the lane. The tolerances are specified in Appendix A of these specifications.

SECTION 1104 ASPHALT CHIP SEAL ROAD

1104-1 Description:

The work under this section shall comply with Section 404, 406 and 416 of these specifications and the requirements specified in this section.

This road is located in Loop Road A as shown on the project plans.

1104-2 Materials:

All materials shall be as specified in Section 404, 406 and 416 of these specifications except, the aggregate for cover material shall be 1/4 inch size, and the gradation shall comply with the following:

Sieve Size	Percentage Passing
1/4"	100
No. 4	60 - 90
No. 8	0 - 30
No. 16	0 - 10
No. 30	0 - 5
No. 200	0 - 3

1104-3 Construction Requirements:

The construction shall comply with Section 404, 406 and 416 of these specifications.

SECTION 1105 FINE TEXTURE SURFACE ROAD

1105-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications in addition to the requirements specified in this section.

The road is located in Loop Road A as shown on the project plans and has a very fine textured surface.

1105-2 Material:

The materials for this work shall comply with Sections 404, 406 and 416 of these specifications and the following requirements. The subcontractor shall provide fine aggregate to meet texture tolerance requirements as specified in Appendix A of these specifications.

1105-3 Construction Requirements:

The requirements for the construction shall comply with Sections 404, 406 and 416 of these specifications and the following requirements:

The subcontractor shall demonstrate that the surface course can meet the texture requirement by using surface course mix design material on the second lift for a distance of 500'.

1105-3.01 Trial Run:

A trial run will be carried out on the demonstration area as mentioned above and on the surface course.

1105-3.02 Construction Profile Measurement:

The profile of the upper three asphalt lifts shall be measured by the 8 meter profilograph, provided by the Engineer.

SECTION 1106 ROUGH ASPHALT ROAD NO. 1

1106-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications, in addition to the requirements specified in this section.

The road is located in the Cornering Course as shown on the project plans. It has small bumps that cause body shake and small shocks to the car.

The profile of the road is random in both longitudinal and transverse directions.

1106-2 Material:

The material for this work shall comply with Sections 404, 406 and 416 of these specifications, in addition to the following requirements:

1106-3 Construction Requirements:

The requirements for the construction shall comply with Section 1103 of these specifications except the following:

1106-3.01 Lot by Lot Construction and Trial Run:

The road is divided into two (2) lots, each two-hundred-fifty (250) feet long.

At the first lot, after the surface course is finished, the Owner will take a trial run by car and check whether the surface can give the expected reaction. The trial run will be carried out on the finished surface course of the remaining lots.

1106-3.02 Construction Profile Measurement:

The profile of the asphaltic concrete surfaces shall be measured by be profilograph along the lane at the wheel positions as specified on the project plans.

SECTION 1107 ROUGH ASPHALT ROAD NO. 2

1107-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications, in addition to the requirements specified in this section.

The road is located in the Cornering Course as shown on the project plans. It has cracks and set-up joints that cause severe shocks, noise and body shakes to cars.

The profile of the road is at random in the longitudinal direction and straight in the transverse direction.

1107-2 Material:

The material for this work shall comply with Sections 404, 406 and 416 of these specifications.

1107-3 Construction Requirements:

The requirements for the construction shall comply with Section 1103 of these specifications, and the requirements specified in this Section.

A total of twenty (20) cracks, depth greater than or equal to three-eighths (3/8) inches and widths varying form one-eighth (1/8) to one (1) inch wide shall be placed. The cracks will be single line configuration or a net configuration. Construction may be done by cutting, pressing or an appropriate alternate method. The configuration and location of cracks will be provided later.

The tolerance for the finished surface and the cracks are specified in Appendix A of these specifications.

1107-3.01 Lot by Lot Construction and Trial Run:

At the first two-hundred-fifty (250) feet long asphaltic concrete surface course section, the trial run will be carried out.

1107-3.02 Construction Profile Measurement:

The finished surface of asphaltic concrete shall be measured by the profilograph at the wheel positions as shown on the project plans.

SECTION 1108 ROUGH ASPHALT ROAD NO. 3

1108-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications, in addition to the requirements specified in this section.

The road is located in the Cornering Course as shown on the project plans. The road has cracks that cause body shake, shock, noise and booming noise to cars.

The profile of the road is at random in both the longitudinal and transverse directions.

1108-2 Material:

The material for this work shall comply with Sections 404, 406 and 416 of these specifications.

1108-3 Construction Requirements:

The requirements for the construction shall comply with Section 1103 of these specifications and the following requirements:

The asphaltic concrete will be paved by the designated paver. The cracks and area adjacent to the cracks shall be paved manually.

Shot blasting, sand blasting or a similar method shall be used for surface finishings to meet the surface texture specified in the specification.

There will be cracks. See Section 1107.

The tolerance of the finished surface, including cracks, is specified in Appendix A of these specifications.

1108-3.01 Lot by Lot Construction and Trial Run:

At the completion of the first three-hundred (300) feet long asphaltic concrete surface course section, a trial run will be carried out.

1108-3.02 Construction Profile Measurement:

The finished surface of asphaltic concrete shall be measured by the profilograph at the wheel positions and at two (2) others designated later.

SECTION 1109 WINDING ROAD NO. 1 & NO. 3

1109-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications, in addition to the requirements specified in this section.

The road is located in the Cornering Course as shown on the project plans. The road has a wave surface which causes bounce, pitting and bottoming to cars. It consists of two (2) types of waved shapes. The first wave (No. 1) is a single positive uneven type, the second wave (No. 3) is a single negative uneven type and the third wave is a subtle continuous wave.

The profile of the two (2) types of roads is random in the longitudinal direction and straight in the transverse direction.

1109-2 Material:

The material for this work shall comply with Sections 404, 406 and 416 of these specifications.

1109-3 Construction Requirements:

The requirements for the construction shall comply with Section 1103 of these specifications and the following requirements.

The Subcontractor shall construct subgrade as well as aggregate base course in the undulated profile to meet the final constructed profile.

1109-3.01 Trial Run:

A trial run will be taken by the Owner on the second lift and finished surface of the asphaltic concrete of the two (2) types of the Winding Road.

The tolerance of the finished surface is specified in Appendix A of these specifications.

1109-3.02 Construction Profile Measurement:

All asphaltic concrete lifts shall be measured by the profilograph.

SECTION 1110 WINDING ROAD NO. 2

1110-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications, in addition to the requirements specified in this section.

The road is located in the Cornering Course as shown on the project plans. The road has random waves that cause bounce, pitting and bottoming to cars.

The profile of the road is random in the longitudinal direction and straight in the transverse direction.

1110-2 Material:

The material for this work shall comply with Sections 404, 406 and 416 of these specifications.

1110-3 Construction Requirements:

The requirements for the construction shall comply with Section 1103 and the requirements specified herein.

The subcontractor shall construct subgrade as well as aggregate base course in the undulated profile to meet the final constructed profile.

1110-3.01 Trial Run:

A trial run will be carried out on the second lift of the asphaltic concrete surface and the finished surface course.

1110-3.02 Profile Measurement:

All asphaltic concrete surface lifts shall be measured by the profilograph.

SECTION 1111 LOW FRICTION ROAD

1111-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications, in addition to the requirements specified in this section.

The road is located in the Cornering Course as shown on the project plans. The road has a low friction surface that shall meet the tolerances as specified in Appendix A of these specifications.

1111-2 Material:

The material for this work shall comply with Sections 404, 406 and 416 of these specifications, and the following requirements:

(A) Aggregate

Aggregate Material for Low Friction Road:

Aggregate used for the low friction surface course shall be the following:

(1) Gradation

Sieve Size	Percent Passing
3/4"	100
1/2"	95-100
No. 4	23-45
No. 8	15-30
No. 30	8-20
No. 50	4-15
No. 100	4-10
No. 200	2-7

(2) Coarse Aggregate Characteristics (aggregate that remains on #8 sieve):

(a) Laboratory Determined Polished Stone Value (PSV)

$$PSV \leq 32$$

(b) Sunshine Weathering

Value difference between, before and after the test in less than four (4). (ASTM G 23)

(c) Hardness

Abrasion value by Method of Test for Abrasion of Coarse Aggregate by use of the Deval Machine is less than two (2) percent.

(B) Asphalt

Rubberized asphalt or thermoplastic polymer asphalt shall be used for the surface course of the road.

The properties of the asphalt shall be as follows:

Penetration (77°F)	50-70
Softening point, °F	122.0 - 140.0
Ductility (45°F), cn	20 or more
Flash Point, °F	500 or more
Weight change in thin film over test	0.6% or less
Penetration change in thin film over test	55% or more
Toughness, kgf. cm	60 or more
Tenacity, kgf. cm	30 or more

(C) Additives

Mineral powder made by crushing limestone or igneous rock and hydrated lime, shall be used as additives.

The grading standards of the mineral filler shall be:

#30	100%
#100	90-100
#200	70-100

(D) Asphalt Mixture

Asphalt mixture shall follow these requirements:

Asphalt Quantity	3.5 - 5.5%
Marshal Stability	350 Kg or more
Flow (1/10 mm)	20-40

1111-3 Construction Requirements:

The construction shall comply with the following procedure and method:

- Mixing of designated aggregate, asphalt and additives.
- Spreading the mixture by an asphalt finisher.

- One (1) week later, the surface shall be blasted by high pressure water to clean the asphalt from the aggregate.

- The jet washer shall inject 1500 kg/cm^2 or more water with at least five (5) liter per minute from six (6) nozzles. Standard duration for cleaning the surface is 1/7.5 hour per one (1) square meter.

- Grinding or polishing the aggregate until getting the specified slide resistance by the polisher with #1500 and #4000 powder. Standard polishing number is fifteen (15) times.

The details of the construction procedure to be followed will be provided later.

The outside marginal strip shall use the same material as the low friction road. However, the outside marginal strip shall not be surface treated.

SECTION 1112 STEEP GRADE

1112-1 Description:

The work under this section shall comply with Sections 401, 404, 406, 416 and 1104 of these specifications.

1112-2 Material:

The material for this work shall comply with Sections 401, 404, 406, 416 and 1104 of these specifications.

1112-3 Construction Requirements:

The requirements for the construction shall comply with Sections 401, 404, 406, 416 and 1104 of these specifications and as per the project plans and Appendix A of these specifications.

SECTION 1113 HIGH SPEED TRACK ROAD

1113-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications, in addition to the requirements specified in this section.

The road consists of tangent portion and curve portion (Transition and Simple Curve). The tangent portion has two (2) different structures and requirements at north and south tangent as shown in the project plans.

The characteristic of the road is surface smoothness defined as PrI and TCR in the Appendix A of these specifications.

Definitions of PrI and TCR are shown in Appendix D of these specifications.

1113-2 Materials:

The materials for this work shall comply with Sections 404, 406 and 416 of these specifications.

1113-3 Construction Requirements:

The asphalt concrete surface is required to have a very smooth finish as specified in Appendix A of these specifications.

Due to this strict smoothness, the subcontractor shall make careful plans to execute the pavement work.

Asphalt concrete shall be compacted to a minimum of ninety-six (96) percent of maximum laboratory density at the low and the middle speed lanes, and to a minimum of ninety-four (94) percent of maximum laboratory density at the high speed lane at the curve section.

At the tangent section, the compaction degree required for all lanes is a minimum of ninety-six (96) percent of maximum laboratory density.

The following are minimum requirements for getting smoothness.

(a) Aggregate Segregation Avoidance of Aggregate Base Course (ABC) at the Curve Section
(b) Segmented Asphalt Finisher and Roller to match the curve at the Curve Section
(c) Supporting Machine for the Curve Section
(d) Longitudinal and Lateral Joint
(e) Smooth Material Supply to the Asphalt Finisher

(f) Uninterrupted continuous paving activity.

The asphalt paving machine for the pavement at the transition zone shall be segmented to meet the section configuration change. The allowable difference between the design curve and the segment line of the paver shall be less than three (3) mm. The paver shall be controlled so as to be kept on accurate track and to get asphalt surface smoothness. A special roller shall be used so as not to displace or permanently mark the asphalt concrete surface during the rolling operation.

While negotiating the curve portion, a supporting machine, to hold the paver and the roller, shall be utilized and its operation shall be controlled so as to run concurrent with the paver or rollers.

It is recommended to use both rubber tired rollers and steel wheel rollers for compaction.

Minimum two (2) foot wide asphaltic concrete paving at high speed lane side on bank road shall be carried out concurrently with High Speed Track paving.

1113-3.01 Smoothness Measurement:

PrI and TCR are measured by three (3) meter and eight (8) meter profilograph provided by the Engineer. The profile shall be measured by the subcontractor and submitted to the Engineer. The tolerance and frequency are as specified in Appendix A of these specifications.

SECTION 1114 DIRT TRACK

1114-1 Description:

The work under this section shall comply with Sections 201, 202, and 203 of these specifications in addition to the requirements specified in this section.

1114-2 Material:

The material for this work shall comply with Sections 201, 202, and 203 of these specifications.

1114-3 Construction Requirements:

The requirements for the construction shall comply with Sections 201, 202, and 203 of these specifications.

SECTION 1115 LOOP ROAD A

1115-1 Description:

The work under this section shall comply with Sections 404, 406 and 416 of these specifications, in addition to the requirements specified in this section.

The road consists of a brake test section and a straight section. It requires a very smooth surface, as does the High Speed Track South Tangent as specified in Appendix A of these specifications.

1115-2 Material:

The material for this work shall comply with Sections 404, 406 and 416 of these specifications, in addition to the following requirements:

The asphalt mixture shall be such that it will produce the surface texture specified in Appendix A.

1115-3 Construction Requirements:

The requirements for the construction shall comply with the requirements of the High Speed Track South Tangent section.

Asphaltic concrete shall be compacted to a minimum of ninety-six (96) percent of maximum proctor density.

The tolerance is specified in Appendix A of these specifications.

SECTION 1116 ROUGH CONCRETE ROAD No. 1 and No. 2

1116-1 Description:

The work under this section shall comply with Section 401 of these specifications, in addition to the requirements specified in this section.

The road is located in the Cornering Course as shown on the project plans. The road No. one (1) has continuous subtle wave surface which causes bounce and bottoming to cars, and the road No. two (2) has gaps at the joints which causes shocks and tire noise to cars.

The profile of the roads are random in the longitudinal direction and straight in the transverse direction.

1116-2 Material:

The material shall comply with 401 and 1101 of these specifications.

1116-3 Construction Requirements:

The construction shall comply with Sections 401 and 1101, unless otherwise specified herein.

1116-3.01 Joints:

Construction joints shown in "(4) Joint Detail" on OV-20.0 of the project plan shall be provided at every fifty (50) feet at Rough Concrete Road No. one (1).

One joint located middle of the road shall be converted to Expansion Joint shown in "(4) Joint Detail" on the project plan OV-20.0.

Between each construction joint, there shall be two (2) saw cut joints to simulate road cracking. The width of the saw cut joints shall vary from one-forth (1/4) inch to seven-eighth (7/8) of an inch. The depth shall be equal to or greater than three-eighth (3/8) of an inch.

The exact location and the width of saw cuts shall be provided later together with the profile data.

In Rough Concrete Road No. two (2), construction joints shown in "(4) Joint Detail" on the project plan OV-20.0 shall be provided perpendicularly every fifteen (15) feet. One joint located middle of the road shall be converted to an expansion joint shown in "(4) Joint Detail" on the project plan OV-20.0.

1116-3.02 Lot-by-Lot Construction:

The roads shall be constructed lot by lot. Each road is divided into two (2), two-hundred-fifty (250) feet long sections.

After first lift is completed, all quality control requirements specified in the specifications shall be checked for acceptance of the work.

1116-3.03 Trial Run:

A trial run shall be carried out at each lot after curing.

1116-4 Construction Profile Measurement:

The finished surface profile shall be measured by the profilograph on the lines that are 2.5 feet from the center line. The acceptance criteria is specified in Appendix A of these specifications.

SECTION 1201 BASIC ELECTRICAL REQUIREMENTS

1201-1 Description:

Basic Electrical Requirements specifically applicable to Sections 1201-1214 of these specifications, in addition to Construction Subcontract General Conditions and Special Conditions.

1201-2 Materials:

Not required.

1201-3 Construction Requirements:

1201-3.01 Work Sequence:

Install work in phases to accommodate Owner's requirements during the construction period coordinate electrical schedule and operations with Owner.

1201-3.02 Alternates:

Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement.

Coordinate related work and modify surrounding work as required.

1201-3.03 References:

A. ANSI/NFPA 70 - National Electrical Code.

B. ANSI/IEEE C2 - National Electrical Safety Code.

1201-3.04 Submittals:

Submit under provisions of Section 105 of these specifications.

Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittals.

Mark dimensions and values in units to match those specified.

1201-3.05 Regulatory Requirements:

Conform to applicable Building Code for Maricopa County, Arizona.

Electrical: Conform to NFPA 70 and ANSI C2.

Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

Obtain permits and request inspections from authority having jurisdiction.

1201-3.06 Project/Site Conditions:

Install work in locations shown on Drawings, unless prevented by Project conditions.

Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other Sections. Obtain permission of Owner before proceeding.

1201-4 Method of Measurement:

Not required.

SECTION 1202 CONDUIT

1202-1 Description:

1202-1.01 Section Includes:

A. Metal conduit.

B. Liquidtight flexible metal conduit.

C. Nonmetal conduit.

D. Fittings and conduit bodies.

1202-1.02 Related Sections:

A. Section 1205 - Boxes.

B. Section 1206 - Grounding and Bonding.

C. Section 1207 - Electrical Identification.

1202-1.03 References:

A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.

C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

D. ANSI/NFPA 70 - National Electrical Code.

E. NECA "Standard of Installation."

F. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1202-1.04 Design Requirements:

Conduit Size: ANSI/NFPA 70.

1202-1.05 Submittals:

Submit under provisions of Section 105 of these specifications.

Product Data: Provide for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, nonmetallic conduit, fittings and conduit bodies.

1202-1.06 Project Record Documents:

Submit under provisions of Section 106 of these specifications.

Accurately record actual routing of conduits larger than 2 inches.

1202-1.07 Delivery, Storage and Handling:

Deliver, store, protect, and handle Products to site under provisions of Section 109 of these specifications.

Accept conduit on site. Inspect for damage.

Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

Protect PVC conduit from sunlight.

1202-1.08 Project Conditions:

Verify that field measurements are as shown on Drawings.

Verify routing and termination locations of conduit prior to rough-in.

Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

1202-2 Materials:

1202-2.01 Conduit Requirements:

Minimum Size: 3/4 inch unless otherwise specified.

Underground Installations: Use thickwall nonmetallic conduit.

Outdoor Locations, Above Grade: Use rigid steel.

1202-2.02 Metal Conduit:

Manufacturers:
1. Allied Tube & Conduit.
2. Triangle PWC, Inc.
3. Wheatland Tube Co.

Rigid Steel Conduit: ANSI C80.1.

Fittings and Conduit Bodies: ANSI/NEMA FB 1; all steel fittings.

1202-2.03 Liquidtight Flexible Metal Conduit:

Manufacturers:

1. Alflex-Corp.
2. Electri-Flex.
3. Universal Metal Hose.

Description: Interlocked steel aluminum construction with PVC jacket.

Fittings: ANSI/NEMA FB 1.

1202-2.04 Nonmetallic Conduit:

Manufacturers:

1. Carlon Products Corp.

Description: NEMA TC 2; Schedule 40 PVC.

Fittings and Conduit Bodies: NEMA TC 3.

1202-3 Construction Requirements:

1202-3.01 Installation:

Install conduit in accordance with NECA "Standard of Installation."

Install nonmetallic conduit in accordance with manufacturer's instructions.

Arrange supports to prevent misalignment during wiring installation.

Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

Arrange conduit to maintain headroom and present neat appearance.

Cut conduit square using saw or pipecutter; de-burr cut ends.

Bring conduit to shoulder of fittings; fasten securely.

Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations.

Install no more than equivalent of three 90-degree bends between boxes. Use factory elbows for bends in metal conduit larger than 2-inch size.

Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.

Provide suitable pull string in each empty conduit except sleeves and nipples.

Use suitable caps to protect installed conduit against entrance of dirt and moisture.

Ground and bond conduit under provisions of Section 1206 of these specifications.

Identify conduit under provisions of Section 1207 of these specifcations

1202-4 Method of Measurement:

Conduits will be measured by lineal foot for each conduit by type and trade size.

SECTION 1203 MEDIUM VOLTAGE CABLE

1203-1 Description:

1203-1.01 Section Includes:

A. Medium voltage cable.

B. Cable terminations.

1203-1.02 References:

A. ANSI/IEEE C2 - National Electrical Safety Code.

B. ANSI/NFPA 70 - National Electrical Code.

C. IEEE 48 - Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.

D. NEMA WC 8 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1203-1.03 Submittals:

Submit under provisions of Section 105 of these specifications.

Product Data: Provide for cable, terminations, and accessories.

Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.

Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1203-1.04 Project Record Documents:

Submit under provisions of Section 106 of these specifications.

Accurately record actual sizes and locations of cables.

1203-1.05 Operation and Maintenance Data:

Submit under provisions of Section 105 of these specifications.

Maintenance Data: Include instructions for testing and cleaning cable and accessories.

1203-1.06 Qualifications:

Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

Installer: Company specializing in installing Products specified in this Section with minimum three years documented experience.

1203-1.07 Delivery, Storage and Handling:

Deliver, store, protect, and handle Products to site under provisions of Section 109 of these specifications.

Accept cable and accessories on site in manufacturer's packaging. Inspect for damage.

Store and protect in accordance with manufacturer's instructions.

Protect from weather. Provide adequate ventilation to prevent condensation.

1203-1.08 Project Conditions:

Verify that field measurements are as shown on Drawings.

Verify routing and termination locations of cable bank prior to rough-in.

Cable routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

1203-2 Materials:

1203-2.01 Manufacturers:

A. Cablec Corp.

B. Okonite Co.

C. Pirelli Cable Corp.

1203-2.02 Medium Voltage Cable:

Description: NEMA WC 8; ethylene propylene rubber insulated cable.

Voltage: 15 kV, grounded.

Conductor: Copper, stranded, with extruded semiconducting shield.

Construction: Single conductor with metal tape insulation shielding.

Insulation Jacket: PVC, 175 mils minimum thickness.

1203-3 Construction Requirements:

1203-3.01 Examination:

Verify installation conditions.

Verify that conduit is ready to receive cable.

1203-3.02 Preparation:

Use swab to clean conduits before pulling cables.

1203-3.03 Installation:

Install cable, terminations, splices, and accessories in accordance with manufacturer's instructions.

Avoid abrasion and other damage to cables during installation.

Use suitable lubricants and pulling equipment.

Do not exceed cable pulling tensions and bending radius.

Ground cable shield at each termination and splice.

Install cables in manholes along wall providing longest route.

Arrange cable in manholes to avoid interference with duct entrances.

Fireproof cables in manholes using fireproofing tape in half-lapped wrapping. Extend fireproofing one inch into duct.

1203-3.04 Field Quality Control:

Field inspection and testing will be performed under provisions of Section 106 of these specifications.

Inspect exposed cable sections for physical damage.

Inspect cable for proper connections as shown on Drawings.

Inspect shield grounding, cable supports, and terminations for proper installation.

Perform DC high potential test of each conductor in accordance with NEMA WC 8.

Connect untested conductors in circuit to ground during test.

Apply test voltage in at least eight equal increments to maximum test voltage.

Record leakage current at each increment, allowing for charging current decay.

Hold maximum test voltage for ten minutes.

1203-3.05 Protection:

Protect installed cables from entrance of moisture.

1203-4 Method of Measurement:

Cables will be measured by 100 lineal foot for each cable by type and size.

SECTION 1204 BUILDING WIRE AND CABLE

1204-1 Description:

1204-1.01 Section Includes:

A. Building wire and cable.

B. Wiring connectors and connections.

1204-1.02 Related Sections:

A. Section 1202 - Conduit.

B. Section 1205 - Boxes.

C. Section 1207 - Electrical Identification.

1204-1.03 References:

ANSI/NFPA 70 - National Electrical Code.

1204-1.04 Qualifications:

Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1204-1.05 Project Conditions:

Verify that field measurements are as shown on Drawings.

Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1204-1.06 Coordination:

Determine required separation between cable and other work.

Determine cable routing to avoid interference with other work.

1204-2 Materials:

1204-2.01 Manufacturers - Building Wire and Cable:

A. Carol Cable Co.

B. Rome Cable.

C. Southwire.

1204-2.02 Building Wire and Cable:

A. Description: Single conductor insulated wire.

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation: ANSI/NFPA 70, Type THHN/THWN.

1204-2.03 Wiring Connectors:

Split Bolt Connectors:
1. Burndy Corp.
2. Panduit.
3. Thomas and Betts Corp.

Solderless Pressure Connectors:
1. Burndy Corp.
2. O/Z Gedney.
3. Thomas and Betts Corp.

Spring Wire Connectors:
1. Buchanan Construction Products.
2. Ideal Industries, Inc.
3. Thomas and Betts Corp.

1204-3 Construction Requirements:

1204-3.01 Examination:

Verify that interior of building has been protected from weather.

Verify that mechanical work likely to damage wire and cable has been completed.

1204-3.02 Preparation:

Completely and thoroughly swab raceway before installing wire.

1204-3.03 Installation:

Install products in accordance with manufacturers instructions.

Use solid conductor for feeders and branch circuits 10 AWG and smaller.

Use stranded conductors for control circuits.

Use conductor not smaller than 12 AWG for power and lighting circuits.

Use conductor not smaller than 14 AWG for control circuits.

Pull all conductors into raceway at same time.

Use suitable wire pulling lubricant for building wire 4 AWG and larger.

Use suitable cable fittings and connectors.

Neatly train and lace wiring inside boxes, equipment, and panelboards.

Clean conductor surfaces before installing lugs and connectors.

Make splices,taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

1204-3.04 Interface with Other Products:

Identify wire and cable under provisions of Section 1207 of these specifications.

Identify each conductor with its circuit number or other designation indicated on Drawings.

1204-3.05 Field Quality Control:

Perform field inspection and testing under provisions of Section 106.

Inspect wire and cable for physical damage and proper connection.

Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

Verify continuity of each branch circuit conductor.

1204-4 Method of Measurement:

Wire/Cable will be measured by 100 lineal foot for each wire/cable by type and size.

SECTION 1205 BOXES

1205-1 Description:

1205-1.01 Section Includes:

A. Wall and ceiling outlet boxes.

B. Pull and junction boxes.

1205-1.02 References:

A. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

B. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

C. ANSI/NFPA 70 - National Electrical Code.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1205-1.03 Project Conditions:

Verify field measurements are as shown on Drawings.

Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose.

1205-2 Materials:

1205-2.01 Outlet Boxes:

Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.

2. Concrete Ceiling Boxes: Concrete type.

Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

1205-2.02 Pull and Junction Boxes:

Sheet Metal Boxes: NEMA OS 1, galvanized steel.

Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box.

1. Material: Galvanized cast iron.

2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

Fiberglass Handholes: Die-molded fiberglass handholes.

1. Cable Entrance: Pre-cut 6 x 6 inch cable entrance at center bottom of each side.

2. Cover: Fiberglass weatherproof cover with nonskid finish.

1205-3 Construction Requirements:

1205-3.01 Installation:

Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

Install electrical boxes to maintain headroom and to present neat mechanical appearance.

Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

Use cast outlet box in exterior locations exposed to the weather and wet locations.

1205-4 Method of Measurement:

Boxes will be measured as a unit for each box by size and NEMA type.

SECTION 1206 GROUNDING AND BONDING:

1206-1 Description:

1206-1.01 Section Includes:

A. Grounding electrodes and conductors.

B. Equipment grounding conductors.

C. Bonding.

1206-1.02 References:

A. ANSI/NFPA 70 - National Electrical Code.

1206-1.03 Grounding Electrode System:

A. Ground ring.

B. Rod electrode.

1206-1.04 Performance Requirements:

Grounding System Resistance: 5 ohms.

1206-1.05 Submittals:

Test Reports: Indicate overall resistance to ground.

Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

1206-1.06 Project Record Documents:

Accurately record actual locations of grounding electrodes.

1206-1.07 Qualifications:

Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

1206-2 Materials:

1206-2.01 Rod Electrode:

Material: Copper-clad steel.

Diameter: 3/4 inch.

Length: 10 feet.

1206-2.02 Mechanical Connectors:

Material: Bronze.

1206-2.03 Exothermic Connections:

Manufacturers:

1. Cadweld.

1206-2.04 Wire:

Material: Stranded copper.

Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

1206-3 Construction Requirements:

1206-3.01 Installation:

Install Products in accordance with manufacturer's instructions.

Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.

Provide bonding to meet Regulatory Requirements.

1206-3.02 Field Quality Control:

Inspect grounding and bonding system conductors and connections for tightness and proper installation.

Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

1206-4 Method of Measurement:

Ground wire will be measured in 100 lineal feet for each conductor size. Ground rods will be measured as unit for each ground rod. Connections will be measured as unit for each connection made by type.

SECTION 1207 ELECTRICAL IDENTIFICATION

1207-1 Description:

1207-1.01 Section Includes:

A. Nameplates and labels.

B. Wire and cable markers.

C. Conduit markers.

1207-2 Materials:

1207-2.01 Nameplates and Labels:

Nameplates: Engraved three-layer laminated plastic, black letters on white background.

Locations:

1. Each electrical distribution and control equipment enclosure.

Letter Size:

1. Use 1/8 inch letters for identifying individual equipment and loads.

2. Use 1/4 inch letters for identifying grouped equipment and loads.

1207-2.02 Wire Markers:

Description: Cloth, tape, split sleeve, or tubing type wire markers.

Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

1207-2.03 Underground Warning Tape:

Description: 4 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

1207-3 Construction Requirements:

1207-3.01 Preparation:

Degrease and clean surfaces to receive nameplates.

1207-3.02 Application:

Install nameplate parallel to equipment lines.

Secure nameplate to equipment front using screws or adhesive.

Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

1207-4 Method of Measurement:

Equipment identification will be measured as a lump sum per each type of identification required.

SECTION 1208 DISTRIBUTION TRANSFORMERS

1208-1 Description:

1208-1.01 Section Includes:

A. Pole mounted distribution transformers.

B. Liquid filled pad mounted distribution transformer.

1208-1.02 Related Sections:

Section 1210 - Overhead Power Distribution: Poles and cutouts.

1208-1.03 References:

A. ANSI C57.12.20 - Requirements for Overhead Type Distribution Transformers, 500 kVA and Smaller: High-Voltage, 67000 Volts and Below; Low-Voltage, 15000 Volts and Below.

B. ANSI C57.12.22 - Requirements for Pad-Mounted, Compartmental- Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings; High Voltage, 34500 GrdY/19920 Volts and Below; 2500 kVA and Smaller.

C. ANSI/IEEE C57.12.90 - Test Code for Liquid-Immersed Distribution Power, and Regulating Transformers.

D. ASTM D877 - Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.

E. NEMA AB1 - Molded Case Circuit Breakers.

F. NEMA 260 - Safety Labels for Padmounted Switchgear and Transformers Sited in Public Areas.

1208-1.04 Submittals:

Submit shop drawings under the provisions of Section 105 of these specifications.

Submit shop drawings indicating outline dimensions, connection and support points, weight, specified ratings and materials.

Submit manufacturer's installation instructions under provisions of Section 105 of these specifications.

1208-1.05 Operation and Maintenance Data:

Submit operation and maintenance data under provisions of Section 105 of these specifications.

Include procedures for sampling and maintaining fluid, cleaning unit, and replacing components.

1208-1.06 Quality Assurance:

Manufacturer: Company specializing in distribution transformers with three (3) years documented experience.

1208-1.07 Delivery, Storage and Handling:

Store and protect products under provisions of Section 109 of these specifications.

1208-2 Materials:

1208-2.01 Manufacturers - Pole Mounted Transformers:

A. General Electric.

B. Square D Co.

C. Westinghouse Electric Corp.

1208-2.02 Pole Mounted Distribution Transformers:

Transformers: ANSI C57.12.20; single phase, oil-filled, self-cooled transformer with primary bushings.

Capacity: As indicated on Drawings.

Primary Voltage: 7.2 kV, provide standard primary taps, with externally operated tap changer.

Secondary Voltage: 120/240 volts.

Impedance: 2.0 percent.

Basic Impulse Level: 95 kV.

Temperature Rise: Sixty-five (65) degrees C above thirty (30) degrees C ambient.

Accessories: ANSI C57.12.20 standard accessories.

1208-2.03 Manufacturers - Pad Mounted Transformers:

A. General Electric.

B. Square D Co.

C. Westinghouse Electric Corp.

1208-2.04 Pad Mounted Transformers:

Liquid-filled Transformers: ANSI C57.12.22; three (3) phase, pad mounted, self-cooled transformer unit.

Capacity: As indicated on Drawings.

Primary Voltage: 12.47 kV, delta connected; provide standard primary taps, with externally operated tap changer.

Secondary Voltage: 480/277 volts, wye connected.

Impedance: Manufacturer's standards.

Basic Impulse Level: 95 kV.

Cooling and Temperature Rise; ANSI C57.12.22; Class OA. sixty-five (65) degrees C, self-cooled.

Liquid: Oil.

Accessories: ANSI C57.12.22 standard accessories and magnetic liquid level gage and dial type thermometer.

Primary Terminations: Bushing wells to ANSI/IEEE 386; provide three (3) for radial feed. Include bushings for insulated loadbreak connectors.

Other Accessories: Primary lightning arrestors.

1208-3 Construction Requirements:

1208-3.01 Examination:

Verify that pads and poles are ready to receive work.

Verify field measurements are as instructed by manufacturer.

Beginning of installation means installer accepts conditions.

1208-3.02 Installation:

Install in accordance with manufacturer's instructions.

Install safety labels to NEMA 260.

1208-3.03 Field Quality Control:

Field testing will be performed under provisions of Section 106 of these specifications.

Test dielectric liquid to ASTM D877, using 25,000 volts minimum breakdown voltage, after installation and before energizing from system.

Test transformer to ANSI/IEEE C57.12.90.

1208-3.04 Adjusting:

Adjust primary taps so that secondary voltage is within two (2) percent of rated voltage.

1208-4 Method of Measurement:

Pole mounted transformers will be measured as a unit for each transformer. Pad mounted transformers will be measured as a unit for each transformer. The concrete pads will be measured as a unit for each pad including concrete and reinforcing steel.

SECTION 1209 PAD-MOUNTED INTERRUPTER SWITCHGEAR

1209-1 Description:

1209-1.01 Section Includes:

Medium voltage interrupter switches.

1209-1.02 References:

A. ANSI/IEEE 24 - Performance Characteristics and Dimensions for Outdoor Apparatus Bushings.

B. ANSI/IEEE 37.20 - Switchgear Assemblies, Including Metal-Enclosed Bus.

C. IEEE 48 - Test Procedures and Requirements for High-Voltage AC Cable Terminations.

D. ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment.

1209-1.03 Submittals:

Submit product data under the provisions of Section 105 of these specifications.

Submit product data for components and accessories.

Submit manufacturer's installation instructions under provisions of Section 105 of these specifications.

1209-1.04 Operation and Maintenance Data:

Submit operation and maintenance data under provisions of Section 105 of these specifications.

Include fuse replacement, adjustment, and lubrication instructions.

1209-1.05 Quality Assurance:

Manufacturer: Company specializing in medium voltage interrupter switches with three years documented experience.

1209-1.06 Delivery, Storage and Handling:

Deliver products to site under provisions of Section 109 of these specifications.

Store and protect products under provisions of Section 109 of these specifications.

Accept interrupter switches on site and inspect for damage.

1209-1.07 Extra Materials:

Submit maintenance materials under provisions of Section 105 of these specifications

Submit two insulated-handle tools designed for pulling fuses.

Provide two sets of spare fuses of each size and rating.

1209-2 Materials:

1209-2.01 Manufacturers:

S&C Electric Company, Model PMH.

1209-2.02 Pad Mounted Interrupter Switchgear:

Pad-Mounted Interrupter Switchgear: Integrated factory assembled single self-supporting enclosure, containing interrupter switches and power fuses with necessary accessory components.

Switch and fuse arrangement: As indicated on Drawings.

Nominal Voltage: 14.4 kV, three phase, 60 Hz.

Maximum Voltage: 17.0 kV.

Basic Impulse Level: 95 kV.

Main Bus Ampacity: 600 amperes continuous.

Short Circuit Rating: 14,000 rms symmetrical amperes; 350 rms symmetrical MVA at rated nominal voltage.

1209-2.03 Interrupter Switches:

Interrupter Switch: Three-pole, non-fused two position load interrupter switch.

Voltage and Short Circuit Ratings: Match ratings specified for integrated assembly.

Continuous Rating: 600 amperes.

Momentary Rating: 22,400 amperes.

Fault Closing: 22,400 amperes rms asymmetrical, two time duty cycle.

1209-2.04 Fuses/Integral Load Interrupter:

Voltage and Short Circuit Ratings: Match ratings specified for integrated assembly.

Continuous Rating: 200 amperes maximum.

Load Dropping: 200 amperes.

Fault Closing: 13,000 amperes rms asymmetrical, two time duty cycle.

1209-2.05 Accessories:

Surge Arrestors: Distribution class, rated 9 kV; mount in incoming line compartment.

1209-2.06 Fabrication:

Construction: Weatherproof, pad-mounted.

Include ground connection pad in each compartment.

Main Bus: Aluminum.

1209-2.07 Factory Finishing:

Clean surfaces before applying paint.

Apply corrosion-resisting primer to all surfaces.

Apply finish coat of baked enamel paint.

Finish Color: ANSI Z55.1; Type 70 - Light Gray.

1209-2.08 Manufacturers - Medium Voltage Fuses:

S&C Electric Co., Type SML-20.

1209-2.09 Medium Voltage Fuses:

Fuse: Enclosed current limiting, non-expulsion type suitable for use outdoors in enclosure.

Fuse Rating: E rated fuse, size as indicated.

Voltage: 15 kV.

Interrupting Rating: 14,000 amperes rms symmetrical.

1209-3 Construction Requirements:

1209-3.01 Examination:

Verify that surfaces are ready to receive work.

Verify field measurements are as instructed by manufacturer.

Beginning of installation means installer accepts existing surface conditions.

1209-3.02 Installation:

Install in accordance with manufacturer's instructions.

1209-3.03 Field Quality Control:

Field inspection and testing will be performed under provisions of Section 106 of these specifications.

Visually inspect for physical damage.

Perform mechanical operator tests in accordance with manufacturer's instructions. Check blade alignment and arc interrupter operations.

Verify key interlock operation.

Perform insulation resistance test on each phase to ground and from each phase to each other phase. Record results.

Perform AC or DC overpotential test to ANSI/IEEE 37.20

Perform contact resistance test across each switch blade; report any contact resistance in excess of 50 microohms.

1209-4 Method of Measurement:

Pad Mounted Interrupter Switchgear will be measured as a unit for each switchgear including fuses and associated hardware. Pads will be measured as a unit for each pad including concrete and reinforcing steel.

SECTION 1210 OVERHEAD POWER DISTRIBUTION

1210-1 Description:

1210-1.01 Section Includes:

A. Poles.

B. Pole hardware.

C. Overhead line conductors.

1210-1.02 References:

A. ANSI C29.2 - Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type.

B. ANSI C29.3 - Wet-Process Porcelain Insulators - Spool Type.

C. ANSI C29.4 - Wet-Process Porcelain Insulators - Strain Type.

D. ANSI C29.5 - Wet-Process Porcelain Insulators - Low and Medium Voltage Type.

E. ANSI C29.7 - Wet-Process Porcelain Insulators - High-Voltage Line-Post Type.

F. ANSI C37.42 - Specifications for Distribution Cutouts and Fuse Links.

G. ANSI C135.1 - Galvanized Steel Bolts and Nuts for Overhead Line Construction.

H. ANSI C135.2 - Threaded Galvanized Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction.

I. ANSI C135.4 Galvanized Ferrous Eyebolts and Nuts for Overhead Line Construction.

J. ANSI C135.5 - Galvanized Ferrous Eyenuts and Eyelets for Overhead Line Construction.

K. ANSI C135.17 - Galvanized Ferrous Bolt-Type Insulator Pins with Lead Threads for overhead Line Construction.

L. ANSI C135.22 - Galvanized Ferrous Pole-Top Insulator Pins with Lead Threads for Overhead Line Construction.

M. ANSI C135.30 - Galvanized Ferrous Ground Rods for Overhead or Underground Line Construction.

N. ANSI C135.31 - Galvanized Ferrous Single and Double Upset Spool Insulator Bolts for Overhead Line Construction.

O. ANSI 05.1 - Specifications and Dimensions for Wood Poles.

P. ASTM A475 - Zinc-Coated Steel Wire Strand.

Q. ASTM A675 - Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.

R. ASTM B398 - Aluminum-Alloy 6201-T81 Wire for Electrical Purposes.

S. ASTM B399 - Concentric-Lay-Stranded 6201-T81 Aluminum-Alloy Conductors.

T. ASTM D390 - Coal-Tar Creosote for the Preservative Treatment of Piles, Poles, and Timbers for Marine, Land, and Fresh Water Use.

U. AWPA C4 - Standard for the Preservative Treatment of Poles by the Pressure Process.

V. FS TT-W-571 - Wood Preservation: Treating Practices.

W. NEMA LA1 - Surge Arrestors.

X. ANSI/UL 96 - Lightning Protection Components

1210-1.03 System Description:

Overhead distribution line consisting of one circuit operating at 12.47 kV, as shown on Drawings.

1210-1.04 Design Requirements:

Comply with ANSI/IEEE C2, light loading conditions, Grade N construction.

1210-1.05 Submittals:

Submit product data under the provisions of Section 106 of these specifications.

Submit product data indicating materials and construction of hardware and line conductors.

Submit sag and tension curves, from the cable manufacturer, for approval by the Engineer.

1210-1.06 Project Record Documents:

Submit documents under provisions of Section 106 of these specifications.

Accurately record exact locations of poles, guys, anchors, and required horizontal and vertical clearances.

1210-1.07 Quality Assurance:

Installer: Company specializing in applying work of this Section with minimum three years documented experience.

1210-1.08 Delivery, Storage and Handling:

Deliver products to site under provisions of Section 109 of these specifications.

Store and protect products under provisions of Section 109 of these specifications.

Accept poles and hardware on site and inspect for damage.

Protect poles from damage and decay by stacking to provide free circulation of air. Maintain one foot minimum spacing between bottom pole and ground or ground vegetation. Do not store poles above decayed or decaying wood.

Stack poles stored for more than two weeks on decay-resistant skids arranged to support poles without noticeable pole distortion.

Handle treated poles with tools which will not produce an indentation greater than one inch deep. Do not drag treated poles along ground. Do not apply tools to that section of treated poles between one foot above and 2 feet below ground line.

1210-2 Materials:

1210-2.01 Poles:

Wood Poles: ANSI 05.1; treated Douglas fir poles of minimum length and class indicated.

Select poles for straightness and minimum sweeps and short crooks.

Preservative: ASTM D390.

Apply preservative to AWPA C4 with minimum net retention of 12 lb/cu ft. Obtain complete sapwood penetration.

1210-2.02 Pole Hardware:

Miscellaneous Pole Hardware: Hot-dipped galvanized after fabrication.

Angle Braces: 60 inch span x 18 inches, drop-formed in one piece from 1-3/4 x 1-3/4 inch angle.

Flat Braces: 1/4 x 1-1/4 inch.

Eye Bolts and Nuts: ANSI C135.4.

Anchor Rods and Nuts: ANSI C135.2

Bolts and Nuts: ANSI C135.1

Eyenuts and Eyelets: ANSI C135.5.

Ground Rods: ANSI C135.30.

Butt Plate: Copper.

Bolt-type Insulator Pins: ANSI C135.17.

Pole-top Insulator Pins: ANSI C135.22

Spool Insulator Bolts: ANSI C135.31.

Hot-line Clamps: Screw type with concealed threads. Fill thread chamber with corrosion-resistant compound.

Secondary Racks: Furnish with spool insulators.

Guy Strand: High strength 7-strand steel cable galvanized to ASTM A475, Class A or B.

Guy Termination: Preformed type.

Guy Guards: 8 foot long galvanized steel, colored yellow.

Ground Wire: Soft drawn copper conductors, 6 AWG minimum size.

1210-2.03 Insulators:

Insulators: Radio interference free wet process porcelain insulators with minimum wet flashover rating of 80 kV.

Line Post Insulators: ANSI C29.7; TR No. 222.

Suspension Insulators: ANSI C29.2; Class 52-1.

Spool Insulators: ANSI C29.3; Class 53-2.

Pin Insulators: ANSI C29.5; Class 55-4.

1210-2.04 Line Conductors:

Medium Voltage Overhead Line Conductors: Bare All Aluminum Alloy.

1210-2.05 Arresters and Cutouts:

Surge Arresters: NEMA LA1; valve type, arranged for pole mounting, and rated 15 kV.

Fused Cutouts: ANSI C37.42; expulsion fused cutouts rated 100 amperes at 14.4 kV ungrounded.

Fuses: Type E, rated as indicated.

1210-3 Construction Requirements:

1210-3.01 Examination:

Verify that site is ready to receive work.

Verify field measurements are as shown on Drawings.

Verify that required utilities are available, in proper location and ready for use.

Beginning of installation means installer accepts existing conditions.

1210-3.02 Installation:

Plug unused holes in poles using treated wood dowel pins. Treat field-cut gains and field-bored holes with preservative.

Cut gains on face of pole, with gained surfaces in parallel planes.

Shorten poles when required by cutting from top end. Apply hot preservative to shortened end of pole.

Set poles in straight line. Place curved poles with curvature in line with lead pole. Maintain an even grade.

Rake poles located at corners, angles, and dead ends so that poles are vertical after line installation.

Do not install poles along the edge of cuts and embankments or where soil may be washed out.

Identify each pole using aluminum marker stamped with characters 2-1/2 inches high minimum. Locate to provide maximum visibility from roadway and fasten with aluminum nails. Obtain identifying numbers from contract drawings.

Set insulators at right angles to line for straight runs; and to bisect the angle of turns in line direction.

Install conductors to ANSI/IEEE C2.

1210-3.03 Field Quality Control:

Field testing will be performed under provisions of Section 106 of these specifications.

Field test at least one anchor of each capacity installed to rated holding power.

1210-3.04 Pole Setting Schedule:

A. Minimum depths in normal firm ground, measured from lower side of pole as shown on contract drawings.

1210-3.04 Method of Measurement:

Poles will be measured as a unit for each pole including pole hardware, guys and anchors, concrete and reinforcing steel. Overhead line conductors will be measured per 1000 lineal feet for each conductor type and size.

SECTION 1211 UTILITY SERVICE ENTRANCE

1211-1 Description:

1211-1.01 Section Includes:

A. Arrangement with Utility Company for permanent electric service, including payment of Utility Company charges for service.

B. Underground service entrance.

C. Metering equipment.

1211-1.02 Related Sections:

A. Section 1202 - Conduit.

B. Section 1206 - Grounding and Bonding.

1211-1.03 References:

ANSI/NFPA 70 - National Electrical Code.

1211-1.04 System Description:

Utility Company: Arizona Public Service Company.

System Characteristics: 12,470/7,200 volts, three phase, four-wire, 60 Hertz.

1211-1.05 Quality Assurance:

Perform work in accordance with Utility Company written requirements.

Maintain one copy of each document on site.

1211-1.06 Regulatory Requirements:

Conform to requirements of ANSI/NFPA 70.

Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1211-1.07 Pre-Installation Conference:

Convene one week prior to commencing work of this Section.

1211-1.08 Field Measurements:

Verify that field measurements are as indicated.

1211-2 Materials:

1211-2.01 Utility Meters:

Meters will be furnished by Utility Company.

1211-2.02 Utility Meter Base:

Meter base will be furnished by Utility Company.

1211-3 Construction Requirements:

1211-3.01 Examination:

Verify conditions.

Verify that service equipment is ready to be connected and energized.

1211-3.02 Preparation:

Make arrangements with Utility Company to obtain permanent electric service to the Project.

Coordinate location of Utility Company's facilities to ensure proper access is available.

1211-3.03 Installation:

Install service entrance conduits from Utility Company's substation to service entrance equipment.

1211-4 Method of Measurement:

Not required.

SECTION 1212 ENCLOSED SWITCHES

1212-1 Description:

1212-1.01 Section Includes:

A. Fusible switches.

B. Nonfusible switches.

C. Fuses.

1212-1.02 References:

A. NEMA KS 1 - Enclosed Switches.

B. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Type.

C. UL 198E - Class R Fuses.

1212-1.03 Quality Assurance:

Perform work in accordance with NECA Standard of Installation.

1212-1.04 Qualifications:

Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

1212-2 Materials:

1212-2.01 Manufacturers:

A. General Electric Co.

B. Square D Co.

C. Westinghouse Electric Corp.

1212-2.02 Enclosed Switches:

Fusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate Class R fuses.

Nonfusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked

to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

Enclosures: NEMA KS 1.

1. Interior Dry Locations: Type 1.

2. Exterior Locations: Type 3R.

1212-2.03 Fuses:

Manufacturers:

1. Bussmann Div.

2. Gould Shawmut.

Description: Dual element, current limiting, time delay, one-time fuse, 600 volt, UL 198E, Class RK 1 or RK 5 as indicated.

Interrupting Rating: 200,000 rms amperes.

1212-3 Construction Requirements:

1212-3.01 Installation:

Install disconnect switches where indicated.

Install fuses in fusible disconnect switches.

Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

1212-4 Method of Measurement:

Enclosed switches will be measured as a unit for each enclosed switch, including fuses.

SECTION 1213 PANELBOARDS

1213-1 Description:

1213-1.01 Section Includes:

Distribution panelboards.

1213-1.02 Related Work:

Section 1207 - Electrical Identification: Engraved nameplates.

1213-1.03 References:

A. NECA (National Electrical Contractors Association) "Standard of Installation."

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 1 - Panelboards.

D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1213-1.04 Submittals:

Submit under provisions of Section 105 of these specifications.

Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, and circuit breaker arrangement and sizes.

Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1213-1.05 Project Record Documents:

Submit under provisions of Section 106 of these specifications.

Record actual locations of Products; indicate actual branch circuit arrangement.

1213-1.06 Operation and Maintenance Data:

Submit under provisions of Section 105 of these specifications.

Maintenance Data: Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1213-1.07 Quality Assurance:

Perform work in accordance with NECA Standard of Installation.

1213-1.08 Qualifications:

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1213-1.09 Field Measurements:

Verify that field measurements are as indicated on shop drawings.

1213-1.10 Maintenance Materials:

Provide maintenance materials under provisions of Section 105 of these specifications.

Provide two of each panelboard key.

1213-2 Materials:

1213-2.01 Manufacturers:

A. General Electric Co.

B. Square D Co.

C. Westinghouse Electric Corp.

1213-2.02 Distribution Panelboards:

Panelboards: NEMA PB 1, circuit breaker type.

Service Conditions:

1. Temperature: 115 degrees F.

2. Altitude: 1700 feet.

Panelboard Bus: Aluminum, ratings as indicated. Provide copper ground bus in each panelboard.

Minimum integrated short circuit rating: As indicated.

Molded Case Circuit Breakers: NEMA AB 1. Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

Enclosure: NEMA PB 1, Type 3R.

1213-3 Construction Requirements:

1213-3.01 Installation:

Install panelboards in accordance with NEMA PB 1.1.

Install panelboards plumb.

Provide filler plates for unused spaces in panelboards.

Provide typed circuit directory for each panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

Provide engraved plastic nameplates under the provisions of Section 1207 of these specifications.

1213-3.02 Field Quality Control:

Field inspection and testing will be performed under provisions of Section 106.

Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

1213-4 Method of Measurement:

Panelboards will be measured as a unit per voltage and current rating for each panelboard including circuit breakers.

SECTION 1214 SITE LIGHTING

1214-1 Description:

1214-1.01 Section Includes:

Exterior luminaires and accessories.

1214-1.02 References:

ANSI C82.4 - Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

1214-1.03 Submittals:

Submit under provisions of Section 105 of these specifications.

Product Data: Provide dimensions, ratings, and performance data.

Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1214-1.04 Project Record Documents:

Submit under provisions of Section 106 of these specifications.

Accurately record actual locations of each luminaire.

1214-1.05 Operation and Maintenance Data:

Submit under provisions of Section 105 of these specifications.

Maintenance Data: Include instructions for maintaining luminaires.

1214-1.06 Qualifications:

Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1214-1.07 Delivery, Storage and Handling:

Deliver, store, protect, and handle products to site under provisions of Section 109 of these specifications.

Accept products on site. Inspect for damage.

1214-2 Materials:

1214-2.01 Luminaires:

Furnish products as specified on Drawings.

1214-2.02 Ballasts:

High Intensity Discharge (HID) Ballast:
1. Advance Transformer Co.
2. Magne Tek Universal Mfg.
3. Valmont Electric Inc.
4. Description: ANSI C82.4, high pressure sodium lamp ballast.
5. Provide ballast suitable for lamp specified.
6. Voltage: Match luminaire voltage.

1214-2.03 Lamps:

A. High Intensity Discharge (HID) Lamp Manufacturers:
1. GE Lighting.
2. GTE Sylvania.
3. Phillips Lighting Co.

B. Provide lamp type specified for luminaire.

1214-3 Construction Requirements:

1214-3.01 Examination:

Examine each luminaire to determine suitability for lamps specified.

1214-3.02 Installation:

Install in accordance with manufacturers' instructions.

Install lamps in each luminaire.

Bond luminaires, metal accessories to branch circuit equipment grounding conductor.

1214-3.03 Field Quality Control:

Operate each luminaire after installation and connection. Inspect for improper connections and operation.

1214-3.04 Cleaning:

Clean electrical parts to remove conductive and deleterious materials.

Remove dirt and debris from enclosure.

Clean photometric control surfaces as recommended by manufacturer.

Clean finishes and touch up damage.

1214-4 Method of Measurement:

Site lighting will be measured as a unit for each luminaire, including ballast and lamp.

SECTION 1301 12" SLEEVE

1301-1 Description:

Work under this item shall consist of furnishing all materials and installing pipe sleeves at the locations shown on the project plans.

During construction of the project, the subcontractor shall mark the location of the sleeves with flagging or other Engineer approved method to protect the sleeves from damage.

At the completion of the work the subcontractor shall provide in writing, to the Engineer, a list of the co-ordinates to both ends of the sleeves.

1301-2 Materials:

Pipe for sleeves shall consist of 12" Schedule 80 PVC pipe meeting the requirements of Subsection 1010-7 of these specifications.

1301-3 Construction Requirements:

1301-3.01 Foundations and Trenches:

Foundations and trenches shall be prepared in accordance with Subsection 501-3.01 of these specifications.

1301-3.02 Bedding:

Bedding shall conform to the requirements of Subsection 501-3.02 of these specifications.

1301-3.03 Installation:

Pipe shall be assembled and installed in accordance with the manufacturer's recommendations. A minimum depth of cover of two feet shall be maintained over the top of the pipe. Ends of pipe shall extend vertically one foot above existing ground. Pipe ends shall be capped and cemented.

1301-3.04 Backfill:

Pipe shall be backfilled in accordance with the requirements of Subsection 501-3.04 of these specifications.

1301-4 Method of Measurement:

12" Sleeve will be measured by the linear foot parallel to the central axis of the pipe line and shall include the length of fittings, flagging during construction, and shall include final co-ordinates as to the location of each end.

APPENDIX A

ADDITIONAL REQUIREMENTS FOR TESTING OF SPECIAL ROADS

SPECIFIC REQUIREMENT OF QC

QC Item	High Speed Track (South Tangent)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade	$\pm 12^{mm}$	3/20'	Level
	Aggregate Base (ABC)	$\pm 12^{mm} \sigma \leq 8^{mm}$	3/20'	Level
	Asphalt Cement Concrete (1st layer)	$\sigma \leq 5^{mm}$	3/20'	Level
	AC (2nd)	$\sigma \leq 4^{mm}$	3/20'	Level
	AC (3rd)	$\sigma \leq 3.5^{mm}$	3/20'	Level
Width	ABC	-50^{mm}	1/100'	Tape
	AC (1st Layer)	-50^{mm}	1/100'	Tape
	AC (2nd)	-30^{mm}	1/100'	Tape
Thickness	AC (1st)	-15^{mm}	1/20,000ft^2	Core Sample
	AC (2nd)	-9^{mm}	1/20,000ft^2	Vernier Caliper
	AC (3rd)	-9^{mm}	1/20,000ft^2	
Proof Rolling	Subgrade	7^{mm}	whole surface	20 ton Tire Roller
	ABC	5^{mm}	whole surface	Benkelman Beam
Smoothness (PrI, TCR)		PrI TCR		
	AC (3rd)	5cm/km 70cm/km	per lane	
	AC (4th)	1 30	per lane	8 meter
	AC (Surface layer)	0 20	per lane	Profilograph
Slide Resistance	AC (Surface Layer)	BPN $\geq$ 80 (Dry)	1/2,000'	Portable Tester
Compaction Degree	ABC	95%	1/20,000ft^2	Site Density
	AC (1st Layer)	95%	1/10,000ft^2	Core Sample
	AC (2nd)	95%	1/10,000	Core Sample
	AC (3rd)	96%	1/10,000	Core Sample
	AC (4th)	96%	1/10,000	Nuclear Method
	AC (Surface)	96%	1/10,000	Nuclear Method

SPECIFIC REQUIREMENT OF QC

QC Item	High Speed Track (North Tangent)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade ABC AC (1st layer) AC (2nd)	$\pm 12^{mm}$ $\pm 12^{mm}$ $\sigma \leq 8^{mm}$ $\sigma \leq 5^{mm}$ $\sigma \leq 4^{mm}$	3/100' 5/100' 5/100' 5/100'	Level Level Level Level
Width	ABC AC	-50^{mm} -30^{mm}	1/100' 1/100'	Tape Tape
Thickness	AC (1st layer)	-15^{mm}	1/20,000ft^2	Core Sample Vernier Caliper
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam
Smoothness (PrI, TCR)	AC (2nd layer) AC (Surface)	PrI TCR 10cm/km 120cm/km 2cm/km 50cm/km	per lane per lane	8 meter Profilograph
Slide Resistance	AC (Surface)	BPN $\geq$ 80 (Dry)	1/2,000'	Portable Tester
Compaction Degree	ABC AC (1st layer) AC (2nd layer) AC (Surface)	95% 95% 96% 96%	1/20,000ft^2 1/10,000ft^2 1/10,000ft^2 1/10,000ft^2	Site Density Core Sample Nuclear Method Nuclear Method

SPECFIC REQUIREMENT OF QC

QC Item	High Speed Track (Curve Section)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade ABC AC (1st layer) AC (2nd) AC (3rd) AC (4th) AC (Surface)	±60mm ±60mm ±50mm ±40mm ±35mm ±30mm ±25mm	5/50' 5/50' 4/20' 4/20' 4/20' 4/20' 5/20'	Level Level Level Level Level Level Level
Width	Subgrade ABC AC (1st layer)	-50mm -50mm -30mm	1/100' 1/100' 1/100'	Tape Tape Tape
Thickness				
Proof Rolling	Subgrade ABC	— —	whole surface whole surface	Visual Inspection Same roller used at construction
Smoothness (PSI TCR)	AC (Surface)	$\sigma \leq 0.8$mm $\sigma \leq 1.0$mm	Middle Spd Lane Low Speed Lane High Speed Lane	3 meter Profilograph
Slide Resistance	AC (Surface)	BPN ≥ 80 (Dry)	1/2,000'	Portable Tester Low Speed Lane Only
Compaction Degree	ABC AC (1st layer) AC (2nd layer) AC (3rd layer) AC (4th layer) AC (5th layer)	95% 95%(L,M), 93%(H) 95% 93% 96% 94% 96% 94% 96% 94%	1/20,000ft² 2/10,000ft² 2/10,000ft² 2/10,000ft² 2/10,000ft² 2/10,000ft²	Site Density Site Density Site Density Nuclear Method Nuclear Method Nuclear Method

SPECIFIC REQUIREMENT OF QC

QC Item	Loop Road A (common to all types)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade ABC AC (1st layer) AC (2nd) AC (3rd)	$\pm 12^{mm}$ $\pm 12^{mm}$ $\sigma \leq 8^{mm}$ $\sigma \leq 5^{mm}$ $\sigma \leq 4^{mm}$ $\sigma \leq 3^{mm}$	3/20' 3/20' 3/20' 3/20' 3/20'	Level Level Level Level Level
Width	ABC AC (1st layer) AC (2nd)	-50^{mm} -50^{mm} -30^{mm}	1/100' 1/100' 1/100'	Tape Tape Tape
Thickness	AC (1st layer) AC (2nd) AC (3rd)	-15^{mm} -9^{mm} -9^{mm}	1/20,000ft^2 1/20,000ft^2 1/20,000ft^2	Core Sample Vernier Caliper
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam
Smoothness (PrI, TCR)	AC (3rd layer) AC (4th) AC (Surface)	PrI TCR 5cm/km 70cm/km 1 30 0 20	per lane per lane per lane	8 meter Profilograph
Slide Resistance	AC (Surface)	BPN $\geq$ 80 (Dry)	1/2,000'	Portable Tester
Compaction Degree	ABC AC (1st layer) AC (2nd) AC (3rd) AC (4th) AC (Surface)	95% 95% 95% 96% 96% 96%	1/20,000ft^2 1/10,000ft^2 1/10,000ft^2 1/10,000ft^2 1/10,000ft^2 1/10,000ft^2	Site Density Core Sample Core Sample Core Sample Nuclear Method Nuclear Method

SPECIFIC REQUIREMENT OF QC

QC Item	Loop Road A (Special Requirements for Each Type)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Transverse Slope Surface Road				
Grade	AC (Surface)	±0.2%	1/20'	Level Slope between 2' inside from road edge
Fine Texture Surface Road				
Surface Roughness	AC (Surface) and	$x = \pm 0.4^{mm}$ $\pm 0.05^{mm}$ $\sigma \leq 0.05^{mm}$	1/100'	Sand Patch Method at wheel position *
Chip Seal Road				

SPECIFIC REQUIREMENT OF QC

QC Item	Choppy Road #1 & #2 (High Speed Track) and Rough Concrete Road No. 2			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade ABC AC Portland Cement Concrete (PCCP) Form Setting	$\pm 12^{mm}$ $\pm 12^{mm}$ $\pm 12^{mm}$ $\sigma \leq 1.2^{mm}$ $\sigma \leq 0.5^{mm}$	2/100' 2/100' 2/50' 2/less than 0.1^{m} 2/less than 0.5^{m}	 Level at Form Setting Location Micro level + Profilograph at wheel position Micro Level
Width	ABC AC	-50^{mm} -30^{mm}	1/100' 1/100'	
Thickness				
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam*
Smoothness (PrI, TCR)				
Slide Resistance				
Compaction Degree	ABC AC	95% 95%	$1/20{,}000ft^2$ $1/10{,}000ft^2$	Site Density Nuclear Method
Elevation Gap	Joint & Step (Choppy Road B only)	$\pm 1^{mm}$	2/Joint or Step	Micro Level at wheel position

SPECIFIC REQUIREMENT OF QC

QC Item	Waved and Repaired Asphalt Road (High Speed Track)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade ABC AC (1st layer) AC (2nd) AC (Surface)	$\pm 12^{mm}$ $\pm 12^{mm}$ $\pm 20^{mm}$ $\pm 10^{mm}$ $\sigma \leq 3^{mm}$	2/25' 2/25' 2/less than 0.1^{m} 2/less than 0.1^{m} 2/less than 0.1^{m}	Level Level Level + Profilograph at wheel position
Width	ABC AC (1st layer)	-50^{mm} -30^{mm}	1/100' 1/100'	
Thickness				
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam
Smoothness (PrI, TCR)				
Slide Resistance				
Compaction Degree	ABC AC (1st layer) AC (2nd) AC (Surface)	95% 93% 93% 93%	1/20,000ft^2 1/10,000ft^2 1/10,000ft^2 1/10,000ft^2	Site Density Nuclear Method Nuclear Method Nuclear Method
Surface Roughness	AC (Surface)	$\pm 0.3^{mm}$	1/300'	Sand Patch Method

SPECIFIC REQUIREMENT OF QC

QC Item	Waved and Repaired Concrete Road (High Speed Track)			
	Type of Work	Tolerance	Frequency	Testing /Measuring Method
Elevation	Subgrade ABC AC	$\pm 12^{mm}$ $\pm 12^{mm}$ $\pm 12^{mm}$	2/100' 2/100' 2/50'	Level Level Level at wheel positions
Width	ABC AC	-50^{mm} -30^{mm}	1/100' 1/100'	Tape Tape
Thickness	PCCP	-6^{mm}	1/20,000ft^2	Core Sample
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam
Smoothness (PrI, TCR)	PCCP	$\sigma \leq 1.3^{mm}$	per lane	3 meter Profilograph
Slide Resistance				
Compaction Degree	ABC AC	95% 95%	1/20,000ft^2 1/10,000ft^2	Site Density Nuclear Method

SPECIFIC REQUIREMENT OF QC

QC Item	Cornering Course (Outer and Inner Good Surface Road)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade ABC AC (1st) AC (2nd)	$\pm 12^{mm}$ $\pm 12^{mm}$ $\sigma \leq 5^{mm}$ $\sigma \leq 4^{mm}$	2/100' 2/100' 2/100' 2/100'	Level Level Level Level
Width	ABC AC (1st)	-50^{mm} -30^{mm}	1/100' 1/100'	Tape Tape
Thickness	AC	-15^{mm}	$1/20{,}000ft^2$	Core Sample Vernier Caliper
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam
Smoothness (PrI, TCR)	AC (Surface)	$\sigma \leq 0.8^{mm}$	per lane	3 meter Profilograph
Slide Resistance	AC (Surface)	BPN $\geq$ 80 (Dry)	1/1,000'	Portable Tester
Compaction Degree	ABC AC (1st layer) AC (2nd) AC (Surface)	95% 95% 96% 96%	$1/20{,}000ft^2$ $1/10{,}000ft^2$ $1/10{,}000ft^2$ $1/10{,}000ft^2$	Site Density Core Sample Nuclear Method Nuclear Method
	Low Friction Surface road			
Smoothness	AC (Surface)	$\sigma \leq 1.0^{mm}$	per lane	3 meter Profilograph
Slide Resistance	AC (Surface)	BPN 39 ± 5 (Wet) Average of BPN 39 ± 1	1/100'	Portable Tester
Surface Roughness		$1.5^{mm} \pm 0.2^{mm}$	1/100'	Sand Patch Method

SPECIFIC REQUIREMENT OF QC

QC Item	Rough Asphalt Road (common to No. 1, 2 & 3)			
	Type of Work	Tolerance	Frequency	Testing /Measuring Method
Elevation	Subgrade ABC AC (1st layer) AC (2nd) AC (Surface) (except No. 3)	$\pm 12^{mm}$ $\pm 12^{mm}$ $\pm 20^{mm}$ $\sigma \leq 4^{mm}$ $\sigma \leq 3^{mm}$	2/25' 2/25' 2/less than 0.1^{m} 2/less than 0.1^{m} 2/less than 0.1^{m}	Level Level Level+Profilograph at wheel position
Width	ABC AC (1st layer)	-50^{mm} -30^{mm}	1/100' 1/100'	Tape Tape
Thickness				
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam
Smoothness (PrI, TCR)				
Slide Resistance	AC (Surface)	BPN $\geq$ 80 (Dry)	1/1,000'	Portable Tester
Compaction Degree	ABC AC (1st layer) AC (2nd) AC (Surface)	95% 93% 93% 93%	$1/20,000ft^2$ $1/10,000ft^2$ $1/10,000ft^2$ $1/10,000ft^2$	Site Density Nuclear Method Nuclear Method Nuclear Method

SPECIFIC REQUIREMENT OF QC

QC Item	Rough Asphalt Road (Special Requirements for Each Type)			
	Type of Work	Tolerance	Frequency	Testing /Measuring Method
Rough Asphalt Road No. 1 & 2				
Elevation at Crack Point	AC	±20%	3/Crack	Level+Cross Profile at wheel positions
Rough Asphalt Road No. 3				
Elevation at Crack	AC (Surface)	$\sigma \leq 3^{mm}$ $\sigma \leq 2^{mm}$	4/less than 0.1^{m} 2/less than 0.1^{m}	Level at 4 lines Level at wheel positions (4'long at cracks)
Width at Crack	AC (Surface)	$\pm 5^{mm}$	2/crack	Tape at wheel position
Surface Roughness	AC (Surface)	$\pm 0.3^{mm}$	1/300'	Sand Patch Method at wheel position
Crack Gap	AC (Surface)	$\pm 2^{mm}$	2/crack	Level at wheel position

SPECIFIC REQUIREMENT OF QC

QC Item	Rough Concrete Road No. 1 (Cornering Course)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade ABC AC Portland Cement Concrete (PCCP) Form Setting	$\pm 12^{mm}$ $\pm 12^{mm}$ $\pm 12^{mm}$ $\sigma \leq 1.5^{mm}$ $\sigma \leq 0.7^{mm}$	2/100' 2/100' 2/50' 2/less than 0.1^{m} 2/less than 0.5^{m}	Level at Form Setting Location Micro level + Profilograph at wheel position Micro Level
Width	ABC AC	-50^{mm} -30^{mm}	1/100' 1/100'	
Thickness				
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam*
Smoothness (PrI, TCR)				
Slide Resistance				
Compaction Degree	ABC AC	95% 95%	$1/20{,}000ft^2$ $1/10{,}000ft^2$	Site Density Nuclear Method
Elevation Gap	Joint & Step (Choppy Road B only)	$\pm 1^{mm}$	2/Joint or Step	Micro Level at wheel position

SPECIFIC REQUIREMENT OF QC

QC Item	Winding Road No. 1			
	Type of Work	Tolerance	Frequency	Testing /Measuring Method
Elevation	Subgrade ABC AC (1st layer) AC (2nd) AC (Surface)	$\pm 12^{mm}$ $\pm 12^{mm}$ $\pm 20^{mm}$ $\sigma \leq 4^{mm}$ $\sigma \leq 3^{mm}$	2/25' 2/25' 4/less than 0.1^{m} 4/less than 0.1^{m} 4/less than 0.1^{m}	Level Level Level+profilograph Level+profilograph Level+profilograph
Width	ABC AC (1st layer)	-50^{mm} -30^{mm}	1/100' 1/100'	
Thickness				
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam
Smoothness (PrI, TCR)				
Slide Resistance	AC (Surface)	BPN $\geq$ 80 (Dry)	1/1,000'	Portable Tester
Compaction Degree	ABC AC AC Ac	95% 93% 93% 93%	1/20,000ft^2 1/10,000ft^2 1/10,000ft^2 1/10,000ft^2	Site Density Nuclear Method Nuclear Method Nuclear Method

SPECIFIC REQUIREMENT OF QC

QC Item	Winding Road No. 2			
	Type of Work	Tolerance	Frequency	Testing /Measuring Method
Elevation	Subgrade ABC AC (1st layer) AC (2nd) AC (Surface)	$\pm 12^{mm}$ $\pm 12^{mm}$ $\pm 20^{mm}$ $\sigma \leq 4^{mm}$ $\sigma \leq 3^{mm}$	2/25' 2/25' 2/less than 0.1^{m} 2/less than 0.1^{m} 2/less than 0.1^{m}	Level Level Level+Profilograph Level+Cross Profile Level+Cross Profile
Width	ABC AC (1st layer)	-50^{mm} -30^{mm}	1/100' 1/100'	Tape Tape
Thickness				
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam
Smoothness (PrI, TCR)				
Slide Resistance	AC (Surface	BPN ≥ 80 (Dry)	1/1,000'	Portable Tester
Compaction Degree	ABC AC (1st layer) AC (2nd) AC (3rd)	95% 93% 93% 93%	$1/20,000ft^2$ $1/10,000ft^2$ $1/10,000ft^2$ $1/10,000ft^2$	Site Density Nuclear Method Nuclear Method Nuclear Method

SPECIFIC REQUIREMENT OF QC

QC Item	Choppy Road #3 (Cornering Course)			
	Type of Work	Tolerance	Frequency	Testing/Measuring Method
Elevation	Subgrade ABC AC Portland Cement Concrete (PCCP) Form Setting	$\pm 12^{mm}$ $\pm 12^{mm}$ $\pm 12^{mm}$ $\sigma \leq 1.5^{mm}$ $\sigma \leq 0.7^{mm}$	2/100' 2/100' 2/50' 2/less than 0.1^{m} 2/less than 0.5^{m}	Level at Form Setting Location Micro level + Profilograph at wheel position Micro Level
Width	ABC AC	-50^{mm} -30^{mm}	1/100' 1/100'	
Thickness				
Proof Rolling	Subgrade ABC	7^{mm} 5^{mm}	whole surface whole surface	20 ton Tire Roller Benkelman Beam*
Smoothness (PrI, TCR)				
Slide Resistance				
Compaction Degree	ABC AC	95% 95%	$1/20{,}000ft^2$ $1/10{,}000ft^2$	Site Density Nuclear Method
S.T.P.	Joint & Step (Choppy Road B only)	$\pm 1^{mm}$	2/Joint or Step	Micro Level at wheel position
Width of Joints & Cracks	Joints & Cracks	$\pm 3^{mm}$	2/joint or crack	Tape at wheel position
Location of Joints & Cracks		$\pm 50^{mm}$	2/joint or crack	Tape at wheel position

*)

Sand Patch Method

A. Sand to be used

100% passing #100 sieve
0% passing #200 sieve

B. Method to measure

- Spread 10 cm^3 sand on the road surface as large as possible by a ruler.

- Measure the size of spread circle diameter on two rectangular points

- Take the average diameter

C. Calculation of Texture

$$t = \frac{V}{A} \times 10$$

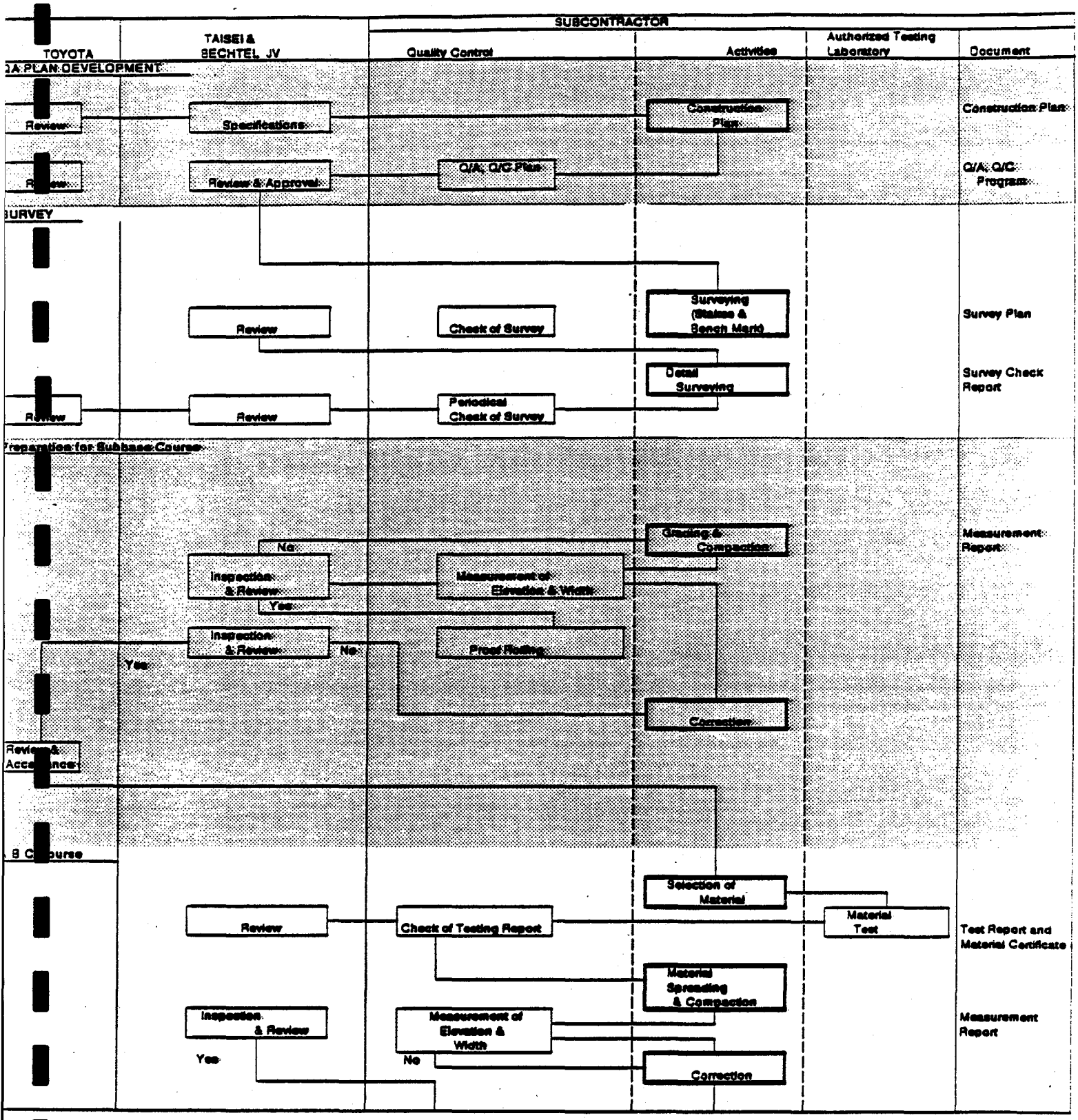
t: surface Texture (mm)
V: Volume of Same (cm^3)
A: Sand spread circle area with the above diameter (cm^2)

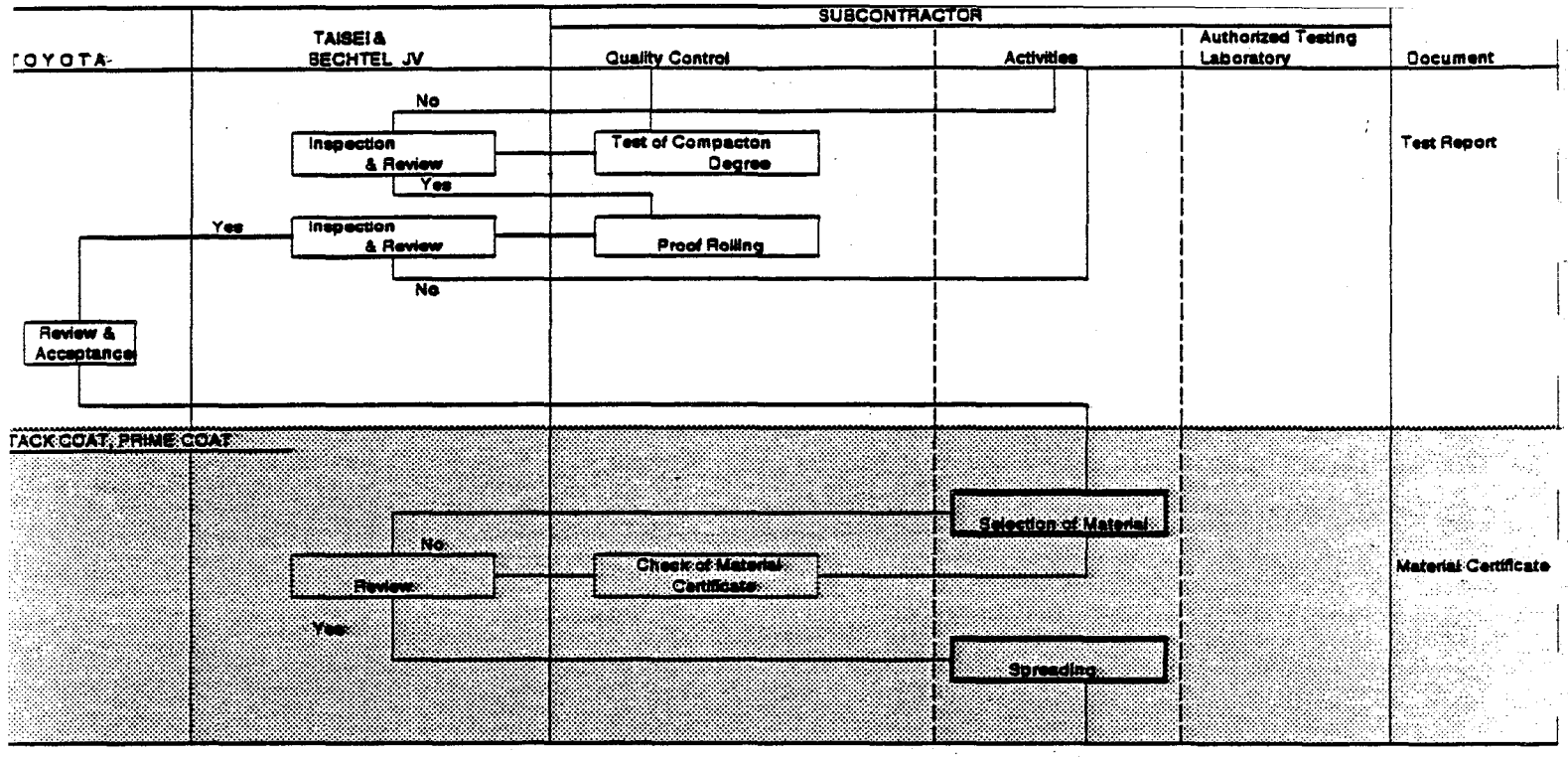
APPENDIX B

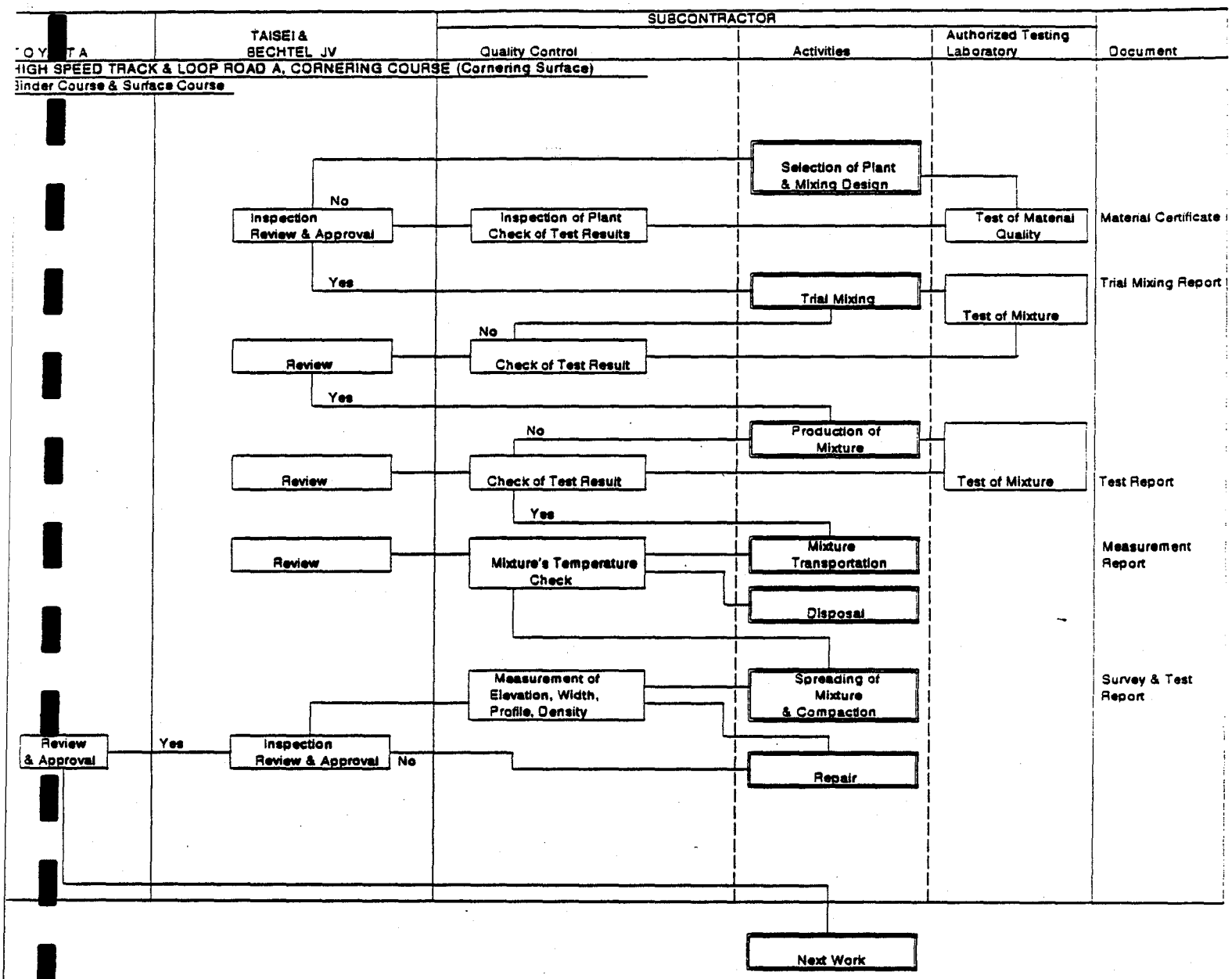
QA/QC FLOW DIAGRAM FOR
HIGH SPEED TRACK AND
RIDE & VIBRATION SURFACE ROAD

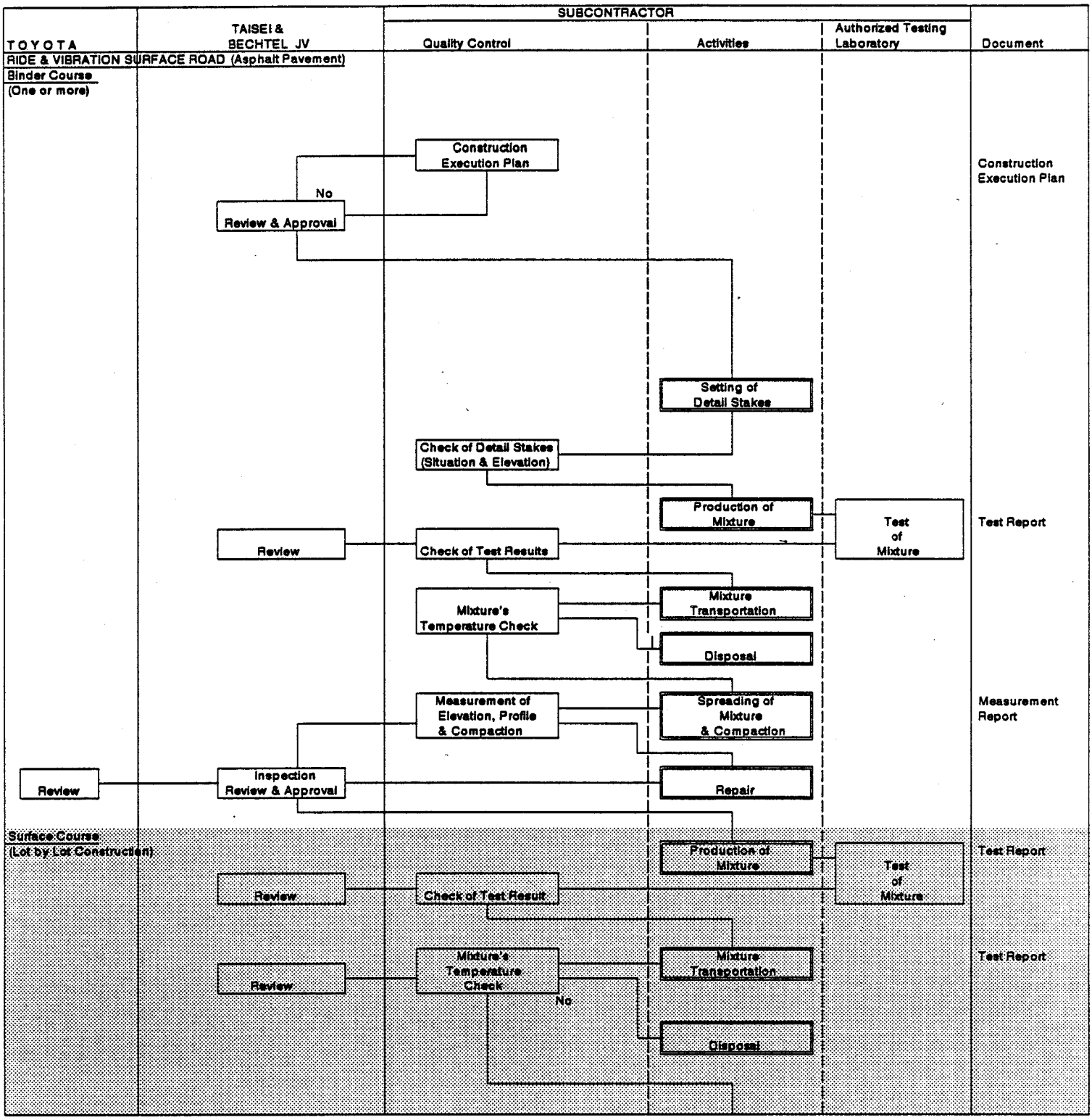
This diagram shows basic QA/QC procedure.

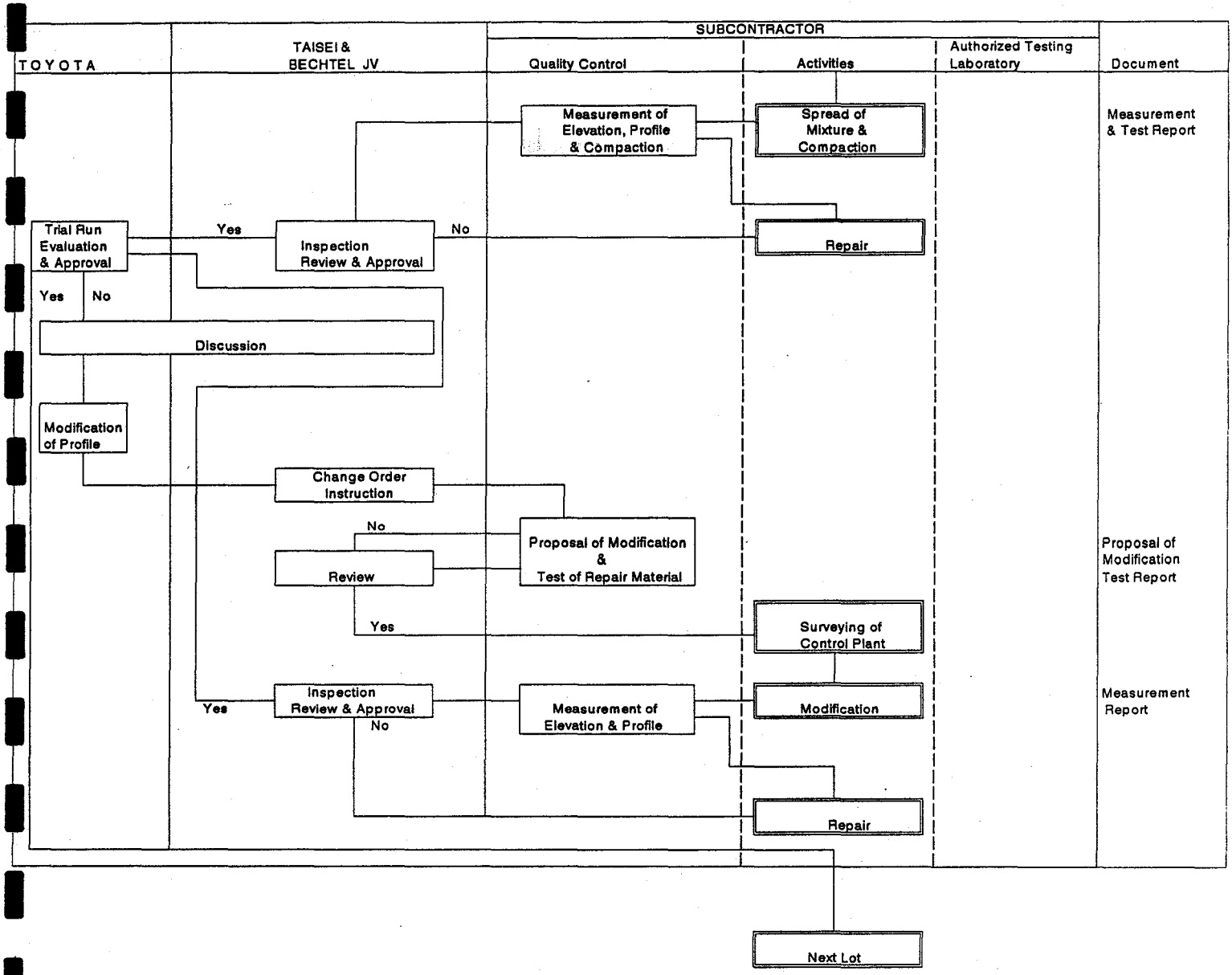
Hold point inspection and trial run varies work by work and may cause a change of procedure in detail.

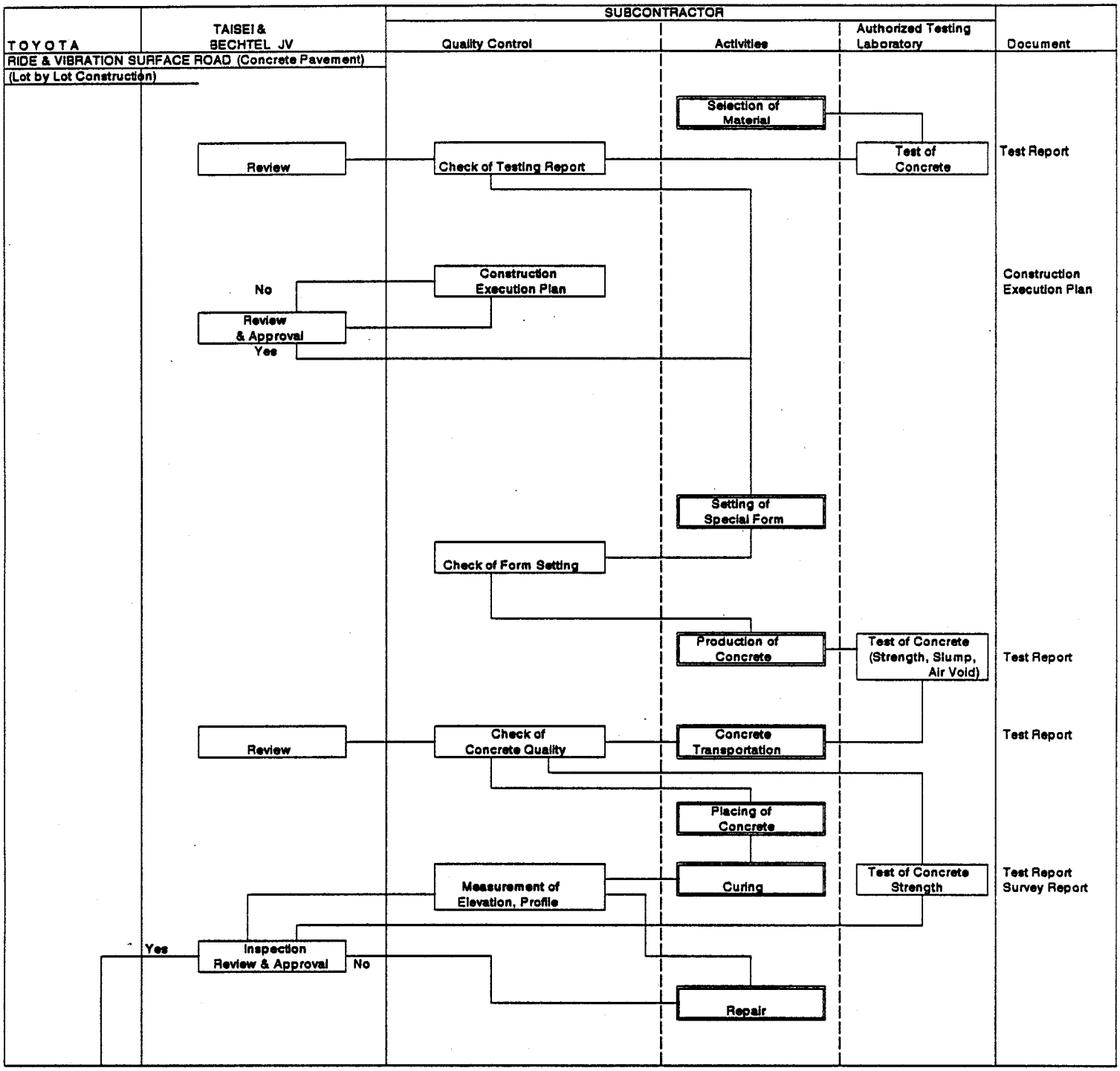

SUBCONTRACTOR
TOYOTA
TAISEI & BECHTEL JV
Quality Control
Activities
Authorized Testing Laboratory
Document
QA PLAN DEVELOPMENT
Review
Specifications
Construction Plan
Construction Plan
Review
Review & Approval
Q/A, Q/C Plan
Q/A, Q/C Program
SURVEY
Review
Check of Survey
Surveying (Staiss & Bench Mark)
Survey Plan
Detail Surveying
Survey Check Report
Review
Review
Periodical Check of Survey
Preparation for Subbase Course
Grading & Compaction
Measurement Report
No
Inspection & Review
Measurement of Elevation & Width
Yes
Inspection & Review
No
Proof Rolling
Yes
Correction
Review & Acceptance
B Course
Selection of Material
Review
Check of Testing Report
Material Test
Test Report and Material Certificate
Material Spreading & Compaction
Inspection & Review
Measurement of Elevation & Width
Measurement Report
Yes
No
Correction

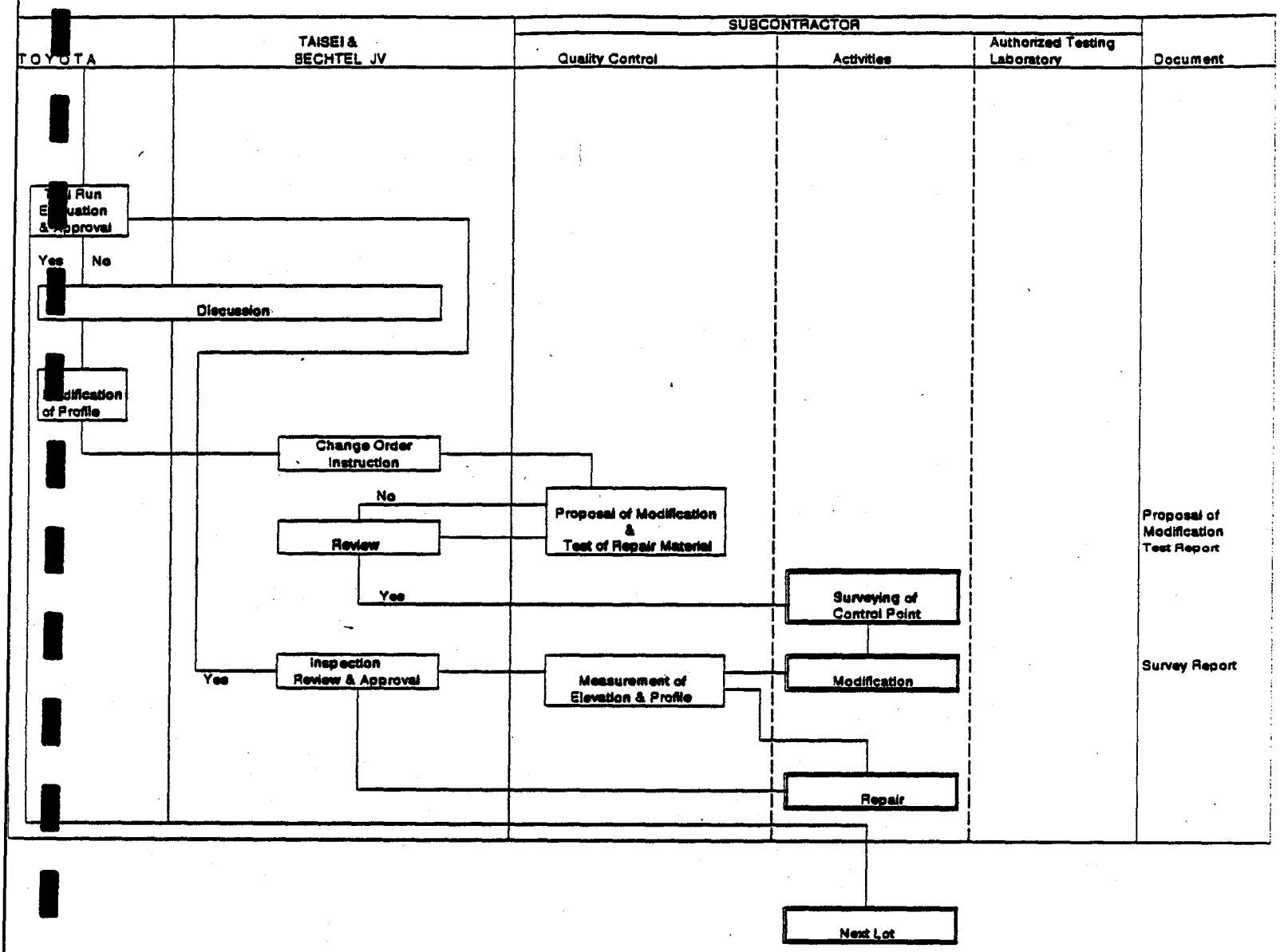

SUBCONTRACTOR
TOYOTA
TAISEI & BECHTEL JV
Quality Control
Activities
Authorized Testing Laboratory
Document
No
Inspection & Review
Test of Compacton Degree
Test Report
Yes
Yes
Inspection & Review
Proof Rolling
No
Review & Acceptance
TACK COAT, PRIME COAT
Selection of Material
No
Review
Check of Material Certificate
Material Certificate
Yes
Spreading


SUBCONTRACTOR
TOYOTA
TAISEI & BECHTEL JV
Quality Control
Activities
Authorized Testing Laboratory
Document
HIGH SPEED TRACK & LOOP ROAD A, CORNERING COURSE (Cornering Surface)
Binder Course & Surface Course
Selection of Plant & Mixing Design
No
Inspection Review & Approval
Inspection of Plant Check of Test Results
Test of Material Quality
Material Certificate
Yes
Trial Mixing
Test of Mixture
Trial Mixing Report
No
Review
Check of Test Result
Yes
No
Production of Mixture
Review
Check of Test Result
Test of Mixture
Test Report
Yes
Review
Mixture's Temperature Check
Mixture Transportation
Disposal
Measurement Report
Measurement of Elevation, Width, Profile, Density
Spreading of Mixture & Compaction
Survey & Test Report
Review & Approval
Yes
Inspection Review & Approval
No
Repair
Next Work


SUBCONTRACTOR
TOYOTA
TAISEI & BECHTEL JV
Quality Control
Activities
Authorized Testing Laboratory
Document
RIDE & VIBRATION SURFACE ROAD (Asphalt Pavement)
Binder Course
(One or more)
Construction Execution Plan
No
Review & Approval
Construction Execution Plan
Setting of Detail Stakes
Check of Detail Stakes (Situation & Elevation)
Production of Mixture
Test of Mixture
Test Report
Review
Check of Test Results
Mixture's Temperature Check
Mixture Transportation
Disposal
Measurement of Elevation, Profile & Compaction
Spreading of Mixture & Compaction
Measurement Report
Review
Inspection Review & Approval
Repair
Surface Course
(Lot by Lot Construction)
Production of Mixture
Test of Mixture
Test Report
Review
Check of Test Result
Mixture's Temperature Check
Mixture Transportation
Test Report
Review
No
Disposal


SUBCONTRACTOR
TOYOTA
TAISEI & BECHTEL JV
Quality Control
Activities
Authorized Testing Laboratory
Document
Measurement of Elevation, Profile & Compaction
Spread of Mixture & Compaction
Measurement & Test Report
Trial Run Evaluation & Approval
Yes
Inspection Review & Approval
No
Repair
Yes
No
Discussion
Modification of Profile
Change Order Instruction
No
Proposal of Modification & Test of Repair Material
Review
Proposal of Modification Test Report
Yes
Surveying of Control Plant
Yes
Inspection Review & Approval
Measurement of Elevation & Profile
Modification
Measurement Report
No
Repair
Next Lot


TOYOTA
TAISEI & BECHTEL JV
SUBCONTRACTOR
Quality Control
Activities
Authorized Testing Laboratory
Document
RIDE & VIBRATION SURFACE ROAD (Concrete Pavement)
(Lot by Lot Construction)
Selection of Material
Review
Check of Testing Report
Test of Concrete
Test Report
Construction Execution Plan
No
Review & Approval
Yes
Construction Execution Plan
Setting of Special Form
Check of Form Setting
Production of Concrete
Test of Concrete (Strength, Slump, Air Void)
Test Report
Review
Check of Concrete Quality
Concrete Transportation
Test Report
Placing of Concrete
Measurement of Elevation, Profile
Curing
Test of Concrete Strength
Test Report
Survey Report
Yes
Inspection Review & Approval
No
Repair


TOYOTA
TAISEI & BECHTEL JV
SUBCONTRACTOR
Quality Control
Activities
Authorized Testing Laboratory
Document
Run
uation
pproval
Yes
No
Discussion
dification
of Profile
Change Order Instruction
No
Proposal of Modification & Test of Repair Material
Review
Proposal of Modification Test Report
Yes
Surveying of Control Point
Yes
Inspection Review & Approval
Measurement of Elevation & Profile
Modification
Survey Report
Repair
Next Lot

APPENDIX C

STANDARD FORM FOR QC REPORTS

Forms shown here are standard forms of measurement for submittal. Material and other testing forms shall follow ADOT standard forms or equivalent.

The subcontractor shall submit all testing and measurement forms with QC plan.

Station	Left Side Point			Center Point			Right Side Point		
	Design Height	Measuring Height	Diff-erence	Design Height	Measuring Height	Diff-erence	Design Height	Measuring Height	Diff-erence

Flatness Test

Work Item

Measuring Section
Sta. ~ Sta.

Measuring Line
ft. from Center-line

Measuring Length ft.

Testing Date

Equipment
3m Profilometer

Personel

n / Gi	1	2	3	4	5	6	7	8	9	10	Gimax 1	Gimin 2	R 1-2
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													

4 Coefficient which value depend on measuring points	2.57	2.70	2.85	2.97	3.08	3 Total ΣRi

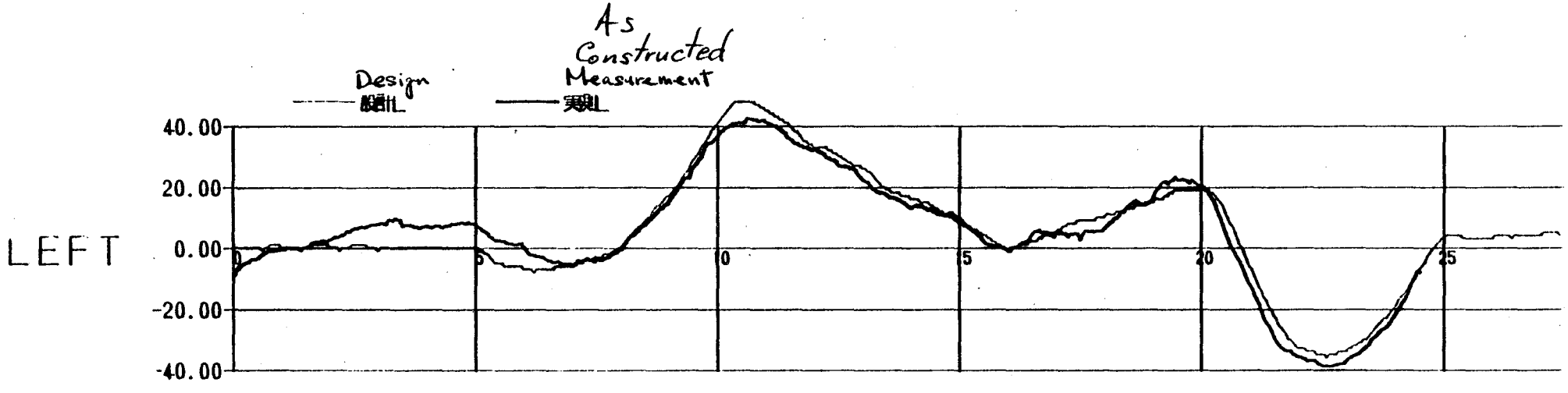
Average of Ri 3/i

Standard Deviation

Remark

YACHIYO WORK'S CO., LTD. KKY-3T 9012

0


As Constructed Measurement
Design
LEFT
40.00
20.00
0.00
-20.00
-40.00
0
5
10
15
20
25

(Flatness Testing Result)

Equimant : 8m Profilometer

Lane		Subbase Course			Bituminous Stabilization Course			Binder Course			Surface Course		
		L	R	Ave	L	R	Ave	L	R	Ave	L	R	Ave
Straight Section	PrI Cm/Km												
	TCR Cm/Km												
Curved Section	PrI Cm/Km												
	TCR Cm/Km												
All Lines	PrI Cm/Km												
	TCR Cm/Km												

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APPENDIX D

METHOD FOR MEASURING
SMOOTHNESS OF PAVEMENT SURFACE

METHOD FOR MEASURING ROUGHNESS OF PAVEMENT SURFACE-1

KODAN 200-1985 METHOD FOR MEASURING ROUGHNESS OF ROAD SURFACE BY 8 M PROFILOMETER

1. Scope

This test method covers the method of measuring and analyzing the longitudinal roughness of road surface using a profilometer.

2. Testing Instruments

2.1 Profilometer

Vertical roughness of each four reference wheels at both ends as illustrated in Fig. 1 is measured by a center measuring wheel.

2.2 Towing Car

A car that can be driven at a constant low speed with a towing mechanism.

3. Method of Measuring

3.1 Measuring Position

Roadway outer edge or 75 cm to 100 cm inside from the outer lane marking of each traffic lane where wheels pass most frequently shall be selected. For a wide two-lane road, where wheels pass most frequently shall be selected.

3.2 Measuring Speed

Standard measuring speed shall be 10 km/h.

3.3 Measuring Magnification

Measuring magnification shall basically be 1/250 longitudinally and 1/1 vertically. For a reduced scale, the longitudinal magnification and the accuracy in the vertical direction (1) shall be checked in advance of measurement in the section where the longitudinal and vertical distances are accurately known.

Note (1): Since accuracy in the vertical direction can be fairly correlated with the air pressure of the measuring wheel, calibration with different air pressure is recommended.

3.4 Record During Measurement

When measuring, the locations of kilo-posts, bridges, over bridges, tunnels, culverts, expansion joints of bridges and over bridges, repaired parts, and cracks shall be recorded. (Refer to Fig. 2)

3.5 Analysis of Data

3.5.1 PrI (Profile Index - Unit is cm/km)

PrI is obtained by adding the maximum distance (ai cm) between the peak and the bottom deviating from a 6 mm long band placed at the center of the profile of a record paper and dividing the added value by a section length (Lkm).

$$PrI = \frac{\Sigma ai}{L}$$

Σai = Deviated distance from a 6 mm band (cm)

L = Section length (km)

3.5.2 TCR (Total Cumulative Roughness - Unit cm/km)

TCR is obtained by dividing the doubled cumulative downward displacement of a measuring wheel by section length.

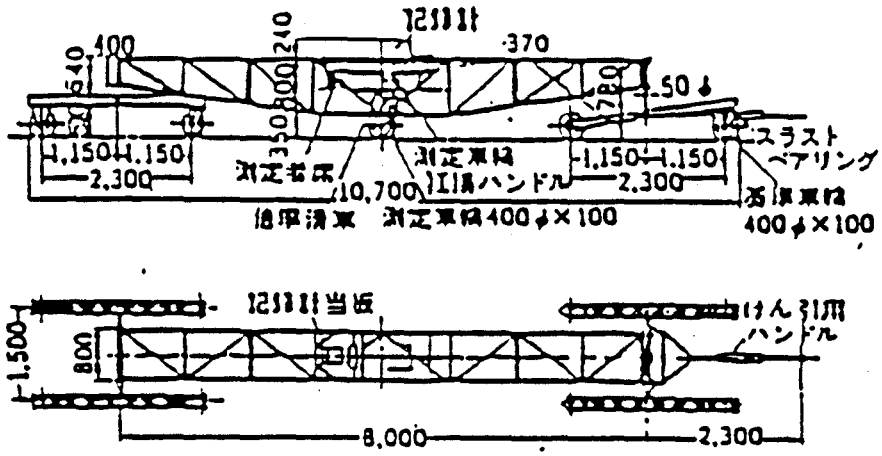
$$TCR = \frac{cumulative\ downward\ displacement\ (cm)\ x\ 2}{L}$$

Note: The section length for obtaining PrI and TCR are basically 200 meters. This section partition line and the PrI value shall be marked on a record paper. Bridges, over bridges, tunnels, culverts, etc. shall be marked in

each section. The calculated value, based on five meters in front of and behind an expansion joint of bridges, over bridges, etc. that are excluded from the section length, shall be recorded in parentheses.

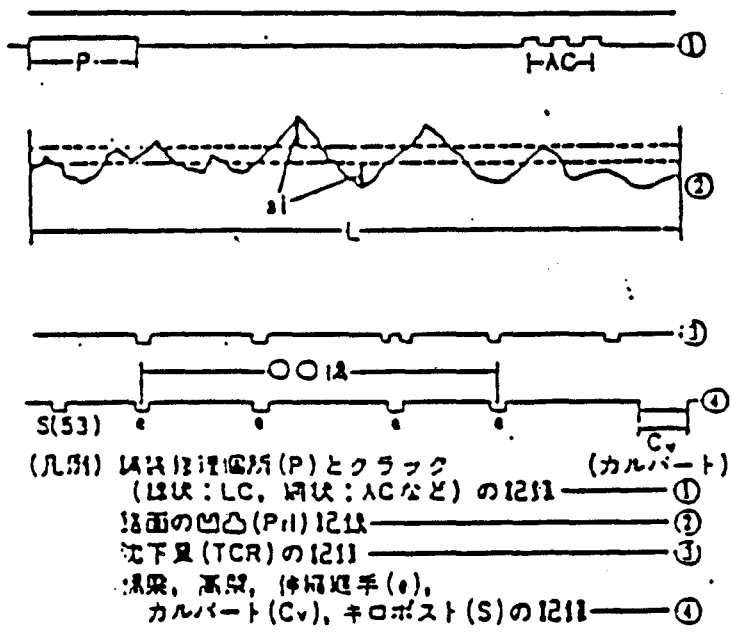
4. Report

Test results shall be classified and printed out on test form-221.



図－1　プロフィルメータの構造

Fig.1　　Structure of a profile meter



図－2　プロフィルメータ記入例

Fig.2　　Example of profile meter record

METHOD FOR MEASURING ROUGHNESS OF PAVEMENT SURFACE-2

1. <u>Purpose</u>

The purpose is to measure the longitudinal roughness of road which affect driving comfort.

2. <u>Scope</u>

This method is applied mainly to measure at site the roughness of roadway surface paved by asphalt mixtures or cement concrete. The following two methods are used according to different measuring instruments.

1) **Method Using 3-Meter Profile Meter**

A 3-meter profile meter is mainly used for a detailed survey of roughness in finishing management or when investigating surface characteristic of pavement.

2) **Method Using 3-Meter Straightedge**

It is most desirable to use a 3-meter profile meter for detailed survey of roughness. However, this method is used when precise survey is not required, when the survey is relatively small scale, or when executing a preliminary survey in advance of a test using a 3-meter profile meter.

3. <u>Measuring Instruments</u>

1) **Method Using 3-Meter Profile Meter**

a) 3-meter profile meter (as shown in Fig. 3.1).

2) **Method Using 3-Meter Straightedge**

a) 3-meter straightedge (with supports as shown in Fig. 3.2).

b) Wedge: Inset a wedge with graduated scale into the gap between straightedge and road surface. The depth inserted corresponds to the gap between straightedge and road surface. The depth inserted corresponds to the gap between straightedge and road surface.

4. <u>Measuring Method</u>

1) Method Using 3-Meter Profile Meter

a) Reconnoiter the measuring section, confirm the location of the beginning and end points and the location of structures that obstruct taking measurements of roughness such as bridge connecting points and manholes, and clean to remove pebbles and trash.

b) Establish one measuring line for each traffic lane parallel to the center of the measuring traffic lane from the beginning to end points. The measuring point shall be about 80 cm to 100 cm distant from the edge of traffic lane for finishing management or inspection purposes and shall be the bottom of rut on the right or left side for a survey of test pavement or a measurement of surface characteristic for road management purpose.

c) Record the road surface roughness by pulling the profile meter at a normal walking pace from the beginning to end points.

2) Method Using 3-Meter Straightedge

a) Reconnoiter the measuring section, confirm the location of the beginning and end points and the location of structures that obstruct taking measurements of roughness such as bridge connecting points and manholes, and clean to remove pebbles and trash.

b) Establish one measuring line for each traffic lane parallel to the center of the measuring traffic lane from the beginning to end points. The measuring point shall be about 80 cm to 100 cm distant from the edge of the traffic lane for finishing management or inspection purposes and shall be the bottom of rut on the right or

left side for a survey of test pavement or a measurement of surface characteristic for road management purpose.

c) Measure the gap between the straightedge and road surface at 1.5 m intervals by moving the straightedge from the beginning to end points as shown in Fig. 3.4.

5. Arrangement of Results

1) Method Using 3-Meter Profile Meter

a) Divide the entire measuring line into 100 - 300 m sections.

b) Draw an arbitrary reference line on the waves recorded on the chart paper and read the wave height from the reference line at 1.5 m intervals.

c) Calculate the standard deviation for each section using equation (3-1) to obtain measured roughness. The unit shall be in mm and the value shall be calculated to two decimal points. However, data around manholes which are obstacles to measure roughness shall be excluded.

$$\sigma = \sqrt{[\Sigma d^2 - (\Sigma d)^2/n]/(n-1)} \qquad \ldots\ldots (3\text{-}1)$$

σ = Roughness (mm)

d = Measured value of wave height (mm)

n = Number of data

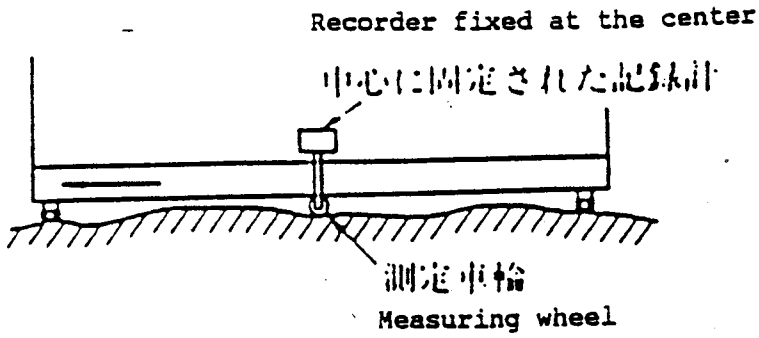
d) Record the obtained roughness, the beginning, and end points of the section, the length of measuring section, and the measuring instruments.

2) Method Using 3-Meter Straightedge

a) Divide the entire measuring line into 100 - 300 mm sections.

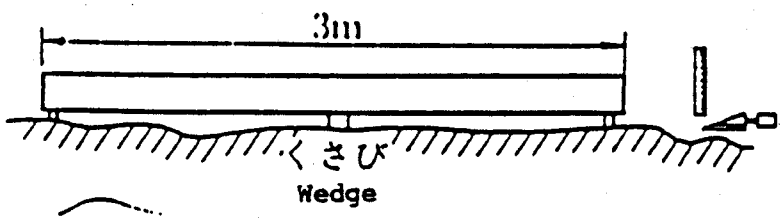
b) Calculate the standard deviation for each section using equation (3-1) to obtain measured roughness. The unit shall be in mm an the value shall be calculated to two decimal points. However, data around manholes which are obstacles to measuring roughness shall be excluded.

c) Record the obtained roughness, the beginning, and the end points of the section, the length of the measuring section, an the measuring instruments.



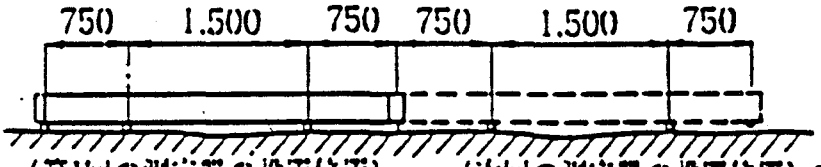
図— 3・1 3mプロフィルメータ

Fig. 3.1 3-meter profile meter



図— 3・2 3m直線定規（足付き）

Fig. 3.2 3-meter straightedge



(第1回の測定器の設置位置) (次回の測定器の設置位置) Second position of straightedge

First position of straightedge

○印は測定箇所を示す

∘: measuring point

Unit

(単位：mm)

図－3・4 直読式の測定方法

Fig. 3-4 Measuring method by direct reading

APPENDIX E

404 PERMIT INFORMATION

PART 330—NATIONWIDE PERMITS

Sec.

330.1 General.
330.2 Definitions.
330.3 Activities occuring before certain dates.
330.4 Public notice.
330.5 Nationwide permits.
330.6 Management practices.
330.7 Notification procedures.
330.8 Discretionary Authority.
330.9 State water quality certification.
330.10 Coastal Zone Management consistency determination.
330.11 Nationwide permit verification.
330.12 Expiration of nationwide permits.

Authority: 33 U.S.C. 401 et seq.; 33 U.S.C. 1344; 33 U.S.C. 1413.

§ 330.1 General.

The purpose of this regulation is to describe the Department of the Army's (DA) nationwide permit program and to list all current nationwide permits which have been issued by publication herein. A nationwide permit is a form of general permit which may authorize activities throughout the nation. (Another type of general permit is a "regional permit" and is issued by division or district engineers on a regional basis in accordance with 33 CFR Part 325). Copies of regional conditions and modifications, if any, to the nationwide permits can be obtained from the appropriate district engineer. Nationwide permits are designed to allow certain activities to occur with little, if any, delay or paperwork. Nationwide permits are valid only if the conditions applicable to the nationwide permits are met. Failure to comply with a condition does not necessarily mean the activity cannot be authorized but rather that the activity can only be authorized by an individual or regional permit. Several of the nationwide permits require notification to the district engineer prior to commencement of the authorized activity. The procedures for this notification are located at § 330.7 of this Part. Nationwide permits can be issued to satisfy the requirements of section 10 of the Rivers and Harbors Act of 1899, section 404 of the Clean Water Act, and/or section 103 of the Marine Protection, Research and Sanctuaries Act. The applicable authority is indicated at the end of each nationwide permit.

§ 330.2 Definitions.

(a) The definitions of 33 CFR Parts 321–329 are applicable to the terms used in this Part.

(b) The term "headwaters" means the point on a non-tidal stream above which the average annual flow is less than five cubic feet per second. The district engineer may estimate this point from available data by using the mean annual area precipitation, area drainage basin maps, and the average runoff coefficient, or by similar means. For streams that are dry for long periods of the year, district engineers may establish the "headwaters" as that point on the stream where a flow of five cubic feet per second is equaled or exceeded 50 percent of the time.

(c) Discretionary authority means the authority delegated to division engineers in § 330.8 of this part to override provisions of nationwide permits, to add regional conditions, or to require individual permit application.

§ 330.3 Activities occurring before certain dates.

The following activities were permitted by nationwide permits issued on July 19, 1977, and unless modified do not require further permitting:

(a) Discharges of dredged or fill material into waters of the United States outside the limits of navigable waters of the United States that occurred before the phase-in dates which began July 25, 1975, and extended section 404 jurisdiction to all waters of the United

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States. (These phase-in dates are: After July 25, 1975, discharges into navigable waters of the United States and adjacent wetlands; after September 1, 1976, discharges into navigable waters of the United States and their primary tributaries, including adjacent wetlands, and into natural lakes, greater than 5 acres in surface area; and after July 1, 1977, discharges into all waters of the United States.) (Section 404)

(b) Structures or work completed before December 18, 1968, or in waterbodies over which the district engineer had not asserted jurisdiction at the time the activity occurred provided, in both instances, there is no interference with navigation. (Section 10)

§ 330.4 Public notice.

(a) *Chief of Engineers.* Upon proposed issuance of new nationwide permits, modification to, or reissuance of, existing nationwide permits, the Chief of Engineers will publish a notice in the Federal Register seeking public comments and including the opportunity for a public hearing. This notice will state the availability of information at the Office of the Chief of Engineers and at all district offices which reveals the Corps' provisional determination that the proposed activities comply with the requirements for issuance under general permit authority. The Chief of Engineers will prepare this information which will be supplemented, if appropriate, by division engineers.

(b) *District engineers.* Concurrent with publication in the Federal Register of proposed, new, or reissued nationwide permits by the Chief of Engineers, district engineers will so notify the known interested public by an appropriate notice. The notice will include regional conditions, if any, developed by the division engineer.

§ 330.5 Nationwide permits.

(a) *Authorized activities.* The following activities are hereby permitted provided they meet the conditions listed in paragraph (b) of this section and, where required, comply with the notification procedures, of § 330.7.

(1) The placement of aids to navigation and regulatory markers which are approved by and installed in accordance with the requirements of the U.S. Coast Guard (33 CFR Part 66, Subchapter C). (Section 10)

(2) Structures constructed in artificial canals within principally residential developments where the connection of the canal to a navigable water of the United States has been previously authorized (see 33 CFR Part 322.5(g)). (Section 10)

(3) The repair, rehabilitation, or replacement of any previously authorized, currently serviceable, structure or fill, or of any currently serviceable structure or fill constructed prior to the requirement for authorization, provided such repair, rehabilitation, or replacement does not result in a deviation from the plans of the original structure or fill, and further provided that the structure or fill has not been put to uses differing from uses specified for it in any permit authorizing its original construction. Minor deviations due to changes in materials or construction techniques and which are necessary to make repair, rehabilitation, or replacement are permitted. Maintenance dredging and beach restoration are not authorized by this nationwide permit. (Section 10 and 404)

(4) Fish and wildlife harvesting devices and activities such as pound nets, crab traps, eel pots, lobster traps, duck blinds, and clam and oyster digging. (Section 10)

(5) Staff gages, tide gages, water recording devices, water quality testing and improvement devices, and similar scientific structures. (Section 10)

(6) Survey activities including core sampling, seismic exploratory operations, and plugging of seismic shot holes and other exploratory-type bore holes. Drilling of exploration-type bore holes for oil and gas exploration is not authorized by this nationwide permit; the plugging of such holes is authorized. (Sections 10 and 404).

(7) Outfall structures and associated intake structures where the effluent from that outfall has been permitted under the National Pollutant Discharge Elimination System program (Section 402 of the Clean Water Act) (see 40 CFR Part 122) provided that the district or division engineer makes a determination that the individual and cumulative adverse environmental effects of the structure itself are minimal in accordance with § 330.7 (c)(2) and (d). Intake structures per se are not included—only those directly associated with an outfall structure are covered by this nationwide permit. This permit includes minor excavation, filling and other work associated with installation of the intake and outfall structures. (Sections 10 and 404)

(8) Structures for the exploration, production, and transportation of oil, gas, and minerals on the outer continental shelf within areas leased for such purposes by the Department of Interior, Mineral Management Service, provided those structures are not placed within the limits of any designated shipping safety fairway or traffic separation scheme (where such limits have not been designated or where changes are anticipated, district engineers will consider recommending the discretionary authority provided by 330.8 of this Part, and further subject to the provisions of the fairway regulations in 33 CFR 322.5(1) (Section 10).

(9) Structures placed within anchorage or fleeting areas to facilitate moorage of vessels where such areas have been established for that purpose by the U.S. Coast Guard. (Section 10)

(10) Non-commercial, single-boat, mooring buoys. (Section 10)

(11) Temporary buoys and markers placed for recreational use such as water skiing and boat racing provided that the buoy or marker is removed within 30 days after its use has been discontinued. At Corps of Engineers reservoirs, the reservoir manager must approve each buoy or marker individually. (Section 10)

(12) Discharge of material for backfill or bedding for utility lines, including outfall and intake structures, provided there is no change in preconstruction bottom contours (excess material must be removed to an upland disposal area). A "utility line" is defined as any pipe or pipeline for the transportation of any gaseous, liquid, liquifiable, or slurry substance, for any purpose, and any cable, line, or wire for the transmission for any purpose of electrical energy, telephone and telegraph messages, and radio and television communication. (The utility line and outfall and intake structures will require a Section 10 permit if in navigable waters of the United States. See 33 CFR Part 322. See also paragraph (a)(7) of this section). (Section 404)

(13) Bank stabilization activities provided:

(i) The bank stabilization activity is less than 500 feet in length;

(ii) The activity is necessary for erosion prevention;

(iii) The activity is limited to less than an average of one cubic yard per running foot placed along the bank within waters of the United States;

(iv) No material is placed in excess of the minimum needed for erosion protection;

(v) No material is placed in any wetland area;

(vi) No material is placed in any location or in any manner so as to impair surface water flow into or out of any wetland area;

(vii) Only clean material free of waste metal products, organic materials, unsightly debris, etc. is used; and

(viii) The activity is a single and complete project. (Sections 10 and 404)

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(14) Minor road crossing fills including all attendant features, both temporary and permanent, that are part of a single and complete project for crossing of a non-tidal waterbody, provided that the crossing is culverted, bridged or otherwise designed to prevent the restriction of, and to withstand, expected high flows and provided further that discharges into any wetlands adjacent to the waterbody do not extend beyond 100 feet on either side of the ordinary high water mark of that waterbody. A "minor road crossing fill" is defined as a crossing that involves the discharge of less than 200 cubic yards of fill material below the plane of ordinary high water. The crossing may require a permit from the US Coast Guard if located in navigable waters of the United States. Some road fills may be eligible for an exemption from the need for a Section 404 permit altogether (see 33 CFR 323.4). District engineers are authorized, where local circumstances indicate the need, to define the term "expected high flows" for the purpose of establishing applicability of this nationwide permit. (Sections 10 and 404)

(15) Discharges of dredged or fill material incidental to the construction of bridges across navigable waters of the United States, including cofferdams, abutments, foundation seals, piers, and temporary construction and access fills provided such discharge has been authorized by the US Coast Guard as part of the bridge permit. Causeways and approach fills are not included in this nationwide permit and will require an individual or regional Section 404 permit. (Section 404)

(16) Return water from an upland, contained dredged material disposal area (see 33 CFR 323.2(d)) provided the state has issued a site specific or generic certification under section 401 of the Clean Water Act (see also 33 CFR 325.2(b)(1)). The dredging itself requires a Section 10 permit if located in navigable waters of the United States. The return water or runoff from a contained disposal area is administratively defined as a discharge of dredged material by 33 CFR 323.2(d) even though the disposal itself occurs on the upland and thus does not require a section 404 permit. This nationwide permit satisfies the technical requirement for a section 404 permit for the return water where the quality of the return water is controlled by the state through the section 401 certification procedures. (Section 404)

(17) Fills associated with small hydropower projects at existing reservoirs where the project which includes the fill is licensed by the Federal Energy Regulatory Commission (FERC) under the Federal Power Act of 1920, as amended; has a total generating capacity of not more than 1500 kw (2,000 horsepower); qualifies for the short-form licensing procedures of the FERC (see 18 CFR 4.61); and the district or division engineer makes a determination that the individual and cumulative adverse effects on the environment are minimal in accordance with § 330.7 (c)(2) and (d). (Section 404)

(18) Discharges of dredged or fill material into all waters of the United States other than wetlands that do not exceed ten cubic yards as part of a single and complete project provided the material is not placed for the purpose of stream diversion. (Sections 10 and 404)

(19) Dredging of no more than ten cubic yards from navigable waters of the United States as part of a single and complete project. This permit does not authorize the connection of canals or other artificial waterways to navigable waters of the United States (see Section 33 CFR 322.5(g)). (Section 10)

(20) Structures, work, and discharges for the containment and cleanup of oil and hazardous substances which are subject to the National Oil and Hazardous Substances Pollution Contingency Plan. (40 CFR Part 300), provided the Regional Response Team which is activated under the Plan concurs with the proposed containment and cleanup action. (Sections 10 and 404)

(21) Structures, work, discharges associated with surface coal mining activities provided they were authorized by the Department of the Interior, Office of Surface Mining, or by states with approved programs under Title V of the Surface Mining Control and Reclamation Act of 1977; the appropriate district engineer is given the opportunity to review the Title V permit application and all relevant Office of Surface Mining or state (as the case may be) documentation prior to any decision on that application; and the district or division engineer makes a determination that the individual and cumulative adverse effects on the environment from such structures, work, or discharges are minimal in accordance with §§ 330.7 (c)(2) and (3) and (d). (Sections 10 and 404)

(22) Minor work, fills, or temporary structures required for the removal of wrecked, abandoned, or disabled vessels, or the removal of man-made obstructions to navigation. This permit does not authorize maintenance dredging, shoal removal, or river bank snagging. (Sections 10 and 404)

(23) Activities, work, and discharges undertaken, assisted, authorized, regulated, funded, or financed, in whole or in part, by another federal agency or department where that agency or department has determined, pursuant to the CEQ Regulation for Implementing the Procedural Provisions of the National Environmental Policy Act (40 CFR Part 1500 et seq.), that the activity, work, or discharge is categorically excluded from environmental documentation because it is included within a category of actions which neither individually nor cumulatively have a significant effect on the human environment, and the Office of the Chief of Engineers (ATTN: DAEN-CWO-N) has been furnished notice of the agency's or department's application for the categorical exclusion and concurs with that determination. Prior to approval for purposes of this nationwide permit of any agency's categorical exclusions, the Chief of Engineers will solicit comments through publication in the Federal Register. (Sections 10 and 404)

(24) Any activity permitted by a state administering its own Section 404 permit program for the discharge of dredged or fill material authorized at 33 U.S.C. 1344(g)-(l) is permitted pursuant to section 10 of the Rivers and Harbors Act of 1899. Those activities which do not involve a section 404 state permit are not included in this nationwide permit but many will be exempted by section 154 of Pub. L. 94-587. (See 33 CFR 322.3(a)(2)). (Section 10)

(25) Discharge of concrete into tightly sealed forms or cells where the concrete is used as a structural member which would not otherwise be subject to Clean Water Act jurisdiction. (Section 404)

(26) Discharges of dredged or fill material into the waters listed in paragraphs (a)(26) (i) and (ii) of this section except those which cause the loss or substantial adverse modification of 10 acres or more of such waters of the United States, including wetlands. For discharges which cause the loss or substantial adverse modification of 1 to 10 acres of such waters, including wetlands, notification to the district engineer is required in accordance with section 330.7 of this section. (Section 404).

(i) Non-tidal rivers, streams, and their lakes and impoundments, including adjacent wetlands, that are located above the headwaters.

(ii) Other non-tidal waters of the United States, including adjacent wetlands, that are not part of a surface tributary system to interstate waters or

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navigable waters of the United States (i.e., isolated waters).

(b) *Conditions.* The following special conditions must be followed in order for the nationwide permits identified in paragraph (a) of this section to be valid:

(1) That any discharge of dredged or fill material will not occur in the proximity of a public water supply intake.

(2) That any discharge of dredged or fill material will not occur in areas of concentrated shellfish production unless the discharge is directly related to a shellfish harvesting activity authorized by paragraph (a)(4) of this section.

(3) That the activity will not jeopardize a threatened or endangered species as identified under the Endangered Species Act (ESA), or destroy or adversely modify the critical habitat of such species. In the case of federal agencies, it is the agencies' responsibility to comply with the requirements of the ESA. If the activity may adversely affect any listed species or critical habitat, the district engineer must initiate Section 7 consultation in accordance with the ESA. In such cases, the district engineer may:

(i) Initiate section 7 consultation and then, upon completion, authorize the activity under the nationwide permit by adding, if appropriate, activity specific conditions, or

(ii) Prior to or concurrent with section 7 consultation he may recommend discretionary authority (See section 330.8) or use modification, suspension, or revocation procedures (See 33 CFR 325.7).

(4) That the activity shall not significantly disrupt the movement of those species of aquatic life indigenous to the waterbody (unless the primary purpose of the fill is to impound water):

(5) That any discharge of dredged or fill material shall consist of suitable material free from toxic pollutants (see section 307 of the Clean Water Act) in toxic amounts:

(6) That any structure or fill authorized shall be properly maintained.

(7) That the activity will not occur in a component of the National Wild and Scenic River System; nor in a river officially designated by Congress as a "study river" for possible inclusion in the system, while the river is in an official study status:

(8) That the activity shall not cause an unacceptable interference with navigation:

(9) That, if the activity may adversely affect historic properties which the National Park Service has listed on, or determined eligible for listing on, the National Register of Historic Places, the permittee will notify the district engineer. If the district engineer determines that such historic properties may be adversely affected, he will provide the Advisory Council on Historic Preservation an opportunity to comment on the effects on such historic properties or he will consider modification, suspension, or revocation in accordance with 33 CFR 325.7. Furthermore, that, if the permittee before or during prosecution of the work authorized, encounters a historic property that has not been listed or determined eligible for listing on the National Register, but which may be eligible for listing in the National Register, he shall immediately notify the district engineer:

(10) That the construction or operation of the activity will not impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights:

(11) That in certain states, an individual state water quality certification must be obtained or waived (See § 330.9):

(12) That in certain states, an individual state coastal zone management consistency concurrence must be obtained or waived (See § 330.10):

(13) That the activity will comply with regional conditions which may have been added by the division engineer (See § 330.8(a)): and

(14) That the management practices listed in § 330.6 of this part shall be followed to the maximum extent practicable.

(c) *Further information.* (1) District engineers are authorized to determine if an activity complies with the terms and conditions of a nationwide permit unless that decision must be made by the division engineer in accordance with § 330.7.

(2) Nationwide permits do not obviate the need to obtain other Federal, state or local authorizations required by law.

(3) Nationwide permits do not grant any property rights or exclusive privileges.

(4) Nationwide permits do not authorize any injury to the property or rights of others.

(5) Nationwide permits do not authorize interference with any existing or proposed Federal project.

(d) *Modification, Suspension or Revocation of Nationwide Permits.* The Chief of Engineers may modify, suspend, or revoke nationwide permits in accordance with the relevant procedures of 33 CFR 325.7. Such authority includes, but is not limited to: adding individual, regional, or nationwide conditions: revoking authorization for a category of activities or a category of waters by requiring individual or regional permits: or revoking an authorization on a case-by-case basis. This authority is not limited to concerns for the aquatic environment as is the discretionary authority in § 330.8.

§ 330.6 Management practices.

(a) In addition to the conditions specified in § 330.5 of this Part, the following management practices shall be followed, to the maximum extent practicable, in order to minimize the adverse effects of these discharges on the aquatic environment. Failure to comply with these practices may be cause for the district engineer to recommend, or the division engineer to take, discretionary authority to regulate the activity on an individual or regional basis pursuant to § 330.8 of this Part.

(1) Discharges of dredged or fill material into waters of the United States shall be avoided or minimized through the use of other practical alternatives.

(2) Discharges in spawning areas during spawning seasons shall be avoided.

(3) Discharges shall not restrict or impede the movement of aquatic species indigenous to the waters or the passage of normal or expected high flows or cause the relocation of the water (unless the primary purpose of the fill is to impound waters).

(4) If the discharge creates an impoundment of water, adverse impacts on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow shall be minimized.

(5) Discharge in wetlands areas shall be avoided.

(6) Heavy equipment working in wetlands shall be placed on mats.

(7) Discharges into breeding areas for migratory waterfowl shall be avoided.

(8) All temporary fills shall be removed in their entirety.

§ 330.7 Notification procedures.

(a) The general permittee shall not begin discharges requiring pre-discharge notification pursuant to the nationwide permit at § 330.5(a)(26):

(1) Until notified by the district engineer that the work may proceed under the nationwide permit with any special conditions imposed by the district or division engineer: or

(2) If notified by the district or division engineer that an individual permit may be required: or

(3) Unless 20 days have passed from receipt of the notification by the district engineer and no notice has been

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received from the district or division engineer.

(b) Notification pursuant to the nationwide permit at § 330.5(a)(26) must be in writing and include the information listed below. Notification is not an admission that the proposed work would result in more than minimal impacts to waters of the United States; it simply allows the district or division engineer to evaluate specific activities for compliance with general permit criteria.

(1) Name, address, and phone number of the general permittee;

(2) Location of the planned work;

(3) Brief description of the proposed work, its purpose, and the approximate size of the waters, including wetlands, which would be lost or substantially adversely modified as a result of the work; and

(4) Any specific information required by the nationwide permit and any other information that the permittee believes is appropriate.

(c) *District engineer review of notification.* Upon receipt of notification, the district engineer will promptly review the general permittee's notification to determine which of the following procedures should be followed:

(1) If the nationwide permit at § 330.5(a)(26) is involved and the district engineer determines either, (i) the proposed activity falls within a class of discharges or will occur in a category of waters which has been previously identified by the Regional Administrator, Environmental Protection Agency; the Regional Director, Fish and Wildlife Service; the Regional Director, National Marine Fisheries Service; or the heads of the appropriate state natural resource agencies as being of particular interest to those agencies; or (ii) the particular discharge has not been previously identified but he believes it may be of importance to those agencies, he will promptly forward the notification to the division engineer and the head and appropriate staff officials of those agencies to afford those agencies an adequate opportunity before such discharge occurs to consider such notification and express their views, if any, to the district engineer concerning whether individual permits should be required.

(2) If the nationwide permits at § 330.5(a) (7), (17), or (21) are involved and the Environmental Protection Agency, the Fish and Wildlife Service, the National Marine Fisheries Service or the appropriate state natural resource or water quality agencies forward concerns to the district engineer, he will forward those concerns to the division engineer together with a statement of the factors pertinent to a determination of the environmental effects of the proposed discharges, including those set forth in the 404(b)(1) guidelines, and his views on the specific points raised by those agencies.

(3) If the nationwide permit at § 330.5(a)(21) is involved the district engineer will give notice to the Environmental Protection Agency and the appropriate state water quality agency. This notice will include as a minimum the information required by paragraph (b) of this section.

(d) *Division engineer review of notification.* The division engineer will review all notifications referred to him in accordance with paragraph (c)(1) or (c)(2) of this section. The division engineer will require an individual permit when he determines that an activity does not comply with the terms or conditions of a nationwide permit or does not meet the definition of a general permit (see 33 CFR 322.2(f) and 323.2(n)) including discharges under the nationwide permit at § 330.5(a)(26) which have more than minimal adverse environmental effects on the aquatic environment when viewed either cumulatively or separately. In reaching his decision, he will review factors pertinent to a determination of the environmental effects of the proposed discharge, including those set forth in the 404(b)(1) guidelines, and will give full consideration to the views, if any, of the federal and state natural resource agencies identified in paragraph (c) of this section. If the division engineer decides that an individual permit is not required, and a federal or appropriate state natural resource agency has indicated in writing that an activity may result in more than minimal adverse environmental impacts, he will prepare a written statement, available to the public on request, which sets forth his response to the specific points raised by the commenting agency. When the division engineer reaches his decision he will notify the district engineer, who will immediately notify the general permittee of the division engineer's decision.

§ 330.8 Discretionary authority.

Except as provided in paragraphs (c)(2) and (d) of this section, division engineers on their own initiative or upon recommendation of a district engineer are authorized to modify nationwide permits by adding regional conditions or to override nationwide permits by requiring individual permit applications on a case-by-case basis, for a category of activities, or in specific geographic areas. Discretionary authority will be based on concerns for the aquatic environment as expressed in the guidelines published by EPA pursuant to section 404(b)(1), (40 CFR Part 230)

(a) *Activity Specific conditions.* Division engineers are authorized to modify nationwide permits by adding individual conditions on a case-by-case basis applicable to certain activities within their division. Activity specific conditions may be added by the District Engineer in instances where there is mutual agreement between the district engineer and the permittee. Furthermore, district engineers will condition NWPs with conditions which have been imposed on a state section 401 water quality certification issued pursuant to § 330.9 of this Part.

(b) *Regional conditions.* Division engineers are authorized to modify nationwide permits by adding conditions on a generic basis applicable to certain activities or specific geographic areas within their divisions. In developing regional conditions, division and district engineers will follow standard permit processing procedures as prescribed in 33 CFR Part 325 applying the evaluation criteria of 33 CFR Part 320 and appropriate parts of 33 CFR Parts 321, 322, 323, and 324. Division and district engineers will take appropriate measures to inform the public of the additional conditions.

(c) *Individual permits*—(1) *Case-by-Case.* In nationwide permit cases where additional individual or regional conditioning may not be sufficient to address concerns for the aquatic environment or where there is not sufficient time to develop such conditions under paragraphs (a) or (b) of this section, the division engineer may suspend use of the nationwide permit and require an individual permit application on a case-by-case basis. The district engineer will evaluate the application and will either issue or deny a permit. However, if at any time the reason for taking discretionary authority is satisfied, then the division engineer may remove the suspension, reactivating authority under the nationwide permit. Where time is of the essence, the district engineer may telephonically recommend that the division engineer assert discretionary authority to require an individual permit application for a specific activity. If the division engineer concurs, he may orally authorize the district engineer to implement that authority. Oral authorization should be followed by written confirmation.

(2) *Category.* Additionally, after notice and opportunity for public hearing, division engineers may decide that individual permit applications

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should be required for categories of activities, or in specific geographic areas. However, only the Chief of Engineers may modify, suspend, or revoke nationwide permits on a statewide or nationwide basis. The division engineer will announce the decision to persons affected by the action. The district engineer will then regulate the activity or activities by processing an application(s) for an individual permit(s) pursuant to 33 CFR Part 325.

(d) For the nationwide permit found at § 330.5(a)(26), after the applicable provisions of § 330.7(a) (1) and (3) have been satisfied, the permittee's right to proceed under the general permit may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 325.7.

(e) A copy of all modifications or revocations of activities covered by nationwide permits will be forwarded to the Office of the Chief of Engineers, ATTN: DAEN-CWO-N.

§ 330.9 State water quality certification.

(a) State water quality certification is required for nationwide permits which may result in any discharge into waters of the United States. If a state issues a water quality certification which includes special conditions, the district engineer will add these conditions as conditions of the nationwide permit in that state. However, if such conditions do not comply with the provisions of 33 CFR 325.4 or if a state denies a required 401 certification for a particular nationwide permit, authorization for all discharges covered by the nationwide permit within the state is denied without prejudice until the state issues an individual or generic water quality certification or waives its right to do so. A district engineer will not process an individual permit application for an activity for which authorization has been denied without prejudice under the nationwide permit program. However, if the division engineer determines that it would otherwise be appropriate to exercise his discretionary authority, pursuant to § 330.8, to override the nationwide permit or permits in question, he may do so, and the district engineer may proceed with the processing of individual permit applications. In instances where a state has denied the 401 water quality certification for discharges under a particular nationwide permit, applicants must furnish the district engineer with an individual or generic 401 certification or a copy of the application to the state for the certification. If a state fails to act within a reasonable period of time (see § 325.2(b)(1)(ii)), a waiver will be presumed. Upon receipt of an individual or generic certification or a waiver of certification, the proposed work is authorized under the nationwide permit. If a state issues a conditioned individual certification, the district engineer will include those conditions that comply with 33 CFR 325.4 as special conditions of the nationwide permit (see 33 CFR Part 330.8(a)) and notify the applicant that the work is authorized under the nationwide permit provided all conditions are met.

(b) Certification requirements for nationwide permits fall into the following general categories:

(1) *No certification required.* Nationwide permits numbered 1, 2, 4, 5, 8, 9, 10, 11, and 19 do not involve activities which may result in a discharge and therefore 401 certification is not applicable.

(2) *Certification sometimes required.* Nationwide permits numbered 3, 6, 7, 13, 20, 21, 22, and 23 each involve various activities, some of which may result in a discharge and require certification, and others of which do not. State denial of certification for any specific nationwide permit in this category affects only those activities involving discharges. Those not involving discharges remain in effect.

(3) *Certification required.* Nationwide permits numbered 12, 14, 15, 16, 17, 18, 24, 25, and 26 involve activities which would result in discharges and therefore 401 certification is required.

(c) District engineers will take appropriate measures to inform the public of which waterbodies or regions within the state, and for which nationwide permits, an individual 401 water quality certification is required.

§ 330.10 Coastal zone management consistency determination.

In instances where a state has not concurred that a particular nationwide permit is consistent with an approved coastal zone management plan, authorization for all activities subject to such nationwide permit within or affecting the state coastal zone agency's area of authority is denied without prejudice until the applicant has furnished to the district engineer a coastal zone management consistency determination pursuant to section 307 of the Coastal Zone Management Act and the state has concurred in it. If a state does not act on an applicant's consistency statement within six months after receipt by the state, consistency shall be presumed. District engineers will take appropriate measures to inform the public of which waterbodies or regions within the state, and for which nationwide permits, such individual consistency determination is required. District engineers will not process any permit application for an activity which has been denied without prejudice under the nationwide permit program. However, if the division engineer determines that it would otherwise be appropriate to exercise his discretionary authority, pursuant to § 330.8, to override the nationwide permit or permits in question, he may do so, and the district engineer may proceed with the processing of individual permit applications.

§ 330.11 Nationwide permit verification.

(a) General permittees may, and in some cases must, request from a district engineer confirmation that an activity complies with the terms and conditions of a nationwide permit. District engineers will respond promptly to such requests. The response will state that the verification is valid for a period of no more than two years or a lesser period of time if deemed appropriate. Section 330.12 takes precedence over this section, therefore, it is incumbent upon the permittee to remain informed of changes to nationwide permits.

(b) If the district engineer decides that an activity does not comply with the terms or conditions of a nationwide permit, he will so notify the person desiring to do the work and indicate that an individual permit is required (unless covered by a regional permit).

(c) If the district engineer decides that an activity does comply with the terms and conditions of a nationwide permit he will so notify the general permittee. In such cases, as with any activity which qualifies under a nationwide permit, the general permittee's right to proceed with the activities under the nationwide permit may be modified, suspended, or revoked only in accordance with the procedures of 33 CFR 325.7.

§ 330.12 Expiration of nationwide permits.

The Chief of Engineers will review nationwide permits on a continual basis, and will decide to either modify, reissue (extend) or revoke the permits at least every five years. If a nationwide permit is not modified or reissued within five years of publication in the Federal Register, it automatically expires and becomes null and void. Authorization of activities which have commenced or are under contract to commence in reliance upon a nationwide permit will remain in effect provided the activity is completed within twelve months of the date a nationwide permit has expired or was revoked unless discretionary permit authority has been exercised in

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accordance with § 330.8 of this Part or modification, suspension, or revocation procedures are initiated in accordance with the relevant provisions of 33 CFR 325.7. Activities completed under the authorization of a nationwide permit which was in effect at the time the activity was completed continue to be authorized by that nationwide permit.

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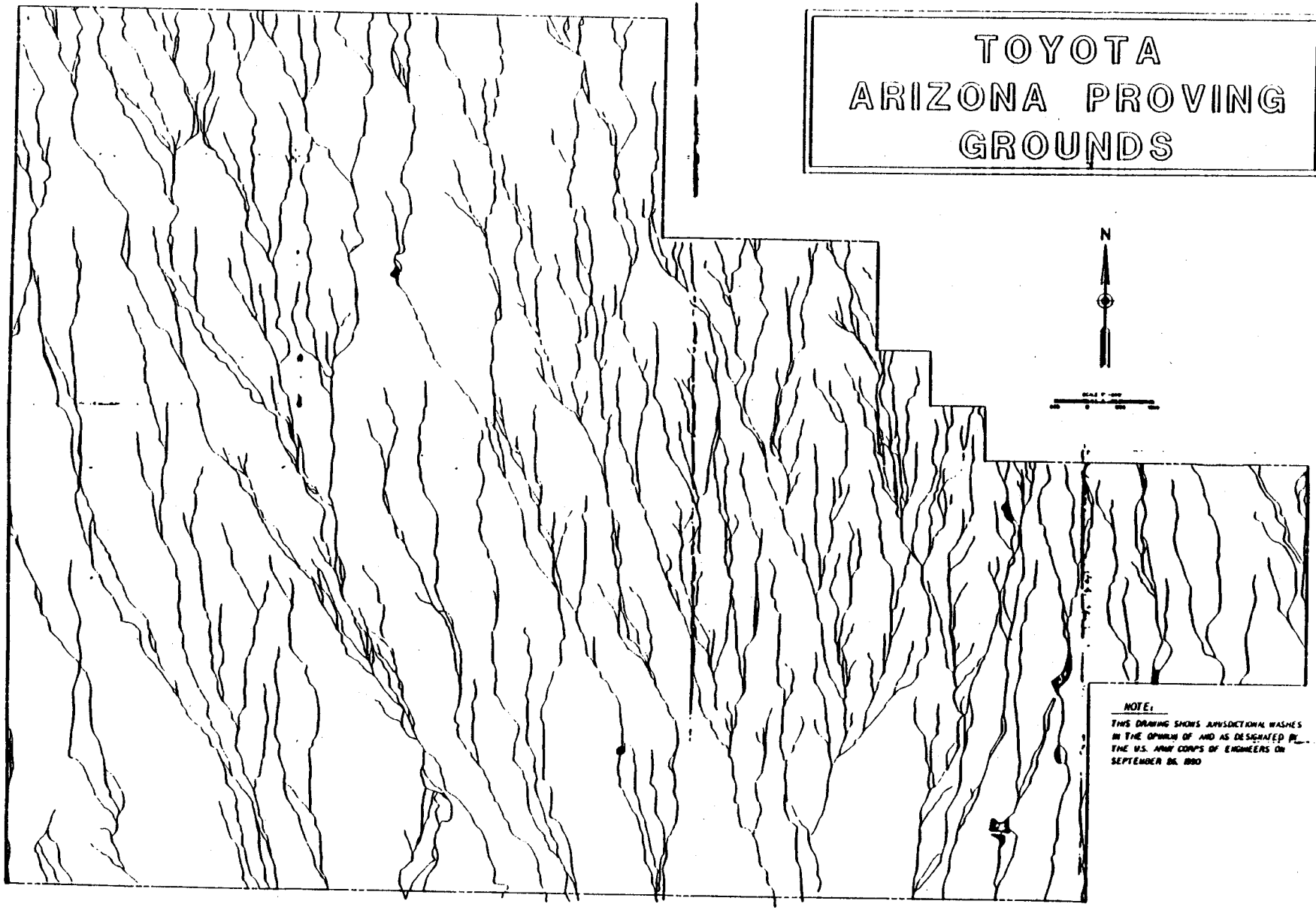

TOYOTA ARIZONA PROVING GROUNDS

NOTE:
THIS DRAWING SHOWS JURISDICTIONAL WASHES IN THE OPINION OF AND AS DESIGNATED BY THE U.S. ARMY CORPS OF ENGINEERS ON SEPTEMBER 26, 1990

UPDATED 11/16/90

COLLAR, WILLIAMS & WHITE