



Standard Specifications for Construction of Airports



Illinois Department
of Transportation
Division of Aeronautics

ILLINOIS
STANDARD SPECIFICATIONS
FOR
CONSTRUCTION OF
AIRPORTS

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION
DIVISION OF AERONAUTICS

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GENERAL PROVISIONS

SECTION 10

DEFINITION OF TERMS

Whenever the following terms are used in these specifications, in the contract, in any documents or other instruments pertaining to construction where these specifications govern, the intent and meaning shall be interpreted as follows:

10-01 ABBREVIATIONS. Wherever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented:

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AC	Federal Aviation Administration Advisory Circulars
ARA	American Railway Association
AREA	American Railway Engineering Association
ASLA	American Society of Landscape Architects
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
AWS	American Welding Society
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards, General Services Administration
SAE	Society of Automotive Engineers
USASI	United States of America Standards Institute

10-02 ACCESS ROAD. The right-of-way, the roadway and all improvements constructed thereon connecting the airport to a public highway.

10-03 ADMINISTRATOR. Administrator of the Federal Aviation Administration of the Department of Transportation, or his duly authorized representative.

10-04 ADVISORY CIRCULARS. As referred to in this document, these publications shall be the latest current document listed in the Federal Register Checklist as of the time of advertisement. They may be obtained from the U.S. Department of Transportation Publication Section, TAD 443.1, Washington, D.C., 20590.

10-05 ADVERTISEMENT. The public announcement, as required by law, inviting bids for work to be performed and/or materials to be furnished.

10-06 AWARD. The decision of the Division, FAA, and Owner (Sponsor) to accept the proposal of the lowest responsible bidder for the work, subject to the execution and approval of a satisfactory contract therefore and bonds to secure the performance thereof, and to such other conditions as may be specified or otherwise required by law.

10-07 AIR OPERATIONS AREA. For the purpose of these specifications, the term air operations area shall mean any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An air operation area shall include such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron.

10-08 AIRPORT. Airport means an area which is used or intended to be used for the landing and takeoff of aircraft, and includes its buildings and facilities, if any.

10-09 BID BOND. The security to be furnished by the bidder as guaranty of good faith that he will enter into a Contract with the Owner and will execute the required Bonds covering the work contemplated, if the same is awarded to him.

10-10 BIDDER. Any individual, partnership, firm, corporation, or a legally stated combination, acting directly or through a duly authorized representative, who submits a proposal for the work contemplated.

10-11.1 BRIDGE. A structure, including supports, erected over a depression or an obstruction, as water, highway, or railroad and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of more than 20 feet between undercopings of abutments or extreme ends of openings for multiple boxes.

10-11.2 LENGTH. The length of a bridge structure is the overall length measured along the line of survey stationing back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor; but in no case less than the total clear opening of the structure.

10-11.3 ROADWAY WIDTH. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or in the case of multiple height of curbs, between the bottoms of the lower risers.

10-12 BUILDING AREA. An area on the airport to be used, considered, or intended to be used for airport buildings or other airport facilities or rights-of-way together with all airport buildings and facilities located thereon.

10-13 CALENDAR DAY. Every day shown on the calendar.

10-14 CHANGE ORDER. A written order to the contractor covering changes in the plans, specifications, or proposal quantities and establishing the basis of payment and contract time adjustment, if any, for the work affected by such changes. The work, covered by a change order, shall be within the scope of the contract.

10-15 CONTRACT. The written agreement between the Division or Owner (Sponsor) and the contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the invitation for bids, proposal, letter of award, contract form, payment bond and performance bond, specifications, supplemental specifications, special provisions, general and detailed plans, also any agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

10-16 CONTRACT ITEM (PAY ITEM). A specific unit of work for which a price is provided in the contract.

10-17 CONTRACT TIME. The number of calendar days allowed for completion of the contract, including authorized time extensions.

10-18 CONTRACTOR. The individual, partnership, firm, corporation, or a legally stated combination, that is liable for the acceptable performance of the work contracted and for the payment of all legal debts pertaining to the work who acts directly or through lawful agents or employees to complete the contract work.

10-19 DEPARTMENT. The State of Illinois, Department of Transportation.

10-20 DIRECTOR. The Director of the Division of Aeronautics, Department of Transportation, State of Illinois.

10-21 DIVISION. The State of Illinois, Department of Transportation, Division of Aeronautics, acting as Authorized Agent, for the purposes of the prosecution of this project of the Owner.

10-22 DRAINAGE SYSTEM. The system of pipes, ditches, and structures by which surface or subsurface waters are collected and conducted from the airport area.

10-23 ENGINEER.

- (a) The Chief Engineer of the State of Illinois, Department of Transportation, Division of Aeronautics (acting directly or through an assistant or representative) when the Division is the awarding authority and Agent for the Owner.
- (b) The designated Engineer of the Airport Authority, Port Authority, or other Political Subdivision which is the awarding authority for projects which have no State or Federal involvement.

10-24 EQUIPMENT. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

10-25 EXTRA WORK. An item of work not provided for in the contract as awarded but found essential to the satisfactory completion of the contract within its intended scope as determined by the Engineer.

10-26 FAA. The Federal Aviation Administration of the United States Department of Transportation. When used to designate a person, FAA shall mean the Administrator or his duly authorized representative.

10-27 FEDERAL SPECIFICATIONS. The Federal Specifications and Standards, and supplements, amendments, and indices thereto are prepared and issued by the General Services Administration of the Federal Government. They may be obtained from the Specifications Activity, Printed Materials Supply Division, Building 197, Naval Weapons Plant, Washington, D.C. 20407.

10-28 INSPECTOR. The authorized representative of the Engineer assigned to make detailed inspection of any or all portions of the work or materials therefor.

10-29 INTENTION OF TERMS. Whenever, in the specifications or on the plans, the words "directed", "required", "permitted", "ordered", "designated", "prescribed", or words of the like import are used, it shall be understood that the direction, requirement, permission, order, designation, or prescription of the Engineer is intended; and similarly, the words "approved", "acceptable", "satisfactory", or words of like import, shall mean approved by, or acceptable to, or satisfactory to the Engineer, subject in each case to the final determination of the Owner.

Any reference to a specific requirement of a numbered paragraph of the contract specifications or a cited standard shall be interpreted to include all general requirements of the entire section, specification item, or cited standard that may be pertinent to such specific reference.

10-30 INVITATION FOR BIDS. The advertisement for proposals for all work or materials on which bids are required. Such advertisement will indicate with reasonable accuracy the quantity and location of the work to be done or the character and quantity of the material to be furnished and the time and place of the opening of proposals.

10-31 LABORATORY. The testing laboratory of the Department or any other testing laboratory which may be approved by the Engineer.

10-32 LANDING STRIP. A portion of the usable area of an airport, generally in its natural state of which, as the result of construction work, is suitable for the landing and taking off of aircraft under all favorable weather conditions. The runway is the paved central portion of the landing strip.

10-33 LANDSCAPING. The planning, planting, establishing and caring for trees, shrubs, vines and other vegetation to provide shade, reduce dust, control erosion, or improve the general appearance of the airport.

10-34 LIGHTING. A system of fixtures providing or controlling the light sources used on or near the airport or within the airport buildings. The field lighting includes all luminous signals, markers, floodlights, and illuminating devices used on or near the airport or to aid in the operation of aircraft landing at, taking off from, or taxiing on the airport surface.

10-35 MAJOR AND MINOR CONTRACT ITEMS. A major contract item shall be any item that is listed in the proposal, the total cost of which is equal to or greater than 10 percent of the total amount of the awarded contract. All other items shall be considered minor contract items.

10-36 MATERIALS. Any substances specified for use in the construction of the project and its appurtenances.

10-37 MEDIAN. The portion of a divided highway or entrance road separating the traveled ways for traffic in opposite directions.

10-38 NOTICE TO BIDDERS. The official notice, included in the proposal form.

10-39 NOTICE TO PROCEED. A written notice to the contractor to begin the actual contract work on a previously agreed to date. If applicable, the Notice to Proceed shall state the date on which the contract time begins.

10-40 OWNER (SPONSOR). The term owner shall mean the party of the first part or the contracting agency signatory to the contract. For Federally assisted contracts, the term "Sponsor" shall have the same meaning as the term "Owner".

10-41 PAVEMENT. The combined surface course, base course, and subbase course, if any, considered as a single unit.

10-42 PAVEMENT STRUCTURE. The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load.

10-43 PAY ITEM. A specifically described unit of work for which a price is provided in the contract.

10-44 PAYMENT BOND. The approved form of security furnished by the contractor and his surety as a guaranty that he will pay in full all bills and accounts for materials and labor used in the construction of the work. The amount of the payment bond shall be not less than one hundred percent (100%) of the total contract amount.

10-45 PERFORMANCE BOND. The approved form of security furnished by the contractor and his surety as a guaranty that the contractor will complete the work in accordance with the terms of the contract. The amount of the performance bond shall be not less than one hundred percent (100%) of the total contract amount.

10-46 PLANS. The approved plans, profiles, typical cross sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be done.

10-47 PROGRESS SCHEDULE. A schedule provided by the contractor showing the sequence of work. The schedule shall indicate also the individual rates and the number of calendar days estimated for the completion of each item in order to carry the project to completion within the contract time.

10-48 PROJECT. The agreed scope of work for accomplishing a specific airport development with respect to a particular airport.

10-49 PROJECT ENGINEER. The representative of the Owner, whether employed directly by the Owner or employed by an engineering firm retained by the Owner, acting as the immediate supervisor of the Resident Engineer.

10-50 PROPOSAL. The offer of a bidder, on the prescribed form, to perform the work and to furnish the labor and materials at the prices quoted to complete the work within the specified contract time.

10-51 PROPOSAL GUARANTY. The security furnished with a proposal to guarantee that the bidder will enter into the contract within a specified period of time if his bid is accepted. The Proposal Guaranty may be in the form of bid bond or in the form of a bank draft drawn on the New York, Chicago, or St. Louis Exchange, a bank cashier's check, or a properly certified check.

10-52 RAILROAD. The Railroad or Railway Company whose property is involved in the work.

10-53 RAILROAD ENGINEER. The Chief Engineer or superintendent of the Railroad, or his authorized representative limited by the particular duties entrusted to him.

10-54 RESIDENT ENGINEER. The representative of the Owner, whether employed directly by the Owner or employed by an engineering firm retained by the Owner, directly in charge of the work and acting under the supervision of the Project Engineer. The Resident Engineer resides on the construction site at all times the contractor is working and is required to properly complete the necessary engineering to carry the project to completion.

10-55 RIGHT-OF-WAY. A general term denoting land, property, or interest therein, acquired for or devoted to a highway, airport, or railroad.

10-56 ROADBED. The graded portion of a highway, access road, or entrance road within side slopes, prepared as a foundation for the pavement structure and shoulders.

10-57 ROADSIDE. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway, access or entrance road may also be considered roadside.

10-58 ROADSIDE DEVELOPMENT. Those items necessary to complete highway, access or entrance road, which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the area.

10-59 ROADWAY. The portion of the right-of-way within limits of construction.

10-60 RUNWAY. The area on the airport prepared for the landing and takeoff of aircraft.

10-61 SHOULDER. The portion of the roadway, taxiway or runway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

10-62 SIDEWALK. That portion of the pavement primarily constructed for use of pedestrians.

10-63 SPECIAL PROVISIONS. Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

10-64 SPECIFICATIONS. The body of directions, provisions, and requirements contained herein, or in any supplement adopted by the Division, together with written agreements and all documents of any description made or to be made pertaining to the method or manner of performing the work, the quantities, or the quality of materials or workmanship to be furnished under the contract.

10-65 STANDARDS. The Division Standard Drawings, and supplements, amendments, and indices thereto, as prepared and issued by the Division. These may be procured from the Division, by written or personal request, free of charge.

10-66 STATE. The State of Illinois.

10-67 STRUCTURE. Unless otherwise defined in the specifications, structures shall comprise all objects constructed of materials other than earth, required by the contract to be built or to be removed, but not including surfacing and base courses, gutters, curbs, sidewalks, and driveway pavement.

10-68 SUBCONTRACTOR. An individual, firm, partnership or corporation who, with the written consent of the Engineer, assumes obligation for performing specified pay items for the contractor.

10-69 SUBGRADE. The compacted soil which forms the pavement foundation.

10-70 SUBSTRUCTURE. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls, wingwalls and wing protection railings.

10-71 SUPERSTRUCTURE. The entire structure except the substructure.

10-72 SUPERINTENDENT. The contractor's representative who is present on the work during progress, authorized to receive and fulfill instructions from the Resident Engineer, and who shall supervise and direct the construction.

10-73 SUPPLEMENTAL AGREEMENT. A written agreement between the contractor and the Division covering: 1) work that would increase or decrease the total amount of the awarded contract, or any major contract item, by more than 25 percent, such increased or decreased work being within the scope of the originally awarded contract, or 2) work that is not within the scope of the originally awarded contract.

10-74 SUPPLEMENTAL SPECIFICATIONS. Additions and revisions to the standard specifications that are adopted subsequent to issuance of this book.

10-75 SURETY. The corporation, partnership or individual, other than the contractor, executing the Performance, Payment or Bid Bond.

10-76 TAXIWAY. For the purpose of this document, the term taxiway means the portion of the air operations area of an airport that has been designated by competent airport authority for movement of aircraft to and from the airport's runways or aircraft parking areas.

10-77 TRAVELED WAY. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

10-78 UTILITY. The privately, publicly, or cooperatively owned lines, facilities and systems for producing, transmitting or distributing communications, power, electricity, light, heat, gas, oil, crude products, water, steam, waste, storm water not connected with airport drainage, and other similar commodities, including publicly owned fire and police signal systems and street lighting systems, which directly or indirectly serve the public or any part thereof. The term "utility" shall also mean the utility company, inclusive of any wholly owned or controlled subsidiary.

10-79 WARRANTY. The contractor's assurance that all materials and all workmanship will be provided as represented in the plans and specifications and in accordance with Section 70-25.

10-80 WORK. Work shall mean the furnishing of all labor, materials, equipment and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.

SECTION 20

SCOPE OF WORK

20-01 INTENT OF THE CONTRACT, PLANS AND SPECIFICATIONS. The intent of the plans and the specifications is to prescribe a complete outline of work which the contractor undertakes to do in full compliance with the contract. The contractor shall perform all earthwork, construct all base and surface courses, structures, and such additional, extra, and incidental construction as may be necessary to complete the work to the finished lines, grades, and cross sections in a substantial and acceptable manner. He shall furnish all required materials, equipment, tools, labor, and incidentals, unless otherwise provided in the contract, and shall include the cost of these items in the unit prices for the several units of work.

20-02 ALTERATION OF WORK AND QUANTITIES. The Owner reserves and shall have the right to make such alterations in the work as may be necessary or desirable to complete the work originally intended in an acceptable manner. Unless otherwise specified herein, the Engineer shall be and is hereby authorized to make such alterations in the work as may increase or decrease the originally awarded contract quantities, provided that the aggregate of such alterations does not change the total contract cost or the total cost of any major contract item by more than 25 percent (total cost being based on the unit prices and estimated quantities in the awarded contract). Alterations which do not exceed the 25 percent limitation shall not invalidate the contract nor release the surety, and the contractor agrees to accept payment for such alterations as if the altered work had been a part of the original contract. These alterations which are for work within the general scope of the contract shall be covered by "Change Orders" issued by the Engineer. Change Orders for altered work shall include extensions of contract time where, in the Engineer's opinion, such extensions are commensurate with the amount and difficulty of added work.

Should the aggregate amount of altered work exceed the 25 percent limitation hereinbefore specified, such excess altered work shall be covered by supplemental agreement. If the Owner and the contractor are unable to agree on a unit adjustment for any contract item that requires a supplemental agreement, the Owner reserves the right to terminate the contract with respect to the item and make other arrangements for its completion.

For ADAP contracts all supplemental agreements shall be approved by the FAA and shall include valid wage determinations of the U.S. Secretary of Labor when the amount of the supplemental agreement exceeds \$2,000.00. However, if the contractor elects to waive the limitations on work that increases or decreases the originally awarded

contract or any major contract item by more than 25 percent, the supplemental agreement shall be subject to the same U.S. Secretary of Labor wage determinations as was included in the originally awarded contract.

All supplemental agreements shall require consent of the contractor's Surety and separate performance and payment bonds.

20-03 OMITTED ITEMS. The Engineer may, in the Owner's best interest, omit from the work any contract item, except major contract items. Major contract items may be omitted by a supplemental agreement. Such omission of contract items shall not invalidate any other contract provision or requirement.

Should a contract item be omitted or otherwise ordered to be nonperformed, the contractor shall be paid for all work performed toward completion of such item prior to the date of the order to omit such item. Payment for work performed shall be in accordance with the subsection titled PAYMENT FOR OMITTED ITEMS of Section 70.

20-04 EXTRA WORK. Should acceptable completion of the contract require the contractor to perform an item of work for which no basis of payment has been provided in the original contract or previously issued change orders or supplemental agreements, and same shall be called Extra Work. Extra work that is within the general scope of the contract shall be covered by written change order. Change orders for such extra work shall contain agreed unit prices for performing the change order work in accordance with the requirements specified in the order, and shall contain any adjustment to the contract time that, in the Engineer's opinion, is necessary for completion of such extra work.

When determined by the Engineer to be in the Owner's best interest, he may order the contractor to proceed with extra work by force account as provided in the subsection titled PAYMENT FOR EXTRA AND FORCE ACCOUNT WORK of Section 70.

Extra work that is necessary for acceptable completion of the project, but is not within the general scope of the work covered by the original contract shall be covered by a Supplemental Agreement as hereinbefore defined in the subsection titled SUPPLEMENTAL AGREEMENT of Section 10.

Any claim for payment of extra work that is not covered by written agreement (change order or supplemental agreement) shall be rejected by the Owner.

20-05 MAINTENANCE OF TRAFFIC. It is the explicit intention of the contract that the safety of aircraft, as well as the contractor's equipment and personnel, is the most important consideration. It is understood and agreed that the contractor shall provide for the free and

unobstructed movement of aircraft in the air operations areas of the airport with respect to his own operations and the operations of all his subcontractors as specified in the subsection titled LIMITATION OF OPERATIONS of Section 60. It is further understood and agreed that the contractor shall provide for the uninterrupted operation of visual and electronic signals (including power supplies thereto) used in the guidance of aircraft while operating to, for, and upon the airport as specified in the subsection titled CONTRACTOR'S RESPONSIBILITY FOR UTILITY SERVICE AND FACILITIES OF OTHERS in Section 50.

With respect to his own operations and the operations of all his subcontractors, the contractor shall provide marking, light, and other acceptable means of identifying personnel; equipment; vehicles; storage areas; and any work area or condition that may be hazardous to the operation of aircraft, fire/rescue equipment, or maintenance vehicles at the airport.

When the contract requires the maintenance of vehicular traffic on an existing road, street, or highway during the contractor's performance of work that is otherwise provided for in the contract, plans, and specifications, the contractor shall keep such road, street, or highway open to all traffic and shall provide such maintenance as may be required to accommodate traffic. The contractor shall furnish, erect, and maintain barricades, warning signs, flagmen and other traffic control devices in reasonable conformity with the manual of Uniform Traffic Control Devices for Streets and Highways (published by the United States Government Printing Office), unless otherwise specified herein. The contractor shall also construct and maintain in a safe condition any temporary connections necessary for ingress to and egress from abutting property or intersecting roads, streets, or highways. Unless otherwise specified herein, the contractor will not be required to furnish snow removal for such existing road, street or highway.

The contractor shall make his own estimate of all labor, materials, equipment and incidentals necessary for providing the maintenance of aircraft and vehicular traffic as specified in this subsection.

When not provided for as a contract item, the cost of maintaining the aircraft and vehicular traffic specified in this subsection shall not be measured or paid for directly, but shall be included in the various contract items.

20-06 REMOVAL OF EXISTING STRUCTURES. All existing structures encountered within the established lines, grades, or grading sections shall be removed by the contractor, unless such existing structures are otherwise specified to be relocated, adjusted up or down, salvaged, abandoned in place, reused in the work or to remain in place. The cost of removing such existing structures shall be measured or counted and paid for in accordance with the contract specifications.

Should the contractor encounter an existing structure (above or below ground) in the work for which the disposition is not indicated on the plans, the Engineer shall be notified prior to disturbing such structure. The disposition of existing structures so encountered shall be immediately determined by the Engineer in accordance with the provisions of the contract.

Except as provided in the subsection titled RIGHTS IN AND USE OF MATERIALS FOUND IN THE WORK of this section, it is intended that all existing materials or structures that may be encountered (within the lines, grades, or grading sections established for completion of work) shall be utilized in the work as otherwise provided for in the contract and shall remain the property of the Owner when so utilized in the work.

20-07 RIGHTS IN THE USE OF MATERIALS FOUND IN THE WORK. Should the contractor encounter any material such as (but not restricted to) sand, stone, gravel, slag, or concrete slabs within the established lines, grades, or grading sections, the use of which is intended by the terms of the contract to be either embankment or waste, he may at his option either:

- (a) Use such material in another contract item, providing such use is approved by the Engineer and is in conformance with the contract specifications application to such use; or
- (b) Remove such material from the site, upon written approval of the Engineer; or
- (c) Use such material for his own temporary construction on site; or
- (d) Use such material as intended by the terms of the contract.

Should the contractor wish to exercise option (a), (b), or (c), he shall request the Engineer's approval in advance of such use.

Should the Engineer approve the contractor's request to exercise option (a), (b), or (c), the contractor shall be paid for the excavation or removal of such material at the applicable contract price. The contractor shall replace, at his own expense, such removed or excavated material with an agreed equal volume of material that is acceptable for use in constructing embankment, backfills, or otherwise to the extent that such replacement material is needed to complete the contract work. The contractor shall not be charged for his use of such material so used in the work or removed from the site.

Should the Engineer approve the contractor's exercise of option (a), the contractor shall be paid, at the applicable contract price, for furnishing and installing such material in accordance with requirements of the contract item in which the material is used.

It is understood and agreed that the contractor shall make no claim for delays by reason of his exercise of option (a), (b), or (c).

The contractor shall not excavate, remove, or otherwise disturb any material, structure, or part of a structure which is located outside the line, grades, or grading sections established for the work, except which such excavation or removal is provided for in the contract, plans, or specifications.

20-08 FINAL CLEANING UP. Upon completion of the work and before acceptance and final payment will be made, the contractor shall remove from the site all machinery, equipment, surplus and discarded materials, rubbish, temporary structures, and stumps or portions of trees. He shall cut all brush and woods within the limits indicated and shall leave the site in a neat and presentable condition. Material cleared from the site and deposited on adjacent property will not be considered as having been disposed of satisfactorily, unless the contractor has obtained the written permission of such property owner.

The contractor shall clean off all cement streaks or drippings, paint smears or drippings, rust stains, oil, grease, bituminous materials, dirt, and other foreign materials deposited or accumulated on or in any structure or curb and gutter due to his operation.

SECTION 30

CONTROL OF WORK

30-01 AUTHORITY OF THE ENGINEER. The Engineer shall decide any and all questions which may arise as to the quality and acceptability of materials furnished, work performed, and as to the manner of performance and rate of progress of the work. He shall decide all questions which may arise as to the interpretation of the specifications or plans relating to the work, the fulfillment of the contract on the part of the contractor, and the rights of different contractors on the project. The Engineer shall determine the amount and quality of the several kinds of work performed and materials furnished which are to be paid for under the contract.

30-02 CONFORMITY WITH PLANS AND SPECIFICATIONS. All work and all materials furnished shall be in reasonably close conformity with the lines, grades, grading sections, cross sections, dimensions, material requirements, and testing requirements that are specified (including specified tolerances in the contract, plans, or specifications).

If the Engineer finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and specifications but that the portion of the work affected will, in his opinion, result in a finished product having a level of safety, economy, durability, and workmanship acceptable, he will order the affected work be accepted and remain in place. In this event, the Engineer will document his determination and recommended contract price adjustments will be based on good engineering judgement and such tests or retests of the affected work as are, in his opinion, needed. Changes in the contract price shall be covered by contract modifications (change order or supplemental agreement) as applicable.

If the Engineer finds the materials furnished, work performed, or the finished product are not in reasonably close conformity with the plans and specifications and have resulted in an unacceptable finished product, the affected work or materials shall be removed and replaced or otherwise corrected by and at the expense of the contractor in accordance with the Engineer's written orders.

For the purpose of this subsection, the term "reasonably close conformity" shall not be construed as waiving the contractor's responsibility to complete the work in accordance with the contract, plans, and specifications. The term shall not be construed as waiving the Engineer's right to insist on strict compliance with the requirements of the contract, plans, and specifications during the contractor's prosecution of the work, when, in the Engineer's opinion, such compliance is essential to provide an acceptable finished portion of the work.

For the purpose of this subsection, the term "reasonably close conformity" is also intended to provide the Engineer with the authority to use good engineering judgement in his determinations as to acceptance of work that is not in strict conformity but will provide a finished product equal to or better than that intended by the requirements of the contract, plans, and specifications.

30-03 COORDINATION OF CONTRACT, PLANS, AND SPECIFICATIONS. The contract, plans, specifications, and all referenced standards cited are essential parts of the contract requirements. A requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; contract technical specifications shall govern over contract general provisions, plans, cited standards for materials or testing, and cited FAA Advisory Circulars; contract general provisions shall govern over plans, cited standards for materials or testing, and cited FAA Advisory Circulars; plans shall govern over cited standards for materials or testing and cited FAA Advisory Circulars.

The contractor shall not take advantage of any apparent error or omission on the plans or specifications. In the event the contractor discovers any apparent error or discrepancy, he shall immediately call upon the Engineer for his interpretation and decision, and such decision shall be final.

30-04 COOPERATION OF CONTRACTOR. The contractor will be supplied with a minimum of two sets of approved plans and contract assemblies including special provisions, one set of which the contractor shall keep available on the work at all times.

The contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, his inspectors, and other contractors in every way possible. The Engineer shall allocate the work and designate the sequence of construction in case of controversy between contractors.

The contractor shall have on the work at all times, as his agent, a competent English-speaking superintendent capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer or his authorized representatives. The Superintendent shall have full authority to execute orders or directions of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. Such superintendence shall be furnished irrespective of the amount of work sublet.

30-05 COOPERATION BETWEEN CONTRACTORS. The Division reserves the right to contract for and perform other or additional work on or near the work covered by this contract.

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

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

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

30-06 CONSTRUCTION LAYOUT. Unless otherwise provided for in this subsection, the Resident Engineer shall furnish the contractor with all lines, grades, and measurements necessary to the proper prosecution and control of the work contracted for under these specifications. The contractor shall satisfy himself as to the accuracy of all measurements before constructing any permanent structure and shall not take advantage of any errors which may have been made in laying out the work. Such stakes and markings as the Resident Engineer may set for either his own or the contractor's guidance shall be scrupulously preserved by the contractor. In case of negligence on the part of the contractor, or his employees, resulting in the destruction of such stakes or markings, an amount equal to the cost of replacing the same may be deducted from subsequent estimates due the contractor at the discretion of the Engineer.

30-07 AUTOMATICALLY CONTROLLED EQUIPMENT. Whenever batching or mixing plant equipment is required to be operated automatically under the contract and a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually or by other methods for a period of 48 hours following the breakdown or malfunction, provided this method of operations will produce results which conform to all other requirements of the contract.

30-08 AUTHORITY AND DUTIES OF THE RESIDENT ENGINEER. As the direct representative of the Project Engineer, the Resident Engineer

has immediate charge of the engineering details of each construction project. He is responsible for the administration and satisfactory completion of the construction. The Resident Engineer is authorized to inspect all work done and all material furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The Resident Engineer is not authorized to revoke, alter, or waive any provision of the contract. The Resident Engineer is not authorized to issue instructions contrary to the plans and specifications or to act as foreman for the contractor.

The Resident Engineer is authorized to notify the contractor or his representative of any failure of the work or materials to conform to the requirements of the contract, plans, or specifications and to reject such nonconforming materials and to suspend any work in question until such issues can be referred to the Engineer for his decision.

The Resident Engineer is responsible for approving all shop drawings within the limits of the plans and specifications.

30-09 DUTIES OF THE INSPECTOR. Inspectors will be authorized to inspect all work done and materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector will not be authorized to alter or waiver the provisions of the contract. The inspector will not be authorized to issue instructions contrary to the plans and specifications, or to act as foreman for the contractor.

30-10 INSPECTION OF THE WORK. All materials and each part or detail of the work shall be subject at all times to inspection by the Engineer. Such inspection may include mill, plant, or shop inspection, and any material furnished under the specifications is subject to such inspection. The Engineer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the contractor as is required to make a complete and detailed inspection.

If the Engineer requests, the contractor, at any time before final inspection of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the placing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering or removing, and the placing of the covering or making good of the parts removed, will be at the contractor's expense.

Any work done or materials used without supervision or inspection by an authorized representative of the Engineer may be ordered removed and replaced at the contractor's expense unless the representative failed to inspect after having been given reasonable notice in writing that the work was to be performed.

When the Federal Government is to pay a portion of the cost of the work covered by the contract, the work shall be subject to the inspection of the representatives of the Federal Government, but such inspections shall in no sense make the Federal Government a party to the contract.

Should the contract work include relocation, adjustment, or any other modification to existing facilities, not the property of the Owner, authorized representatives of the owners of such facilities shall have the right to inspect such work. Such inspection shall in no sense make any facility owner a party to the contract, and shall in no way interfere with the rights of the parties to this contract.

30-11 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK. All work which does not conform to the requirements of the contract, plans, and specifications will be considered unacceptable, unless otherwise determined acceptable by the Engineer as provided in the subsection titled CONFORMITY WITH PLANS AND SPECIFICATIONS of this section.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner in accordance with the provisions of the subsection titled CONTRACTOR'S RESPONSIBILITY FOR WORK of Section 50.

No work shall be done without lines and grades having been given by the Resident Engineer. Work done contrary to the instructions of the Resident Engineer, work done beyond the lines shown on the plans or as given, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the contractor's expense.

30-12 LOAD RESTRICTIONS. The contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the work. A special permit will not relieve the contractor of liability for damage which may result from the moving of material or equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or to any other type of construction will not be

permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed. No loads will be permitted on a concrete pavement, base, or structure before the expiration of the curing period. The contractor shall be responsible for all damage done by his hauling equipment and shall correct such damage at his own expense.

30-13 MAINTENANCE DURING CONSTRUCTION. The contractor shall maintain the work during construction and until the work is accepted. This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces so that the work is maintained in satisfactory condition at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the contractor shall maintain the previous course or subgrade during all construction operations.

All costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various contract items, and the contractor will not be paid an additional amount for such work.

30-14 FAILURE TO MAINTAIN THE WORK. Should the contractor at any time fail to maintain the work as provided in the subsection titled MAINTENANCE DURING CONSTRUCTION of this section, the Engineer shall immediately notify the contractor of such noncompliance. Such notification shall specify a reasonable time within which the contractor shall be required to remedy such unsatisfactory maintenance condition. The time specified will give due consideration to any exigency that exists.

Should the contractor fail to respond to the Engineer's notification, the Engineer may suspend any work necessary for the Owner to correct such unsatisfactory maintenance condition, depending of the exigency that exists. Any maintenance cost incurred by the Owner shall be deducted from monies due or to become due the contractor.

30-15 PARTIAL ACCEPTANCE. If at any time during the prosecution of the project the contractor substantially completes a usable unit or portion of the work, the occupancy of which will benefit the Owner, he may request the Engineer to make final inspection of that unit. If the Engineer finds upon inspection that the unit has been satisfactorily completed in compliance with the contract, he may accept it as being completed, and the contractor may be relieved of further responsibility for that unit. Such partial acceptance and beneficial occupancy by the Owner shall not void or alter any provision of the contract.

30-16 FINAL INSPECTION. Upon due notice from the contractor of presumptive completion of the entire project, the Engineer will make an inspection. If all construction provided for and contemplated by the contract is found to be completed in accordance with the contract, plans, and specifications such inspection shall constitute the final inspection. The Engineer shall notify the contractor in writing of final acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the Engineer will give the contractor the necessary instructions for correction of same, and the contractor shall immediately comply with and execute such instructions. Upon correction of the work, another inspection will be made which shall constitute the final inspection, provided the work has been satisfactorily completed. In such event, the Engineer will make the final acceptance and notify the contractor in writing of this acceptance as of the date of final inspection.

30-17 CLAIMS FOR ADJUSTMENT AND DISPUTES. If for any reason the contractor deems that additional compensation is due him for work or materials not clearly provided for in the contract, plans, or specifications or previously authorized as extra work, he shall notify the Engineer in writing of his intention to claim such additional compensation before he begins the work on which he bases the claim. If such notification is not given or the Engineer is not afforded proper opportunity by the contractor for keeping strict account of actual cost as required, then the contractor hereby agrees to waive any claim for such additional compensation. Such notice by the contractor and the fact that the Engineer has kept account of the cost of the work shall not in any way be construed as proving or substantiating the validity of the claim. When the work on which the claim for additional compensation is based has been completed, the contractor shall, within 10 calendar days, submit his written claim to the Engineer.

Nothing in this subsection shall be construed as a waiver of the contractor's right to dispute final payment based on difference in measurements or computations.

30-18 PLANS AND WORK DRAWINGS. Plans showing such details as are necessary to give a comprehensive idea of the construction contemplated will be furnished by the Engineer. The contractor shall submit to the Engineer for approval such additional shop, working, or layout drawings pertaining to the construction of the work, as may be required, and prior to the approval of such plans or drawings, any work done or materials ordered shall be at the contractor's risk.

When the contract includes work adjacent to a highway or roadway and falsework, cofferdams, or sheeting is required, the contractor shall

submit to the Engineer for his approval and the Highway District Engineer's approval, plans for the falsework, cofferdams, or sheeting. The plans shall be submitted sufficiently in advance of the time the contractor intends to start work to permit checking. No such work shall be started prior to receipt by the contractor of approval of the plans for the falsework, cofferdams, or sheeting. The contractor shall give the Engineer not less than 10 days notice, in writing, prior to beginning such construction. The cost of furnishing such drawings shall be incidental to the contract and no additional compensation will be allowed the contractor for any delays resulting therefrom.

SECTION 40

CONTROL OF MATERIALS

40-01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS. The materials used on the work shall conform to the requirements of the contract, plans, and specifications. Unless otherwise specified, such materials that are manufactured or processed shall be new (as compared to used or reprocessed).

In order to expedite the inspection and testing of materials, the contractor shall furnish complete statements to the Engineer as to the origin, composition, and manufacture of all materials to be used in the work. Such statements shall be furnished promptly after execution of the contract but, in all cases, prior to delivery of such materials.

At the Engineer's option, materials may be approved at the source of supply before delivery is started. If it found after trial that sources of supply for previously approved materials do not produce specified products, the contractor shall furnish materials from other sources.

The contractor shall furnish airport lighting equipment that conforms to the requirements of cited materials specifications. In addition, where an FAA specification for airport lighting equipment is cited in the plans or specifications, the contractor shall furnish such equipment that is:

- (a) Listed in the FAA Advisory Circular (AC) 150/5345-1, Approved Airport Lighting Equipment, that is in effect on the date of advertisement; and,
- (b) Produced by a manufacturer qualified (by FAA) to produce such specified and listed equipment.

40-02 SAMPLES, TESTS AND CITED SPECIFICATIONS. All materials used in work shall be subject to inspection, testing and approval by the Engineer before incorporation in the work. Any work in which untested materials are used without approval or written permission of the Engineer shall be performed at the contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed by the Engineer, shall be removed at the contractor's expense. Unless otherwise designated, tests in accordance with the cited standard methods of AASHTO or ASTM which are current on the date of advertisement for bids will be made by and at the expense of the Engineer. Samples will be taken by a qualified representative of the Engineer. All materials being used are subject to inspection, test, or rejection at any time prior to or during incorporation into the work. Copies of all tests will be furnished to the contractor's representatives at his request.

40-03 CERTIFICATION OF COMPLIANCE. The Engineer may permit the use, prior to sampling and testing, of certain materials or assemblies when accompanied by manufacturer's certificates of compliance stating that such materials or assemblies fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer. Each lot of such materials or assemblies delivered to the work must be accompanied by a certificate of compliance in which the lot is clearly identified.

Materials or assemblies used on the basis of certificates of compliance may be sampled and tested at any time and if found not to be in conformity with contract requirements will be subject to rejection whether in place or not.

The form and distribution of certificates of compliance shall be as approved by the Engineer.

When a material or assembly is specified by "brand name or equal" and the contractor elects to furnish the specified "brand name", the Contractor shall be required to furnish the manufacturer's certificate of compliance for each lot of such material or assembly delivered to the work. Such certificate of compliance shall clearly identify each lot delivered and shall certify as to:

- (a) Conformance to the specified performance, testing, quality or dimensional requirements; and,
- (b) Suitability of the material or assembly for the use intended in the contract work.

Should the contractor propose to furnish an "or equal" material or assembly, he shall furnish the manufacturer's certificates of compliance as hereinbefore described for the specified brand name material or assembly. However, the Engineer shall be the sole judge as to whether the proposed "or equal" is suitable for use in the work.

The Engineer reserves the right to refuse permission for use of materials or assemblies on the basis of certificates of compliance.

40-04 PLANT INSPECTION. The Engineer or his authorized representative may inspect, at its source, any specified material or assembly to be used in the work. Manufacturing plants may be inspected from time to time for the purpose of determining compliance with specified manufacturing methods or materials to be used in the work and to obtain samples required for his acceptance of the material or assembly.

Should the Engineer conduct plant inspections, the following conditions shall exist:

- (a) The Engineer shall have the cooperation and assistance of the contractor and the producer with whom he has contracted for materials.
- (b) The Engineer shall have full entry at all reasonable times to such parts of the plant that concern the manufacture or production of the materials being furnished.
- (c) If required by the Engineer, the contractor shall arrange for adequate office or working space that may be reasonably needed for conducting plant inspections. Office or working space should be conveniently located with respect to the plant.

It is understood and agreed that the Engineer shall have the right to re-test any material which has been tested and approved at the source of supply after it has been delivered to the site. The Engineer shall have the right to reject only material which, when re-tested, does not meet the requirements of the contract, plans or specifications.

40-05 RESIDENT ENGINEER'S FIELD OFFICE. The contractor shall furnish a trailer or building for the exclusive use of the Resident Engineer as a field office and field testing laboratory when and as specified in each project.

40-06 STORAGE OF MATERIALS. Materials shall be so stored as to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be located so as to facilitate their prompt inspection. The contractor shall coordinate the storage of all materials with the Engineer. Materials to be stored on airport property shall not create an obstruction to air navigation nor shall they interfere with the free and unobstructed movement of aircraft. Unless otherwise shown on the plans, the storage of materials and the location of the contractor's plant and parked equipment or vehicles shall be as directed by the Engineer. Private property shall not be used for storage purposes without written permission of the owner or lessee of such property. The contractor shall make all arrangements and bear all expenses for the storage of materials on private property. Upon request, the contractor shall furnish the Engineer a copy of the property owner's permission.

All storage sites on private or airport property shall be restored to their original condition by the contractor at his entire expense, except as otherwise agreed to (in writing) by the owner or lessee of the property.

40-07 UNACCEPTABLE MATERIALS. Any material or assembly that does not conform to the requirements of the contract, plans or specifications shall be considered unacceptable and shall be rejected. The contractor shall remove any rejected material or assembly from the site of the work, unless otherwise instructed by the Engineer.

No rejected material or assembly, the defects of which have been corrected by the contractor, shall be returned to the site of the work until such time as the Engineer has approved its use in the work.

40-08 OWNER-FURNISHED MATERIALS. The contractor shall furnish all materials required to complete the work, except those specified herein (if any) to be furnished by the Owner. Owner-furnished materials shall be made available to the contractor at the location specified herein.

All costs of handling, transportation from the specified location to the site of work, storage, and installing Owner-furnished materials shall be included in the unit price bid for the contract item in which such Owner-furnished material is used.

After any Owner-furnished material has been delivered to the location specified, the contractor shall be responsible for any demurrage, damage, loss, or other deficiencies which may occur during the contractor's handling, storage, or use of such Owner-furnished material. The Owner will deduct from any monies due or to become due the contractor any cost incurred by the Owner in making good such loss due to the contractor's handling, storage, or use of Owner-furnished materials.

40-09 SOURCE OF MATERIALS. The contractor, as soon as possible following the contract award, shall inform the Division of the sources of all materials contained in the contract. If the contractor decides to investigate new sources of supply, he shall furnish without charge such preliminary samples and reports rendered, but it is understood that such tests are for informational purposes only and that they shall not be construed as a guarantee of acceptance of any material which may be delivered later for incorporation in the work. Only materials actually delivered for use will be considered, and their acceptance will be based solely upon the results of the tests made on these materials.

If the contractor installs equipment or apparatus to produce materials from new sources of supply, he does so at his own risk, and he shall assume full responsibility for the production of uniform and satisfactory materials. In case of failure of a source of supply to produce materials satisfactory to the Division, the contractor shall indemnify and save harmless the Division from any and all claims for loss or damage of whatever nature which he may have suffered by reason of the installation of equipment and the operation of such sources of supply.

40-10 HANDLING MATERIALS. All materials shall be handled in such manner as to preserve their quality and fitness for the work. Aggregates shall be transported from the storage sites to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operations.

SECTION 50

LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

50-01 LAWS TO BE OBSERVED. The contractor shall at all times observe and comply with all Federal and State laws, local laws, ordinances, and regulations which in any manner affect the conduct of the work, and all such orders or decrees as exist at the present and which may be enacted later, of legislative bodies or tribunals having legal jurisdiction or authority over the work, and no plea of misunderstanding or ignorance thereof will be considered. He shall indemnify and save harmless the Sponsor and the State and all of its officers, agents, employees, and servants against any claim or liability arising from or based on the violation of such law, ordinance, regulation, order, or decree, whether by himself or his employees.

50-02 WORKER'S COMPENSATION INSURANCE. Such insurance required by "Worker's Compensation Act of the State of Illinois", or other means of protection as herein provided, shall be kept in force until all work to be performed under the terms of the contract has been completed and accepted in accordance with the specifications, and it is hereby understood and agreed that the maintenance of such insurance or other protection, until acceptance of the work by the Division, is a part of the contract. Failure to maintain such insurance, cancellation by the Industrial Commission of its approval of such other means of protection as might have been elected, or any other act which results in lack of protection under the said "Worker's Compensation Act" may be considered as a breach of the contract.

50-03 EMPLOYMENT PREFERENCE. The contractor shall comply with "AN ACT to give preference to the veterans of the United States military and naval service in appointments and employment upon public works, by , or for the use of, the State or its political subdivisions," passed by the 59th General Assembly and approved on June 12, 1935. (Chapter 126 1/2, Paragraph 23 of the Illinois Revised Statutes 1981.) The foregoing requirements do not apply to any airport improvement, or part thereof, financed in whole or in part with Federal funds.

50-04 PERMITS, LICENSES, AND FEES. The contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful prosecution of the work.

50-05 PATENTED DEVICES, MATERIALS, AND PROCESSES. If any design, device, material, or process covered by letters, patent or copyright is used by the contractor, whether required or not, he shall provide for such use by suitable legal agreement with the patentee or owner, guaranteeing the Division indemnity from and against all claims for infringement, and shall include the cost of such agreement in the price bid for the work. It shall be the duty of the contractor, if so demanded by the Division, to furnish said Division with a copy of the legal agreement with the patentee or owner, and if such copy is not furnished when demanded, then the Division may, if it so elects, withhold any and all payments to said contractor until said legal agreement is furnished. If a suitable legal agreement with the patentee or owner is not made as required herein, the contractor and surety shall indemnify and save harmless the Division from any and all claims for infringement by reason of the use of any such patented design, device, material, or process, or any trademark or copyright in connection with the work agreed to be performed under the contract, and shall indemnify the Division for any cost, expense, and damages which it may be obliged to pay by reason of any such infringement at any time during the prosecution or after the completion of the work.

50-06 RESTORATION OF SURFACES DISTURBED BY OTHERS. The Owner reserves the right to authorize the construction, reconstruction, or maintenance of any public or private utility service, FAA or National Oceanic and Atmospheric Administration (NOAA) facility, or a utility service of another government agency at any time during the progress of the work.

The contractor shall not permit any individual, firm, or corporation to excavate or otherwise disturb such utility services or facilities located within the limits of the work without the written permission of the Engineer.

Should the owner of public or private utility service, FAA, or NOAA facility, or a utility service of another government agency be authorized to construct, reconstruct, or maintain such utility service or facility during the progress of the work, the contractor shall cooperate with such owners by arranging and performing the work in this contract so as to facilitate such construction, reconstruction or maintenance by others whether or not such work by others is listed above. When ordered as extra work by the Engineer, the contractor shall make all necessary repairs to the work which are due to such authorized work by others, unless otherwise provided for in the contract, plans, or specifications. It is understood and agreed that the contractor shall not be entitled to make any claim for damages due to such authorized work by others or for any delay to the work resulting from such authorized work.

50-07 FEDERAL AID PARTICIPATION. For Federally assisted contracts, the United States Government has agreed to reimburse the

Owner for some portion of the contract costs. Such reimbursement is made from time to time upon the Owner's (Sponsor's) request to the FAA. In consideration of the United States Government's (FAA) agreement with the Owner, the Owner has included provisions in this contract pursuant to the requirements of the Rules and Regulations of the Federal Aviation Administration that pertain to the work.

The contract work is subject to the inspection and approval of duly authorized representatives of the Administrator, Federal Aviation Administration and is further subject to those provisions of the rules and regulations that are cited in the contract, plans, or specifications.

No Federal requirement, rules and regulation, nor this contract shall be construed as making the Federal Government a party to the contract nor will any such requirement interfere, in any way, with the rights of either party to the contract.

50-08 SANITARY, HEALTH AND SAFETY PROVISIONS. The contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements of the State and local Board of Health, or of other bodies or tribunals having jurisdiction.

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

50-09 PUBLIC CONVENIENCE AND SAFETY. The contractor shall control his operations and those of his subcontractors and all supplies, to assure the least inconvenience to the traveling public. Under all circumstances, safety shall be the most important consideration.

The contractor shall maintain the free and unobstructed movement of aircraft and vehicular traffic with respect to his own operations and those of his subcontractors and all suppliers in accordance with the subsection titled MAINTENANCE OF TRAFFIC of Section 20 hereinbefore specified and shall limit such operations for the convenience and safety of the traveling public as specified in the subsection titled LIMITATIONS OF OPERATIONS of Section 60 hereinafter.

50-10 BARRICADES, WARNING SIGNS AND HAZARD MARKINGS. The contractor shall furnish, erect, and maintain all barricades, warning signs and markings for hazards necessary to protect the public and the work. When used during periods of darkness, such barricades, warning signs and hazard markings shall be suitably illuminated.

For vehicular and pedestrian traffic, the contractor shall furnish, erect, and maintain barricades, warning signs, lights and other traffic control devices in reasonable conformity with the Manual of Uniform Traffic Control Devices for Streets and Highways (published by the United States Government Printing Office).

When the work requires closing an airport operations area of the airport or portion of such area, the contractor shall furnish, erect and maintain temporary markings and associated lighting conforming to the requirements of FAA Advisory Circular 150/5340-1 (latest revision), Marking of Paved Areas on Airports.

The contractor shall furnish, erect, and maintain markings and associated lighting of open trenches, excavations, temporary stock piles, and his parked construction equipment that may be hazardous to the operation of emergency fire-rescue or maintenance vehicles on the airport in reasonable conformance to FAA Advisory Circular 150/5370-2 (latest revision), Safety on Airports During Construction Activity.

The contractor shall identify each motorized vehicle or piece of construction equipment in reasonable conformance to FAA Advisory Circular 150/5370-2 (latest revision).

The contractor shall furnish and erect all barricades, warning signs and markings for hazards prior to commencing work which requires such erection and shall maintain the barricades, warning signs and markings for hazards until their dismantling is directed by the Engineer.

Open-flame type lights shall not be permitted within the air operations areas of the airport.

50-11 USE OF EXPLOSIVES. When the use of explosives is necessary for the prosecution of the work, the contractor shall exercise the utmost care not to endanger life or property, including new work. The contractor shall be responsible for all damage resulting from the use of explosives.

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

The contractor shall notify each property owner and public utility company having structures or facilities in proximity to the site of the work of his 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 injury. The use of electrical blasting caps shall not be permitted on or within 1,000 feet of the airport property.

50-12 PROTECTION AND RESTORATION OF PROPERTY. The contractor 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 and shall not move them until directed.

The contractor shall be responsible for all damage or injury to property of any character, during the prosecution of the work, resulting from any act, omission, neglect, or misconduct in his manner or method of executing the work, or at any time due to defective work or materials, and said responsibility will not be released 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 contractor, he shall restore, at his own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner.

50-13 RESPONSIBILITY FOR DAMAGE CLAIMS. The contractor shall indemnify and save harmless the Division, the Owner and the FAA and their officers and employees from all suits, actions or claims of any character brought because of any injuries or damage received or sustained by any person or persons, or property on account of the operations of the contractor; on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act of omission, neglect, or misconduct of said contractor; or because of any claims or amounts arising or recovered under the "Worker's Compensation Act" or any other law, ordinance, order, or decree. Money due the contractor under and by virtue of his contract retained as may be considered necessary by the Division for such purpose may be retained for the use of the Division or, in case no money is due, his claims for injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Division, except that money due the contractor will not be withheld when the contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

This contract is not intended by any of the Provisions of any part of the contract to create the public or any member thereof a third party beneficiary, or to authorize any one not a party to this contract to

maintain a suit for personal injuries or property damage pursuant to the terms or Provisions of this contract. The duties, obligations and responsibilities of the parties to this contract with respect to third parties shall remain as imposed by law.

The Contractor, prior to execution of the contract, shall file with the Division copies of completed certificates of insurance, satisfactory to the Division, to afford protection against all claims for damages to public or private property, and injuries to persons, arising out of and during the progress of the work to its completion, as defined by Section 80-12. The policy of insurance shall include the owner and the participating agencies as an additional insured or provide separate coverage with an Owner's Protective policy. The minimum amounts of insurance limits shall be as follows, except no restrictions or occurrence limits will be permitted:

<u>Bodily Injury Liability</u>	<u>Property Damage Liability</u>	
<u>Each Occurrence</u>	<u>Each Occurrence</u>	<u>Aggregate</u>
\$1,000,000	\$500,000	\$1,000,000

All such insurance must include an endorsement whereby the insurer agrees to notify the Division at least 30 days prior to nonrenewal, reduction or cancellation. The Contractor shall cease operations on the project if the insurance is cancelled or reduced below the required amount of coverage. All costs for insurance as specified herein will not be paid for separately, but shall be considered as incidental to the contract.

50-14 THIRD PARTY BENEFICIARY CLAUSE. It is specifically agreed between the parties executing the contract that it is not intended by any of the provisions of any part of the contract to create the public or any member thereof a third party beneficiary or to authorize anyone not a party to the contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of the contract.

50-15 OPENING SECTIONS OF THE WORK TO TRAFFIC. No portion of the work may be opened by the contractor for public use until ordered by the Engineer in writing. Should it become necessary to open a portion of the work to public traffic on a temporary or intermittent basis, such openings shall be made when, in the opinion of the Engineer, such portion of work is in an acceptable condition to support the intended traffic. Temporary or intermittent openings are considered to be inherent in the work and shall not constitute either acceptance of the portion of the work so opened or a waiver of any provisions of the contract. Any damage to the portion of the work so opened that is not attributable to traffic which is permitted by the Owner shall be repaired by the contractor at his expense.

The contractor shall make his own estimate of the inherent difficulties involved in completing the work under the conditions herein described and shall not claim any added compensation by reason of delay or increased cost due to opening a portion of the contract work.

50-16 CONTRACTOR'S RESPONSIBILITY FOR WORK. The work shall be under the charge and care of the contractor until final acceptance by the Division. The contractor shall assume all responsibility for injury or damage to the work by action of the elements or from any other cause whatsoever, and shall rebuild, repair, restore, and make good, at his expense, all injuries or damages to the work, except that when the work is opened to traffic by written order of the Engineer, the provisions of this article shall not apply to damage caused by such traffic and not due to the contractor's fault or negligence.

When materials are furnished to the contractor by the Division or Owner, for inclusion in the work, the contractor's responsibility for all such materials shall be the same as for materials furnished by him.

In case of suspension of work from any cause whatever, the contractor 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 his expense. During such period of suspension of work, the contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under his contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

50-17 CONTRACTOR'S RESPONSIBILITY FOR UTILITY SERVICE AND FACILITIES OF OTHERS. As provided in the subsection titled RESTORATION OF SURFACES DISTURBED BY OTHERS of this section, the contractor shall cooperate with the owner of any public or private utility service, FAA or National Oceanic and Atmospheric Administration (NOAA), or a utility service of another government agency that may be authorized by the Owner to construct, reconstruct, or maintain such utility services or facilities during the progress of the work. In addition, the contractor shall control his operations or prevent the unscheduled interruption of such utility services and facilities.

To the extent that such public or private utility services, FAA, or NOAA facilities, or utility services of another governmental agency are known to exist within the limits of the contract work, the approximate locations have been indicated on the plans and the owners are indicated as follows:

	Person to Contact	
Utility Service or Facility	(Name, Title, Address & Phone)	Owner's Emergency Contact (Phone)
_____	_____	_____

(Project Engineer to complete this section)

It is understood and agreed that the Owner does not guarantee the accuracy of the completeness of the location information relating to existing utility services, facilities, or structures that may be shown on the plans or encountered in the work. Any inaccuracy or omission in such information shall not relieve the contractor of his responsibility to protect such existing features from damage or unscheduled interruption of service.

At points where the Contractor's operations are adjacent to properties of railroad, telegraph, telephone and power companies, or are adjacent to other property, damage to which might result in considerable expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

It is further understood and agreed that the contractor shall, upon execution of the contract, notify the owners of all utility services or other facilities of his plan of operations. Such notification shall be in writing addressed to THE PERSON TO CONTACT as provided hereinbefore in this subsection and the subsection titled RESTORATION OF SURFACES DISTURBED BY OTHERS of this section. A copy of each notification shall be given to the Engineer.

In addition to the general written notification hereinbefore provided, it shall be the responsibility of the contractor to keep such individual owners advised of changes in his plan of operations that would affect such owners. The contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication of rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

Prior to commencing the work in the general vicinity of an existing utility service or facility, the contractor shall again notify each such owner of his plan of operation. If, in the contractor's opinion, the owner's assistance is needed to locate the utility service or facility or the presence of a representative of the owner is desirable to observe the work, such advice should be included in the notification. Such notification shall be given by the most expeditious means to reach the

utility owner's PERSON TO CONTACT no later than two normal business days prior to the contractor's commencement of operations in such general vicinity. The contractor shall furnish a written summary of the notification to the Engineer.

The contractor's failure to give the two days notice hereinabove provided shall be cause for the Engineer to suspend the contractor's operations in the general vicinity of a utility service or facility.

Where the outside limits of an underground utility service have been located and staked on the ground, the contractor shall be required to use excavation methods acceptable to the Engineer within 3 feet of such outside limits at such points as may be required to insure protection from damage due to the contractor's operations.

Should the contractor damage or interrupt the operation of a utility service or facility be accident or otherwise, he shall immediately notify the proper authority and the Engineer and shall take all reasonable measures to prevent further damage or interruption of service. The contractor, in such events, shall cooperate with the utility service or facility owner and the Engineer continuously until such damage has been repaired and service restored to the satisfaction of the utility or facility owner.

The contractor shall bear all costs of damage and restoration of service to any utility service or facility due to his operation whether or not due to negligence or accident. The Division reserves the right to deduct such costs from any monies due or which may become due the contractor, or his surety.

Within the State of Illinois, a Joint Utility Locating Information for Excavators (JULIE) System has been established. All utility companies and municipalities which have gas mains and a number of others are a part of this system.

Instead of the Contractor notifying each individual utility owner that he will be working in the area, it will only be necessary to call the JULIE number which is (800) 892-0123 and they will notify all member utility companies involved that their respective utility should be located. A minimum of forty-eight hours advance notice is required and the political name of the township where the work is located, as shown on the location map, along with other location information such as land section and quarter section will have to be given.

For utilities which are not members of the JULIE system, it will still be necessary to contact the owners directly. The plan general notes will indicate which agencies are members of JULIE.

The type of utility and color used for marking are shown in the following table:

UTILITY SERVICE

COLOR

Gas, Oil or Petroleum	Yellow
Electric	Red
Communication, Telephone	Orange
Potable Water	Blue
Sewer	Green

50-18 FURNISHING RIGHTS-OF-WAY. The Owner will be responsible for furnishing all rights-of-way upon which the work is to be constructed in advance of the contractor's operations.

50-19 PERSONAL LIABILITY OF PUBLIC OFFICIALS. In carrying out any of the contract provisions or in exercising any power or authority granted to him by this contract, there shall be no liability upon the Engineer, his authorized representatives, or any official of the Owner either personally or as an official of the Owner. It is understood that in such matters they act solely as agents and representatives of the Owner.

50-20 NO WAIVER OF LEGAL RIGHTS. The Division shall not be precluded or stopped by any measurement, estimate, or certificate made either before or after completion and acceptance of the work and payment therefor, from showing the true amount and character of the work performed and materials furnished by the contractor, nor from showing that any such measurement, estimate or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Division shall not be precluded or stopped, notwithstanding any such measurement, estimate, or certificate and payment in accordance therewith, from recovering from the contractor or his sureties, or both, such damage as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the Division, or any representative of the Division, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Division, shall operate as a waiver of any portion of the contract or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other subsequent breach.

50-21 ENVIRONMENTAL PROTECTION. The contractor shall comply with all Federal, State and local laws and regulations controlling pollution of the environment. The contractor shall take sufficient precautions to prevent pollution of streams, lakes, and reservoirs with fuels, oils, bitumens, calcium chloroxide, or other harmful materials. He shall conduct and schedule his operations so as to avoid or minimize siltation of streams, lakes and reservoirs. Where, in the opinion of the Engineer, the land has a high potential for erosion the areas that can be

exposed by construction operations at any one time will be subject to approval by the Engineer and the duration of the exposure of the uncompleted construction to the elements shall be as short as practicable. Erosion control features shall be constructed concurrently with other work as directed by the Engineer.

50-22 ARCHAEOLOGICAL AND HISTORICAL FINDINGS. Unless otherwise specified in this subsection, the contractor is advised that the site of the work is not within any property, district, or site, and does not contain any building, structure, or object listed in the current National Register of Historic Places published by the United States Department of Interior.

Should the contractor encounter, during his operations, any building, part of a building, structure, or object which is incongruous with its surroundings, he shall immediately cease operations in that location and notify the Engineer. The Engineer will immediately investigate the contractor's findings and will direct the contractor to either resume his operations or to suspend operations as directed.

Should the Engineer order suspension of the contractor's operations in order to protect an archaeological or historical finding, or order the contractor to perform extra work, such shall be covered by an appropriate contract modification (change order or supplemental agreement) as provided in the subsection titled EXTRA WORK of Section 20 and the subsection titled PAYMENT FOR EXTRA WORK AND FORCE ACCOUNT WORK of Section 70. If appropriate, the contract modification shall include an extension of contract time in accordance with the subsection titled DETERMINATION AND EXTENSION OF CONTRACT TIME of Section 60.

50-23 CONTRACTOR'S PUBLIC LIABILITY AND PROPERTY DAMAGE LIABILITY INSURANCE. The contractor, with respect to the work that he performs, will be required to carry regular contractors' Public Liability Insurance, including automobile coverage, in limits of not less than \$500,000 for all damages arising out of bodily injuries to or death of one person and subject to that limit for each person, a total amount of \$1,000,000 for all damages arising out of bodily injuries to or death of two or more persons in any one accident, and regular contractors' Property Damage Liability Insurance, including automobile coverage, in limits of not less than \$500,000 for all damages arising out of injury to or destruction of property in any one accident and, subject to that limit per accident, a total (or aggregate) limit of \$1,000,000 for all damages arising out of injury to or destruction of property during the policy period.

He shall furnish a certified copy of the policy to the Division. The policy shall provide that in the event the insurance should be changed or

cancelled, such change or cancellation shall not be effective until 30 days after the Division has received notice of such change or cancellation from the insurance company.

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24 CONTRACTOR'S PROTECTIVE PUBLIC LIABILITY AND PROPERTY DAMAGE

INSURANCE. At the time of filing his contract and bonds, the contractor shall notify the Division, in writing, as to whether or not he proposes to sublet any of the work under the terms of his contract. The contractor, with respect to the operations performed for him by subcontractors, will be required to carry Contractors' Protective Public Liability and Property Damage Liability Insurance, including automobile coverage, in the same limits as prescribed in the subsection titled CONTRACTORS' PUBLIC LIABILITY AND PROPERTY DAMAGE LIABILITY INSURANCE of this section, and shall furnish copies of policies of such insurance and certificates as above required. If no part of the work is to be sublet, this article will not apply.

Insurance coverages as required above shall be kept in force until all work to be performed under the terms of the contract has been accepted by the Division and it is clearly understood that the upkeep of these insurance policies until acceptance of the work by the Division is a part of the contract. The contractor shall include the cost of all such insurance in his unit bid prices and no extra compensation will be granted to him, nor will any deduction be made by the Division due to extra work and/or decreased quantities of work and/or elimination of items.

Such insurance or other means of protection as herein provided shall be kept in force until all work to be performed under the terms of the contract has been completed and accepted in accordance with the specifications and it is hereby understood and agreed that the maintenance of such insurance or other protection, until acceptance of the work by the Division, is a part of the contract. Failure to maintain such insurance, cancellation by the Industrial Commission of its approval of such other means of protection as might have been elected, or any other act which results in lack of protection under the said "Worker's Compensation Act" may be considered as a breach of the contract.

50-25 CONTRACTOR'S WARRANTY. All materials and equipment furnished under this contract will be new unless otherwise specified, and that all work will be of good quality, free from faults and defects and in conformance with the contract documents. All work not so conforming to these standards may be considered defective. If required by the Division, the contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

Except where otherwise required by the Specifications, the contractor shall provide written guarantee of all of the work performed under the contract, certifying the work to be free from defects in materials and workmanship for a period of one (1) year from the date of final acceptance of his completed contract work. Final completion and acceptance of the work shall be deemed to have occurred on the date of acceptance by the Owner, the Division, and the FAA, if applicable, and shall be the date of the final inspection providing no defects are observed.

In specific instances where longer guarantees are stipulated for a particular portion of the work, such longer periods shall govern and be subject to the terms of this paragraph. If the Owner has exercised his privilege of partial occupancy or use, the guarantee period for that occupied or used portion, and that portion only, shall commence on the date of such partial occupancy or use, provided, however, that if such equipment or portion of work is found defective or otherwise not to comply with the requirements of the contract documents, the guarantee period shall not commence until the work is corrected to comply with the contract requirements.

If the contractor, after such notice, fails to promptly comply with the terms of the guarantee, the Owner may have the defects corrected and the contractor and his surety shall be liable for all expenses thus incurred.

SECTION 60

PROSECUTION AND PROGRESS

60-01 SUBLETTING OF CONTRACT. The contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof, or of his right, title, or interest therein, without written consent of the Engineer. In case such consent is given, the contractor will be permitted to sublet a portion thereof, but shall perform with his own organization, work amounting to not less than 51 percent of the total contract cost, except that any items designated in the contract as "specialty items" may be performed by subcontract and the cost of any such specialty items so performed by subcontract may be deducted from the total cost before computing the amount of work required to be performed by the contractor with his own organization. No subcontracts, or transfer of contract, shall in any case release the contractor of his liability under the contract and bonds. All transactions of the Engineer shall be with the contractor; subcontractors shall be recognized only in the capacity of employees or workmen and shall be subject to the same requirements as to character and competence.

The contractor shall have his own representative on the job at all times when either contract or subcontract work is being performed.

60-02 PROGRESS SCHEDULE. Promptly after the award of the contract and prior to the preconstruction conference, the contractor shall submit to the Engineer a satisfactory progress schedule or critical path schedule which shall show the proposed sequence of work, and how the contractor proposes to complete the various items of work within the number of calendar days set up in the contract.

This schedule shall be used for checking the progress of the work.

The contractor shall confer with the Engineer at regular intervals in regard to the prosecution of the work in accordance with the progress schedule or critical path schedule.

60-03 NOTICE TO PROCEED. The notice to proceed shall state the date on which it is expected the contractor will begin the construction and from which date contract time will be charged. The contractor shall begin the work to be performed under the contract within 10 days of the date set by the Engineer in the written notice to proceed, but in any event, the contractor shall notify the Project Engineer at least 24 hours in advance of the time actual construction operations will begin. If no date is specified, the Contract Time will begin on the date the

contractor actually begins construction or ten (10) days from the date of the Notice to Proceed, whichever is earlier.

60-04 PROSECUTION AND PROGRESS. Unless otherwise specified, the contractor shall submit his progress schedule for the Engineer as stated in subsection 60-02 PROGRESS SCHEDULE above. The contractor's progress schedule, when approved by the Engineer, may be used to establish major construction operations and to check on the progress of the work. The contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the proposal.

If the contractor falls significantly behind the submitted schedule, the contractor shall, upon the Engineer's request, submit a revised schedule for completion of the work within the contract time and modify his operations to provide such additional materials, equipment, and labor necessary to meet the revised schedule. Should the prosecution of the work be discontinued for any reason, the contractor shall notify the Engineer at least 24 hours in advance of resuming operations.

For Federal Aid contracts, the contractor shall not commence any actual construction prior to the date on which the notice to proceed is issued by the Engineer. Payment for work accomplished prior to the Notice to Proceed will be disallowed.

60-05 LIMITATIONS OF OPERATIONS. The contractor shall control his operations and the operations of his subcontractors and all suppliers so as to provide for the free and unobstructed movement of aircraft in the AIR OPERATIONS AREAS of the airport.

When the work requires the contractor to conduct his operations within an AIR OPERATIONS AREA of the airport, the work shall be coordinated with airport management (through the Resident Engineer) at least 48 hours prior to commencement of such work. The contractor shall not close an AIR OPERATIONS AREA until so authorized by the Engineer and until the necessary temporary marking and associated lighting are in place as provided in the subsection titled BARRICADES, WARNING SIGNS, AND HAZARD MARKINGS of Section 50.

When the contract work requires the contractor to work within an AIR OPERATIONS AREA of the airport on an intermittent basis (intermittent opening and closing of the AIR OPERATIONS AREA), the contractor shall maintain constant communications as hereinafter specified; immediately obey all instructions to vacate the AIR OPERATIONS AREA; and immediately obey all instruction to resume work in such AIR OPERATIONS AREA. Failure to maintain the specified communications or to obey instructions shall be cause for suspension of the contractor's operations in the AIR OPERATIONS AREA until the satisfactory conditions are provided. The contractor shall not commence new work that would be prejudicial to work already started.

60-06 CHARACTER OF WORKERS, METHODS, AND EQUIPMENT. The contractor shall, at all times, employ sufficient labor and equipment for prosecuting the work to full completion in the manner and time required by the contract, plans, and specifications.

All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person employed by the contractor or by a subcontractor who, in the opinion of the Resident Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Resident Engineer, be removed forthwith by the contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Resident Engineer.

Should the contractor fail to remove such person or persons or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Resident Engineer may suspend the work by written notice until compliance with such orders.

All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the work shall be such that no injury to previously completed work, adjacent property, or existing airport facilities will result from its use.

When the methods and equipment to be used by the contractor in accomplishing the work are not prescribed in the contract, the contractor is free to use any methods or equipment that will accomplish the work in conformity with the requirements of the contract, plans, and specifications.

When the contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the contractor desires to use a method or type of equipment other than that specified in the contract, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and of the reasons for desiring to make the change. If the approval is given, it will be on the condition that the contractor will be fully

responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet contract requirements, the contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The contractor shall remove any deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the contract items involved nor in the contract time as a result of authorizing a change in methods or equipment under this subsection.

60-07 TEMPORARY SUSPENSION OF THE WORK. The Resident Engineer shall have the authority to suspend the work wholly, or in part, for such period or periods as he may deem necessary, due to unsuitable weather, or such other conditions as are considered unfavorable for the prosecution of the work, or for such time as is necessary due to the failure on the part of the contractor to carry out orders given or perform any or all provisions of the contract.

In the event that the contractor is ordered by the Resident Engineer, in writing, to suspend work for some unforeseen cause not otherwise provided for in the contract and over which the contractor has no control, the contractor may be reimbursed for actual money expended on the work during the period of shutdown. No allowance will be made for anticipated profits. The period of shutdown shall be computed from the effective date of the Resident Engineer's order to suspend work to the effective date of the Resident Engineer's order to resume the work. Claims for such compensation shall be filed with the Resident Engineer within the time period stated in the Resident Engineer's order to resume work. The contractor shall submit with his claim information substantiating the amount shown on the claim. The Resident Engineer will forward the contractor's claim to the Division for the consideration in accordance with local laws or ordinances. No provision of this article shall be construed as entitling the contractor to compensation for delays due to inclement weather, for suspension made at the request of the contractor, or for any other delay provided for in the contract, plans, or specifications.

If it should become necessary to suspend work for an indefinite period, the contractor shall store all materials in such a manner that they will not become an obstruction nor become damaged in any way. He shall take every precaution to prevent damage or deterioration of the work performed and provide for normal drainage of the work. The contractor shall erect temporary structures where necessary to provide for traffic on, to, or from the airport.

60-08 DETERMINATION AND EXTENSION OF CONTRACT TIME. The number of calendar days allowed for completion of the work shall be stated in the proposal and contract and shall be known as the CONTRACT TIME.

Conditions beyond the contractor's control such as strikes, lockouts, unusual delays in transportation, temporary suspension of the principal item of work under construction or temporary suspension of the entire work which have been ordered by the Engineer for reasons not the fault of the contractor, shall not be charged against the contract time.

The Engineer will not make charges against the contract time prior to the effective date of the notice to proceed.

The Engineer will begin charges against the contract time on the first working day after the effective date of the notice to proceed, as stated in Subsection 10-39.

The Engineer will not make charges against the contract time after the date of final acceptance as defined in the Subsection 30-16 titled FINAL INSPECTION of Section 30.

The contractor will be allowed one week in which to file a written protest setting forth his objections to the Engineer's weekly statement. If no objection is filed within such specified time, the weekly statement shall be considered as acceptable to the contractor.

The contract time (stated in the proposal) is based on the originally estimated quantities as described in the Subsection titled INTERPRETATION OF QUANTITIES IN BID SCHEDULE in the PROCUREMENT POLICIES Section of the proposal. Should the satisfactory completion of the contract require performance of work in greater quantities than those estimated in the proposal, the contract time shall be increased in the same proportion as the cost of the actually completed quantities bears to the cost of the originally estimated quantities in the proposal. Such increase in contract time shall not consider either the cost of work or the extension of contract time that has been covered by change order or supplemental agreement and shall be made at the time of final payment.

CONTRACT TIME based on CALENDAR DAYS shall consist of the number of calendar days stated in the contract counting from the effective date of the notice to proceed and including all Saturdays, Sundays, holidays, and non-work days. All calendar days elapsing between the effective dates of the Engineer's orders to suspend and resume all work, due to causes not the fault of the contractor, shall be excluded.

At the time of final payment, the contract time shall be increased in the same proportion as the cost of the actually completed quantities bears to the cost of the originally estimated quantities in the proposal. Such increase in the contract time shall not consider either the cost of work

or the extension of contract time that has been covered by a change order or supplemental agreement. Charges against the contract time will cease as of the date of final acceptance.

When the contract time is a specified completion date, it shall be the date on which all contract work shall be substantially completed.

If the contractor finds it impossible for reasons beyond his control to complete the work within the contract time as specified, or as extended in accordance with the provisions of this subsection, he may, at any time prior to the expiration of the contract time as extended, make a written request to the Engineer for an extension of time setting forth the reasons which he believes will justify the granting of his request. The contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the Engineer finds that the work was delayed because of conditions beyond the control and without the fault of the contractor, he may extend the time for completion in such amount as the conditions justify. The extended time for completion shall then be in full force and effect, the same as though it were the original time for completion.

60-09 FAILURE TO COMPLETE ON TIME. For each calendar day, as specified in the contract, that any work remains uncompleted after the contract time (including all extensions and adjustments as provided in the subsection titled DETERMINATION AND EXTENSION OF CONTRACT TIME of this section) the sum specified in the contract and proposal as liquidated damages will be deducted from any money due or to become due the contractor or his surety. Such deducted sums shall not be deducted as a penalty but shall be considered as liquidation of a reasonable portion of damages that will be incurred by the Division should the contractor fail to complete the work in the time provided in his contract. Should the contractor fail to complete the work within the final contract time, he shall be liable to the Division in the amount shown in the following schedule of deductions, not as a penalty but as liquidated damages, for each day of overrun in the final contract time.

Schedule of Deductions for Each
Day of Overrun in Contract Time

<u>FROM MORE THAN</u>	<u>TO AND INCLUDING</u>	<u>DAILY CHARGE</u>
0	25,000	50
25,000	50,000	100
50,000	100,000	200
100,000	500,000	300
500,000	1,000,000	400
1,000,000	2,000,000	600
2,000,000	3,000,000	900
3,000,000	5,000,000	1200
5,000,000	7,500,000	1500
7,500,000	10,000,000	1700
10,000,000	15,000,000	2000
15,000,000	20,000,000	2300
20,000,000	25,000,000	2600
25,000,000	30,000,000	3000
30,000,000	35,000,000	3500
35,000,000	Over	4000

60-10 DEFAULT AND TERMINATION OF CONTRACT. If the contractor fails to begin the work under contract within the time specified, or fails to perform the work with sufficient workmen and equipment or with sufficient materials to insure the completion of said work within the specified time, or shall perform the work unsuitably, as determined by the Project Engineer, or shall neglect or refuse to remove materials or perform anew such work as shall be rejected as defective and unsuitable, or shall discontinue the prosecution of the work, or if the contractor shall become insolvent or be declared bankrupt, or shall commit any act of bankruptcy, or insolvency, or shall make an assignment for the benefit of creditors, or from any other cause whatsoever shall not carry on the work in a manner approved by the Project Engineer, the Project Engineer shall give notice in writing to the contractor and his surety of such delinquency, said notice to specify the corrective measures required. If the contractor, within a period of 10 days after said notice, shall not proceed in accordance therewith, the Division shall, upon written certificate from the Project Engineer of the fact of such delinquency and the contractor's failure to comply with said notice, have full power and authority to forfeit the rights of the contractor and at its option to call upon the surety to complete the work in accordance with the terms of the contract, or it may take over the work, including any or all materials and equipment on the ground as may be suitable and acceptable, and may complete the work with its own forces, or use such other methods as, in its opinion, shall be required for the completion of said contract in an acceptable manner. All costs and charges incurred by the Division, together with the cost of completing the work under contract, shall be deducted from any monies due or which become due on such contract. In case the expense so incurred by the

Division shall be less than the sum which would have been payable under the contract if it had been completed by the contractor, the contractor shall be entitled to receive the difference subject to any claims or liens thereon which may be filed with the Division or any prior assignment filed with it, and in case such expense shall exceed the sum which would have been payable under the contract, the contractor and the surety shall be liable and shall pay to the Division the amount of such excess.

60-11 TERMINATION FOR NATIONAL EMERGENCIES. The Owner shall terminate the contract or portion thereof by written notice when the contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense.

When the contract, or any portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract price or as mutually agreed for items of work partially completed or not started. No claims or loss of anticipated profits shall be considered.

Reimbursement for organization of the work, and other overhead expenses, (when not otherwise included in the contract) and moving equipment and materials to and from the job will be considered, the intent being that an equitable settlement will be made with the contractor.

Acceptable materials, obtained or ordered by the contractor for the work and that are not incorporated in the work, shall at the option of the contractor be purchased from the contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the Engineer.

Termination of the contract or a portion thereof shall neither relieve the contractor of his responsibilities for the completed work nor shall it relieve his surety of its obligation for and concerning any just claim arising out of the work performed.

60-12 TERMINATION OF THE CONTRACTOR'S RESPONSIBILITY. Whenever the improvement called for by the contract shall have been completely performed on the part of the Contractor and all parts of the work have been approved by the Engineer and accepted by the participating agencies according to the contract, and the final estimate paid, the Contractor's obligations shall then be considered fulfilled, except as set forth in his bond and in Sections 50-13 and 50-20.

SECTION 70

MEASUREMENT AND PAYMENT

70-01 MEASUREMENT OF QUANTITIES. All work completed under the contract will be measured by the Resident Engineer, or his duly authorized representatives, using United States Customary Units of Measurement.

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures (or leave-outs) having an area of 9 square feet or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the Resident Engineer.

Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.

Unless otherwise specified, all contract items which are measured by the linear foot such as electrical ducts, conduits, pipe culverts, underdrains and similar items shall be measured parallel to the base or foundation upon which such items are placed.

In computing volumes of excavation, the average end area method or other acceptable methods will be used.

The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe, culverts and arches, and metal cribbing will be specified and measured in decimal fraction of inches.

The term "ton" consisting of 2,000 pounds avoirdupois. All materials which are measured or proportioned by weights shall be weighed on accurate, approved scales by competent, qualified personnel at locations designated by the Project Engineer. If material is shipped by rail, the car weight may be accepted provided that payment will be made only for the actual weight of material. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the Resident Engineer directs, and each truck shall bear a plainly legible identification mark.

Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery.

Vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles shall be loaded to at least their water level capacity and all loads shall be leveled when the vehicles arrive at the point of delivery.

When requested by the contractor and approved by the Engineer in writing, material specified to be measured by the cubic yard may be weighed and such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the contractor before such method of measurement of pay quantities is used.

Bituminous materials will be measured by the gallon or ton. When measured by volume, such volumes will be measured at 60 degrees F. or will be corrected to the volume at 60 degrees F. using ASTM D 1250 for asphalts or ASTM D 633 for tars.

Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when bituminous material has been lost from the car or the distributor, wasted, otherwise not incorporated in the work.

When bituminous materials are shipped by truck or transport, net certified weights by volume, subject to correction for loss or foaming, may be used for computing quantities.

Cement will be measured by the ton or hundred weight unless otherwise specified.

Timber will be measured by the thousand feet board measure (M.F.B.M.) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.

The term "lump sum" when used as an item of payment will mean complete payment for the work described in the contract.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

Rental of equipment will be measured by time in hours of actual working time and necessary traveling time of the equipment within the limits of the work. Special equipment ordered by the Engineer in connection with force account work will be measured as agreed in the change order or supplemental agreement authorizing such force account work as provided in the subsection titled PAYMENT FOR EXTRA AND FORCE ACCOUNT WORK of this section.

When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gage, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

Scales for weighing materials which are required to be proportioned or measured and paid for by weight shall be furnished, erected, and maintained by the contractor, or be certified permanently installed commercial scales.

Scales shall be accurate within one-half of one percent of the correct weight throughout the range of use. The contractor shall have the scales checked under the observation of the inspector before beginning work and at such other times as requested. The intervals shall be uniform in spacing throughout the graduated or marked length of the beam of dial and shall not exceed one-tenth of one per cent of the nominal rated capacity of the scale, but not less than one pound. The use of spring balances will not be permitted.

Beams, dials, platforms, and other scale equipment shall be so arranged that the operator and inspector can safely and conveniently view them.

Scale installations shall have available, ten standard fifty-pound weights for testing the weighing equipment or suitable weights and devices for other approved equipment.

Scales must be tested for accuracy and serviced before use at a new site. Platform scales shall be installed and maintained with the platform level and rigid bulkheads at each end.

Scales "overweighing" (indicating more than correct weight) will not be permitted to operate and all materials received subsequent to the last previous correct weighing-accuracy-test will be reduced by the percentage of error in excess of one-half of one percent.

In the event inspection reveals the scales have been "underweighing" (indicating less than correct weight) they shall be adjusted and no additional payment to the contractor will be allowed for materials previously weighed and recorded.

All costs in connection with furnishing, installing, certifying, testing, and maintaining scales; for furnishing check weights and scale house; and for all other items specified in this subsection for the weighing of materials for proportioning or payment, shall be included in the unit contract prices for the various items of the project.

When the estimated quantities for a specific portion of the work are designated as the pay quantities in the contract, they shall be the final quantities for which payment for such specific portion of the work will be made, unless the dimensions of said portions of the work shown on the plans are revised by the Engineer. If revised dimensions result in an increase or decrease in the quantities of such work, the final quantities for payment will be revised in the amount represented by the authorized (approved by Change Order) changes in the dimensions.

70-02 SCOPE OF PAYMENT. The contractor shall receive and accept the compensation as herein provided, in full payment for furnishing all materials, labor, tools, and equipment; for performing all work contemplated and embraced under the contract; for all loss or damage arising out of the nature of the work or from the action of the elements; for any unforeseen difficulties or obstructions which may arise or be encountered during the prosecution of the work until its final acceptance by the Division; for all risks of every description connected with the prosecution of the work; also, for all expenses incurred by or in consequence of suspension or discontinuance of such prosecution of the work as herein specified, or for any infringement of patents, trademarks, or copyrights, and for completing the work in an acceptable manner according to the plans and specifications.

The payment of any current estimate prior to final acceptance of the work by the Division shall in no way constitute an acknowledgement of the acceptance of the work, nor in any way prejudice or affect the obligation of the contractor, at his expense, to repair, correct, renew, or replace any defects or imperfections in the construction of the work under contract and its appurtenances, nor any damage due or attributable to such defects, which defects, imperfections, or damage shall have been discovered on or before the final inspection and acceptance of the work. The Engineer shall be the sole judge of such defects, imperfections, or damage, and the contractor shall be liable to the Division or Owner (Sponsor) for failure to correct the same as provided herein.

70-03 INCREASED OR DECREASED QUANTITIES. When the accepted quantities of work vary from the quantities in the proposal, the contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract price for the accepted quantities of work actually completed and accepted. No allowance, except as provided for in the subsection titled ALTERATION OF WORK AND QUANTITIES of Section 20 will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the contractor which results directly from such alterations or indirectly from his unbalanced allocation of overhead and profit among the contract items, or from any other cause.

70-04 PAYMENT FOR OMITTED ITEMS. As specified in the subsection titled OMITTED ITEMS of Section 20, the Engineer shall have the right to omit from the work (order nonperformance) any contract item, except major contract items, in the best interest of the Owner.

Should the Engineer omit or order nonperformance of a contract item or portion of such item from the work, the contractor shall accept payment in full at the contract prices for any work actually completed and acceptable prior to the Engineer's order to omit or nonperform such contract item.

Acceptable materials ordered by the contractor or delivered on the work prior to the date of the Engineer's order will be paid for at the actual cost to the contractor and shall thereupon become the property of the Owner.

In addition to the reimbursement hereinbefore provided, the contractor shall be reimbursed for all actual costs incurred for the purpose of performing the omitted contract item prior to the date of the Engineer's order. Such additional costs incurred by the contractor must be directly related to the deleted contract item and shall be supported by certified statements by the contractor as to the nature and amount of such costs.

70-05 PAYMENT FOR EXTRA AND FORCE ACCOUNT WORK. Extra work which results from any of the changes as specified in Section 20 shall not be started until authorization from the Engineer is received which authorization shall state the items of work to be performed and the methods of payment for each item. Work performed without such order will not be paid for.

Extra work will be paid for:

- (1) Either as a lump sum price or at unit prices agreed upon by the contractor and engineer.
- (2) On the following force account basis:
 - (a) Labor. For all labor (skilled and unskilled) and foremen in direct charge of a specific force account item, the contractor shall receive the rate of wage (or scale) for every hour that such labor or foreman is actually engaged in the specified force account work. Such wage (or scale) shall be agreed upon in writing before beginning the work.
 - (b) Insurance and Taxes. For property damage, liability, and workmen's compensation insurance premiums, unemployment insurance contributions, and social security taxes on the force account work the contractor

shall receive the actual cost, to which cost (sum) an amount not to exceed 5 percent will be added. The contractor shall furnish satisfactory evidence of the rate or rates paid for such insurance and taxes.

- (c) Materials. For materials accepted by the Engineer and used, the contractor shall receive the actual cost of such materials delivered on the work, including transportation charges paid by him (exclusive of machinery rentals as hereinafter set forth), to which cost (sum) an amount not to exceed 15 percent will be added.
- (d) Equipment. For any machinery or special equipment (other than small tools) the use of which has been authorized by the Engineer, the contractor will be paid in accordance with the latest revision of "SCHEDULE OF AVERAGE ANNUAL EQUIPMENT OWNERSHIP EXPENSE WITH OPERATING COST" as issued by the Department. The equipment should be of a type and size reasonably required to complete the extra work.
- (e) Miscellaneous. No additional allowance will be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.
- (f) Comparison of Records. The contractor and the Resident Engineer shall compare records of the cost of force account work at the end of each day. Agreement shall be indicated by signature of the contractor and Resident Engineer or their duly authorized representatives.
- (g) Statements. No payment will be made for work performed on a force account basis until the contractor has furnished the Engineer with duplicate itemized statements of the cost of such force account work detailed as follows:
 - (1) Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.
 - (2) Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment.
 - (3) Quantities of materials, prices, and extensions.
 - (4) Transportation of materials.

- (5) Cost of property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, and social security tax.

Statements shall be accompanied and supported by receipted invoice for all materials used and transportation charges. However, if materials used on force account work are not specifically purchased for such work but are taken from the contractor's stock, then in lieu of the invoices the contractor shall furnish an affidavit certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the contractor.

The additional payment, based on the percentages specified above, shall constitute full compensation for all items of expense not specifically provided for the force account work. The total payment made as provided above shall constitute full compensation for such work.

70-06 PARTIAL PAYMENTS. At least twice a month, and/or when construction progress warrants, the Division shall prepare a Construction Progress Payment (CPP) based upon the weekly construction reports prepared in the field by the Resident Engineer. This CPP will be computed for the amount of the value of the work completed since the previous CPP. Retainage for each CPP to the Contractor shall be calculated as follows:

- A. For the first 50 percent of the total contract value, an amount of 10 percent of the value of the completed work shall be retained from the Contractor until after completion of the entire final contract and to the satisfaction of the Division.
- B. After more than 50 percent of the total contract value is completed, the Division may, at its discretion, certify the remaining partial payments be made to the Contractor without further retainage, provided that satisfactory progress is being made, and provided that the total retained amount is not less than 5 percent of the total adjusted contract value.
- C. At the discretion of the Division and with the consent of the surety, a semi-final Construction Progress Payment may be made when the principal contract payment items have been satisfactorily completed. In no event shall the amount retained from the Contractor after making the semi-final payment be less than 1 percent of the adjusted contract value, nor less than \$500.00. (This provision of making a semi-final construction progress payment is not applicable when the Contractor chooses the Trust Agreement option of Article 70-09.)

70-07 PAYMENT FOR MATERIALS ON HAND. A payment may, at the discretion of the Division and upon presentation of receipted bills and freight bills, be made for the value of acceptable reinforcing steel, structural steel, stone, gravel, sand, or other nonperishable materials delivered on the work or in acceptable storage places and not used at the time of such payment. From the value of such materials, retainage shall be calculated as per provision in Article 70-06. Such materials, when so paid for by the Division, shall become the property of the Division, and in the event of default on the part of the Contractor, the Division may use or cause to be used such materials in the construction of the work provided for in the contract. The value of stored or stockpiled items shall be reduced on progress payments as the stockpiled items are used in the work.

Such delivered costs of stored or stock-piled materials may be included in a separate progress payment or be included in the next partial payment after the following conditions are met:

- A. The material has been stored or stockpiled in a manner acceptable to Resident Engineer at or on an approved site.
- B. The Division has been furnished with acceptable evidence of the quantity and quality of such stored or stockpiled materials.
- C. The Contractor has furnished the Division with satisfactory evidence that the material and transportation costs have been paid.

It is understood and agreed that the Contractor is solely responsible for all material so stored or stockpiled.

It is understood and agreed that the Division's payment for such stored or stockpiled materials shall in no way relieve the Contractor of his responsibility for furnishing and placing such materials in accordance with the requirements of the contract, plans and specifications.

In no case will the amount of the partial payments for materials on hand exceed the delivered purchase price for such materials, or the total value of the contract payment item in which the material is intended to be used.

No partial payment will be made for stored or stockpiled living or perishable plant materials.

The Contractor shall bear all costs associated with the storage of stockpiled materials in accordance with the provisions of this subsection.

70-08 ACCEPTANCE AND FINAL PAYMENT. Whenever the improvement provided for by the contract shall have been completely performed on the part of the Contractor, and all parts of the work have been approved by the Division, a final construction payment showing the value of the work, will be prepared by the Division as soon as the necessary measurements and computations can be made, all prior CPP's upon which payments have been made being approximate only and subject to conditions in the final payment. The amount of the final payment will be the final adjusted contract value, less all previous payments and less any sums that have been deducted or retained by virtue of liquidated damages or otherwise under the provisions of the contract. The final payment will be paid to the Contractor as soon as practicable after the final approval of work, provided the Contractor has furnished to the Division satisfactory evidence that all sums of money due for any labor, materials, apparatus, fixtures, or machinery furnished for the purpose of the contract have been paid or that the person or persons to whom the same may be due have consented to such final payment.

If the Contractor has filed a claim for additional compensation under the provisions of the subsection titled CLAIMS FOR ADJUSTMENTS AND DISPUTES of Section 30 or under the provisions of this subsection, such claims will be considered by the Owner in accordance to local laws or ordinances. Upon final adjudication of such claims, any additional payment determined to be due the Contractor will be paid pursuant to a supplemental final payment.

70-09 TRUST AGREEMENT OPTION. When the awarding authority is the State of Illinois and at the request of a Contractor the amounts to be paid to the Contractor, including the amounts to be retained from the Contractor as set forth in this Article and Articles 70-06 and 70-07, may be deposited under the Division of Aeronautics Trust Agreement with an Illinois financial institution of the Contractor's choice. The Contractor shall receive any interest thereon. The Trust Agreement contains, as a minimum, the following provisions:

- A. The terms and conditions for depositing the retainage, holding the retainage in trust and the final disbursement of the retainage;
- B. The return or repayment of retainage upon demand made by the Division;
- C. The types of investments the financial institution may make with the retainage;
- D. The terms and conditions of the return or repayment of retainage in case of default of the Contractor;
- E. The Division's right to withhold progress payments on account of lien claims, liquidated damages, or as otherwise provided by the contract.

- F. The Contractor's responsibilities for obtaining the written consent of the financial institution, and any costs or service fees for administering the Trust Agreement shall be borne by the Contractor;
- G. The termination of the Trust Agreement upon completion of the contract.

DIVISION II

PAVING CONSTRUCTION DETAILS

EARTHWORK

ITEM 151 CLEARING AND GRUBBING

DESCRIPTION

151-1.1 This item shall consist of clearing or clearing and grubbing, including the disposal of materials, for all areas within the limits designated on the plans or as required by the Resident Engineer.

Clearing shall consist of the cutting and removal of all trees, stumps, brush, logs, hedges, the removal of fences and other loose or projecting material from the designated areas. The grubbing of stumps and roots will not be required. Clearing, when so designated, shall consist of the cutting and removal of isolated single trees or isolated groups of trees. The cutting of all the trees of this classification shall be in accordance with the requirements for the particular area being cleared, or as shown on the plans, or as directed by the Engineer. The trees shall be considered isolated when they are 40 feet or more apart, with the exception of a small clump of approximately five trees or less.

Clearing and grubbing shall consist of clearing the surface of the ground of the designated areas of all trees, stumps, down timber, logs, snags, brush, undergrowth, hedges, heavy growth of grass or weeds, fences structures, debris, and rubbish of any nature, natural obstructions or such material which in the opinion of the Resident Engineer is unsuitable for the foundation of strips, pavements, or other required structures, including the grubbing of stumps, roots, matted roots, foundations, and the disposal from the project of all spoil materials resulting from clearing and grubbing by burning or otherwise.

CONSTRUCTION METHODS

151-2.1 GENERAL. The areas denoted on the plans to be cleared or cleared and grubbed under this item shall be staked on the ground by the Resident Engineer. The clearing and grubbing shall be done at a satisfactory distance in advance of the grading operations.

All spoil materials removed by clearing or by clearing and grubbing shall be disposed of by burning or by removal to approved disposal areas. Piles for burning shall be placed either in the cleared area near the center or in adjacent open spaces where no damage to trees, other vegetation, or other property will occur. The contractor will be responsible for controlling fires in compliance with all Federal and State laws and regulations relative to building fires at the site. Ashes resulting from burning shall be removed and disposed of when directed by the Resident Engineer.

As far as practicable, waste concrete and masonry shall be placed on slopes of embankments or channels. When embankments are constructed of such material, this material shall be placed in accordance with requirements for formation of embankments. Any broken concrete or masonry which cannot be used in construction, and all other materials not considered suitable for use elsewhere, shall be disposed of by the contractor. In no case shall any discarded materials be left in windrows or piles adjacent to or within the airport limits. The manner and location of disposal of materials shall be subject to the approval of the Engineer and shall not create an unsightly or objectionable view. When the contractor is required to locate a disposal area outside the airport property limits at his own expense, he shall obtain and file with the Engineer, permission in writing from the property owner for the use of private property for this purpose.

If the plans or the specifications require the saving of merchantable timber, the contractor shall trim the limbs and tops from designated trees, saw them into suitable lengths, and make the material available for removal by other agencies.

The removal of existing structures and utilities required to permit orderly progress of work shall be accomplished by local agencies, unless otherwise shown on the plans. Whenever a telephone or telegraph pole, pipeline, conduit, sewer, roadway, or other utility is encountered and must be removed or relocated the contractor shall advise the Resident Engineer who will notify the proper local authority or owner and attempt to secure prompt action.

151-2.2 CLEARING. The contractor shall clear the staked or indicated area of all objectionable materials. Trees unavoidably falling outside the specified limits must be cut up, removed, and disposed of in satisfactory manner. In order to minimize damage to trees that are to be left standing, trees shall be felled toward the center of area being cleared. The contractor shall preserve and protect from injury all trees not to be removed. The trees, stumps, and brush shall be cut to a height of not more than 12 inches above the ground. The grubbing of stumps and roots will not be required.

When isolated trees are designated for clearing, the trees shall be classed in accordance with the butt diameter size as measured at a point of 12 inches above the ground level or at a designated height specified in the proposal.

Fences shall be removed and disposed of when directed by the Resident Engineer. Fence wire shall be neatly rolled and the wire and posts stored on the airport if they are to be used again, or stored at a designated location if the fence is to remain the property of a local owner or of the Airport Owner.

151-2.3 CLEARING AND GRUBBING. In areas designated to be cleared and grubbed, all stumps, roots, buried logs, brush, grass, and other unsatisfactory materials shall be removed, except where embankments exceeding 3-1/2 feet in depth are to be made outside of paved areas. In cases where such depth of embankments is to be made, all unsatisfactory materials shall be removed, but sound trees, stumps, and brush can be cut off within 6 inches above the ground and allowed to remain. Tap roots and other projections over 1-1/2 inches in diameter shall be grubbed out to a depth of at least 18 inches below the finished subgrade or slope elevation.

Any buildings and miscellaneous structures that are shown on the plans to be removed shall be demolished or removed, and all materials therefrom shall be disposed of either by burning or otherwise removed from the site. The remaining or existing foundations, wells, cesspools, and all like structures shall be destroyed by breaking out or breaking down the materials of which the foundations, wells, cesspools, etc., are built to a depth at least 2 feet below the existing surrounding ground. Any broken concrete, blocks, or other objectionable material which cannot be used in backfill shall be removed and disposed of. The holes or openings shall be backfilled with acceptable material and properly compacted.

All holes remaining after the grubbing operation in embankment areas shall have the sides broken down to flatten out the slopes, and shall be filled with acceptable material, moistened and properly compacted in layers to the density required in Item 152. The same construction procedure shall be applied to all holes remaining after grubbing in excavation areas where the depth of holes exceeds the depth of the proposed excavation.

METHOD OF MEASUREMENT

151-3.1 The quantities of clearing or clearing and grubbing as shown by the limits on the plans or as ordered by the Resident Engineer shall be cited in terms of the number of acres or fractions thereof, of land specifically cleared or cleared and grubbed, unless lump sum bid is specified in the proposal.

When isolated trees are designated for clearing, the quantities of trees, as determined in accordance with ranges of butt diameter size, measured at a point 12 inches above the ground level at the tree, shall be paid for according to the schedule of sizes as follows:

The number of trees:

From 0 to 2-1/2 feet, butt diameter

From 2-1/2 to 5 feet, butt diameter

For 5 feet or more, butt diameter

BASIS OF PAYMENT

151-4.1 Payment shall be made at the contract unit price per acre or in a lump sum for clearing. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

151-4.2 Payment shall be made at the contract unit price for clearing isolated trees. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

151-4.3 Payment shall be made at the contract unit price per acre or in a lump sum for clearing and grubbing. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 151-4.10	Clearing - per acre.
Item 151-4.	Clearing for isolated trees:
.20	0 to 2-1/2 ft. butt dia.-per each.
.30	2-1/2 to 5 ft. butt dia.-per each.
.40	Over 5 ft. butt dia.-per each.
Item 151-4.50	Clearing and grubbing - per acre.

ITEM 152 EXCAVATION AND EMBANKMENT

DESCRIPTION

152-1.1 This item shall consist of excavating, removing, and satisfactorily disposing of all materials within the limits of the work required to construct the landing strips, runways, taxiways, aprons, intermediate, and other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity with the dimensions and typical section shown on the plans and with the lines and grades established by the Resident Engineer.

All suitable material taken from excavation shall be used in the formation of embankment, subgrade, and for backfilling as indicated on the plans or as directed by the Resident Engineer.

When the volume of the excavation exceeds that required to construct the embankments to the grades indicated, the excess shall be used to grade the areas of ultimate development or wasted as directed. When the volume of excavation is not sufficient for constructing the fill to the grades indicated, the deficiency shall be supplied from borrow sources at locations within the airport or other authorized areas.

152-1.2 CLASSIFICATION. All material excavated shall be defined as "Unclassified Excavation" unless, in the proposal form, prices are asked and bids are taken for "Solid Rock Excavation", "Common Excavation" and "Borrow Excavation".

"Unclassified Excavation" shall include all excavation performed under this item regardless of the material encountered.

"Solid Rock Excavation", when provided in the proposal shall include all solid rock in ledges, in bedded deposits, in unstratified masses, and conglomerate deposits which are so firmly cemented as to present all the characteristics and difficulty of removal of solid rock as determined by the Engineer. All boulders containing a volume of more than 1/2 cubic yard will be classified as "Solid Rock Excavation." The method of removal shall be approved by the Engineer.

"Common Excavation", when provided in the proposal, shall consist of all excavation not included in "Solid Rock Excavation."

"Borrow Excavation", when provided in the proposal shall consist of excavation made outside the normal grading limits.

Frozen condition of any of the different classified materials taken from excavation does not constitute a basis for a claim for higher classification or for extra work on the part of the contractor.

CONSTRUCTION METHODS

152-2.1 GENERAL. The rough excavation shall be carried to the necessary depth to obtain the specified depth of subgrade densification shown on the plans. Likewise, on embankments, the depth of subgrade densification shall be as shown on the plans. Should the contractor, through negligence or other fault, excavate below the designated lines, he shall replace the excavation with approved materials, in an approved manner and condition, at his own expense. The Resident Engineer shall have complete control over the excavation, moving, placing, and disposition of all material and shall determine the suitability of material to be placed in embankments. All material determined unsuitable shall be disposed of in waste areas or as directed. Topsoil shall not be used in fills or in subgrades but shall be handled and placed as directed.

The contractor shall inform and satisfy himself as to the character, quantity, and distribution of all material to be excavated. No payment will be made for any excavated material which is used for purposes other than those designated. All spoil areas shall be leveled to a uniform line and section and shall present a neat appearance before project acceptance. The surface elevation of spoil areas shall not extend above the surface elevation of adjacent or contiguous usable areas of the airport.

Those areas outside of the pavement areas in which the top layer of soil material becomes compacted, due to hauling or to any other activity of the contractor, shall be scarified and disced to a depth of 4 inches, as directed, to loosen and pulverize the soil.

If it is necessary to interrupt existing surface drainage, sewers or underdrainage, conduits, utilities, or similar underground structures, or parts thereof, the contractor shall be responsible for and shall take all necessary precautions to protect and preserve or provide temporary services. When such facilities are encountered, the contractor shall notify the Resident Engineer, who shall arrange for their removal, if necessary. The contractor shall, at his own expense, satisfactorily repair all damage to such facilities or structures which may result from any of his operations during the period of the contract.

152-2.2 EXCAVATION. Excavation shall be performed as indicated on the contract plans to the lines, grades, and elevation shown or as directed by the Resident Engineer, and shall be made so that the requirements for formation of embankments can be followed. No excavation or stripping shall be started until the Resident Engineer has taken cross-sectional elevations and measurements of the existing ground

surface, and has staked out the proposed work. All material encountered within the limits indicated shall be removed and disposed of as directed. During the process of excavation, the grade shall be maintained so that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the work.

When selective grading is specified or required as indicated on the plans, the excavated material shall be handled to allow the selected material to be properly placed in the embankment and in the capping of pavement subgrades as determined from the soil profile and soil characteristics. This material shall be deposited within the designated areas of the airport as shown on the plans or as directed by the Resident Engineer.

If, at the time of excavation, it is not possible to place any material in its proper section of the permanent construction, it shall be stockpiled in approved areas for later use.

Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for landing strips, subgrades, roads, shoulders, intermediate areas, or any areas intended for turfing shall be excavated to a minimum depth of 12 inches, or to the depth specified by the Resident Engineer, below the contemplated surface of the subgrade or the designated grades. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified, to provide a satisfactory foundation. Unsatisfactory materials shall be disposed of at locations designated by the Resident Engineer. All material so excavated shall be paid for at the contract unit price per cubic yard for "Unclassified Excavation" or for "Common Excavation" or for "Solid Rock Excavation" as the case may be, when the classification for the last two items is provided in the proposal. The portion so excavated shall be refilled with suitable selected material as specified, obtained from the grading operations or borrow area and thoroughly compacted by rolling. The necessary refilling will constitute a part of the embankment. Where rock cuts are made and refilled with selected material, or where trenching out is done to provide for a course of pavement, the depths thus created shall be ditched at frequent intervals to provide adequate drainage.

The contractor shall make the distribution as indicated on the plans. Widening or narrowing of the section and raising or lowering of the grade to avoid haul will not be permitted. The right is reserved to make minor adjustments or revisions in lines or grades, if found necessary, as the work progresses due to discrepancies in the plans or to obtain satisfactory construction.

Overbreak, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the Resident Engineer. The Resident Engineer shall determine if the displacement of such material was unavoidable and his decision shall be final. All overbreak shall be removed by the contractor and disposed of as directed; however, payment will not be made for the removal and disposal of overbreak which the Resident Engineer determines as avoidable. Unavoidable overbreak will be classified as "Unclassified Excavation", except when the contract provides for the classification of "Common Excavation", or "Solid Rock Excavation", in which case unavoidable overbreakage from slides will be classified as such.

The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by local agencies, unless otherwise shown on the plans. All existing foundations shall be excavated for at least 2 feet below the top of the subgrade and the material disposed of as directed. All foundations thus excavated shall be backfilled with suitable material and compacted.

In cut areas, the subgrade under areas to be paved shall be compacted to the depths and to the densities at optimum moisture as shown on the plans or as specified in the specifications, or when not otherwise shown or specified, to a minimum depth of 6 inches and to a density of not less than 95%, for cohesive soils, and 100% for noncohesive soils, of the maximum density at optimum moisture as determined by the compaction control tests specified in Division VII. Any unsuitable materials encountered shall be removed and paid for as specified.

No payment or measurement for payment will be made for suitable materials removed, manipulated, and replaced in order to obtain density. Any removal, manipulation, aeration, replacement, and recompaction of suitable materials necessary to obtain the required density shall be considered as incidental to the excavation and embankment operations, and shall be performed by the contractor at no additional cost to the project.

Stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in the top 6 inches of the subgrade. The finished grading operations conforming to the typical cross section shall be completed and maintained at least 1,000 feet ahead of the paving operations.

In cuts, all loose or protruding rocks on the back slopes shall be barred loose or otherwise removed to the line or finished grade of the slope. All cut-and-fill slopes shall be uniformly dressed to the slope, cross section, and alignment shown on the plans or as directed by the Resident Engineer.

Blasting, when necessary, will be permitted only when proper precautions are taken for the protection and safety of all persons, the work, and the property. All damage done to the work or property shall be repaired at the contractor's expense. All operations of the contractor in connection with the transportation, storage, and use of explosives shall be approved by the Engineer. Any approval given will not relieve the contractor of his responsibility in blasting operations.

152-2.3 BORROW EXCAVATION. When provided for in the proposal, borrow excavation shall consist of excavation made from borrow areas within the limits of the airport property outside the normal grading limits, or from areas outside the airport when specified. Borrow area(s) within the airport property from which borrow may be obtained will be designated. Borrow excavation shall be made only at these designated locations and within the horizontal and vertical limits as staked or as directed. On completion of borrow operations, the borrow area shall be finished to a neat and uniform grade acceptable to the Resident Engineer.

When borrow sources are outside the boundaries of the airport property, it shall be the contractor's responsibility to locate and obtain the supply, subject to the approval of the Project Engineer. The contractor shall notify the Resident Engineer, sufficiently in advance of the beginning of excavation, so necessary measurements and tests can be made. All objectionable material shall be disposed of as directed. All borrow pits shall be opened up immediately to expose the vertical face of various strata of acceptable material to enable obtaining a uniform product. Borrow pits shall be excavated to regular lines to permit accurate measurements and shall be drained and left in a neat and presentable condition with all slopes dressed uniformly.

The borrow excavation shall be handled and placed as specified in these specifications for excavation and embankment.

152-2.4 DITCH EXCAVATION. Ditch excavation shall consist of excavating for drainage ditches such as intercepting, inlet or outlet, temporary levee construction, or any other type as designed or as shown on the plans. The work shall be performed in the proper sequence with the other construction. The location of all ditches or levees shall be established on the ground. All satisfactory material shall be placed in fills; unsatisfactory material shall be placed in spoil areas or as directed. Waste or surplus material shall be disposed of as shown on plans or as directed. Intercepting ditches shall be constructed prior to the starting of adjacent excavation operations. All necessary handwork shall be performed to secure a finish true to line, elevation, and cross section, as designated.

Ditches constructed on the project shall be maintained to the required cross section and shall be kept free from debris or obstructions until the project is accepted. Where necessary, sufficient openings shall be

provided through spoil banks to permit drainage from adjacent lands. Unless otherwise specified, no separate payment will be made for ditch excavation other than for the material removed which will be paid for at the unit price for "Unclassified Excavation", "Common Excavation" or "Solid Rock Excavation", as the case may be, if the proposal includes classification of these excavated materials.

152-2.5 PREPARATION OF EMBANKMENT AREA. Embankment areas shall be cleared and grubbed in accordance with the requirements in Item 151. All depressions or holes below the ground surface, whether caused by grubbing or otherwise, shall be backfilled with suitable material and compacted to ground surface before the construction of the embankment will be permitted to start.

Immediately prior to the placing of the fill materials, the entire area upon which the embankment is to be placed, except where limited by rock, shall be scarified and broken by means of a disc harrow or plow, or other approved equipment, to a depth of 6 inches. Scarifying shall be done approximately parallel to the axis of the fill. All roots, debris, large stones, or objectionable material that would cause interference with the compaction of the foundation or fill shall be removed from the area and disposed of as directed. A thin layer (approximately 3 inches) of the fill material shall be spread over the scarified foundation and the whole area compacted as required in the specifications.

Where embankments are to be placed on natural slopes steeper than 3-to-1, horizontal benches shall be constructed as shown on the plans or as directed by the Resident Engineer. Suitable excavated material shall be incorporated in embankments. Payment will be made for the material excavated at the unit price for grading.

No direct payment shall be made for the work performed under this section. The necessary clearing and grubbing and the yardage removed or used will be paid for under the respective item of work.

152-2.6 STRIPPING. All vegetation such as brush, heavy sods, heavy growth of grass, decayed vegetable matter, rubbish, and any other unsuitable material within the area upon which embankment is to be placed shall be stripped or otherwise removed before the embankment is started, and in no case shall such objectionable material be allowed in or under the embankment. No direct payment will be made for stripping. The yardage removed and disposed of shall be paid for at the contract unit price per cubic yard for "Unclassified Excavation", or for "Common Excavation", when the latter classification is provided for in the proposal.

152-2.7 FORMATION OF EMBANKMENTS. Embankments shall be formed of satisfactory materials placed in successive horizontal layers of

not more than 8 inches in loose depth for the full width of the cross section.

The grading operations shall be conducted, and the various soil strata shall be placed, to produce a soil structure as shown on the typical cross section or as directed. All materials entering the embankment shall be reasonably free of organic matter such as leaves, grass, roots, and other objectionable material. Soil, granular material, shale, and any other material permitted for use in embankment shall be spread in successive layers as specified.

Operations on earthwork shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing weather, or other unsatisfactory conditions of the field. The contractor shall drag, blade, or slope the embankment to provide proper surface drainage.

The material in the layers shall be of the proper moisture content before rolling to obtain the prescribed compaction. Wetting or drying of the material and manipulation when necessary to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. Sprinkling shall be done with approved equipment that will sufficiently distribute the water. Sufficient equipment to furnish the required water shall be available at all times. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken at frequent intervals. From these tests, corrections, adjustments, and modifications of methods, materials, and moisture content will be made to construct the embankment.

Rolling operations shall be continued until the embankment is compacted to not less than 95% for noncohesive soils; and 90% for cohesive soils of the maximum density, at optimum moisture, as determined by the compaction control tests cited in Division VII. Under all areas to be paved, the embankment shall be compacted to the depths and to the densities at optimum moisture as shown on the plans or as specified in the specifications, or, when not otherwise shown or specified, to a minimum depth of 9 inches and to a density of not less than 95% for cohesive soils, and 100% for noncohesive soils, of the maximum density at optimum moisture as determined by the compaction control tests specified in Division VII. On all areas outside of the pavement areas, no compaction will be required on the top 4 inches. Any areas inaccessible to a roller shall be consolidated and compacted by mechanical tampers.

During construction of the embankment, the contractor shall route his equipment at all times, both when loaded and when empty, over the layers as they are placed and shall distribute the travel evenly over

the entire width of the embankment. The equipment shall be operated in such a manner that hardpan, cemented gravel, clay, or other chunky soil material will be broken up into small particles and become incorporated with the other material in the layer.

In the construction of embankments, starting layers shall be placed in the deepest portion of the fill; as placement progresses, layers shall be constructed approximately parallel to the finished pavement grade line.

When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portion of the embankment and the other material shall be incorporated under the future paved areas. Stones or fragmentary rock larger than 4 inches in their greatest dimension will not be allowed in the top 6 inches of the subgrade. Rockfill shall be brought up in layers as specified or as directed and every effort shall be exerted to fill the voids with the finer material to form a dense, compact mass. Rock or boulders shall not be disposed of outside of the excavation or embankment areas, except at places and in the manner designated by the Resident Engineer.

Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material.

The contractor shall be responsible for the stability of all embankments made under the contract and shall replace any portion which, in the opinion of the Resident Engineer, has become displaced due to carelessness or negligence on the part of the contractor.

There will be no separate measurement or payment for compacted embankment, and all costs incidental to placing in layers, compacting, discing, watering, mixing, sloping, and other necessary operations of the embankments will be included in the contract price for excavation, borrow, or other items.

When stockpiling of excavated material and later rehandling of such material is directed by the Resident Engineer in order to produce the specified subgrade structure, the material shall be paid for at the contract unit price per cubic yard for "Unclassified Excavation" or "Common Excavation."

152-2.8 EQUIPMENT. The contractor may use any type of earth-moving compaction, and watering equipment he may desire or has at his disposal, provided the equipment is in a satisfactory condition and is of such capacity that the construction schedule can be maintained as planned by the contractor and as approved by the Project Engineer in accordance with the total calendar days or working days bid for the construction. The contractor shall furnish, operate, and maintain such equipment as is necessary to control uniform density, layers, section, and smoothness of grade.

152-2.9 PREPARATION AND PROTECTION OF THE TOP OF THE SUBGRADE. On areas to be paved, the specified depth in cut areas and the top of embankment shall be compacted to the density specified. When completed, the surface shall be true to the lines, grades, and cross section shown on the plans or as directed by the Resident Engineer. After all drains, structures, ducts, and other underground appurtenances along the edges or under the pavement have been completed, the subgrade shall be compacted to the depth specified at not less than 95% density for cohesive soils and 100% for noncohesive soils, as determined by the compaction control tests specified in Division VII. Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding, removing, or replacing material until the surface is smooth and uniform. Any portion of the area which is not accessible to a roller shall be compacted to the required density by approved mechanical tampers. The material shall be sprinkled with water during rolling or tamping, when directed by the Resident Engineer.

All soft and yielding material and material which will not compact readily when rolled or tamped shall be removed as directed by the Resident Engineer and replaced with suitable material. After grading operations are complete, all loose stones larger than 2 inches in their greatest dimension shall be removed from the surface of all proposed graded paving areas and disposed of as directed by the Resident Engineer.

At all times, the top of the subgrade shall be kept in such condition that it will drain readily and effectively. In handling materials, tools, and equipment, the contractor shall protect the subgrade from damage by laying planks when directed and shall take other precautions as needed. In no case will vehicles be allowed to travel in a single track. If ruts are formed, the subgrade shall be reshaped and rolled. Storage or stockpiling of materials on the top of the subgrade will not be permitted. Until the subgrade has been checked and approved, no subbase, base, surface course, or pavement shall be laid thereon.

152-2.10 HAUL. No payment will be made separately or directly for haul on any part of the work. All hauling will be considered a necessary and incidental part of the work and its cost shall be considered by the contractor and included in the contract unit price for the pay items of work involved.

152-2.11 TOLERANCES. In those areas upon which a subbase or base course is to be placed, the top of the subgrade shall be of such smoothness that, when tested with a 16-foot straightedge applied parallel and at right angles to the centerline, it shall not show any deviation in excess of 1/2 inch, or shall not be more than 0.05 foot from the true grade as established by grade hubs or pins. Any deviation in excess of these amounts shall be corrected by loosening, adding, or removing materials, reshaping, and recompacting by sprinkling and rolling.

On landing strips, intermediate and other designated areas, the surface shall be of such smoothness that it will not vary more than 0.10 of a foot from true grade as established by grade hubs. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

152-2.12 TOPSOIL. When topsoil is specified or required, as shown on the plans or under Item 905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item 905 or shall be approved by the Resident Engineer. If, at the time of excavation or stripping, the topsoil cannot be placed in its proper and final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall not be placed within 50 feet of pavement areas and shall not be placed on areas which subsequently will require any excavation or embankment.

Upon completion of grading operations as specified, topsoil shall be handled and placed as directed, or as required in Item 905. The Resident Engineer shall set grade stakes for grading operations in both cut and fill so that the topsoil will be placed at the finished plan elevation.

No direct payment will be made for topsoil as such under Item 152. The quantity removed and placed or stockpiled shall be paid for at the contract unit price per cubic yard for "Unclassified Excavation," or for "Common Excavation" when the latter classification is provided in the proposal.

When topsoil is paid for under Item 152, as excavation, no payment shall be made for the same work under Item 905.

When stockpiling of topsoil and later rehandling of such material is directed by the Resident Engineer to produce the specified soil structure, the material so rehandled shall be paid for at the contract unit price per cubic yard for "Unclassified Excavation," or for "Common Excavation" when the latter classification is provided in the proposal.

METHOD OF MEASUREMENT

152-3.1 The yardage paid for shall be the number of cubic yards measured in its original position. Pay quantities shall be computed to the neat lines staked, by the method of average end areas of materials acceptably excavated and stripped as specified.

Measurement shall not include the yardage of material excavated without authorization beyond normal slope lines, or the yardage of material used for purposes other than those directed.

152-3.2 Stockpiled material paid for shall be the number of cubic yards measured by cross sectioning the ground surface prior to the placing of the material, and later cross sectioning as soon as material has been stockpiled. Pay quantities shall be computed by the method of average end areas.

152-3.3 Borrow material paid for shall be the number of cubic yards measured in its original position in excavation, and pay quantities shall be computed by the method of average end areas.

BASIS OF PAYMENT

152-4.1 Payment shall be made at the contract unit price per cubic yard for "Unclassified Excavation." This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

152-4.2 Payment shall be made at the contract unit price per cubic yard for "Common Excavation." This price shall be the full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

152-4.3 Payment shall be made at the contract unit price per cubic yard for "Solid Rock Excavation." This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

152-4.4 Payment shall be made at the contract unit price per cubic yard for "Borrow Excavation." This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

- Item 152-4.10 Unclassified Excavation-per cubic yard.
- Item 152-4.20 Common Excavation - per cubic yard.
- Item 152-4.30 Solid Rock Excavation - per cubic yard.
- Item 152-4.40 Borrow Excavation - per cubic yard.

ITEM 155 LIME TREATED SUBGRADE

DESCRIPTION

155-1.1 This item shall consist of constructing one or more courses of a mixture of soil, lime, and water in accordance with this specification, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Resident Engineer.

MATERIALS

155-2.1 HYDRATED LIME. Hydrated lime shall conform to the requirements of ASTM C 207, Type N.

155-2.2 COMMERCIAL LIME SLURRY. Commercial lime slurry shall be a pumpable suspension of solids in water. The water or liquid portion of the slurry shall not contain dissolved material in sufficient quantity naturally injurious or objectionable for the purpose intended. The solids portion of the mixture, when considered on the basis of "solids content," shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.

- (a) Chemical composition. The "solids content" of the lime slurry shall consist of a minimum of 70%, by weight, of calcium and magnesium oxides.
- (b) Residue. The percent by weight of residue retained in the "solids content" of lime slurry shall conform to the following requirements:
 - Residue retained on a No. 6 sieve ----- Max. 0.0%
 - Residue retained on a No. 10 sieve ----- Max. 1.0%
 - Residue retained on a No. 30 sieve ----- Max. 2.5%
- (c) Grade. Commercial lime slurry shall conform to one of the following two grades:
 - Grade 1. The "dry solids content" shall be at least 31%, by weight, of the slurry.
 - Grade 2. The "dry solids content" shall be at least 35%, by weight, of the slurry.

155-2.3 WATER. Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water of questionable quality shall be tested in accordance with the applicable ASTM Part 31 tests as deemed necessary by the Engineer. Water known to be of potable quality may be used without testing.

155-2.4 SOIL. The soil for this work shall consist of materials on the site or selected materials from other sources and shall be uniform in quality and gradation, and shall be approved by the Resident Engineer. The soil shall be free of roots, sod, weeds, and stones larger than 2 1/2 inches.

COMPOSITION

155-3.1 LIME. Lime shall be applied at the rate specified on the plans for the depth of subgrade treatment shown.

155-3.2 TOLERANCES. At final compaction, the lime and water content for each course of subgrade treatment shall conform to the following tolerances:

Material	Tolerance
Lime	+ 0.5%
Water	+ 2%-0%

WEATHER LIMITATIONS

155-4.1 WEATHER LIMITATIONS. The lime-treated subgrade shall not be mixed while the atmospheric temperature is below 40° F. or when conditions indicate that temperatures may fall below 40° F. within 24 hours, when it is foggy or rainy, or when soil or subgrade is frozen.

EQUIPMENT

155-5.1 EQUIPMENT. The equipment required shall include all equipment necessary to complete this item such as: grading and scarifying equipment, a spreader for the lime or lime slurry, mixing or pulverizing equipment, sheepsfoot and pneumatic or vibrating rollers, sprinkling equipment, trucks, and truck scales. All machinery, tools, and equipment shall be on the site and approved by the Resident Engineer prior to the beginning of construction operations and shall be maintained in a satisfactory working condition throughout the construction period.

CONSTRUCTION METHODS

155-6.1 GENERAL. It is the primary requirement of this specification to secure a completed subgrade containing a uniform lime mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface suitable for placing subsequent courses. It shall be the responsibility of the contractor to regulate the sequence of his work, to use the proper amount of lime, maintain the work, and rework the courses as necessary to meet the above requirements.

Prior to beginning any lime treatment the subgrade shall be constructed and brought to grade as specified in Item 152 "Excavation and Embankment" and shall be shaped to conform to the typical sections, lines, and grades as shown on the plans or as established by the Resident Engineer. The material to be treated shall then be excavated to the secondary grade (proposed bottom of lime treatment) and removed or windrowed to expose the secondary grade. Any wet or unstable materials below the secondary grade shall be corrected, as directed by the Resident Engineer, by scarifying, adding lime, and compacting until it is of uniform stability. The excavated material shall then be spread to the desired cross section.

If the contractor elects to use a cutting and pulverizing machine that will remove the subgrade material accurately to the secondary grade and pulverize the material at the same time, he will not be required to expose the secondary grade nor windrow the material. However, the contractor shall be required to roll the subgrade, as directed by the Resident Engineer, and correct any soft areas that this rolling may reveal before using the pulverizing machine. This method will be permitted only where a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a smooth surface over the entire width of the cut. The machine must give visible indication at all times that it is cutting to the proper depth.

155-6.2 APPLICATION. Lime shall be spread only on that area where the first mixing operations can be completed during the same working day. The application and mixing of lime with the soil shall be accomplished by the methods hereinafter described as "Dry Placing" or "Slurry Placing." When hydrated lime is specified, the contractor may use either method.

(a) Dry placing. The lime shall be spread uniformly over the top of the subgrade by an approved screw-type spreader box or other approved spreading equipment. The amount of lime spread shall be the amount required for mixing to the specified depth which will result in the percentage determined in the job mix formula.

The lime shall be distributed in such manner that scattering by wind will be minimal. Lime shall not be applied when wind conditions, in the opinion of the Resident Engineer, are detrimental to a proper application. A motor grader shall not be used to spread the lime. The material shall be sprinkled, as directed by the Resident Engineer, until the proper moisture content has been reached.

(b) Slurry placing. The lime shall be mixed with water in trucks with approved distributors and applied as a thin water suspension or slurry. Commercial lime slurry shall be applied with a lime percentage not less than that applicable for the grade used. The distribution of lime shall be attained by successive passes over a measured section of subgrade until the proper amount of lime has been spread. The amount of lime spread shall be the amount required for mixing to the specified depth which will result in the percentage determined in the job mix formula. The distributor truck shall continually agitate the slurry to keep the mixture uniform.

155-6.3 MIXING. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as hereinafter described:

(a) First mixing. The full depth of the treated subgrade shall be mixed with an approved mixing machine. Lime shall not be left exposed for more than six hours. The mixing machine shall make two coverages. Water shall be added to the subgrade during mixing to provide a moisture content above the optimum moisture content of the material and to insure chemical action of the lime and subgrade. After mixing, the subgrade shall be lightly rolled to seal the surface and help prevent evaporation of moisture. The water content of the subgrade mixture shall be maintained at a moisture content above the optimum moisture content for a minimum of 48 hours or until the material becomes friable. During the curing period, the material shall be sprinkled as directed. During the interval of time between application and mixing, lime that has been exposed to the open air for 6 hours or more, or to excessive loss due to washing or blowing will not be accepted for payment.

(b) Final mixing. After the required curing time, the material shall be uniformly mixed by approved methods. If the mixture contains clods, they shall be reduced in size by blading, discing, harrowing, scarifying, or the use of other approved pulverization methods so that the remainder of the clods shall meet the following requirements when tested dry by laboratory sieves:

	Percent
Minimum of clods passing 1 1/2 inch sieve -----	100
Minimum of clods passing No. 4 sieve -----	60

155-6.4 COMPACTION. Compaction of the mixture shall begin immediately after final mixing. The material shall be aerated or sprinkled as necessary to provide optimum moisture.

Compaction should begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted. The entire thickness of the treated subgrade shall be compacted to a density of at least 93% of maximum density at optimum moisture, as determined by the compaction control tests in Division VII.

The material shall be sprinkled and rolled as directed by the Resident Engineer. All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting by sprinkling and rolling. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the Resident Engineer. If the material fails to meet the density requirements, it shall be reworked to meet these requirements. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and shall conform with the typical section shown on the plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at the sole expense of the contractor.

155-6.5 FINISHING AND CURING. After the final layer or course of lime-treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling, as directed, with a pneumatic or other suitable roller sufficiently light to prevent hair cracking. The finished surface shall not vary more than 3/8 inch when tested with a 16-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the contractor, at his own expense, in a manner satisfactory to the Resident Engineer.

The completed section shall be moist-cured for a minimum of 7 days before further courses are added or any traffic is permitted, unless otherwise directed by the Resident Engineer. Subsequent courses shall be applied within 14 days after the lime-treated subgrade is cured.

155-6.6 THICKNESS. The thickness of the lime-treated subgrade shall be determined by depth tests or cores taken at intervals so that each test shall represent no more than 300 square yards. When the base deficiency is more than 1/2 inch, the contractor shall correct such areas in a manner satisfactory to the Resident Engineer. The contractor shall replace, at his expense, the subgrade material where borings are taken for test purposes.

155-6.7 MAINTENANCE. The contractor shall maintain, at his own expense, the entire lime-treated subgrade in good condition from the start of work until all the work has been completed, cured, and accepted by the Engineer.

METHOD OF MEASUREMENT

155-7.1 The yardage of lime-treated subgrade to be paid for shall be the number of square yards completed and accepted.

BASIS OF PAYMENT

155-8.1 Payment shall be made at the contract unit price per square yard for the lime-treated subgrade of the thickness specified. The price shall be full compensation for furnishing all material, lime, and for all preparation, delivering, placing and mixing these materials, and all labor, equipment, tools and incidentals necessary to complete this item.

Payment will be made under:

Item 155-8.10 Lime-treated subgrade -per square yard.

FLEXIBLE BASE COURSES

ITEM 201 BITUMINOUS BASE COURSE

(Central Plant Hot Mix)

DESCRIPTION

201-1.1. This item shall consist of a base course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the plans.

Each course shall be constructed to the depth, typical section, or elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

MATERIALS

201-2.1 AGGREGATE. Aggregates shall consist of crushed stone with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 8 sieve shall be known as coarse aggregate, the portion passing the No. 8 sieve and retained on the No. 200 sieve as fine aggregate, and the portion passing the No. 200 sieve as mineral filler.

(a) Coarse Aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from adherent coatings of clay, organic matter, and other deleterious substances. It shall show no more wear than 45 percent when tested in accordance with ASTM C 131, nor shall the sodium sulfate soundness loss exceed 15 percent, or the magnesium soundness loss exceed 15 percent, after five cycles, when tested in accordance with ASTM C 88.

Crushed aggregate shall contain at least 75 percent by weight of crushed pieces having two or more fractured faces. The area of each face shall be equal to at least 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of fractures shall be at least 30 degrees to count as two fractured faces.

The aggregate shall not contain more than 8 percent, by weight, of flat or elongated pieces. A flat particle is one having a ratio of width to thickness greater than five; an elongated particle is one having a ratio of length to width greater than five.

(b) Fine Aggregate. Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing stone that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls. The fine aggregate, including any blended filler, shall have a plasticity index of not more than six when tested in accordance with ASTM D 424, and a liquid limit of not more than 25 when tested in accordance with ASTM D 423.

If necessary to obtain the gradation of aggregate blend or workability, natural sand may be used. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification.

(c) Sampling and Testing. All aggregate samples required for testing shall be furnished by the contractor. ASTM D 75 shall be used in sampling coarse aggregate and fine aggregate, and ASTM C 183 shall be used in sampling mineral filler. All tests for initial aggregate submittals necessary to determine compliance with requirements specified herein will be made by the Engineer at no expense to the contractor. Costs for testing additional sources shall be borne by the contractor. Sampling will be observed and supervised by the Engineer. No aggregate shall be used in the production of mixtures without prior approval.

(d) Sources of Aggregates. Sources of aggregates shall be selected well in advance of the time the materials are required in the work. When the aggregates are obtained from a previously approved source or an existing source producing aggregates that has a satisfactory service record in airport bituminous pavement construction for at least five years, samples shall be submitted 14 days prior to start of production. An inspection of the producer's operation will be made by the Engineer. When new sources are to be developed, the contractor shall indicate the sources and shall submit a plan for operation 30 days in advance of starting production. Samples from test pits, borings, and other excavations shall be submitted at the same time. Approval of the source of aggregate does not relieve the contractor in any way of the responsibility for delivery at the job site of aggregates that meet the requirements specified herein.

(e) Samples of Aggregates. Samples of aggregates shall be furnished by the contractor at the start of production and at intervals during production of bituminous mixtures. The intervals and points of sampling will be designated by the Engineer. The samples will be the basis of approval of specific aggregates from the standpoint of the quality requirements of this section.

201-2.2 FILLER. If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242.

201-2.3 BITUMINOUS MATERIAL. The types, grades, and controlling specifications and maximum mixing temperatures for the bituminous materials are given in Table 1.

The contractor shall furnish vendor's certified test reports for each carload or equivalent of bitumen shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall be the basis for final acceptance.

TABLE 1. BITUMINOUS MATERIAL

Type & Grade	Specification	Maximum Mixing Temperature		
		°F	°C	
<u>Asphalt Cement</u>				
Penetration	60-70	ASTM D 946	325	165
Grade	85-100		325	165
	100-120		325	165
Viscosity	AC-5	ASTM D 3381	325	165
Grade	AC-10		325	165
	AC-20		325	165
Viscosity	AR-2000	ASTM D 3381	325	165
Grade	AR-4000		325	165
	AR-8000		325	165

201-3.1 COMPOSITION OF MIXTURE. The bituminous plant mix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula.

201-3.2 JOB MIX FORMULA. No bituminous mixture for payment shall be produced until a job mix formula has been approved by the Engineer. The contractor shall submit samples of the materials intended for use and the Project Engineer shall establish a satisfactory job mix formula. The formula shall be submitted in writing by the Project Engineer to the contractor and shall indicate the definite percentage of each sieve fraction of aggregate, the percentage of bitumen, and the recommended temperature of the completed mixture when discharged from the mixer.

The job mix formula for each mixture shall be in effect until modified in writing by the Project Engineer. Should a change in sources of materials be made, a new job mix formula shall be established before the new material is used.

The bituminous mixture shall be designed using the procedures contained in ASTM D 1559 and shall meet the criteria set forth in Tables 2 and 3.

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory screens, will conform to the gradation or gradations specified in Table 4, when tested in accordance with ASTM Standard C 136 (dry sieve only). The percentage by weight for the bituminous material shall be within the limits specified.

TABLE 2. MARSHALL DESIGN CRITERIA

	OVER 60,000 LB.	UNDER 60,000 LB. & 200,000 OPERATIONS/YR.
Number of Blows	75	50
Stability, minimum pounds (newtons)	1800*	1000*
Flow, 0.01 in. (0.25 mm)	8-16	8-18
Percent air voids	2-3	2-3
Percent voids in mineral aggregate	See Table 3	See Table 3

*NOTE: If the stability exceeds 3,000 lb., the mix shall be re-evaluated.

TABLE 3. MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE

U. S. A. Standard Sieve Designation in.	Nominal Maximum Particle Size in.	Minimum Voids in Mineral Aggregate percent
1/2	0.500	15
3/4	0.750	14
1	1.000	13

TABLE 4. AGGREGATE-BITUMINOUS BASE COURSE

Percentage by Weight Passing Sieves			
Sieve Size	Gradation A 1-1/4" maximum	Gradation B 1" maximum	Gradation C 3/4" maximum
1-1/4 in.	100	---	---
1 in.	88-100	100	---
3/4 in.	75-96	84-100	100
1/2 in.	59-83	64-86	81-100
3/8 in.	50-75	55-78	70-90
No. 4	32-60	40-62	47-73
No. 8	25-49	28-50	30-60
No. 16	19-41	22-43	22-47
No. 30	15-32	17-32	17-34
No. 100	5-14	6-16	6-16
No. 200	3-8	3-8	3-8
Bitumen %:			
Stone	4.5-6.5	4.5-7.0	5.0-7.0

The gradations in Table 4 represent the limits which shall determine the suitability of aggregate for use from the sources of supply. The selection of any of the gradations shown in Table 4 shall be such that the maximum size aggregate used shall not be more than one-half of the thickness of the layer of the course being constructed. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 4 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

The course and fine aggregate gradations specified in the Illinois Division of Highways Specifications for Road and Bridge Construction, current edition, may be blended to meet the job mix formula.

The job mix tolerances shown in Table 5 shall be applied to the job mix formula to establish a job control grading band. The full tolerances will only apply if application of the job mix tolerances results in a job control grading band inside the master grading band.

TABLE 5. JOB MIX FORMULA TOLERANCES
(Based on a Single Test)

Material	Tolerances Plus or Minus
Aggregate passing No. 4 sieve or larger	7 percent
Aggregate passing Nos. 8 and 16 sieves	5 percent
Aggregate passing Nos. 30 sieve	4 percent
Aggregate passing Nos. 100 and 200 sieves	2 percent
Bitumen	0.45 percent
Temperature of mixing and placing	20 degrees F.

The aggregate gradation may be adjusted within the limits of Table 4, as directed, without adjustments in the contract unit prices.

Should a change in sources of materials be made, a new job mix formula shall be established before the new material is used. Deviation from the final approved design for bitumen content and gradation of aggregates shall not be greater than the tolerances permitted and shall be based on daily plant extraction. The mixture will be tested for bitumen content in accordance with ASTM D 2172 and for aggregate gradation in accordance with ASTM C 117 and C 136.

If the index of retained strength of the specimens of composite mixture, as determined by ASTM D 1075, is less than 75, the aggregates shall be rejected or the asphalt shall be treated with an approved antistripping agent. The amount of antistripping agent added to the asphalt shall be sufficient to produce an index of retained strength of not less than 75.

201-3.3 BITUMINOUS AND AGGREGATE MATERIAL CONTRACTOR'S RESPONSIBILITY. Samples of the bituminous and aggregate materials that the contractor proposes to use, together with a statement of their source and character, shall be submitted to the Engineer; approval must be obtained before the use of such material begins. The contractor shall require the manufacturer or producer of the bituminous and aggregate

materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials that have demonstrated performance under the proposed design requirements will be accepted.

The Engineer or his authorized representative shall have access, at all times, to all parts of the paving plant for the purpose of inspecting equipment, conditions and operation of the plant, for verification of weights or proportions and character of materials, and to determine temperatures maintained in the preparation of the mixtures.

The contractor shall furnish vendor's certified test reports for each carload or equivalent of bitumen shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All such test reports shall be subject to verification by testing samples of materials received for use on the project.

201-3.4 TEST SECTION. Prior to full production, the contractor shall prepare a quantity of bituminous mixture according to the job mix formula. The amount of mixture should be sufficient to construct a test section at least 400 square yards and shall be of the same depth specified for the construction of the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

The test section shall be part of the proposed work. If the test section should prove to be unsatisfactory, the necessary adjustments to the mix design, plant operation, and/or rolling procedures shall be made. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. When test sections do not conform to specification requirements, the pavement shall be removed and replaced at the contractor's expense. Full production shall not begin without approval of the Engineer. Test sections will be paid for in accordance with Section 201-6.1.

CONSTRUCTION METHODS

201-4.1 WEATHER LIMITATIONS. The bituminous mixture shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 6. The temperature requirements may be waived, but only when so directed by the Engineer.

TABLE 6. BASE TEMPERATURE LIMITATIONS

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 in. or greater	40	4
Greater than 1 in. but less than 3 in.	45	7
1 in or less	50	10

No paving shall commence unless the ambient air temperature is 40°F. and rising. Paving shall halt when the ambient air temperature is 45°F. and falling.

201-4.2 BITUMINOUS MIXING PLANT. If the supplier is equipped with an automated plant the automation feature shall be used in the production of bituminous material for the project. If the supplier is equipped with a recordation feature, it also shall be used. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold elevator feeding the drier. The storage yard shall be neat and orderly, and the separate stockpiles shall be readily accessible for sampling.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (a), except that scale requirements shall apply only where weight proportioning is used. In addition, batch mixing plants shall conform to the requirements under (b), continuous mixing plants shall conform to the requirements under (c), and drum mixers shall conform to the requirements under (d).

(a) Requirements for All Plants. Mixing plants shall be of sufficient capacity to adequately handle the proposed bituminous construction.

(1) Plant scales. Scales shall be accurate to 0.5 percent of the required load. Poises shall be designed to be locked in any position to prevent unauthorized change of position. In lieu of plant and truck scales, the contractor may provide an approved automatic printer system to print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load. Scales shall be inspected for accuracy and sealed as often as the Resident Engineer may deem necessary. The contractor shall have on hand not less than ten 50-pound weights for testing the scales.

(2) Equipment for preparation of bituminous material. Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. Heating shall be accomplished by approved means so that flames will not contact the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring quantities and for sampling the material in the storage tanks.

(3) Cold feeders. The plant shall be provided with accurate mechanical or electrical means for uniformly feeding the aggregates into the drier to obtain uniform production and temperature. When added mineral filler is specified, a separate bin and feeder shall be furnished with its drive interlocked with the aggregate feeders.

(4) Drier. The plant shall include a drier(s) which continuously agitates the aggregate during the heating and drying process.

(5) Screens. Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided.

(6) Bins. The plant shall include storage bins of sufficient capacity to supply a mixer operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. When used, separate dry storage shall be provided for filler of hydrated lime, and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes of such size and at such location to prevent backup of material into the compartments or bins. Each compartment shall be provided with its individual outlet gate to prevent leakage. The gates shall cut off quickly and completely. Bins shall be constructed so that samples may be obtained readily. Bins shall be equipped with adequate tell-tale devices which indicate the position of the aggregates in the bins at the lower quarter points.

(7) Bituminous control unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the specified amount of bituminous material in the mix. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

(8) Thermometric equipment. An armored thermometer of adequate range shall be placed in the bituminous feed line at a suitable location near the charging valve of the mixer unit. The plant shall also be equipped with an approved thermometric instrument placed at the discharge chute of the drier to indicate the temperature of the heated aggregates.

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

(9) Dust collector. The plant shall be equipped with a dust collector to waste any material collected or to return all or any part of the material uniformly to the mixture as directed.

(10) Truck scales. Unless an automatic batching plant with automatic printers is used, the bituminous mixture shall be weighed on approved scales furnished by the contractor or on public scales at the contractor's expense. Scales shall be inspected for accuracy and sealed as often as the Resident Engineer deems necessary.

(11) Safety requirements. Adequate and safe stairways to the mixer platform and sampling points shall be provided, and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by suitable device to enable the Resident Engineer to obtain sampling and mixture temperature data. Means shall be provided to raise and lower scale calibration equipment, sampling equipment, and other similar equipment between the ground and the mixer platform. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded. Ample and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free of drippings from the mixing platform.

(12) Testing laboratory. The contractor or producer shall provide a testing laboratory for control and acceptance testing functions during periods of mix production, sampling, and testing and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.

(b) Requirements for Batching Plants.

(1) Weigh box or hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

(2) Bituminous control. The equipment used to measure the bituminous material shall be accurate to within ± 0.5 percent. The

bituminous material bucket shall be of a nontilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than three-fourths the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve(s), and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained, and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15 percent in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated, quick-acting nondrip charging valve located directly over the bituminous material bucket.

The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used per batch. The controls shall be constructed to lock at any dial setting and automatically reset to that reading after each additional batch of bituminous material. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled to begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has begun. The size and spacing of the spray-bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall have a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

(3) Mixer. The batch mixer shall be an approved type capable of producing a uniform mixture within the job mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust. The clearance of blades from all fixed and moving parts shall not exceed 1 inch.

(4) Control of mixing time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh-box gate after the charging of the mixer and keep it locked until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh-box gate and the introduction of bituminous material. The wet mixing period is the interval of time between the introduction of bituminous material and the opening of the mixer gate.

The timing control shall be flexible and shall be capable of settings of 5-second intervals or less throughout a 3-minute cycle. A mechanical batch counter shall be installed as a part of the timing device and shall be designed to register only completely mixed batches.

The setting of time intervals shall be at the direction of the Engineer who shall then lock the case covering the timing device until a change is made in the timing periods.

(c) Requirements for Continuous Mix Plants.

(1) Aggregate proportioning. The plant shall include means for accurately proportioning each size of aggregate.

The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for the volumetric measuring of material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means and provided with a lock.

Indicators shall be provided for each gate to show the respective gate opening in inches.

(2) Weight calibration of aggregate feed. The plant shall include a means for calibration of gate openings by weighing test samples. Provision shall be made so that materials fed out of individual orifices may be bypassed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples of not less than 200 pounds. Accurate scales shall be provided by the contractor to weigh such test samples.

(3) Synchronization of aggregate feed and bituminous material feed. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device. This control shall be by interlocking mechanical means or by any other positive method satisfactory to the Engineer.

(4) Mixer. The plant shall include an approved continuous mixer adequately heated and capable of producing a uniform mixture within the job mix tolerances. It shall be equipped with a discharge hopper with dump gates to permit rapid and complete discharge of the mixture. The paddles shall be adjustable for angular position on the shafts and shall be reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed per minute for each aggregate used.

(d) Requirements for Drum Mixers.

(1) Exclusions. Paragraphs 201-4.2(a) (4) through 201-4.2(a) (9) do not apply to drum mixers.

(2) Aggregate delivery system. An automatic plant shutoff shall be provided to operate when any aggregate bin becomes empty. Provisions shall be provided for conveniently sampling the full flow of materials from each cold feed and the total cold feed. Total cold feed shall be weighed continuously. The weighing system shall have an accuracy of 0.5 percent when tested for accuracy. The plant shall provide positive weight control of the cold aggregate feed by use of a belt scale, or other appropriate device, which will automatically regulate the feed gate and permit instant correction of variations in load. The cold feed flow shall be automatically coupled with the asphalt flow to maintain the required proportions of each material. Provisions shall be made for introducing the moisture content of the cold feed aggregates into the belt weighing signal and correcting wet aggregate weight to dry aggregate weight. Screens or other suitable devices which will reject oversize particles or lumps of aggregate that have been cemented together shall be installed in the feeder mechanism between the bins and the dryer drum.

Dry weight of the aggregate flow shall be displayed digitally in appropriate units of weight and time and totalized.

(3) Bituminous material and additive delivery systems. Satisfactory means of metering shall be provided to introduce the proper amount of bituminous material and additives into the mix. Delivery systems shall prove accurate to plus or minus 1 percent when tested for accuracy. The bituminous material and additive delivery shall be interlocked with the aggregate weight. The bituminous material and additive flow shall be displayed digitally in appropriate units of volume (or weight) and time shall be totalized.

(4) Thermometric equipment. A recording thermometer of adequate range shall be located to indicate the temperature of the bituminous material in storage. The plant shall also be equipped with approved recording thermometers, pyrometers, or other approved recording thermometric instruments at the discharge chute of the drum mixer.

(5) Drum mixer. A drum mixer of satisfactory design shall be provided. It shall be capable of drying and heating the aggregate to the moisture and temperature requirements set forth in the paving mixture requirements and capable of producing a uniform mixture. If the quality requirements of Section 201-3.2 cannot be met, the contractor will be required to utilize either batch or continuous mix plants.

(6) Temporary storage of bituminous mixture. Use of surge bins or storage bins for temporary storage of hot bituminous mixtures will be permitted as follows:

(a) The bituminous mixture may be stored in surge bins for a period of time not to exceed 3 hours.

(b) The bituminous mixture may be stored in insulated and heated storage bins for a period of time not to exceed 12 hours, provided an inert gas atmosphere is maintained in the bin during the storage period.

If the Engineer determines that there is an excessive amount of heat loss, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.

(e) Inspection of Plant. The Engineer or his authorized representative shall have access, at all times, to all parts of the paving plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking the temperatures maintained in the preparation of the mixtures.

201-4.3 HAULING EQUIPMENT. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds. To prevent the mixture from adhering to them, the beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, so that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

201-4.4 BITUMINOUS PAVERS. Bituminous pavers shall be self-contained, power-propelled units with an activated screed or strike-off assembly, heated if necessary, and shall be capable of spreading and finishing courses of bituminous plant mix material which will meet the specified thickness, smoothness, and grade. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the plans.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the screed

elevation as specified herein. The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

The controls shall be capable of working in conjunction with any of the following attachments, as specified by the Project Engineer:

- (a) Ski-type device of not less than 30 feet in length or as directed by the Engineer.
- (b) Taut stringline (wire) set to grade.
- (c) Short ski or shoe.

201-4.5 ROLLERS. Rollers may be of the vibratory, steel wheel, or pneumatic-tired type. They shall be in good condition, capable of reversing without backlash, and operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material.

201-4.6 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature. The temperature of the bituminous material delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed the applicable maximum temperature set forth in Table 1 and not be more than 25°F above the temperature of the aggregate as specified in Section 201-4.7.

201-4.7 PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be dried and heated to the temperature designated by the job formula within the job tolerance specified. The maximum temperature and rate of heating shall be such that no permanent damage occurs to the aggregates. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

201-4.8 PREPARATION OF BITUMINOUS MIXTURE. The aggregates and the bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula.

The combined materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate are secured. Wet mixing time shall be approved by the Engineer for each plant and for each type aggregate used. Normally, the mixing time after introduction of bituminous material should not be less than 30 seconds. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer.

$$\text{Mixing time (seconds)} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Pugmill output in pounds per second}}$$

201-4.9 TRANSPORTING, SPREADING, AND FINISHING. The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Section 201-4.3. Deliveries shall be scheduled so that spreading and rolling of all mixture prepared for one day's run can be completed during daylight, unless adequate artificial lighting is provided. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to atmospheric temperature.

Immediately before placing the bituminous mixture, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms, or hand brooms as directed.

The mix shall be placed at a temperature of not less than 275° F. Moisture content of the mix shall not exceed 0.5 percent.

Upon arrival, the mixture shall be spread to the full width by an approved bituminous paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and shall conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the bituminous mat. Unless otherwise directed, placing shall begin along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet, except where edge lanes require strips less than 10 feet to complete the area. The longitudinal joint in one layer shall offset that in the layer immediately below by at least 1 foot; however, the joint in the top layer shall be at the centerline of the pavement. Transverse joints in one layer shall be offset by at least 2 feet from transverse joints in the previous layer. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread, raked, and luted by hand tools.

201-4.10 COMPACTION OF MIXTURE. After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers as directed by the Resident Engineer. Rolling of the mixture shall begin as soon after spreading as it will bear the roller without undue displacement or hair checking. On the first strip spread, rolling shall start at the low edge and progress toward the high edge. When adjoining lanes are placed, the same rolling procedure should be followed, but only after compaction of fresh mix at the longitudinal joint with 6 to 8 inches of the vibrating roller width overlapping on the previously compacted lane. If a static roller is being used, 6 to 8 inches should be on the fresh mix at the longitudinal joint with the remainder of the roller width on the previously compacted lane.

Initial rolling shall be done longitudinally. The rollers shall overlap on successive trips. Alternate trips of the roller shall be of slightly different lengths, and cross rolling shall not exceed more than one half the width of the pavement on crowned sections. The speed of the roller shall, at all times, be slow to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by rakes and fresh mixture.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until all roller marks are eliminated, the surface of uniform texture and true to grade and cross section, and a density of at least 99% of target density is obtained.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers.

Any mixture which becomes loose and broken, mixed with dirt, or in any way defective prior to the application of the finish coat shall be removed and replaced with fresh hot mixture and immediately compacted to conform with the surrounding area. This shall be done at the contractor's expense.

201-4.11 JOINTS. The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture, density, and smoothness as other sections of the course.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical face. In both methods all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

Longitudinal joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be given a tack coat of bituminous material prior to placing any fresh mixture against the joint.

201-4.12 SHAPING EDGES. While the surface is being compacted and finished, the contractor shall carefully trim the outside edges of the pavement to the proper alignment. Edges so formed shall be beveled while still hot with the back of a rake or a smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.

201-4.13 ACCEPTANCE TESTING OF BITUMINOUS MIXES FOR DENSITY. At the option of the Project Engineer, one of the following methods may be used to determine density of bituminous mixtures required by these Standard Specifications. A Troxler Nuclear Gauge or a model agreed to by the Engineer shall be used in the backscatter position on a one (1) minute setting in accordance with ASTM D 2950 or cores may be cut from the pavement to determine the density in accordance with ASTM D 2726.

This procedure will consist of constructing a test section for use with nuclear density testing equipment and the acceptance of density based on the parameters established herein. A correlation will be made between the nuclear readings and core densities in accordance with Section 3.2 of ASTM D 2950.

A test section shall be constructed at the beginning of the placement of each type and course of mix in accordance with Section 401-3.4 of these Specifications. The mix for each strip shall be placed and compacted according to the Standard Specifications and shall become part of the pavement provided the section meets the specification requirements.

The section shall be constructed and evaluated in accordance with the following procedure:

(a) Construction.

(1) The section shall be an area of approximately 400 square yards and shall be constructed to the nominal thickness shown on the plans.

(2) The mix shall be placed and compacted in accordance with applicable specification for each type of mix.

(3) Compaction of the section shall commence immediately after the course is placed and shall be continuous and uniform over the entire area. Compacting shall be continued until no discernible increase in density can be obtained by additional compactive efforts as indicated by random nuclear density readings.

(b) Mixture Parameters. Two or more random extraction samples shall be taken from within the test section, behind the paver, prior to compaction. These samples shall be extracted as soon as possible by the Project Engineer's personnel. The mean of the extractions shall be within the job mix tolerance for the section to be accepted.

(c) Target Density. Upon completion of the compaction, the Mean Target Density of the section will be determined by averaging the results of five (5) nuclear density tests or five (5) core tests taken at random from within the test section area. A Nuclear Density Test is the average of five (5) readings and a core test is a single core.

If the Mean Target Density is less than 97 percent of the maximum laboratory density (ASTM D 2726), or the mean of the extraction tests is not within the job mix tolerance, a new section shall be constructed meeting these requirements. The Engineer may allow any strips not meeting these requirements to remain in place.

The Mean Target Density of passing sections will be in effect for the remainder of the course and mix which it represents.

(d) Changes in Materials or Mixture. A new test section will be required for changes in materials in the mix and/or an appreciable change in the job mix formula. The Engineer or the contractor may require a new test section if there is reason to believe that the mixture being placed is not the same as the mixture used to determine the target density.

(e) Measurement of Compaction of Mixtures. Each lot shall be divided into four (4) sub-lots. Two (2) random nuclear density tests or cores shall be taken from within each sub-lot. The average of the two (2) tests shall be at least 99 percent of the mean target density established in the test section. If the density falls below this level, the contractor shall be required to provide additional compaction by modifying his rolling pattern and/or changing the number or types of rollers. A lot shall be defined as 1200 tons or one day's production, whichever is less.

Extraction tests for bitumen content and aggregate gradation will be made at least once daily. The mixture will be tested for bitumen content in accordance with ASTM D 2172 and for aggregate gradation in accordance with ASTM C 117 and C 136.

When the average density of any sub-lot of the pavement is less than 99% of mean target density, Table No. 7 will be applied to the tonnage represented by the deficient density test results.

201-4.14 SURFACE TESTS. Tests for conformity with the specified crown and grade shall be made by the contractor immediately after initial compression. Any variation shall be corrected by the removal or addition of materials and by continuous rolling.

The finished surface shall not vary more than 1/4 inch for the base course when tested with a 16-foot straightedge applied parallel with, or at right angles to, the centerline.

After the completion of final rolling, the smoothness of the course shall again be tested; humps or depressions exceeding the specified tolerances shall be immediately corrected by removing the defective work and replacing with new material, as directed by the Resident Engineer. This shall be done at the contractor's expense.

The finished surfaces of bituminous courses shall not vary from the gradeline, elevations, and cross sections shown on the contract drawings by more than 1/2 inch. The contractor shall correct pavement areas varying in excess of this amount by removing and replacing the defective work. Skin patching will not be permitted.

TABLE 7. SLIDING SCALE PAY FACTORS

Average Percent Mean Target Density	Recommended Percent Payment
99.0 and greater	100
98.0 - 98.9	98
97.0 - 97.9	95
96.0 - 96.9	85
95.0 - 95.9	75
Less than 95.0	reject

201-4.15 SAMPLING PAVEMENT. Samples for determination of thickness and density of completed pavements shall be obtained by the contractor at no extra cost. The size, number, and locations of the samples will be as directed by the Resident Engineer. Samples shall be neatly cut with a saw, core drill, or other approved equipment. The contractor shall furnish all tools, labor, and materials for cutting samples and replacing pavement.

All tests necessary to determine conformance with requirements specified herein will be performed without cost to the contractor.

METHOD OF MEASUREMENT

201-5.1 Plant mix bituminous base course will be measured by the ton. The tonnage shall be the weight used in the accepted pavement. No deduction will be made for the weight of bituminous material in the mixture. Plant batch weights will be accepted. Loads shall be checked periodically by weighing full truck loads of the bituminous mixture on an approved platform scale at the plant or on a commercial scale.

The contractor shall furnish approved duplicate load tickets upon which is recorded the net weight of the bituminous mixture in each truck. The load ticket shall have sufficient space for signatures, identification of the bituminous mixture, date of delivery, and any other data which the Project Engineer may require. The contractor shall submit one load ticket to the Project Engineer, or his duly authorized representative, at the plant after the truck is loaded and another load ticket to the Project Engineer, or his duly authorized representative, at the construction site when the truck load is incorporated into the pavement.

BASIS OF PAYMENT

201-6.1 The quantity of bituminous base course material determined, as provided in paragraph 5.1, shall be paid for at the contract unit price per ton, which price shall include the aggregate and bituminous materials, for furnishing, handling, mixing, hauling, and placing all materials; for all shaping, compacting and rolling; for furnishing certified scales; for all labor, equipment, and incidentals necessary to complete the item.

Payment will be made under:

Item 201-6.10 Bituminous Base Course - Per Ton.

ITEM 208 AGGREGATE BASE COURSE

DESCRIPTION

208-1.1 This item shall consist of a base course composed of crushed or partially crushed coarse aggregate bonded with fine aggregate. It shall be constructed on a prepared underlying course in accordance with these specifications and shall conform to the dimensions and typical cross section shown on the plans and with the lines and grades established by the Resident Engineer.

MATERIALS

208-2.1 PARTIALLY CRUSHED COARSE AGGREGATE. The base course material shall consist of hard, durable particles or fragments of stone or gravel mixed or blended with sand, stone dust, or other similar binding or filler materials produced from approved sources. All oversized stones, rocks and boulders occurring in the pit or quarry material shall be wasted; those of acceptable quality may be crushed and become a part of the base material, provided the blend meets the specified gradations. The aggregate shall be free from vegetation, lumps, or excessive amounts of clay and other objectionable substances. The coarse aggregate shall have a percent of wear not more than 45 at 500 revolutions as determined by ASTM C 131 (Los Angeles Rattler Test).

208-2.2 CRUSHED COARSE AGGREGATE. The aggregates shall consist of both fine and coarse fragments of crushed stone or crushed gravel mixed or blended with sand, screenings, or other similar approved materials. The crushed stone shall consist of hard, durable particles or fragments of stone and shall be free from excess flat, elongated, soft or disintegrated pieces, dirt, or other objectionable matter.

The crushed gravel shall consist of hard, durable stones, rock, and boulders crushed to specified size and shall be free from excess flat, elongated, soft or disintegrated pieces, dirt, or other objectionable matter. The method used in production of crushed gravel shall be such that the fractured particles occurring in the finished product shall be as nearly constant and uniform as practicable and shall result in at least the specified percentage of material retained on a No. 4 mesh sieve having one or more fractured faces.

If necessary to meet this requirement or to eliminate an excess of fine, uncrushed particles, the gravel shall be screened before crushing. All stones, rocks, and boulders of inferior quality in the pit shall be wasted.

The crushed coarse aggregate shall have a percent of wear not more than 50 at 500 revolutions as determined by ASTM C 131.

All material passing the No. 4 mesh sieve produced in the crushing operation of either stone or gravel shall be incorporated in the base material to the extent permitted by the gradation requirements.

208-2.3 GRADATION. The gradation of the partially crushed or crushed material shall meet the requirements of one of the gradations given in the following table when tested in accordance with ASTM C 117 and C 136.

TABLE 1. REQUIREMENTS FOR GRADATION OF AGGREGATE

Sieve designation (square openings)	Percentage by weight passing sieves		
	A	B	C
	2" max.	1-1/2" max.	1" max.
2 inch	100	-----	-----
1-1/2 inch	90-100	100	-----
1 inch	70-95	80-100	100
1/2 inch	45-75	55-80	65-95
No. 4	30-50	30-56	40-60
No. 16	15-35	10-40	15-45
No. 200	4-12	4-12	5-14
(IDOT Gradations)	(Mod. CA-4)	(Mod. CA-6)	(CA-10)

The gradations in the table represent the limits which shall determine suitability of aggregate for use from the sources of supply. The final gradations decided on within the limits designated in the table shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieves, or vice versa.

The amount of the fraction of material passing the No. 200 mesh sieve shall not exceed one-half the fraction passing the No. 40 mesh sieve.

The portion of the filler and binder, including any blended material, passing the No. 40 mesh sieve shall have a liquid limit not more than 25 and a plasticity index not more than 6 when tested in accordance with ASTM D 4318.

The selection of any of the gradations shown in the table shall be such that the maximum size aggregate used in any course shall be not more than two-thirds the thickness of the layer of the course being constructed.

208-2.4 FILLER FOR BLENDING. If filler, in addition to that naturally present in the base course material, is necessary for satisfactory bonding of the material, for changing the soil constants of the material passing the No. 40 mesh sieve, or for correcting the gradation to the limitations of the specified gradation, it shall be uniformly blended with the base course material at the crushing plant or at the mixing plant. The material for such purpose shall be obtained from sources approved by the Engineer and shall be of a gradation necessary to accomplish the specified gradation in the finally processed material.

The additional filler may be composed of sand, but the amount of sand shall not exceed 20% by weight of the total combined base aggregate. All the sand shall pass a No. 4 mesh sieve and not more than 5% by weight shall pass a No. 200 mesh sieve.

CONSTRUCTION METHODS

208-3.1 OPERATIONS IN PITS AND QUARRIES. All work involved in clearing and stripping pits and quarries, including handling of unsuitable material, shall be performed by the contractor. All material shall be handled in a manner that shall secure a uniform and satisfactory base product. The base course material shall be obtained from sources that have been approved.

208-3.2 EQUIPMENT. All equipment necessary for the proper construction of this work shall be on the project, in first-class working condition, and approved by the Resident Engineer before construction is permitted to start.

208-3.3 PREPARING UNDERLYING COURSE. The underlying course shall be checked and accepted by the Resident Engineer before placing and spreading operations are started. Any ruts or soft, yielding places due to improper drainage conditions, hauling, or any other cause, shall be corrected and rolled to the required density before the base course is placed thereon.

Grade control between the edges of the pavement shall be accomplished by grade stakes, steel pins, or forms placed in lanes parallel to the centerline of the pavement at intervals sufficiently close that string lines or check boards may be placed between the stakes, pins, or forms.

To protect the underlying course and to insure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

208-3.4 METHODS OF PRODUCTION.

(a) Plant Mix. When provided in the proposal, or when selected by the contractor and approved by the Engineer, the base material shall be uniformly blended or mixed in an approved plant. The mixing plant shall include bins for storage and batching of the aggregate, pump and tanks for water, and batch mixers of either the pugmill or drum type. All mineral aggregates shall be batched into the mixer by weight. The agitation shall be such that a thorough dispersion of moisture is obtained. The size of the batch and the time of mixing shall be fixed by the Engineer and shall produce the results and requirements specified. The base course material produced by combining two or more materials from different sources shall be mixed in a mixing plant described herein. The mixture material shall be at a satisfactory moisture content to obtain maximum density.

(b) Travel Plant. When the use of a traveling plant is allowed, the plant shall blend and mix the materials to meet these specifications. It shall accomplish a thorough mixing in one trip. The agitation shall be such that the dispersion of the moisture is complete. The machine shall move at a uniform rate of speed and this speed shall be regulated to fix the mixing time. If a windrow-type of travel plant is employed for mixing, the aggregate shall be placed in windrows parallel to the pavement centerline.

The windrow volume shall be sufficient to cover exact areas as planned. The windrow contents shall produce a mixture of the required gradation and bonding qualities. If a travel plant is used which is of the type that mixes previously spread aggregates in-place, the material shall have been spread in such thickness and proportions as may be handled by the machine to develop a base course of the thickness of each layer and of the gradation required. With either type of equipment, the mixed material shall be at a satisfactory moisture content to obtain the maximum density.

(c) Materials of Proper Gradation. When the entire base course material from coarse to fine is secured in a uniform and well-graded condition and contains approximately the proper moisture, such approved material may be handled directly to the spreading equipment. The material may be obtained from gravel pits, stockpiles, or produced from a crushing and screening plant with the proper blending. The materials from these sources shall meet the requirements for gradation, quality, and consistency. The intent of this section of these specifications is to secure materials that will not require further mixing. The base material shall be at a satisfactory moisture content to obtain maximum density. Any minor deficiency or excess of moisture may be corrected by

surface sprinkling or by aeration. In such instances some mixing or manipulation may be required immediately preceding the rolling to obtain the required moisture content. The final operation shall be blading or dragging, if necessary, to obtain a smooth uniform surface true to line and grade.

208-3.5 METHODS OF SPREADING.

(a) The aggregate base material that is correctly proportioned, or has been processed in a plant, shall be placed on the prepared underlying course and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material shall commence where designated and shall progress continuously without breaks. The material shall be deposited and spread in lanes in a uniform layer and without segregation of size to such loose depth that, when compacted, the layer shall have the required thickness. The base aggregate shall be spread by spreader boxes or other approved devices having positive thickness controls that shall spread the aggregate in the required amount to avoid or minimize the need for hand manipulation. Dumping from vehicles in piles which require rehandling shall not be permitted. Hauling over the uncompacted base course shall not be permitted.

(b) The aggregate base material that has been processed in a traveling plant shall be spread in a uniform layer of required depth and width and to the typical cross section. The spreading shall be by a self-powered blade grader, mechanical spreader, or other approved method. In spreading, care shall be taken to prevent cutting into the underlying layer. The material shall be bladed until a smooth, uniform surface is obtained, true to line and grade.

(c) The base course shall be constructed in a layer not less than 2-1/2 inches nor more than 4-1/2 inches of compacted thickness. The aggregate as spread shall be of uniform grading with no pockets of fine or coarse materials. The aggregate, unless otherwise permitted by the Resident Engineer, shall not be spread more than 2,000 square yards in advance of the rolling. Any necessary sprinkling shall be kept within these limits. No material shall be placed in snow or on a soft, muddy, or frozen course.

When more than one layer is required, the construction procedure described herein shall apply similarly to each layer.

The Resident Engineer shall make tests to determine the maximum density and the proper moisture content of the base material, and this information will be available to the contractor. The base material shall be at a satisfactory moisture content when rolling is started and any minor variation prior to or during rolling shall be corrected by sprinkling or by aeration if necessary.

During the mixing and spreading process, sufficient caution shall be exercised to prevent the incorporation of subgrade, subbase, or shoulder material in the base course mixture.

208-3.6 FINISHING AND COMPACTING. After spreading, the aggregate shall be thoroughly compacted by rolling. The rolling shall progress gradually from the sides to the center of the lane under construction, or from one side toward previously placed material by lapping uniformly each preceding rear-wheel track by one half the width of such track. The rolling shall continue until the entire area of the course has been rolled by the rear wheels. The rolling shall continue until the aggregate is thoroughly set, the interstices of the material reduced to a minimum, and until creeping of the material ahead of the roller is no longer visible. Rolling shall continue until the base material has been compacted to not less than 100% density as determined by the compaction control tests specified in Division VII. Blading and rolling shall be done alternately, as required or directed, to obtain a smooth, even, and uniformly compacted base.

The course shall not be rolled when the underlying course is soft or yielding or when the rolling causes undulation in the base course. When the rolling develops irregularities that exceed 3/8 inch when tested with a 16-foot straightedge, the irregular surface shall be loosened, refilled with the same kind of material as that used in constructing the course, and rolled again as required.

In areas inaccessible to rollers, the base course material shall be tamped thoroughly with mechanical tampers.

The sprinkling during rolling, if necessary, shall be in the amount and by equipment approved by the Resident Engineer.

208-3.7 SURFACE TEST. After the course has been completely compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified, reshaped, recompact, and otherwise manipulated as the Resident Engineer may direct until the required smoothness and accuracy are obtained. The finished surface shall not vary more than 3/8 inches from a 16-foot straightedge when applied to the surface parallel with, and at right angles to the centerline.

208-3.8 THICKNESS. The thickness of the base course shall be determined by depth tests or cores taken at intervals in such manner that each test shall represent no more than 400 square yards. When the base deficiency is more than 1/2 inch, the contractor shall correct such areas by scarifying, adding satisfactory base mixture, rolling, sprinkling, reshaping, and finishing in accordance with these specifications. The contractor shall replace, at his expense, the base material where borings have been taken for test purposes.

208-3.9 PROTECTION. Work on the base course shall not be accomplished during freezing temperatures nor when the subgrade is wet. When the aggregates contain frozen materials or when the underlying course is frozen, the construction shall be stopped.

Hauling equipment may be routed over completed portions of the base course, provided no damage results and provided that such equipment is routed over the full width of the base course to avoid rutting or uneven compaction. However, the Resident Engineer in charge shall have full and specific authority to stop all hauling over completed or partially completed base course when, in his opinion, such hauling is causing damage. Any damage resulting to the base course from routing equipment over the base course shall be repaired by the contractor at his own expense.

208-3.10 MAINTENANCE. Following the completion of the base course, the contractor shall perform all maintenance work necessary to keep the base course in a condition satisfactory for priming. After priming, the surface shall be kept clean and free from foreign material. The base course shall be properly drained at all times. If cleaning is necessary, or if the prime coat becomes disturbed, any work or restitution necessary shall be performed at the expense of the contractor.

Before preparations begin for the application of a surface treatment or for a surface course, the base course shall be allowed to partially dry until the average moisture content of the full depth of base is less than 80% of the optimum moisture of the base mixture. The drying shall not continue to the extent that the surface of the base becomes dusty with consequent loss of binder. If during the curing period, the surface of the base dries too fast, it shall be kept moist by sprinkling until such time as the prime coat is applied as directed.

METHOD OF MEASUREMENT

208-4.1 The quantity of aggregate base course to be paid for as required in the proposal shall be the number of tons of base course material placed, bonded, and accepted in the completed base course. The aggregate shall be weighed either at the place of loading in the trucks, at the place of unloading from the trucks, or at such other point that the Resident Engineer may designate. The contractor shall furnish approved duplicate load tickets upon which is recorded the net weight of the aggregates in each truck. The contractor shall submit one (1) load ticket to the Resident Engineer, or his duly authorized representative, at the job site when the truck load is incorporated into the base. If at the time

the aggregates are weighed they contain more than three (3) per cent of absorbed and free moisture by weight, a deduction for the moisture in excess of this amount shall be made in determining the pay quantity.

The contractor shall furnish or arrange for the use of scales of a type approved by the Resident Engineer.

BASIS OF PAYMENT

208-5.1 Payment shall be made at the contract unit price per ton for aggregate base course. This price shall be full compensation for furnishing all materials and for all operations, hauling, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 208-5.10 Aggregate Base Course - per ton.

ITEM 209 CRUSHED AGGREGATE BASE COURSE

DESCRIPTION

209-1.1. This item shall consist of a base course composed of crushed aggregates constructed on the prepared underlying course in accordance with these specifications and shall conform to the dimensions and typical cross section shown on the plans and with the lines and grades established by the Resident Engineer.

MATERIALS

209-2.1. The aggregate shall be crushed stone. The fine aggregate shall be screenings obtained from crushed stone.

The crushed stone shall consist of hard, durable particles or fragments of stone, free from dirt or other objectionable matter, and shall contain not more than 8% of flat, elongated, soft, or disintegrated pieces.

The crushed aggregate shall have a percent of wear not more than 45 at 500 revolutions, as determined by ASTM C 131 (Los Angeles Rattler Test).

The crushed aggregate shall not show evidence of disintegration nor show a total loss greater than 15% when subjected to 5 cycles of the sodium sulphate accelerated soundness test using ASTM C 88.

All material passing the No. 4 mesh sieve produced in the crushing operation of the stone shall be incorporated in the base material unless there is an excessive amount which, if included, would not meet the gradation requirements.

The crushed aggregate shall meet the requirements of one of the gradations given in the following table when tested in accordance with ASTM C 117 and C 136.

TABLE 1. REQUIREMENTS FOR GRADATION OF AGGREGATE

Sieve designation (square openings)	Percentage by weight passing sieves		
	A	B	C
	2" max.	1-1/2" max.	1" max.
2 inch	100	-----	-----
1-1/2 inch	90-100	100	-----
1 inch	70-95	80-100	100
1/2 inch	45-75	55-80	65-95
No. 4	30-50	30-56	40-60
No. 16	15-35	10-40	15-45
No. 200	4-12	4-12	5-14
(IDOT Gradations)	(Mod. CA-4)	(Mod. CA-6)	(CA-10)

The gradations in the table represent the limits which shall determine suitability of aggregate for use from the sources of supply. The final gradations decided on within the limits designated in the table shall be wellgraded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieves or vice versa.

The amount of the fraction of material passing the No. 200 mesh sieve shall not exceed one half the fraction passing the No. 40 mesh sieve.

The portion of the base aggregate, including any blended material, passing the No. 40 mesh sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 6 when tested in accordance with ASTM D 4318.

The selection of any of the gradations shown in the table shall be such that the maximum size aggregate used in any course shall not be more than two thirds the thickness of the layer of course being constructed.

209-2.2 ADDITIONAL FINE MATERIAL. If additional fine material, in excess of that naturally present in the base course material, is necessary for correcting the gradation to the limitations of the specified gradation, or for the satisfactory bonding of the base material, or for changing the soil constants of the material passing the No. 40 mesh sieve, it shall be uniformly blended and mixed with the base course material at the crushing plant or by an approved plant.

There shall be no reworking of the base course material in-place to obtain the specified gradation. The additional fine material for this purpose shall be obtained from the crushing of stone, and when used, shall be of a gradation as necessary to accomplish the specified gradation in the final mixed base course material.

CONSTRUCTION METHODS

P-209-3.1 OPERATION AT SOURCES OF SUPPLY. All work involved in clearing and stripping of quarries and pits, including the handling of unsuitable material, shall be performed by the contractor at his own expense. The base material shall be obtained from approved sources. The material shall be handled in a manner that shall secure a uniform and satisfactory product.

209-3.2 EQUIPMENT. All equipment necessary for the proper construction of this work shall be on the project, in first-class working condition, and approved by the Resident Engineer before construction is permitted to start.

209-3.3 PREPARING UNDERLYING COURSE. The underlying course shall be checked and accepted by the Resident Engineer before placing and spreading operations are started. Any ruts or soft, yielding places caused by improper drainage conditions, hauling, or any other cause, shall be corrected and rolled to the required compaction before the base course is placed thereon.

Grade control between the edges of the runways shall be accomplished by grade stakes, steel pins, or forms placed in lanes parallel to the centerline of the pavement and at intervals sufficiently close that string lines or check boards may be placed between the stakes, pins, or forms.

To protect the underlying course and to insure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

209-3.4 PLANT MIX. The base material shall be uniformly blended during crushing operations or mixed in an approved plant. The type of plant may be either a central proportioning and mixing plant or a traveling plant. The plant shall blend and mix the materials to meet these specifications and to secure the proper moisture content for compaction.

209-3.5 PLACING AND SPREADING.

(a) Central Plant. The crushed aggregate base material that has been proportioned in a crushing and screening plant, or proportioned and processed in a central mixing plant, shall be placed on the prepared

underlying course and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material shall commence where designated and shall progress without breaks. The material shall be deposited and spread in lanes in a uniform layer and without segregation of size to such loose depth that, when compacted, the layer shall have the required thickness. The base aggregate shall be spread by spreader boxes or other approved devices or methods that shall spread the aggregate in the required amount to avoid or minimize the need for rehandling the material and to prevent the rutting of the underlying course. The spreader boxes or other devices shall be equipped with strike-off templates or screeds that can be adjusted or controlled to secure the required thickness of the material. Dumping from vehicles in piles on the underlying course which will require rehandling shall not be permitted. Hauling over the uncompacted base course shall not be permitted.

(b) Traveling Plant. If a traveling plant is used for mixing, the base material shall be placed on the underlying course in such condition to provide a base mixture conforming to the specified gradation and moisture content, and in such quantity to develop the thickness of the layer of the base and the density after compaction. The material shall be shaped to a uniform section. The Resident Engineer shall examine the mixture to determine that the mixing is complete and satisfactory and that the proper moisture content is maintained before compaction is started. No spreading shall be done except when authorized. Care shall be taken that no material from the underlying course is mixed with the base material.

If necessary, the base course shall be bladed until a smooth, uniform surface is obtained that is true to line, grade, and cross section and until the mix is in condition for compacting.

(c) Method of Placing. The base course shall be constructed in a layer not less than 2-1/2 inches nor more than 4-1/2 inches of compacted thickness. The aggregate, as spread, shall be of uniform gradation with no segregation or pockets of fine or coarse materials. Unless otherwise permitted by the Resident Engineer, the aggregate shall not be spread more than 2,000 square yards in advance of the rolling. Any necessary sprinkling shall be kept within these limits. No material shall be placed in snow or on a soft, muddy, or frozen underlying course.

When more than one layer is required, the construction procedure described herein shall apply similarly to each layer.

The Resident Engineer shall make tests to determine the maximum density and the proper moisture content of the base material, and this information will be available to the contractor. The base material shall have a satisfactory moisture content when rolling is started, and any minor variations prior to or during rolling shall be corrected by sprinkling or aeration, if necessary.

During the placing and spreading, sufficient caution shall be exercised to prevent the incorporation of subgrade, subbase, or shoulder material in the base course mixture.

209-3.6 FINISHING AND COMPACTING. After spreading, the crushed aggregate shall be thoroughly compacted by rolling. The rolling shall progress gradually from the sides to the center of the lane under construction, or from one side toward previously placed material by lapping uniformly each preceding rear wheel track by one-half the width of such track. Rolling shall continue until the entire area of the course has been rolled by the rear wheels. The rolling shall continue until the stone is thoroughly set, the interstices of the material reduced to a minimum, and until creeping of the stone ahead of the roller is no longer visible. Rolling shall continue until the base material has been compacted to not less than 100% density, as determined by the compaction control tests specified in Division VII. Blading and rolling shall be done alternately, as required or directed, to obtain smooth, even, and uniformly compacted base.

The course shall not be rolled when the underlying course is soft or yielding or when the rolling causes undulation in the base course. When the rolling develops irregularities that exceed 3/8 inch when tested with a 16-foot straightedge, the irregular surface shall be loosened, refilled with the kind of material as that used in constructing the course, and rolled again as required.

In areas inaccessible to rollers, the base course material shall be tamped thoroughly with mechanical tampers.

The sprinkling during rolling, if necessary, shall be in the amount and by equipment approved by the Resident Engineer.

209-3.7 SURFACE TEST. After the course has been completely compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified, reshaped, recompact, and otherwise manipulated as the Resident Engineer may direct until the required smoothness and accuracy are obtained. The finished surface shall not vary more than 3/8 inch from a 16-foot straightedge when applied to the surface parallel with, and at right angles to, the centerline.

209-3.8 THICKNESS. The thickness of the base course shall be determined by depth tests or cores taken at intervals in such a manner that each test shall represent no more than 400 square yards. When the base deficiency is more than 1/2 inch, the contractor shall correct such areas by scarifying, adding satisfactory base mixture, rolling, sprinkling, reshaping, and finishing in accordance with these specifications. The contractor shall replace, at his expense, the base material where borings have been taken for test purposes.

209-3.9 PROTECTION. Work on the base course shall not be accomplished during freezing temperatures nor when the subgrade is wet. When the aggregates contain frozen materials or when the underlying course is frozen, the construction shall be stopped.

Hauling equipment may be routed over completed portions of the base course, provided no damage results and provided that such equipment is routed over the full width of the base course to avoid rutting or uneven compaction. However, the Resident Engineer in charge shall have full and specific authority to stop all hauling over completed or partially completed base course when, in his opinion, such hauling is causing damage. Any damage resulting to the base course from routing equipment over the base course shall be repaired by the contractor at his own expense.

209-3.10 MAINTENANCE. Following the completion of the base course, the contractor shall perform all maintenance work necessary to keep the base course in a condition satisfactory for priming. After priming, the surface shall be kept clean and free from foreign material. The base course shall be properly drained at all times. If cleaning is necessary, or if the prime coat becomes disturbed, any work or restitution necessary shall be performed at the expense of the contractor.

METHOD OF MEASUREMENT

209-4.1 The quantity of crushed aggregate base course to be paid for shall be the number of tons of material placed, bonded, and accepted in the completed base course. The aggregate shall be weighed either at the place of loading in the trucks, at the place of unloading from the trucks, or at such other point as the Resident Engineer may designate. The contractor shall furnish approved duplicate load tickets upon which is recorded the net weight of the aggregates in each truck. The contractor shall submit one (1) load ticket to the Resident Engineer, or his duly authorized representative, at the job site when the truck load is incorporated into the base. If at the time the aggregates are weighed they contain more than three (3) per cent of absorbed and free moisture by weight, a deduction for the moisture in excess of this amount shall be made in determining the pay quantity.

The contractor shall furnish or arrange for the use of scales of a type approved by the Resident Engineer.

BASIS OF PAYMENT

209-5.1 Payment shall be made at the contract unit price per ton for crushed aggregate base course. This price shall be full compensation for furnishing all materials and for all preparation, hauling, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 209-5.10 Crushed Aggregate Base - per ton.

ITEM 217 AGGREGATE-TURF PAVEMENT

DESCRIPTION

217-1.1 This item shall consist of an aggregate-turf pavement composed of a base course of soil-bound crushed stone or soil-bound crushed or uncrushed gravel, and a seedbed of suitable soil or combination of soil and aggregate, constructed on a prepared subgrade or a previously constructed underlying course in accordance with these specifications, and shall conform to the dimensions and typical cross section shown on the plans and with the lines and grades established by the Project Engineer.

This item may include the furnishing and applying of fertilizer, lime, topsoil, or other plant nutrients; the furnishing and planting of seed; and the furnishing and spreading of mulch. When any of these turfing materials are required, the quality, quantity, and construction methods shall be in accordance with applicable Turf Specifications. When turf is to be established, the seedbed soil or topsoil shall be a natural friable soil, possessing characteristics of the best locally obtainable soils, which can produce a fairly heavy growth of crops, grass, or other vegetation.

The prepared composite mixture of aggregates used for the base course shall be Type A or B of Table 1, or stabilizer aggregate of Table 2 mixed with in-place materials, whichever is specified in the bid schedule.

MATERIALS

217-2.1 STABILIZED MIXES. The designated stabilized base course mixtures shall conform to the following requirements.

Type A or B - The materials shall be natural or artificial mixtures of gravel or stone, and soil so proportioned as to meet the requirement specified. The aggregate shall consist of clean, hard durable particles of crushed or uncrushed gravel or stone, and shall be free from soft, thin, elongated, or laminated pieces, and vegetable or other deleterious substances.

The prepared composite mixture used shall meet one of the applicable gradation requirements as follows when tested in accordance with ASTM C 117 and C 136.

TABLE 1. REQUIREMENTS FOR GRADATION OF MIXTURE

Sieve designation (square openings)	Percentage by weight passing sieves		
	A	B	C
2 inch	----	----	100
1 inch	100	100	70-95
3/4 inch	----	70-100	----
No. 4	----	----	40-70
No. 10	60-90	40-70	32-60
No. 20	50-90	----	----
No. 40	40-75	20-45	20-40
No. 200	12-30	10-20	10-20

The fraction of the composite mixture passing the No. 200 mesh sieve shall be less than two-thirds of the fraction passing the No. 40 mesh sieve. The fraction passing the No. 40 mesh sieve shall have a liquid limit not greater than 30 and a plasticity index not greater than 8 when tested in accordance with ASTM D 423 and D 424.

217-2.2 STABILIZER AGGREGATE. When specified in the bid proposal, stabilizer aggregate conforming to one of the gradations specified in Table 2, when tested in accordance with ASTM C 136, shall be placed upon the existing soil or base course in the specified quantity per square yard. The aggregate shall be uniformly blended with the soil or base course material to the depth required or as shown on the plans. The aggregate shall consist of crushed stone, crushed or uncrushed gravel, and it shall have a percent of wear not more than 60 at 500 revolutions as determined by ASTM C 131 (Los Angeles Rattler Test). The aggregate shall be free from soft, thin, elongated, or laminated pieces, disintegrated material, or other deleterious substances.

Where sand, as existing subgrade or base, requires stabilization, it shall be secured by the addition of clay or lime rock. The operations of spreading and mixing shall be handled as stated under construction methods.

TABLE 2. REQUIREMENTS FOR GRADATION OF STABILIZER AGGREGATE

Sieve designation (square openings)	Percentage by weight passing sieves		
	D	E	F
2 inch	-----	100	-----
1-1/2 inch	100	-----	-----
1 inch	90-100	-----	-----
1/2 inch	-----	0-15	100
No. 4	20-50	-----	85-100
No. 10	0-10	-----	-----
No. 100	-----	-----	0-30

CONSTRUCTION METHODS

217-3.1 OPERATION IN PITS. All work involved in clearing and stripping pits, including handling of unsuitable material, shall be performed by the contractor at his own expense. The base or binder material shall be obtained from approved sources. The material in the pits shall be excavated and handled in a manner that will secure a uniform and satisfactory product.

217-3.2 EQUIPMENT. All equipment necessary for the proper construction of this work shall be on the project in first-class working condition and approved by the Engineer before construction is permitted to start.

217-3.3 PREPARING SUBGRADE. Before any base course material is placed, the subgrade or underlying course shall be prepared and conditioned as specified. The underlying course shall be checked and accepted by the Engineer before placing and spreading operations are started.

Grade control between the edges of the pavement shall be accomplished by grade stakes, steel pins, or forms placed in lanes parallel to the centerline of the pavement and at intervals sufficiently close that string lines or check boards may be placed between the stakes, pins, or forms.

To protect the underlying course and to insure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

217-3.4 PLACING MATERIALS.

(a) All new material shall be placed on the prepared course and compacted in layers of the thickness shown on the plans. The depositing and spreading of the material on the

prepared and completed layer shall commence where designated and shall progress without breaks. The material shall be deposited and spread in lanes in a uniform layer and without segregation of size to such loose depth that, when compacted, the layer will have the required thickness. The material shall be spread with approved equipment. When it is necessary to combine materials from different sources, it may be done either at the pits, in a processing plant prior to delivery of the material, or on the course in the proper proportions and in successive spreadings that give the required gradation and thickness of layer. If the combining is done on the course, the mixing shall be as specified hereinafter.

(b) When it is necessary to blend new material with material on the existing surface, the existing surface shall first be scarified lightly and bladed to uniform grade and cross section as shown on the plans. After blading, and when necessary, the existing surface shall be further scarified and/or pulverized to provide sufficient loose material of the required depth to be mixed with the added material.

217-3.5 SPREADING AND MIXING.

(a) Materials that have been mixed and processed in a processing plant at the pits, or elsewhere, shall be delivered and spread by specified equipment to the required depth.

(b) Following the placing of the required materials being combined on the base course, the total base material shall be thoroughly pulverized and mixed by approved rotary-pulverizing mixers. The moisture content of the aggregate and soil binder shall be as specified by the Project Engineer to secure thorough mixing and the required compaction. The mixing shall produce a homogeneous mass of the specified gradation and soil characteristics to form a base course of the desired qualities. When the mixing is completed, the material shall be spread in a uniform layer which, when compacted, shall meet the requirements for thickness and typical cross section.

217-3.6 ROLLING. Immediately following final spreading, the material shall be compacted to full width by rolling with approved compacting equipment. Rolling shall progress gradually from the sides to the center of the lane under construction, or from one side toward previously placed material, and shall continue until the entire surface has been rolled and compacted. Rolling shall continue until the base material has been compacted to 70 to 90% density as determined by the compaction control test specified in Division VII.

Any irregularities or depressions that develop under rolling shall be corrected by loosening the material at these places and adding or removing materials until the surface is smooth and uniform.

217-3.7 SURFACE TEST, THICKNESS, AND MAINTENANCE. The surface shall not deviate more than 1/2 inch when tested with a 16-foot straightedge applied parallel with, and at right angles to, the centerline. Any deviation in excess of this amount shall be corrected by loosening, adding, or removing material, reshaping, and recompacting.

The thickness of the base course shall be determined by depth tests or cores taken at intervals in such manner that each test shall represent not more than 500 square yards. When the base deficiency exceeds 1/2 inch, it shall be corrected. The contractor shall replace, at his expense, the base material where borings have been taken for test purposes.

The surface of the base course shall be maintained and kept in a well drained condition until the construction of another course. Sprinkling, blading, and rolling shall be performed when necessary to prevent the base material from becoming unbonded.

217-3.8 TURF-SURFACING. Following the construction of the soil-aggregate base, the contractor shall prepare the seedbed for the turf. If topsoil is to be placed, the surface of the base course shall be loosened slightly, as directed by the Resident Engineer. If seeding is to be done without topsoiling, the surface of the base shall be loosened sufficiently to prepare a seedbed. This can be accomplished by discing, harrowing, rotary-tilling, or other approved methods, and should be to a depth not less than 1 inch nor greater than 3 inches. Any topsoil shall be spread to the depth as required. The seedbed preparation, applying lime, fertilizer and water, seeding, rolling and mulching, shall be performed in accordance with the respective turfing specification requirements.

METHOD OF MEASUREMENT

217-4.1 The quantities of aggregate-turf pavement base course to be paid for shall be the number of square yards of material placed, bonded, and accepted in the completed base course. The quantity shall be measured in final position of the completed work.

BASIS OF PAYMENT

217-5.1 Payment shall be made at the contract unit price per square yard for Aggregate-Turf Pavement. This price shall be full compensation for furnishing all stabilizer aggregate, the conditioning

operation, topsoiling, liming, fertilizing, seeding, watering, mulching and for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 217-5.10 Aggregate-Turf Pavement
-- per square yard.

RIGID BASE COURSE

ITEM 304 CEMENT TREATED BASE COURSE

(Plant Mixed)

DESCRIPTION

304-1.1 This item shall consist of furnishing, mixing, spreading, shaping, and compacting mineral aggregate, cement, and water in accordance with the requirements of this specification and shall conform to the dimensions and typical cross sections shown on the plans and to the lines and grades established by the Resident Engineer.

Runway, taxiway, or apron pavements shall be built in a series of parallel lanes 20 to 30 feet wide. Longitudinal construction joints shall be formed by temporary forms set firmly to the required grade to permit thorough compaction and finishing operations to proceed along their length. The side forms shall be removed before the adjoining lanes are constructed.

MATERIALS

304-2.1 PORTLAND CEMENT. Portland cement shall be a standard brand and shall conform to the requirements specified in ASTM C 150 for the type specified. Air-entrained portland cement shall conform to the requirements of ASTM C 150 for the type specified.

Contractors may use bulk cement, subject to the Engineer's approval of the apparatus for handling, weighing, applying the cement, and performance.

304-2.2 WATER. The water for the base course shall be clean, clear, and free from injurious amounts of sewage, oil, acid, strong alkalies, or vegetable matter and it shall be free from clay or silt. If the water is of questionable quality, it shall be tested in accordance with the requirements of the applicable ASTM Part 31 tests as deemed necessary by the Engineer. Water known to be of potable quality may be used without testing.

304-2.3 AGGREGATE. The aggregate may be either crushed stone or crushed gravel. The fine aggregate shall be that naturally contained in the base course material. In addition, sand may be used as filler but shall not exceed 15% by weight of the total combined aggregates.

The crushed gravel shall consist of hard, durable stones, rocks, and boulders of accepted quality, crushed to specified sizes, and free from an excess of flat, elongated, soft or disintegrated pieces, dirt, or other objectionable matter. The method used in the production of crushed gravel shall be such that the finished product shall be as consistent as practicable. If necessary to meet this requirement or to eliminate an excess of fine particles, the gravel shall be screened before crushing. All stones, rock, and boulders of inferior quality shall be wasted.

The aggregate shall have a percent of wear not more than 45 at 500 revolutions as determined by ASTM C 131.

The aggregate shall show no evidence of disintegration nor show a total loss greater than 15% when subjected to 5 cycles of the sodium sulphate accelerated soundness test specified in ASTM C 88.

All material passing the No. 4 mesh sieve produced in the crushing operation of either the stone or gravel shall be incorporated in the base material to the extent permitted by the gradation requirement.

The aggregate shall meet the requirements given in Table 1 when tested in accordance with ASTM C 117 and C 136.

TABLE 1. REQUIREMENTS FOR GRADATION OF AGGREGATE

Sieve designation (square openings)	Percentage by weight passing sieves		
	A	B	C
max.	2" max.	1-1/2 max.	1"
2 inch	100	-----	-----
1-1/2 inch	90-100	100	-----
1 inch	70-95	80-100	100
1/2 inch	45-75	55-80	65-95
No. 4	30-50	30-56	40-60
No. 16	15-35	10-40	15-45
No. 200	4-12	4-12	5-14
(IDOT Gradations)	(Mod. CA-4)	(Mod. CA-6)	(CA-10)

The gradations in the table represent the limits which shall determine suitability of aggregate for use from the sources of supply. The final gradations decided on, within the limits designated in the table, shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieves, or vice versa. The

amount of the fraction of material passing the No. 200 mesh sieve shall not exceed one-half the fraction passing the No. 40 mesh sieve.

The portion of the base aggregate, including any blended material, passing the No. 40 mesh sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than 6 when tested in accordance with ASTM D 423 and D 424.

304-2.4 BITUMINOUS MATERIAL. The types, grades, controlling specifications, and application temperatures for the bituminous materials used for curing the cement-treated base course are given below. The Project Engineer shall designate the specific material to be used.

Type & Grade	Specification	Application Temperature
Cutback asphalt		
RC-70	ASTM D 2028	120°--160°F.
RC-250	ASTM D 2028	160°--200°F.
Emulsified asphalt		
RS-1, RS-2K	Fed.Spec.SS-A-674	75°--130°F.

LABORATORY TESTS AND CEMENT CONTENT

304-3.1 CEMENT CONTENT. The quantity of cement, approximately 3 to 6% by weight to be used with the aggregate and water, shall be determined by tests for the materials submitted by the contractor.

304-3.2 LABORATORY TESTS. Specimens of aggregate, cement, and water must develop a compressive strength of at least 750 psi in 7 days. The specimens are to be subjected to 12 cycles of the wet-dry and the freeze-thaw tests in accordance with ASTM D 559 and D 560, respectively, for specimens when molded in accordance with Division VII of these specifications. The maximum weight loss of the specimens for either the wet-dry or the freeze-thaw shall be less than 15%.

CONSTRUCTION METHODS

304-4.1 WEATHER LIMITATIONS. The cement-treated base shall not be mixed or placed while the atmospheric temperature is below 40° F., or when conditions indicate that the temperature may fall below 40° F. within 24 hours, or when the weather is foggy or rainy. The temperature requirement may be waived only when so directed by the Engineer.

304-4.2 OPERATION AT PITS. All work involved in clearing and stripping pits, including handling unsuitable materials, shall be performed by the contractor. The contractor shall notify the Project Engineer sufficiently in advance of the opening of any designated pit to permit staking of boundaries at the site, to take elevations and measurements of the ground surface before any material is produced, to permit the Project Engineer to take samples of the material for tests to determine its quality and gradation, and to prepare a preliminary design of base mixture.

The pits, as utilized, shall be opened immediately to expose vertical faces of the various strata of acceptable material and, unless otherwise directed, the material shall be secured in successive vertical cuts extending through all the exposed strata in order to secure a uniform material.

304-4.3 EQUIPMENT. All methods employed in performing the work and all equipment, tools, other plants and machinery used for handling materials and executing any part of the work shall be subject to the approval of the Engineer before the work is started. If unsatisfactory equipment is found, it shall be changed and improved. All equipment, tools, machinery, and plants must be maintained in a satisfactory working condition.

304-4.4 FORMS. When forms are required, they shall be of metal and shall be placed to line and grade as staked by the Resident Engineer.

Steel forms shall be of a section commonly required for portland cement concrete pavement. They shall be of a depth at least equal to the edge thickness of the work prescribed. They shall be straight and shall have a minimum section length of 10 feet.

When directed by the Engineer, side forms will not be required. In such cases, the spreading equipment and supply of base mixture shall be such as will permit the continuous and satisfactory spreading of material for one or two-lane construction and compaction to the proper thickness and contour.

304-4.5 PREPARING UNDERLYING COURSE. The underlying course shall be checked and accepted by the Engineer before placing and spreading operations are started. Any ruts or soft, yielding places caused by improper drainage conditions, hauling, or any other cause, shall be corrected and rolled to the required compaction before the base course is placed thereon.

Grade control between the edges of the pavement shall be accomplished by grade stakes, steel pins, or forms placed in lanes parallel to the centerline of the runway and at intervals sufficiently close that string lines or check boards may be placed between the stakes, pins, or forms.

To protect the subbase and to insure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

304-4.6 MIXING.

(a) General Requirement. Cement-treated base shall be mixed at a central mixing plant by either batch or continuous mixing. The aggregates and cement may be proportioned either by weight or by volume.

Aggregates for the cement-treated base shall be separated into the sizes and each size shall be stored separately. One storage bin shall contain aggregate retained on a No. 4 sieve and not more than 15% shall be finer than a No. 4 sieve. The other storage bin shall contain aggregate finer than a No. 4 sieve. Additional breakdown in aggregate may be used at the option of the contractor with the approval of the Engineer.

In all plants, water shall be proportioned by weight or volume, and there shall be means by which the Resident Engineer may readily verify the amount of water per batch or the rate of flow for continuous mixing. The discharge of the water into the mixer shall not be started before part of the aggregate is placed into the mixer. The inside of the mixer shall be kept free from any hardened mix.

In all plants, cement shall be added in such a manner that it is uniformly distributed throughout the aggregates during the mixing operation.

The charge in a batch mixer, or the rate of feed into a continuous mixer shall not exceed that which will permit complete mixing of all the material. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected either by a reduction in the volume of material or by other adjustments.

(b) Batch Mixing. In addition to the "General Requirements" as provided in 304-4.6(a), batch mixing of the materials shall conform to the following requirements:

The mixer shall be equipped with a sufficient number of paddles of a type and arrangement to produce a uniformly mixed batch.

The mixer platform shall be of ample size to provide safe and convenient access to the mixer and other equipment. The mixer and batch-box housing shall be provided with hinged gates of ample size to permit easy sampling of the discharge of aggregate from each of the plant bins and of the mixture from each end of the mixer.

The mixer shall be equipped with a timing device which will indicate by a definite audible or visual signal the expiration of the mixing period. The device shall be accurate to within 2 seconds. The plant shall be equipped with a suitable automatic device for counting the number of batches.

The mixing time of a batch shall begin after all ingredients are in the mixer and shall end when the mixer is half emptied. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly coated aggregates of unchanging appearance is produced. In general, the time of mixing shall be not less than 30 seconds, except that the time may be reduced when tests indicate that the requirement for cement content and compressive strength can be consistently met.

(1) Weight proportioning. When weight proportioning is used, the discharge gate on the weigh box shall be arranged to blend the different aggregates as they enter the mixer.

(2) Volumetric proportioning. When volumetric proportioning is used for batch mixing, the volumetric proportioning device for the aggregate shall be equipped with separate bins, adjustable to size, for the various sizes of aggregates. Each bin shall have an accurately controlled gate or other device designed so that each bin shall be completely filled and accurately struck-off in measuring the volume of aggregate to be used in the mix. Means shall be provided for accurately calibrating the amount of material in each measuring bin.

(c) Continuous mixing. In addition to the "General Requirements" as provided in 304-4.6(a), continuous mixing of the materials shall conform to the following requirements:

The correct proportions of each aggregate size introduced into the mixer shall be drawn from the storage bins by a continuous feeder, which will supply the correct amount of aggregate in proportion to the cement and will be so arranged that the proportion of each aggregate size can be separately adjusted. The fine bin shall be equipped with a vibrating unit which will effectively vibrate the side walls of the bin and prevent any "hang up" of material while the plant is operating.

A positive signal system shall be provided to indicate the level of material in each bin, and as the level of material in any one bin approaches the strike-off capacity of the feed gate, the device shall automatically and instantly close down the plant. The plant shall not be permitted to operate unless this automatic signal is in good working condition.

The drive shaft on the aggregate feeder shall be equipped with a revolution counter accurate to 1/100 of a revolution and of sufficient capacity to register the total number of revolutions in a day's run.

The continuous feeder for the aggregate may be mechanically or electrically driven. Aggregate feeders that are mechanically driven shall be directly connected with the drive on the cement feeder.

Aggregate feeders that are electrically driven shall be actuated from the same circuit that serves the motor driving the cement feeder. An indicating frequency meter, reading to one fourth cycle, shall be installed at a convenient location in the circuit leading to the cement feeder motor. A voltage regulating transformer, controlling the current delivery to a maximum variation of 1% shall be installed in the circuit leading to the aggregate feeders; an indicated voltmeter graduated to 2-volt increments shall be installed. Current for operation of plants equipped with electrically actuated aggregate feeders shall not vary in frequency in excess of 1 cycle nor in voltage in excess of 10%.

All continuous mixing plants shall be equipped with a hopper of at least 20 cubic feet capacity which is divided into as many compartments as there are sizes of aggregate being proportioned. The hopper shall be suspended under the aggregate feeders, on a scale frame, in such a manner that the discharge from each aggregate feeder may be diverted into separate compartments in the hopper when the feeders are in full operation. The full weight of the loaded hopper shall be indicated on a springless, dial scale, not exceeding a 5,000-pound capacity, with 5-pound graduations. Each compartment of the hopper shall be equipped with a gate, so that each size aggregate may be withdrawn separately on a conveyor below the hopper, in order that the total weight of each size of aggregate may be determined and representative samples obtained. The material so withdrawn may be returned to storage.

The mixing time in a continuous mix plant shall be not less than 30 seconds, except that the time may be reduced when tests indicate that the requirement for cement content and compressive strength can be consistently met. To compute the mixing time in a continuous mixer, the weight of its contents at operating level is divided by the weight of the mixture delivered per second by the mixer:

$$\text{Mixing time in seconds} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Output in pounds per second}}$$

The pugmill for the continuous mixer shall be equipped with a surge hopper containing sufficient baffles and gates to prevent segregation of material discharged into the truck and to allow for closing of the hopper between trucks without requiring shut down of the plant.

304-4.7 PLACING. The use of mixers having a chute delivery shall not be permitted except as approved. In all such cases the arrangement of chutes, baffle plates, etc., shall insure the placing of the cement-treated base without segregation.

The prepared underlying course shall be free of all ruts or soft yielding places. The surface, if dry, shall be moistened but not to the extent of producing a muddy condition at the time the base mixture is placed.

Trucks for transporting the mixed base material shall be provided with protective covers. The material shall be spread on the prepared underlying course to such depth that, when thoroughly compacted, it will conform to the grade and dimensions shown on the plans. Not more than 30 minutes shall elapse between the time the base material is mixed and the time it is deposited in place.

The materials shall be spread by a spreader box, self-propelled spreading machine, or other method approved by the Engineer. It shall not be placed in piles or windrows. If spreader boxes or other spreading machines are used that do not spread the material the full width of the lane or the width being placed in one construction operation, a sufficient number of them shall be provided and operated in staggered formation to obtain full-width spreading. If, in the opinion of the Resident Engineer, full-width construction is undesirable due to inadequate equipment, operating difficulties, or climatic conditions, the base shall be constructed in partial widths. If the time elapsing between the placing of adjacent partial widths exceed 30 minutes, a construction joint satisfactory to the Resident Engineer shall be provided.

The equipment and methods employed in spreading the base material shall insure accuracy and uniformity of depth and width. If conditions arise where such uniformity in the spreading cannot be obtained, the Resident Engineer may require additional equipment or modification in the spreading procedure to obtain satisfactory results. Spreading equipment shall be not more than 30 feet nor less than 9 feet in width.

Immediately upon completion of the spreading operations, the base material shall be thoroughly compacted. Self-propelled rollers, in sufficient number, size, and type, shall be provided to obtain the specified results. Care shall be exercised in routing construction equipment to avoid the formation of unnecessary ridges due to wheel tracks or tractor treads. If necessary, the base material after compaction shall be trimmed by means of a self-propelled motor grader to the grade and section shown on the plans. All material loosened in

this operation shall be swept from the surface before any further rolling. Finishing operations shall continue until the surface is true to the specified cross section and until the surface shows no variations of more than 3/8 inch from a 16-foot straightedge laid in any location parallel with, or at right angles to, the longitudinal axis of the pavement.

It is the intent of this specification to secure the practical maximum weight of dry materials per cubic foot of compacted base material. In no case shall the weight of dry materials be less than 96% of the weight determined by the Engineer as agreeing with the standard density obtainable with the equipment and materials used. The field density shall be determined by methods described in the Compaction Control Tests contained in Division VII of these specifications. The base material shall be compacted immediately after spreading, and not more than 45 minutes shall elapse between the time of spreading and the completion of the final rolling to obtain maximum density.

No equipment or traffic which, in the opinion of the Resident Engineer, will damage the base course or the curing material shall be permitted on the finished base course during the 72-hour curing period.

304-4.8 CONSTRUCTION JOINTS. At the end of each day's run a transverse construction joint shall be formed by a header or by cutting back into the compacted material to form a true transverse vertical face. These faces shall be protected by banking damp earth against them or by other approved suitable methods.

The protection provided for construction joints shall permit the placing, spreading, and compacting of base material without injury to the work previously laid.

When a longitudinal construction joint is required in part-width construction, side forms shall be used or it shall be formed by cutting back into the compacted material to form a true vertical edge. Suitable curing shall be provided for any exposed longitudinal edge.

Care shall be exercised to insure thorough compaction of the base material immediately adjacent to all construction joints.

304-4.9 PROTECTION AND CURING. After the base course has been finished as specified herein, it shall be protected against drying for 7 days by the application of bituminous material or other acceptable methods. The curing method shall begin as soon as possible, but no later than 24 hours after the completion of finishing operations. The finished base course shall be kept continuously moist until the curing material is placed.

The bituminous material specified shall be uniformly applied to the surface of the completed base course at the rate of approximately 0.2 gallon per square yard using approved heating and distributing equipment. The exact rate and temperature of application to give complete coverage without excessive runoff shall be as specified.

At the time the bituminous material is applied, the surface shall be dense, free of all loose and extraneous material, and shall contain sufficient moisture to prevent penetration of the bituminous material. Water shall be applied in sufficient quantity to fill the surface voids immediately before the bituminous curing material is applied.

Should it be necessary for construction equipment or other traffic to use the bituminous-covered surface before the bituminous material has dried sufficiently to prevent pickup, sufficient granular cover shall be applied before such use.

The curing material shall be maintained and applied as needed by the contractor during the 7-day protection period so that all of the base course shall be covered effectively during this period.

Finished portions of base course that are used by equipment in constructing an adjoining section shall be protected in such a manner to prevent equipment from marring or damaging the completed work.

When the air temperature may be expected to reach the freezing point, sufficient protection from freezing shall be given the base course for 7 days after its construction and until it has hardened.

Other curing materials such as moist straw or hay may be used upon approval. Upon completion of the curing period, the straw shall be removed and disposed of as directed by the Resident Engineer.

304-4.10 COLD WEATHER PROTECTION. During cold weather, when the air temperature may be expected to drop below 35° F., a sufficient supply of hay, straw, or other material suitable for cover and protecting previously placed material shall be provided at the site. Any base which has been damaged by freezing, or otherwise, shall be removed and replaced by the contractor at his own expense.

METHODS OF MEASUREMENTS

304-5.1. The quantity of one course, cement-treated base, to be paid for will be determined by measurement of the number of square yards of base actually constructed and accepted by the Engineer as complying with the plans and specifications.

BASIS OF PAYMENT

304-6.1. Payment shall be made at the contract unit price per square yard for cement-treated base course. This price shall be full compensation for furnishing all materials, and for all preparation, manipulation, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 304-6.10 Cement Treated Base Course -per sq. yd.

FLEXIBLE SURFACE COURSES

ITEM 401 BITUMINOUS SURFACE COURSE

(Central Plant Hot Mix)

DESCRIPTION

401-1.1. This item shall consist of a surface course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the plans.

Each course shall be constructed to the depth, typical section, or elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

MATERIALS

401-2.1 AGGREGATE. Aggregates shall consist of crushed stone with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 8 sieve shall be known as coarse aggregate, the portion passing the No. 8 sieve and retained on the No. 200 sieve as fine aggregate, and the portion passing the No. 200 sieve as mineral filler.

(a) Coarse Aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from adherent coatings of clay, organic matter, and other deleterious substances. It shall show no more wear than 45 percent when tested in accordance with ASTM C 131, nor shall the sodium sulfate soundness loss exceed 15 percent, or the magnesium soundness loss exceed 15 percent, after five cycles, when tested in accordance with ASTM C 88.

Crushed aggregate shall contain at least 75 percent by weight of crushed pieces having two or more fractured faces. The area of each face shall be equal to at least 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of fractures shall be at least 30 degrees to count as two fractured faces.

The aggregate shall not contain more than 8 percent, by weight, of flat or elongated pieces. A flat particle is one having a ratio of width to thickness greater than five; an elongated particle is one having a ratio of length to width greater than five.

(b) Fine Aggregate. Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing

stone that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls. The fine aggregate, including any blended filler, shall have a plasticity index of not more than six when tested in accordance with ASTM D 424, and a liquid limit of not more than 25 when tested in accordance with ASTM D 423.

If necessary to obtain the gradation of aggregate blend or workability, natural sand may be used. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification.

(c) Sampling and Testing. All aggregate samples required for testing shall be furnished by the contractor. ASTM D 75 shall be used in sampling coarse aggregate and fine aggregate, and ASTM C 183 shall be used in sampling mineral filler. All tests for initial aggregate submittals necessary to determine compliance with requirements specified herein will be made by the Engineer at no expense to the contractor. Costs for testing additional sources shall be borne by the contractor. Sampling will be observed and supervised by the Engineer. No aggregate shall be used in the production of mixtures without prior approval.

(d) Sources of Aggregates. Sources of aggregates shall be selected well in advance of the time the materials are required in the work. When the aggregates are obtained from a previously approved source or an existing source producing aggregates that has a satisfactory service record in airport bituminous pavement construction for at least five years, samples shall be submitted 14 days prior to start of production. An inspection of the producer's operation will be made by the Engineer. When new sources are to be developed, the contractor shall indicate the sources and shall submit a plan for operation 30 days in advance of starting production. Samples from test pits, borings, and other excavations shall be submitted at the same time. Approval of the source of aggregate does not relieve the contractor in any way of the responsibility for delivery at the job site of aggregates that meet the requirements specified herein.

(e) Samples of Aggregates. Samples of aggregates shall be furnished by the contractor at the start of production and at intervals during production of bituminous mixtures. The intervals and points of sampling will be designated by the Engineer. The samples will be the basis of approval of specific aggregates from the standpoint of the quality requirements of this section.

401-2.2 FILLER. If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242.

401-2.3 BITUMINOUS MATERIAL. The types, grades, and controlling specifications and maximum mixing temperatures for the bituminous materials are given in Table 1.

The contractor shall furnish vendor's certified test reports for each carload or equivalent of bitumen shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall be the basis for final acceptance.

TABLE 1. BITUMINOUS MATERIAL

Type & Grade	Specification	Maximum Mixing Temperature		
		°F	°C	
<u>Asphalt Cement</u>				
Penetration Grade	60-70	ASTM D 946	325	165
	85-100		325	165
	100-120		325	165
Viscosity Grade	AC-5	ASTM D 3381	325	165
	AC-10		325	165
	AC-20		325	165
Viscosity Grade	AR-2000	ASTM D 3381	325	165
	AR-4000		325	165
	AR-8000		325	165

COMPOSITION

401-3.1 COMPOSITION OF MIXTURE. The bituminous plant mix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula.

401-3.2 JOB MIX FORMULA. No bituminous mixture for payment shall be produced until a job mix formula has been approved by the Engineer. The contractor shall submit samples of the materials intended for use and the Project Engineer shall establish a satisfactory job mix formula. The formula shall be submitted in writing by the Project Engineer to the contractor and shall indicate the definite percentage of each sieve fraction of aggregate, the percentage of bitumen, and the recommended temperature of the completed mixture when discharged from the mixer.

The job mix formula for each mixture shall be in effect until modified in writing by the Project Engineer. Should a change in sources of materials be made, a new job mix formula shall be established before the new material is used.

The bituminous mixture shall be designed using the procedures contained in ASTM D 1559 and shall meet the criteria set forth in Tables 2 and 3.

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory screens, will conform to the gradation or gradations specified in Table 4, when tested in accordance with ASTM Standard C 136 (dry sieve only). The percentage by weight for the bituminous material shall be within the limits specified.

TABLE 2. MARSHALL DESIGN CRITERIA

	OVER 60,000 LB.	UNDER 60,000 LB. & 200,000 OPERATIONS/YR.
Number of Blows	75	50
Stability, minimum pounds (newtons)	1800*	1000*
Flow, 0.01 in. (0.25 mm)	8-16	8-18
Percent air voids	2-3	2-3
Percent voids in mineral aggregate	See Table 3	See Table 3

*NOTE: If the stability exceeds 3,000 lbs., the mix shall be re-evaluated.

TABLE 3. MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE

U. S. A. Standard Sieve Designation in.	Nominal Maximum Particle Size in.	Minimum Voids in Mineral Aggregate percent
1/2	0.500	15
3/4	0.750	14
1	1.000	13

TABLE 4. AGGREGATE-BITUMINOUS SURFACE COURSE

Percentage by Weight Passing Sieves			
Sieve Size	Gradation A 1"maximum	Gradation B 3/4"maximum	Gradation C 1/2"maximum
1 in.	100	---	---
3/4 in.	84-100	100	---
1/2 in.	64-86	81-100	100
3/8 in.	55-78	70-90	79-99
No. 4	40-62	47-73	56-76
No. 8	28-50	30-60	40-60
No. 16	22-43	22-47	28-46
No. 30	17-32	17-34	20-36
No. 100	6-16	6-16	7-17
No. 200	3-8	3-8	3-8
Bitumen %:			
Stone	4.5-7.0	5.0 - 7.0	5.0 - 7.0

NOTE: Gradation C is to be used for leveling courses only.

The gradations in Table 4 represent the limits which shall determine the suitability of aggregate for use from the sources of supply. The selection of any of the gradations shown in Table 4 shall be such that the maximum size aggregate used shall not be more than one-half of the thickness of the layer of the course being constructed. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 4 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

The course and fine aggregate gradations specified in the Illinois Division of Highways Specifications for Road and Bridge Construction, current edition, may be blended to meet the job mix formula.

The job mix tolerances shown in Table 5 shall be applied to the job mix formula to establish a job control grading band. The full tolerances will only apply if application of the job mix tolerances results in a job control grading band inside the master grading band.

TABLE 5. JOB MIX FORMULA TOLERANCES
(Based on a Single Test)

Material	Tolerances Plus or Minus
Aggregate passing No. 4 sieve or larger	7 percent
Aggregate passing Nos. 8 and 16 sieves	5 percent
Aggregate passing Nos. 30 sieve	4 percent
Aggregate passing Nos. 100 and 200 sieves	2 percent
Bitumen	0.45 percent
Temperature of mixing and placing	20 degrees F.

The aggregate gradation may be adjusted within the limits of Table 4, as directed, without adjustments in the contract unit prices.

Should a change in sources of materials be made, a new job mix formula shall be established before the new material is used. Deviation from the final approved design for bitumen content and gradation of aggregates shall not be greater than the tolerances permitted and shall be based on daily plant extraction. The mixture will be tested for bitumen content in accordance with ASTM D 2172 and for aggregate gradation in accordance with ASTM C 117 and C 136.

If the index of retained strength of the specimens of composite mixture, as determined by ASTM D 1075, is less than 75, the aggregates shall be rejected or the asphalt shall be treated with an approved antistripping agent. The amount of antistripping agent added to the asphalt shall be sufficient to produce an index of retained strength of not less than 75.

401-3.3 BITUMINOUS AND AGGREGATE MATERIAL CONTRACTOR'S RESPONSIBILITY. Samples of the bituminous and aggregate materials that the contractor proposes to use, together with a statement of their source and character, shall be submitted to the Engineer; approval must be obtained before the use of such material begins. The contractor shall require the manufacturer or producer of the bituminous and aggregate

materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials that have demonstrated performance under the proposed design requirements will be accepted.

The Engineer or his authorized representative shall have access, at all times, to all parts of the paving plant for the purpose of inspecting equipment, conditions and operation of the plant, for verification of weights or proportions and character of materials, and to determine temperatures maintained in the preparation of the mixtures.

The contractor shall furnish vendor's certified test reports for each carload or equivalent of bitumen shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All such test reports shall be subject to verification by testing samples of materials received for use on the project.

401-3.4 TEST SECTION. Prior to full production, the contractor shall prepare a quantity of bituminous mixture according to the job mix formula. The amount of mixture should be sufficient to construct a test section at least 400 square yards and shall be of the same depth specified for the construction of the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

The test section shall be part of the proposed work. If the test section should prove to be unsatisfactory, the necessary adjustments to the mix design, plant operation, and/or rolling procedures shall be made. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. When test sections do not conform to specification requirements, the pavement shall be removed and replaced at the contractor's expense. Full production shall not begin without approval of the Engineer. Test sections will be paid for in accordance with Section 401-6.1.

CONSTRUCTION METHODS

401-4.1 WEATHER LIMITATIONS. The bituminous mixture shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 6. The temperature requirements may be waived, but only when so directed by the Engineer.

TABLE 6. BASE TEMPERATURE LIMITATIONS

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 in. or greater	40	4
Greater than 1 in. but less than 3 in.	45	7
1 in or less	50	10

No paving shall commence unless the ambient air temperature is 40°F. and rising. Paving shall halt when the ambient air temperature is 45°F. and falling.

401-4.2 BITUMINOUS MIXING PLANT. If the supplier is equipped with an automated plant the automation feature shall be used in the production of bituminous material for the project. If the supplier is equipped with a recordation feature, it also shall be used. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold elevator feeding the drier. The storage yard shall be neat and orderly, and the separate stockpiles shall be readily accessible for sampling.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (a), except that scale requirements shall apply only where weight proportioning is used. In addition, batch mixing plants shall conform to the requirements under (b), continuous mixing plants shall conform to the requirements under (c), and drum mixers shall conform to the requirements under (d).

(a) Requirements for All Plants. Mixing plants shall be of sufficient capacity to adequately handle the proposed bituminous construction.

(1) Plant scales. Scales shall be accurate to 0.5 percent of the required load. Poises shall be designed to be locked in any position to prevent unauthorized change of position. In lieu of plant and truck scales, the contractor may provide an approved automatic printer system to print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load. Scales shall be inspected for accuracy and sealed as often as the Resident Engineer may deem necessary. The contractor shall have on hand not less than ten 50-pound weights for testing the scales.

(2) Equipment for preparation of bituminous material. Tanks for the storage of bituminous material shall be equipped to heat and hold the material at the required temperatures. Heating shall be accomplished by approved means so that flames will not contact the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring quantities and for sampling the material in the storage tanks.

(3) Cold feeders. The plant shall be provided with accurate mechanical or electrical means for uniformly feeding the aggregates into the drier to obtain uniform production and temperature. When added mineral filler is specified, a separate bin and feeder shall be furnished with its drive interlocked with the aggregate feeders.

(4) Drier. The plant shall include a drier(s) which continuously agitates the aggregate during the heating and drying process.

(5) Screens. Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided.

(6) Bins. The plant shall include storage bins of sufficient capacity to supply a mixer operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. When used, separate dry storage shall be provided for filler of hydrated lime, and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes of such size and at such location to prevent backup of material into the compartments or bins. Each compartment shall be provided with its individual outlet gate to prevent leakage. The gates shall cut off quickly and completely. Bins shall be constructed so that samples may be obtained readily. Bins shall be equipped with adequate tell-tale devices which indicate the position of the aggregates in the bins at the lower quarter points.

(7) Bituminous control unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the specified amount of bituminous material in the mix. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

(8) Thermometric equipment. An armored thermometer of adequate range shall be placed in the bituminous feed line at a suitable location near the charging valve of the mixer unit. The plant shall also be equipped with an approved thermometric instrument placed at the discharge chute of the drier to indicate the temperature of the heated aggregates.

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

(9) Dust collector. The plant shall be equipped with a dust collector to waste any material collected or to return all or any part of the material uniformly to the mixture as directed.

(10) Truck scales. Unless an automatic batching plant with automatic printers is used, the bituminous mixture shall be weighed on approved scales furnished by the contractor or on public scales at the contractor's expense. Scales shall be inspected for accuracy and sealed as often as the Resident Engineer deems necessary.

(11) Safety requirements. Adequate and safe stairways to the mixer platform and sampling points shall be provided, and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by suitable device to enable the Resident Engineer to obtain sampling and mixture temperature data. Means shall be provided to raise and lower scale calibration equipment, sampling equipment, and other similar equipment between the ground and the mixer platform. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded. Ample and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free of drippings from the mixing platform.

(12) Testing laboratory. The contractor or producer shall provide a testing laboratory for control and acceptance testing functions during periods of mix production, sampling, and testing and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.

(b) Requirements for Batching Plants.

(1) Weigh box or hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

(2) Bituminous control. The equipment used to measure the bituminous material shall be accurate to within ± 0.5 percent. The bituminous material bucket shall be of a nontilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than three-fourths the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve(s), and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained, and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15 percent in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated, quick-acting nondrip charging valve located directly over the bituminous material bucket.

The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used per batch. The controls shall be constructed to lock at any dial setting and automatically reset to that reading after each additional batch of bituminous material. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled to begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has begun. The size and spacing of the spray-bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall have a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

(3) Mixer. The batch mixer shall be an approved type capable of producing a uniform mixture within the job mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust. The clearance of blades from all fixed and moving parts shall not exceed 1 inch.

(4) Control of mixing time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh-box gate after the charging of the mixer and keep it locked until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh-box gate and the introduction of bituminous material. The wet mixing period is the interval of time between the introduction of bituminous material and the opening of the mixer gate.

The timing control shall be flexible and shall be capable of settings of 5-second intervals or less throughout a 3-minute cycle. A mechanical batch counter shall be installed as a part of the timing device and shall be designed to register only completely mixed batches.

The setting of time intervals shall be at the direction of the Engineer who shall then lock the case covering the timing device until a change is made in the timing periods.

(c) Requirements for Continuous Mix Plants.

(1) Aggregate proportioning. The plant shall include means for accurately proportioning each size of aggregate.

The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for the volumetric measuring of material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means and provided with a lock.

Indicators shall be provided for each gate to show the respective gate opening in inches.

(2) Weight calibration of aggregate feed. The plant shall include a means for calibration of gate openings by weighing test samples. Provision shall be made so that materials fed out of individual orifices may be bypassed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples of not less than 200 pounds. Accurate scales shall be provided by the contractor to weigh such test samples.

(3) Synchronization of aggregate feed and bituminous material feed. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device. This control shall be by interlocking mechanical means or by any other positive method satisfactory to the Engineer.

(4) Mixer. The plant shall include an approved continuous mixer adequately heated and capable of producing a uniform mixture within the job mix tolerances. It shall be equipped with a discharge hopper with dump gates to permit rapid and complete discharge of the mixture. The paddles shall be adjustable for angular position on the shafts and shall be reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed per minute for each aggregate used.

(d) Requirements for Drum Mixers.

(1) Exclusions. Paragraphs 401-4.2(a) (4) through 401-4.2(a) (9) do not apply to drum mixers.

(2) Aggregate delivery system. An automatic plant shutoff shall be provided to operate when any aggregate bin becomes empty. Provisions shall be provided for conveniently sampling the full flow of materials from each cold feed and the total cold feed. Total cold feed shall be weighed continuously. The weighing system shall have an accuracy of 0.5 percent when tested for accuracy. The plant shall provide positive weight control of the cold aggregate feed by use of a belt scale, or other appropriate device, which will automatically regulate the feed gate and permit instant correction of variations in load. The cold feed flow shall be automatically coupled with the asphalt flow to maintain the required proportions of each material. Provisions shall be made for introducing the moisture content of the cold feed aggregates into the belt weighing signal and correcting wet aggregate weight to dry aggregate weight. Screens or other suitable devices which will reject oversize particles or lumps of aggregate that have been cemented together shall be installed in the feeder mechanism between the bins and the dryer drum.

Dry weight of the aggregate flow shall be displayed digitally in appropriate units of weight and time and totalized.

(3) Bituminous material and additive delivery systems. Satisfactory means of metering shall be provided to introduce the proper amount of bituminous material and additives into the mix. Delivery systems shall prove accurate to plus or minus 1 percent when tested for accuracy. The bituminous material and additive delivery shall be interlocked with the aggregate weight. The bituminous material and additive flow shall be displayed digitally in appropriate units of volume (or weight) and time shall be totalized.

(4) Thermometric equipment. A recording thermometer of adequate range shall be located to indicate the temperature of the bituminous material in storage. The plant shall also be equipped with approved recording thermometers, pyrometers, or other approved recording thermometric instruments at the discharge chute of the drum mixer.

(5) Drum mixer. A drum mixer of satisfactory design shall be provided. It shall be capable of drying and heating the aggregate to the moisture and temperature requirements set forth in the paving mixture requirements and capable of producing a uniform mixture. If the quality requirements of Section 401-3.2 cannot be met, the contractor will be required to utilize either batch or continuous mix plants.

(6) Temporary storage of bituminous mixture. Use of surge bins or storage bins for temporary storage of hot bituminous mixtures will be permitted as follows:

(a) The bituminous mixture may be stored in surge bins for a period of time not to exceed 3 hours.

(b) The bituminous mixture may be stored in insulated and heated storage bins for a period of time not to exceed 12 hours, provided an inert gas atmosphere is maintained in the bin during the storage period.

If the Engineer determines that there is an excessive amount of heat loss, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.

(e) Inspection of Plant. The Engineer or his authorized representative shall have access, at all times, to all parts of the paving plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking the temperatures maintained in the preparation of the mixtures.

401-4.3 HAULING EQUIPMENT. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds. To prevent the mixture from adhering to them, the beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, so that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

401-4.4 BITUMINOUS PAVERS. Bituminous pavers shall be self-contained, power-propelled units with an activated screed or strike-off assembly, heated if necessary, and shall be capable of spreading and finishing courses of bituminous plant mix material which will meet the specified thickness, smoothness, and grade. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the plans.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture. If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the screed elevation as specified herein.

The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

The controls shall be capable of working in conjunction with any of the following attachments, as specified by the Project Engineer:

- (a) Ski-type device of not less than 30 feet in length or as directed by the Engineer.
- (b) Taut stringline (wire) set to grade.
- (c) Short ski or shoe.

401-4.5 ROLLERS. Rollers may be of the vibratory, steel wheel, or pneumatic-tired type. They shall be in good condition, capable of reversing without backlash, and operating at slow speeds to avoid displacement of the bituminous mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material.

401-4.6 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the bituminous material to the mixer at a uniform temperature. The temperature of the bituminous material delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed the applicable maximum temperature set forth in Table 1 and not be more than 25°F above the temperature of the aggregate as specified in Section 401-4.7.

401-4.7 PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be dried and heated to the temperature designated by the job formula within the job tolerance specified. The maximum temperature and rate of heating shall be such that no permanent damage occurs to the aggregates. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

401-4.8 PREPARATION OF BITUMINOUS MIXTURE. The aggregates and the bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job mix formula.

The combined materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate are secured. Wet mixing time shall be approved by the Engineer for each plant and for each type aggregate used. Normally, the mixing time after introduction of bituminous material should not be less than 30 seconds. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer.

$$\text{Mixing time (seconds)} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Pugmill output in pounds per second}}$$

401-4.9 TRANSPORTING, SPREADING, AND FINISHING. The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Section 401-4.3. Deliveries shall be scheduled so that spreading and rolling of all mixture prepared for one day's run can be completed during daylight, unless adequate artificial lighting is provided. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to atmospheric temperature.

Immediately before placing the bituminous mixture, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms, or hand brooms as directed.

The mix shall be placed at a temperature of not less than 275° F. Moisture content of the mix shall not exceed 0.5 percent.

Upon arrival, the mixture shall be spread to the full width by an approved bituminous paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and shall conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the bituminous mat. Unless otherwise directed, placing shall begin along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet, except where edge lanes require strips less than 10 feet to complete the area. The longitudinal joint in one layer shall offset that in the layer immediately below by at least 1 foot; however, the joint in the top layer shall be at the centerline of the pavement. Transverse joints in one layer shall be offset by at least 2 feet from transverse joints in the previous layer. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread, raked, and luted by hand tools.

401-4.10 COMPACTION OF MIXTURE. After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers as directed by the Resident Engineer. Rolling of the mixture shall begin as soon after spreading as it will bear the roller without undue displacement or hair checking. On the first strip spread, rolling shall start at the low edge and progress toward the high edge. When adjoining lanes are placed, the same rolling procedure should be followed, but only after compaction of fresh mix at the longitudinal joint with 6 to 8 inches of the vibrating roller width overlapping on the previously compacted lane. If a static roller is being used, 6 to 8 inches should be on the fresh mix at the longitudinal joint with the remainder of the roller width on the previously compacted lane.

Initial rolling shall be done longitudinally. The rollers shall overlap on successive trips. Alternate trips of the roller shall be of slightly different lengths, and cross rolling shall not exceed more than one half the width of the pavement on crowned sections. The speed of the roller shall, at all times, be slow to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by rakes and fresh mixture.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until all roller marks are eliminated, the surface of uniform texture and true to grade and cross section, and a density of at least 99% of target density is obtained.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers.

Any mixture which becomes loose and broken, mixed with dirt, or in any way defective prior to the application of the finish coat shall be removed and replaced with fresh hot mixture and immediately compacted to conform with the surrounding area. This shall be done at the contractor's expense.

401-4.11 JOINTS. The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture, density, and smoothness as other sections of the course.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical face. In both methods all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

Longitudinal joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be given a tack coat of bituminous material prior to placing any fresh mixture against the joint.

401-4.12 SHAPING EDGES. While the surface is being compacted and finished, the contractor shall carefully trim the outside edges of the pavement to the proper alignment. Edges so formed shall be beveled while still hot with the back of a rake or a smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.

401-4.13 ACCEPTANCE TESTING OF BITUMINOUS MIXES FOR DENSITY. At the option of the Project Engineer, one of the following methods may be used to determine density of bituminous mixtures required by these Standard Specifications. A Troxler Nuclear Gauge or a model agreed to by the Engineer shall be used in the backscatter position on a one (1) minute setting in accordance with ASTM D 2950 or cores may be cut from the pavement to determine the density in accordance with ASTM D 2726.

This procedure will consist of constructing a test section for use with nuclear density testing equipment and the acceptance of density based on the parameters established herein. A correlation will be made between the nuclear readings and core densities in accordance with Section 3.2 of ASTM D 2950.

A test section shall be constructed at the beginning of the placement of each type and course of mix in accordance with Section 401-3.4 of these Specifications. The mix for each strip shall be placed and compacted according to the Standard Specifications and shall become part of the pavement provided the section meets the specification requirements.

The section shall be constructed and evaluated in accordance with the following procedure:

(a) Construction.

(1) The section shall be an area of approximately 400 square yards and shall be constructed to the nominal thickness shown on the plans.

(2) The mix shall be placed and compacted in accordance with applicable specification for each type of mix.

(3) Compaction of the section shall commence immediately after the course is placed and shall be continuous and uniform over the entire area. Compacting shall be continued until no discernible increase in density can be obtained by additional compactive efforts as indicated by random nuclear density readings.

(b) Mixture Parameters. Two or more random extraction samples shall be taken from within the test section, behind the paver, prior to compaction. These samples shall be extracted as soon as possible by the Project Engineer's personnel. The mean of the extractions shall be within the job mix tolerance for the section to be accepted.

(c) Target Density. Upon completion of the compaction, the Mean Target Density of the section will be determined by averaging the results of five (5) nuclear density tests or five (5) core tests taken at random from within the test section area. A Nuclear Density Test is the average of five (5) readings and a core test is a single core.

If the Mean Target Density is less than 97 percent of the maximum laboratory density (ASTM D 2726), or the mean of the extraction tests is not within the job mix tolerance, a new section shall be constructed meeting these requirements. The Engineer may allow any strips not meeting these requirements to remain in place.

The Mean Target Density of passing sections will be in effect for the remainder of the course and mix which it represents.

(d) Changes in Materials or Mixture. A new test section will be required for changes in materials in the mix and/or an appreciable change in the job mix formula. The Engineer or the contractor may require a new test section if there is reason to believe that the mixture being placed is not the same as the mixture used to determine the target density.

(e) Measurement of Compaction of Mixtures. Each lot shall be divided into four (4) sub-lots. Two (2) random nuclear density tests or cores shall be taken from within each sub-lot. The average of the two (2) tests shall be at least 99 percent of the mean target density established in the test section. If the density falls below this level, the contractor shall be required to provide additional compaction by modifying his rolling pattern and/or changing the number or types of rollers. A lot shall be defined as 1200 tons or one day's production, whichever is less.

Extraction tests for bitumen content and aggregate gradation will be made at least once daily. The mixture will be tested for bitumen content in accordance with ASTM D 2172 and for aggregate gradation in accordance with ASTM C 117 and C 136.

When the average density of any sub-lot of the pavement is less than 99% of mean target density, Table No. 7 will be applied to the tonnage represented by the deficient density test results.

401-4.14 SURFACE TESTS. Tests for conformity with the specified crown and grade shall be made by the contractor immediately after initial compression. Any variation shall be corrected by the removal or addition of materials and by continuous rolling.

The finished surface shall not vary more than 1/4 inch for the surface course when tested with a 16-foot straightedge applied parallel with, or at right angles to, the centerline.

After the completion of final rolling, the smoothness of the course shall again be tested; humps or depressions exceeding the specified tolerances shall be immediately corrected by removing the defective work and replacing with new material, as directed by the Resident Engineer. This shall be done at the contractor's expense.

The finished surfaces of bituminous courses shall not vary from the gradeline, elevations, and cross sections shown on the contract drawings by more than 1/2 inch. The contractor shall correct pavement areas varying in excess of this amount by removing and replacing the defective work. Skin patching will not be permitted.

TABLE 7. SLIDING SCALE PAY FACTORS

Average Percent Mean Target Density	Recommended Percent Payment
99.0 and greater	100
98.0 - 98.9	98
97.0 - 97.9	95
96.0 - 96.9	85
95.0 - 95.9	75
Less than 95.0	reject

401-4.15 SAMPLING PAVEMENT. Samples for determination of thickness and density of completed pavements shall be obtained by the contractor at no extra cost. The size, number, and locations of the samples will be as directed by the Resident Engineer. Samples shall be neatly cut with a saw, core drill, or other approved equipment. The contractor shall furnish all tools, labor, and materials for cutting samples and replacing pavement.

All tests necessary to determine conformance with requirements specified herein will be performed without cost to the contractor.

METHOD OF MEASUREMENT

401-5.1 Plant mix bituminous surface course will be measured by the ton. The tonnage shall be the weight used in the accepted pavement. No deduction will be made for the weight of bituminous material in the mixture. Plant batch weights will be accepted. Loads shall be checked periodically by weighing full truck loads of the bituminous mixture on an approved platform scale at the plant or on a commercial scale.

The contractor shall furnish approved duplicate load tickets upon which is recorded the net weight of the bituminous mixture in each truck. The load ticket shall have sufficient space for signatures, identification of the bituminous mixture, date of delivery, and any other data which the Project Engineer may require. The contractor shall submit one load ticket to the Project Engineer, or his duly authorized representative, at the plant after the truck is loaded and another load ticket to the Project Engineer, or his duly authorized representative, at the construction site when the truck load is incorporated into the pavement.

BASIS OF PAYMENT

401-6.1 The quantity of bituminous surface course material determined, as provided in paragraph 5.1, shall be paid for at the contract unit price per ton, which price shall include the aggregate and bituminous materials, for furnishing, handling, mixing, hauling, and placing all materials; for all shaping, compacting and rolling; for furnishing certified scales; for all labor, equipment, and incidentals necessary to complete the item.

Payment will be made under:

Item 401-6.10 Bituminous Surface Course - Per Ton.

ITEM 402 POROUS FRICTION COURSE

(Central Plant Hot Mix)

DESCRIPTION

402-1.1 This item shall consist of an open-graded, bituminous surface course composed of mineral aggregate and bituminous material, mixed in a central mixing plant, and placed on a prepared surface in accordance with these specifications and shall conform to the dimensions shown on the plans.

The porous friction course shall be constructed in one layer having a compacted nominal thickness as shown on the plans.

No porous friction course shall be constructed until the underlying surface has been cleaned, prepared and accepted by the Engineer.

MATERIALS

402-2.1 AGGREGATE. The aggregate shall consist of crushed stone. Crushed novaculite will not be allowed. The aggregate shall be composed of clean, sound, tough, durable particles, free from clay balls, organic matter and other deleterious substances.

The crushed stone aggregate used shall not show a total weighted average loss greater than 6% in sodium sulfate solution when tested in accordance with ASTM C-88.

The portion of the crushed stone passing the 3/8 inch sieve and retained in the No. 4 sieve shall show an estimated coated area "above 95 percent" when tested in accordance with ASTM D-1664, coating and stripping of Bitumen-Aggregate mixtures. Should the coarse aggregate, proposed by the contractor, show evidence of stripping (less than 95 percent retained coating area), the bituminous binder may be treated with a heat-stable anti-stripping agent that has been approved by the Engineer. The anti-stripping agent shall be used in accordance with the manufacturer's specifications in such amounts that the aggregate will not show evidence of stripping. No additional compensation shall be allowed the contractor as payment for furnishing and using an anti-stripping agent.

402-2.2 MINERAL FILLER. Mineral filler shall consist of finely divided mineral matter conforming to the requirements of ASTM D-242. If the crushed stone does not contain sufficient finely divided mineral matter to conform to the grading requirements of Table 1, mineral filler shall be batched separately in amounts necessary to make up the deficiency in the amount of material passing the No. 200 sieve.

402-2.3 BITUMINOUS MATERIAL. The bituminous material for porous friction courses shall conform to the requirements of ASTM D 946, Penetration Graded Asphalt Cement or ASTM D 3381, Viscosity Graded Asphalt Cement. The grade of asphalt to be used shall be in accordance with Table 1.

TABLE 1.

Type & Grade		Specification	Maximum Mixing Temperature	
			°F	°C
Penetration Grade	60-70	ASTM D 946	335	170
	85-100		325	165
	120-150		310	155
	200-300		295	146
Viscosity Grade	AC-5	ASTM D 3381	295	145
	AC-10		315	155
	AC-20		330	165
Viscosity Grade	AR-2000	ASTM D 3381	325	165
	AR-4000		325	165
	AR-8000		325	165

COMPOSITION

402-3.1 COMPOSITION OF MIXTURES. The porous friction course shall be composed of a mixture of aggregate, filler, bituminous material, and antistripping agent (if required). The several aggregate fractions shall be sized, graded, and combined in the proportions that meet the requirements of the job mix formula.

402-3.2 JOB MIX FORMULA. Work shall not begin nor shall any mixture be accepted until the contractor has submitted samples of the materials intended for use and the Engineer has established a satisfactory job mix formula for each PFC gradation to be used. The job mix formula for each PFC mixture shall be in effect until modified in writing by the Engineer. The job mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate and a single temperature for the mixture as it is discharged into the hauling units.

The aggregate, as finally selected, shall have a gradation within the limits designated in Table 2 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

The best asphalt content may fall outside this range depending on the absorptive aggregate at specific gravities. The proper asphalt content shall be determined by trial batches.

The gradation shown in the above table are based on aggregate showing the same (uniform) specific gravity such that the percent passing each sieve size by weight is equal to the percent passing each sieve size by volume. Should the aggregates proposed for use, when tested by ASTM C-127 or C-128, show nonuniform apparent specific gravities (more than 0.20) between any two or more of the sieve sizes shown in Table 2, the Engineer will make appropriate adjustments to the job mix formula to retain the intended particle size distribution of the aggregate (percent passing by volume). Such adjustments to the job mix gradation should result in an aggregate gradation curve (sieve size vs. percent passing by volume) that will, when plotted on semi-logarithmic paper, show a curve of the same general shape as the median curve of the gradation band in Table 2. In addition, the "adjusted" gradation curve of the job mix formula (sieve size vs. percent passing by volume) shall fall within the gradation band of Table 2.

TABLE 2. AGGREGATE-POROUS FRICTION COURSE

Sieve Size	Percentage by Weight Passing Sieves	
	3/4 in. maximum	1/2 in. maximum
3/4 in.	100	---
1/2 in.	70-100	100
3/8 in.	45-75	80-100
No. 4	20-40	20-40
No. 8	12-20	12-20
No. 30	8-14	8-14
No. 200	3-5	3-5
Compacted Thickness	1 in.	3/4 in.
Bituminous Content	5-7 percent by weight of total mix	

The minimum thickness of the layer of the course being constructed, shall be 1" when the 3/4" maximum size aggregate is to be used and 5/8" when the 1/2" maximum size aggregate is to be used. During construction the Resident Engineer shall check the minimum thickness on a daily basis.

The job mix tolerances shown in Table 3 shall be applied to the job mix formula to establish a job control grading band. The full tolerances will only apply if application of the job mix tolerances results in a job control grading band inside the master grading band.

TABLE 3. JOB MIX FORMULA TOLERANCES
(Based on a Single Test)

Material	Tolerances Plus or Minus
Aggregate passing No. 4 sieve or larger	7.0 percent
Aggregate passing Nos. 8 and 30 sieves	4.0 percent
Aggregate passing No. 200 sieve	1.0 percent
Bitumen	0.40 percent
Temperature of mix	20° F.

If a change is made in any component of the bituminous mix, a new job mix formula shall be established and approved by the Engineer before any additional material on the project is produced and placed. When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job mix formula.

402-3.3 TEST SECTIONS. Prior to full plant production, the contractor shall prepare a quantity of PFC mixture according to the job mix formula. The amount of mixture should be sufficient to construct a test section 100 feet long and 25 feet wide. The test area will be designated by the Engineer. The mixture shall be placed in two sections and shall be of the same depth specified on the plans. The underlying pavement on which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment to be used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

The test section shall be a part of the project and if the test section should prove to be unsatisfactory, it shall be removed and the necessary adjustments to the mix design, plant operation, and/or rolling procedures shall be made. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. When test sections do not conform to specification requirements, the pavement shall be removed and replaced at the contractor's expense. Full production shall not begin without approval of the Engineer. Test sections will be paid for in accordance with Paragraph 402-6.1.

CONSTRUCTION METHODS

402-4.1 WEATHER AND SEASONAL LIMITATIONS. The porous friction course shall be constructed only upon a dry surface when the atmospheric temperature has been 60° F. for 2 days before and is 60° F. and rising on the day of placement and the weather is not foggy or rainy.

402-4.2 BITUMINOUS MIXING PLANT. The bituminous mixing plant shall include all facilities or equipment necessary to produce the bituminous mix. The mix shall be delivered, in place, within 60 minutes after final mixing. Storage in surge bins or silos will not be allowed.

Plants used for the preparation of bituminous mixtures shall conform to all requirements under (a), except that scale requirements shall apply only where weight proportioning is used. In addition, batch-mixing plants shall conform to the requirements under (b), and continuous or drum dryer mixing plants shall not be allowed.

(a) Requirements for All Plants. Mixing plants shall be of sufficient capacity and coordinated to adequately produce the quantity of bituminous mixture for the proposed construction.

(1) Aggregate stockpiles. In preparation of the mineral aggregates, sufficient storage space shall be provided so that such aggregate size can be kept in separate stockpiles. The stockpile will be constructed in uniform layers by use of a clamshell or other approved methods in such manner as to prevent segregation. The use of bulldozers in stockpiling of aggregates will not be permitted. The storage yard shall be neat and orderly and the separate stockpiles readily accessible for sampling.

(2) Cold bins. The plant shall have an adequate number of cold bins or silos for each aggregate size. These cold bins or silos shall be constructed such that no overflow from one bin to the other occurs. They shall also have individual, adjustable outlet devices to provide a uniform and continuous flow of materials in the desired proportions.

Prior to start of production of any mixture, the contractor shall furnish the Resident Engineer with calibrations showing the rate of feet of each aggregate for the cold bin or silo in which it is to be used. Change of material or change of cold bin or silo will require new calibrations. The calibrations shall show the rate of feed per minute per unit of opening or setting of feed.

(3) Feeder for drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier to obtain uniform production and temperature.

(4) Drier. The plant shall include a drier(s) which continuously agitates the aggregate during the heating and drying process.

(5) Screens. Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided.

(6) Dust collector. The plant shall be equipped with a dust collector to waste or return uniformly to the hot elevator all or any part of the material collected as directed. The plant shall have a mixed cover and such additional housing necessary to the control of dust.

(7) Hot bins. The plant shall include storage hot bins of sufficient capacity to supply a mixer operating at full capacity. Hot bins shall be arranged to assure separate and adequate storage of appropriate fractions of the batching mineral filler and hydrated lime. The plant shall be equipped to proportion and feed such material into the mixer. Each bin shall be provided with overflow pipes of such size and at such location to prevent backup of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate to prevent leakage. The gates shall cut off quickly and completely. Hot bins shall be constructed so that samples may be obtained readily. Hot bins shall be equipped with adequate telltale devices which indicate the position of the aggregates in the bins at the lower quarter points.

(8) Plant scales. Scales shall be accurate to 0.5 percent of the required load. Poises shall be designed to be locked in any position to prevent unauthorized change of position. In lieu of plant scales, the contractor may provide an approved automatic printer system to print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load. Scales shall be inspected for accuracy and sealed as often as the Engineer may deem necessary. The contractor shall have on hand no less than ten 50-pound weights for testing the scales.

(9) Equipment for preparation of bituminous material. Tanks for storage of bituminous material shall be capable of heating the material under effective and positive control, at all times, to the temperature requirements specified herein. Heating shall be accomplished by steam coils, electricity, or other means that will allow no direct flame to come in contact with the bituminous material or its fumes. The circulating system for the bituminous material shall be of adequate size to insure proper and continuous circulation between storage tank and mixer during the entire operating period. Pipelines and fittings shall be steam-jacketed or otherwise properly heated, if required, or insulated to prevent heat loss. The storage tank capacity shall be sufficient for at least a one-day run. Provision shall be made for measuring quantities and for sampling the material in the storage tanks.

(10) Bituminous control unit. Satisfactory means shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified by the job mix formula, either by weighing, metering, or volumetric measurements. Suitable means shall be provided, either by steam-jacketing or other methods of insulation, for maintaining the specified temperature of the bituminous material in the pipelines, meters, weigh buckets, spray bars, and other containers or flow lines.

(11) Thermometric equipment. An armored thermometer of adequate range shall be fixed in the bituminous feed line at a suitable location near the discharge valve at the mixer unit. The plant shall be further equipped with either an approved recording dial scale, a mercury-actuated thermometer, an electric recording pyrometer, or other thermometric instruments, so placed at the discharge chute of the dryer as to register automatically or indicate the temperature of the heated aggregate. When required by the Engineer, additional thermometric equipment shall be placed at the pug mill to control the temperature of the mixture.

(12) Safety requirements. Adequate and safe stairways to the mixer platform and sampling points shall be provided. Guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a suitable device to enable the Engineer to obtain mixture samples and temperature data. Means shall be provided to raise and lower calibration equipment, sampling equipment, and other similar equipment between the ground and the mixer platform. All belts, gears, pulleys, chains, sprockets, projecting setscrews, keys and other dangerous moving parts shall be guarded to prevent inadvertent contact by workmen or other moving equipment. Ample and unobstructed passage shall be maintained at all times in and around the truck-loading area.

This area shall be kept free of drippings from the mixing platform. Equipment exposed to steam or other lines carrying high temperatures, so located as to endanger workmen or create a fire hazard, shall be properly guarded or insulated as to prevent inadvertent injurious contact by workmen.

(13) Surge bins will not be allowed.

(b) Requirements for Batching Plants.

(1) Weigh box or hopper. The equipment shall include means for weighing each bin size of aggregate in a weigh box or hopper suspended on scales, ample size to hold a full batch without hand raking or running over. The assembly, consisting of the weigh box or hopper and the supporting fulcrums and knife edges, shall be so constructed that no part of the assembly will be easily thrown out of alignment or adjustment. The gates on both the bins and hoppers shall be so constructed as to prevent leakage of aggregate when closed. On manually operated plants, an interlocking device shall be provided that will prevent the opening of more than one gate at a time. On automatic plants, designed for simultaneous weighing of all sizes of aggregate, this provision shall not apply while the plant is operating under automatic control.

(2) Bituminous control. The equipment used to measure the bituminous material shall be accurate to within plus or minus 0.5 percent. The bituminous material bucket shall be of a nontilting type with a loose sheet metal cover. The length of the discharge opening of the spray-bar shall be not less than three-fourths the length of the mixer, and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve(s), and the spray-bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained, and all connections shall be constructed so that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15 percent of the weight of bituminous material required in any batch. The plant shall have an adequately heated, quick-acting, nondrip charging valve located directly over the bituminous material bucket.

The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used per batch. The controls shall be constructed to lock at any dial setting and automatically reset to that reading after each additional batch of bituminous material. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled to begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has begun. The size and spacing of the spray-bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the

spray-bar shall have a valve and an outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

(3) Mixer. The batch mixer shall be an approved type capable of producing a uniform mixture with well-coated aggregate in the prescribed mixing time within the job mix tolerance specified. If not enclosed, the mixer box shall be equipped with a hood to prevent loss of dust.

(4) Control of mixing time. The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh-box gate after the charging of the mixer and keep it locked until the closing of the mixer gate at the completion of the cycle. It shall lock the bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is the time interval between the opening of the weigh-box gate and the introduction of bituminous material. The wet mixing period is the time interval between the introduction of the bituminous material and the opening of the mixer gate.

The timing control shall be flexible and shall be capable of settings at 5-second intervals or less throughout a 3-minute cycle. A mechanical batch counter shall be installed as a part of the timing device and shall be designed to register only completely mixed batches.

The setting of time intervals shall be at the direction of the Resident Engineer who shall then lock the case covering the timing device. It shall remain locked until a change is made in the timing periods.

402-4.3 HAULING EQUIPMENT. Trucks used for hauling the bituminous mixture shall have tight, clean, smooth beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of concentrated hydrated lime and water solution. The truck beds shall be raised to drain any excess solution before loading the mixture in the trucks. Each truck shall have a suitable cover to protect the mixture from adverse weather or long hauls. An insulated bed may be required to maintain the mixture at the specified temperature during hauling.

402-4.4 BITUMINOUS PAVERS. Bituminous pavers shall be self-contained, power-propelled units with an activated screed or strike-off assembly, heated if necessary, and shall be capable of spreading and finishing courses of bituminous plant mix material which will meet the specified thickness, smoothness, and grade.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a

distribution system to place the mixture uniformly in front of the screed. The screed or strike-off assembly shall produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the screed elevation as specified herein. The control system shall be automatically actuated from either a reference line or a surface through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

402-4.5 ROLLERS. A minimum of two self-propelled, steel-wheel rollers shall be furnished. They shall be in good condition capable of reversing without backlash, and capable of operating at slow speeds to avoid displacement of the bituminous mixture. The wheels shall be equipped with adjustable scrapers, water tanks, and sprinkling apparatuses to prevent the bituminous mixture from sticking to the sheels. The weight of each roller shall be 6 to 12 tons. The use of equipment which results in excessive crushing of the aggregate will not be permitted.

402-4.6 PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be dried and heated at the central mixing plant before entering the mixer. When introduced into the mixer, the combined aggregate moisture content (weighted according to the composition of the blend) shall be less than 0.25 percent for aggregate blends with water absorption of 2.5 percent or less and less than 0.50 percent for aggregate blends with water absorption greater than 2.5 percent. Water absorption of aggregates shall be determined by ASTM C127 and ASTM C128. The water absorption for the aggregate blend shall be the weighted average of the absorption values for the coarse aggregate retained on the No. 4 sieve and the fine aggregate passing the No. 4 sieve. The water content test will be conducted in accordance with ASTM C566. In no case shall the moisture content be such that foaming of the mixture occurs prior to placement. At the time of mixing, the temperature of the aggregate shall be within the range specified in the job mix formula. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. Particular care shall be taken so that aggregates high in calcium or magnesium content are not damaged by overheating. The aggregate shall be screened to specified sizes and conveyed in separate bins ready for mixing with bituminous material.

402-4.7 PREPARATION OF BITUMINOUS MIXTURE. The bituminous mixture shall be prepared in a central mixing plant. The mixture shall be prepared at the temperature designated by the Engineer within the range shown in Paragraph 402-2.3.

The dry aggregate shall be combined in the plant in the proportionate amounts of each aggregate size required to meet the specified gradation. The quantity of aggregate for each batch shall be determined, measured, and conveyed into the mixer. In case of volumetric proportioning, the size of the openings shall be determined, and the gates shall be locked in position.

The quantity of bituminous material for each batch shall be determined by the Engineer. It shall be measured by weight and introduced into the mixer within the temperature range specified in the job mix formula. For batch mixers, all aggregates shall be in the mixer before the bituminous material is added. In no case shall the temperature of the aggregate be more than 25 degrees F (4 degrees C) above the temperature of the bituminous material when adding the bituminous material. As determined by the Engineer, the mixing shall continue until all particles are coated uniformly. In no case shall the bituminous mixture be stored in storage silos or surge bins.

402-4.8 TRANSPORTATION AND DELIVERY OF THE MIXTURE. The mixture shall be transported from the central mixing plant to the paving job in trucks described in Paragraph 402-4.3. The mixture shall be placed at a temperature between 200 degrees F (94 degrees C) and 295 degrees F (146 degrees C). Delivery of the mixture shall be scheduled so that spreading and rolling of a day's production can be completed during daylight hours the same day.

402-4.9 SPREADING AND LAYING.

(a) Preparation of Existing Surfaces. All porous friction courses shall be constructed on an existing pavement surface that is structurally sound; is in good condition; is constructed to new pavement surface course smoothness criteria; and has Marshall stability and flow values comparable to those specified in Item 401. The work involved in rehabilitating the existing pavement surface shall be otherwise provided for in the contract and is not a part of this PFC specification. Rehabilitation of the existing pavement including: construction of bituminous overlay; joint sealing; crack repair; reconstruction of failed pavement areas; removal of rubber deposits; removal of pavement markings; and cleaning of grease, oil, and fuel spills shall be completed and accepted by the Engineer prior to the placement of the porous friction course.

Immediately before placing the porous friction course, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms, or hand brooms as directed. A tack coat conforming to Item 603 shall be placed, as directed by the Resident Engineer, on those existing surfaces where a tack coat is necessary for bonding the PFC to the existing surface.

(b) Placing. Hauling over material already placed shall not be permitted until the material has been thoroughly compacted as specified and allowed to develop its stability for a period of, at least, 12 hours. In areas where extremely hot temperatures occur, it is suggested that no traffic be allowed on the PFC until it has cooled overnight. Traffic should be discontinued if any closing of the PFC is observed. The bituminous mixture shall be placed at the required minimum lane width with an approved bituminous paver as specified in Paragraph 402-4.4.

402-4.10 COMPACTION OF MIXTURE. After spreading, the mixture shall be thoroughly and uniformly compacted with power rollers. Rolling of the mixture shall begin as soon after spreading as it will bear the roller without undue displacement or hair-checking. Rolling shall be initiated with the drive wheel toward the paving machine. The sequence of rolling the first paving lane should be to first roll the lower edge (with reference to the transverse slope) of the lane and then to roll the upper edge. The interior of the lane should then be rolled from the lower side toward the upper edge with overlapping roller paths. On adjoining paving lanes, rolling shall begin by overlapping the joint (with the previous lane) by 6 to 9 inches and then rolling the outside edge of the new lane. The interior should be rolled from the outside edge toward the compacted joint with overlapping wheel paths. Alternate trips of the roller shall be of slightly different lengths. The number of passes with a steel-wheel roller shall be as determined by the test section. The optimum weight of the roller shall also be determined during test section construction.

The speed of the roller shall be slow enough to avoid displacement of the hot mixture. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once by raking and applying fresh mixture.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until all roller marks are eliminated and the surface is of uniform texture and conforms to the required cross section.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hot hand tampers.

Any mixture which becomes loose and broken, mixed with dirt, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work will be done at the contractor's expense. Skin patching and handworking of the PFC mixture will not be allowed.

402-4.11 JOINTS. The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture, density, and smoothness as other sections of the course.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose vertical face. In both methods all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

Longitudinal joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be given a tack coat of bituminous material prior to placing any fresh mixture against the joint. The longitudinal joint shall offset that in the existing course by at least 1 foot.

402-4.12 SHAPING EDGES. While the surface is being compacted and finished, the contractor shall carefully shape the longitudinal outside edges of the PFC to a vertical face at the established edge. When transitioning from PFC to existing pavement, transverse edges shall be constructed with a finer graded bituminous mixture.

402-4.13 SURFACE TESTS. After completion of the final rolling, the finished surface shall be tested with a 16-foot straightedge and shall not vary more than 1/4 inch. The 16-foot straightedge shall be applied parallel with and at right angles to the runway centerline in a pattern that includes longitudinal and transverse joints. The 16-foot straightedge shall be advanced approximately 1/2 its length in the line of measurement.

Areas of the porous friction course exceeding the specified tolerances shall be corrected at the contractor's expense by removing the defective work and replacing it with new material. Skin patching or handworking will not be permitted.

402-4.14 SAMPLING PFC MIXTURE AND HOT BINS. Samples of the PFC mixture shall be taken at the point of discharge in hauling units and tested to control uniformity in the bituminous content and gradation. Samples shall be taken in accordance with ASTM D979. Enough mixture shall be taken to prepare duplicate tests on each sample of mixture in

accordance with ASTM D2172. Samples shall be taken, at least, once for any central plant-run of more than 30 minutes and at least twice for any central plant-run of more than 5 hours.

Should the bituminous content of the duplicate tests agree within 0.50 percent, the average results shall be recorded. Variations greater than 0.50 percent between duplicate tests of the same sample shall also be recorded, and duplicate tests on an additional sample shall be run. The average value of the bituminous content should fall within the tolerance of the job mix formula as specified in Paragraph 402.3.2. Should the average bituminous content for four samples not fall within the job mix tolerances, the Resident Engineer may order the contractor to cease production until such out-of-tolerance conditions have been remedied by the contractor. The gradation of the residual aggregate should be determined by using ASTM D 2172 and compared to the approved job mix formula.

The samples of PFC mixture will be used to control the uniformity of the contractor's plant production. In addition, the contractor shall clearly mark each hauling unit from which the representative samples have been taken so that the same mixture sample may be located in the completed pavement.

Completed PFC shall be determined "acceptable" or "unacceptable" on the basis of visual inspection by the Engineer. The Resident Engineer shall immediately notify the contractor of visual defects such as nonuniform texture, roller marks, bleeding of bituminous material, cracking and shoving of the mixture, and evidence of aggregate crushing during the roller operations, or nonconformance to the surface smoothness criteria as specified in Paragraph 402-4.13.

"Unacceptable" PFC shall be removed, leaving a vertical face at the remaining PFC. The underlying surface shall be cleaned and a tack coat applied prior to replacing the PFC. All work shall be at the contractor's expense. Unacceptable PFC shall not be measured for payment.

In addition to sampling and testing the PFC mixture, the Resident Engineer shall sample each hot bin twice daily and furnish a gradation analysis of each hot bin according to ASTM C136. The combined gradation analysis of the hot bins shall fall within the job mix formula tolerances. Should the hot bin gradation analysis fail to meet the tolerances of the job mix formula (on the same sieve size), the Resident Engineer may order another analysis in addition to the two analyses required each day to confirm the results of the previous tests or tell the contractor to cease plant production until such out-of-tolerance conditions have been corrected.

402-4.15 BITUMINOUS AND AGGREGATE MATERIAL (CONTRACTOR'S RESPONSIBILITY). Samples of the bituminous and aggregate materials that the contractor proposes to use, together with a

statement of their source and character, shall be submitted for approval prior to use. The contractor shall require the manufacturer or producer of the bituminous and aggregate materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials which have been tested and approved for the intended use shall be acceptable.

The Engineer or the Engineer's authorized representative shall have access, at all times, to all parts of the paving plant to inspect the equipment, the conditions, and the operation of the plant; to verify the weights or proportions and character of materials; and to determine the temperatures maintained in the storage of the bituminous material and preparation of the mixtures.

The contractor shall furnish the vendor's certified test reports for each carload or equivalent of bituminous material shipped to the project. The report shall be delivered to the Engineer before permission is granted to use the material. The vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All test reports shall be subject to verification by testing sample materials received for use on the project.

402-4.16 PROTECTION OF PAVEMENT. After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until it has cured at least 12 hours. Newly constructed pavement areas shall not be opened to aircraft traffic until 24 hours after completion. This time interval may be increased depending upon temperature and the opening to traffic must be authorized by the Engineer.

METHOD OF MEASUREMENT

402-5.1 MEASUREMENT OF BITUMINOUS FRICTION COURSE. The quantity of PFC, of the gradation specified, shall be the number of square yards actually placed and accepted in accordance with the lines and dimensions shown on the plans or as directed by the Engineer, or his authorized representative. Only those areas shown on the plans or ordered by the Engineer, or his authorized representative, shall be measured for payment. The neat dimensions shown on the plans or ordered by the Engineer shall be used to calculate the square yards of porous friction course.

BASIS OF PAYMENT

402-6.1 Payment shall be made at the contract price per square yard of Porous Friction Course. The price shall be full compensation for furnishing all materials, for all preparation and storage of materials, for cleaning the underlying surface, for mixing, hauling, placing and

compaction of the mixtures, and for all tools, equipment and incidentals necessary to complete the item. No separate payment will be made for furnishing and batching mineral filler, antistripping agents, or additional bituminous material, should such items be required.

Payment will be made under:

Item 402-6.10 Porous Friction Course - per sq. yd.

RIGID PAVEMENT

ITEM 501 PORTLAND CEMENT CONCRETE PAVEMENT

(PLAIN AND REINFORCED)

DESCRIPTION

501-1.1. This work shall consist of pavement composed of portland cement concrete, with or without reinforcement, constructed on a prepared subgrade, subbase, or base course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the plans.

MATERIALS

501-2.1 FINE AGGREGATE. Fine aggregate for concrete shall conform to the requirements of ASTM C33 and shall meet the requirements of Table 1.

TABLE 1. GRADATION FOR FINE AGGREGATE

Sieve Designation (Square Openings)	Percentage by Weight Passing Sieves
3/8 in.	100
No. 4	94-100
No. 16	45-85
No. 50	3-29
No. 100	0-10
(IDOT Gradation)	(FA-1)

501-2.2 COARSE AGGREGATE. Coarse aggregate shall conform to the requirements of ASTM C33. Gradation shall be in accordance with Table 2.

TABLE 2. GRADATION FOR COARSE AGGREGATE

Sieve Designations (square openings)	From 1-1/2" to No. 4		From 1" to No. 4
	Percentage by Weight Passing Sieves		
In.	1-1/2"-3/4	3/4"-No. 4	1" to No. 4
2	100	---	---
1-1/2	94-100	---	100
1	15-65	100	90-100
3/4	---	90-100	---
1/2	0-10	40-70	30-60
No. 4	0-6	5-15	0-10
No. 16	---	0-6	---
(IDOT Gradation)	(CA-5)	(CA-11)	(CA-7)

The percentage of wear shall be no more than 40 percent when tested in accordance with ASTM C131 for aggregates smaller than 1-1/2 inches and in accordance with ASTM C535 larger than 3/4 inches.

Aggregates delivered to the mixer shall consist of crushed stone or natural sand. The aggregate shall be composed of sound, tough, durable particles and shall meet the requirements for deleterious substances given in ASTM C33. The aggregate in any size group shall not contain more than 8 percent by weight of flat or elongated pieces. A flat or elongated particle is one having a ratio between the maximum and the minimum dimensions of a circumscribing rectangular prism exceeding 5 to 1.

501-2.3 CEMENT. Cement shall conform to the requirements of ASTM C150, Type I, IA, III or IIIA, as specified by the Engineer.

If, for any reason, cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

501-2.4 PREMOLDED JOINT FILLER. Premolded joint filler for expansion joints shall conform to the requirements of ASTM D1751 and shall be punched to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Project Engineer. When the use of more than one piece is authorized for

a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Resident Engineer.

501-2.5 JOINT SEALER. The joint sealer for the joints in the concrete pavement shall meet the requirements of Item 605.

501-2.6 STEEL REINFORCEMENT. Reinforcing shall consist of ** _____ conforming to the requirements of ** _____.

** The Engineer shall designate one of the following:

Welded steel wire fabric ASTM A185

Welded deformed steel fabric ASTM A497

Bar mats ASTM A184 or A704.

501-2.7 DOWEL AND TIE BARS. Tie bars shall be deformed steel bars and conform to the requirements of ASTM A615 or ASTM A616, except that rail steel bars, Grade 50 or 60, shall not be used for tie bars that are to be bent or restraightened during construction. Tie bars designated as Grade 40 in ASTM A615 can be used for construction requiring bent bars.

Dowel bars shall be plain steel bars conforming to ASTM A617 and shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the construction site, a minimum of two-thirds of the length of each dowel bar shall be painted with one coat of lead or tar paint. If plastic or epoxy-coated steel dowels are used, no lead or tar paint coating is required, except when specified for a particular situation on the contract plans. Coated dowels shall conform to the requirements given in AASHTO M 254.

The sleeves for dowel bars used in expansion joints shall be metal, of an approved design to cover 2 to 3 inches of the dowel, with a closed end and with a suitable stop to hold the end of the bar at least 1 inch from the closed end of the sleeve. Sleeves shall be of such design that they will not collapse during construction.

501-2.8 WATER. Water used in mixing or curing shall be as clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product as possible. If the water is of questionable quality, it shall be tested in accordance with the requirements of the applicable ASTM Part 31 tests as deemed necessary by the Engineer. Water known to be of potable quality may be used without testing.

501-2.9 COVER MATERIAL FOR CURING. Curing materials shall conform to one of the following specifications:

(a) Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2.

(b) White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.

(c) White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.

(d) Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

501-2.10 ADMIXTURES. The use of any material added to the concrete mix shall be approved by the Engineer. The contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests will be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

(a) Pozzolanic Admixtures. Pozzolanic admixtures shall be fly ash or raw or calcined material pozzolans meeting the requirements of ASTM C618 with the exception of loss of ignition, where the maximum should be less than 6 percent.

(b) Air-Entraining Admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall be added to the mixer in the amount necessary to produce the specified air content. The air-entrainment agent and the water reducer admixture shall be compatible.

(c) Water-Reducing Admixtures. Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C494, Type A, water-reducing or Type D, water-reducing and retarding. Water-reducing admixtures shall be added at the mixer separately from air-entraining admixtures in accordance with the manufacturer's printed instructions.

CONSTRUCTION METHOD

501-3.1 EQUIPMENT. Equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity, and mechanical condition. The equipment shall be at the job site before the start of construction operations for examination and approval.

(a) Batching Plant and Equipment.

(1) General. The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and coarse aggregate. If bulk cement is used, a bin, hopper, and separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation.

(2) Bins and hopper. Bins with adequate separate compartments for fine aggregate and coarse aggregate shall be provided in the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that, as the quantity desired in the weighing hopper is approached, the material may be added slowly and shut off with precision. A port or other opening for removing an overload of any one of the several materials from the hopper shall be provided. Weighing hoppers shall be constructed to eliminate accumulations of materials and to discharge fully.

(3) Scales. The scales for weighing aggregates and cement shall be of either the beam or the springless dial type. They shall be accurate within 0.5 percent throughout their range of use. When beam-type scales are used, provisions such as a "telltale" dial shall be made for indicating to the operator that the required load in the weighing hopper is being approached. A device on the weighing beams shall clearly indicate critical position. Poises shall be designed to be locked in any position and to prevent unauthorized change. The weight beam and "telltale" device shall be in full view of the operator while charging the hopper, and the operator shall have convenient access to all controls.

Scales shall be inspected and sealed as often as the Resident Engineer may deem necessary to assure their continued accuracy. The contractor shall have on hand not less than ten 50-pound weights for testing of all scales when directed by the Resident Engineer.

(b) Mixers.

(1) General. Concrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

A device accurate within 3 percent and satisfactory to the Engineer shall be provided at the mixer for determining the amount of air-entraining agent or other admixture to be added to each batch requiring such admixtures.

Mixers shall be examined daily for the accumulation of hard concrete or mortar and the wear of blades.

(2) Central plant mixer. Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging the mixture without segregation. Central plant mixers shall be equipped with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed.

The water system for a central mixer shall be either a calibrated measuring tank or a meter and shall not necessarily be an integral part of the mixer. The mixers shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 inch or more. The contractor shall have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

(3) Truck mixers and truck agitators. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall conform to the requirements of ASTM C94.

(4) Nonagitator trucks. Nonagitating hauling equipment shall conform to the requirements of ASTM C94.

(c) Finishing Equipment.

(1) Finishing machine. The finishing machine shall be equipped with one or more oscillating-type transverse screeds.

(2) Vibrators. For side-form construction, vibrators may be either the surface pan type for pavements less than 8 inches thick or the internal type with either immersed tube or multiple spuds, for the full width of the concrete slab. They may be attached to the spreader or the finishing machine, or they may be mounted on a separate carriage. They shall not come in contact with the joint, load-transfer devices, subgrade, or side forms. The frequency of the surface vibrators shall not be less than 3,500 vibrations per minute, and the frequency of the internal type shall not be less than 7,000 vibrations per minute for spud vibrators. When spud-type internal vibrators are used adjacent to the side forms, they shall have a frequency of not less than 3,500 vibrations per minute. Hand vibrators should be used to consolidate the concrete along forms and other isolated areas.

For slip-form construction, the paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Vibration shall be accomplished by internal vibrators with a frequency range variable between 7,000 and 12,000 vibrations per minute. The amplitude of vibration shall be between 0.025 and 0.06 inches.

The number, spacing, frequency, and eccentric weights shall be provided as necessary to achieve an acceptable concrete density and finishing quality. Adequate power to operate all vibrators at the weight and frequency required for a satisfactory finish shall be available on the paver. The internal vibrators may be supplemented by vibrating screeds operating on the surface of the concrete. The frequency of surface vibrators shall not be less than 3,500 vibrations per minute. The contractor shall furnish a tachometer or other suitable device for

measuring the frequency of the vibrators. The vibrators and tamping elements shall be automatically controlled so that they shall be stopped as forward motion ceases. Any override switch shall be of the spring-loaded, momentary contact type.

(d) Concrete Saw. When sawing of joints is specified, the contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate. The contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and at all times during concrete placement.

(e) Forms. Straight side forms shall be made of steel having a thickness of not less than 7/32 inch and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth equal to the prescribed edge thickness of the concrete without horizontal joint, and a base width equal to the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of 100-foot radius or less. Flexible or curved forms shall be of a design acceptable to the Engineer. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than two-thirds the height of the form. Forms with battered top surfaces and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. Built-up forms shall not be used, except as approved by the Engineer. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary more than 1/4 inch. The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting.

(f) Slip-form Pavers. The paver shall be fully energized, self-propelled, and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement, true to grade, tolerances, and cross section. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown in the plans, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. The paver should be equipped with electronic or hydraulic horizontal and vertical control devices.

501-3.2 FORM SETTING. Forms shall be set sufficiently in advance of the concrete placement to insure continuous paving operation. After the forms have been set to correct grade, the grade shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than 3 pins for each 10-foot section. A pin shall be placed at each side of every joint.

Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch at any joint. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the placing of concrete.

The alignment and grade elevations of the forms shall be checked and corrections made by the contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

501-3.3 CONDITIONING OF UNDERLYING COURSE, SLIP-FORM CONSTRUCTION. The compacted subgrade, subbase, or base on which the pavement will be placed shall be widened approximately 3 feet to extend beyond the paving machine track to support the paver without any noticeable displacement. After the subgrade, subbase, or base has been placed and compacted to the required density, the areas which will support the paving machine and the area to be paved shall be trimmed to the proper elevation and profile by means of a properly designed machine. The grade of the subgrade, subbase, or base on which the concrete pavement is to be placed shall be controlled automatically by steel guide wires erected and maintained by the contractor. If the density of the base is disturbed by the trimming operations, it shall be corrected by additional compaction before the concrete is placed except when stabilized subbases are being constructed. If damage occurs on a stabilized subbase, it shall be corrected full depth by the contractor or the damaged areas filled with concrete integral with the pavement. The grading operations should be delayed as long as possible and immediately precede paving insofar as practical, particularly if the base course is subjected to haul traffic. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placement of concrete. The prepared grade shall be well moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. In cold weather the underlying subbase shall be protected so that it will be entirely free of frost when concrete is placed.

501-3.4 CONDITIONING OF UNDERLYING COURSE, SIDE-FORM CONSTRUCTION. The prepared grade shall be well moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from the concrete. Ruts or depressions in the subgrade or subbase caused by hauling or usage of other equipment shall be filled as they develop with suitable material (not with concrete or concrete aggregates) and thoroughly compacted by rolling. If

damage occurs to a stabilized subbase, it shall be corrected full depth by the contractor, or the damaged areas filled with concrete integral with the pavement. A multiple-pin templet weighing not less than 1,000 pounds per 20 feet or other approved templet shall be provided and operation on the forms immediately in advance of the placing of the concrete. The templet shall be propelled only by and not attached to a tractor or other power unit. Templets shall be adjustable so that they may be set and maintained at the correct contour of the underlying course. The adjustment and operation of the templet shall be such as will provide an accurate retest of the grade before placing the concrete thereon. All excess material shall be removed. Low areas may be filled and compacted to a condition similar to that of the surrounding grade, or filled with concrete integral with the pavement. In cold weather, the underlying subbase shall be protected so that it will be entirely free from frost when the concrete is placed. The use of chemicals to eliminate frost in the underlying material will not be permitted. The templet shall be maintained in accurate adjustment, at all times by the contractor, and should be checked daily. The work described under the foregoing paragraphs does not constitute a regular subgrading operation, but rather a final accurate check of the underlying course.

501-3.5 HANDLING, MEASURING, AND BATCHING MATERIAL. The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be built up in layers of not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next layer and shall not be allowed to "cone" down over the next lower layer. Aggregates from different sources and of different grading shall not be stockpiled together. Improperly placed stockpiles will not be accepted by the Resident Engineer.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner to secure the specified grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. The fine aggregate and coarse aggregate shall be separately weighed into hoppers in the respective amounts set by the Engineer in the job mix. Cement shall be measured by weight. Separate scales and hopper, with a device to positively indicate the complete discharge of the batch of cement into the batch box or container, shall be used for weighing the cement.

When required by the contract or when permitted, batching plants shall be equipped to proportion aggregates and bulk cement, by weight, automatically using interlocked proportioning devices of an approved type. When bulk cement is used, the contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer, such as a chute, boot, or other approved device, to prevent loss of cement. The device shall be arranged to provide positive assurance of the actual presence in each batch of the entire cement content specified.

When cement is placed in contact with the aggregates, batches may be rejected unless mixed within 1 1/2 hours of such contact. Batching shall be conducted so that the results in the weights of each material required will be within a tolerance of 1 percent for cement and 2 percent for aggregates.

Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within plus or minus 1 percent of required amounts. Unless the water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

Methods and equipment for adding air-entraining agent or other admixtures to the batch, when required, shall be approved by the Engineer. All admixtures shall be measured into the mixer with an accuracy of plus or minus 3 percent.

501-3.6 (A) PROPORTIONS. Proportioning requirements for concrete shall be designed for a compressive strength of 4000 psi for pavements designed for aircraft weighing less than 60,000 pounds.

Prior to the start of paving operations and after approval of all material to be used in the concrete, the Engineer shall obtain test data showing the proportions and actual compressive strength obtained from the concrete. Compressive strength shall be as specified at 28 days using test specimens prepared in accordance with ASTM C31 and tested in accordance with ASTM C39. The mix determined shall be workable concrete having a slump for side-form concrete between 1 and 2 inches, as determined by ASTM C143. For vibrated slip-form concrete, the slump shall be between 3/4 inch and 1 1/2 inches.

The minimum cement content shall be maintained to produce concrete of suitable durability and workability. The maximum water-cement ratio specified for concrete shall not be exceeded. Entrained air shall be required to increase durability and provide workability.

For slip-form construction, a high degree of uniformity in the plastic concrete is required. Caution should be exercised in establishing the air-entrainment percentage, as excessive air entrainment will aggravate edge slumping and insufficient air entrainment will result in poor concrete durability. Batches with slump in excess of 1 1/2 inches shall be wasted. Some edge slump of the wet concrete behind the slip form on the paving machine will occur, even with low slump concrete. This may continue, though very slowly, until initial set has taken place. Provision for adequate compensating adjustment in the slip form and in the final screed must be incorporated in the paver.

The cement content shall not be less than 6.0 sacks per cubic yard nor shall the water-cement ratio, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates, be more than 6 gallons per sack of cement. The cement content shall be determined in accordance with ASTM C138.

Air-entraining admixture shall be added in such a manner that will insure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air entrainment in the mix shall be 6 percent plus or minus 1 1/2 percentage points. Air content shall be determined by testing in accordance with ASTM C231.

501-3.6 (B) PROPORTIONS. Proportioning requirements for concrete shall be designed for flexural strength of 700 psi for pavements designed for aircraft weighing 60,000 pounds or more.

Prior to the start of paving operations and after approval of all material to be used in the concrete, the Engineer shall obtain test data showing the proportions and actual flexural strength obtained from the concrete. Flexural strength shall be as specified at 28 days using test specimens prepared in accordance with ASTM C31 and tested in accordance with ASTM C78. The mix determined shall be workable concrete having a slump for side-form concrete between 1 and 2 inches, as determined by ASTM C143. For vibrated slip-form concrete, the slump shall be between 3/4 inch and 1 1/2 inches.

The minimum cement content shall be maintained to produce concrete of suitable durability and workability. The maximum water-cement ratio specified for concrete shall not be exceeded. Entrained air shall be required to increase durability and provide workability.

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air-entrainment percentage, as excessive air entrainment will aggravate edge slumping and insufficient air entrainment will result in poor concrete durability. Batches with slump in excess of 1 1/2 inches shall be wasted. Some edge slump of the wet concrete behind the slip form on the paving machine will occur, even with low slump concrete. This may continue, though very slowly, until initial set has taken place. Provision for adequate compensating adjustment in the slip form and in the final screed must be incorporated in the paver.

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501-3.7 FIELD TEST SPECIMENS. Concrete samples shall be furnished by the contractor and shall be taken in the field to determine the consistency, air content, and strength of the concrete. Compressive test cylinders or flexural beam specimens shall be made each day that the concrete is placed. Each group of test cylinders or beams shall be molded from the same batch of concrete and shall consist of a sufficient number of specimens to provide two compressive or flexural strength tests at each test age. One group of specimens will be made during the first half of each shift, and the other during the last portion of the shift. The specimens shall be made in accordance with ASTM C31 by the contractor. However, at the start of paving operations and when the aggregate source, aggregate characteristics, or mix design is changed, additional groups of test specimens may be required until the Engineer is satisfied that the concrete mixture being used complies with the strength requirements of these specifications. Test ages will be 7 days and 28 days.

The compressive or flexural strength of the concrete shall meet the following requirements: (1) the average of any 4 consecutive strength tests, tested at the end of 28 days, shall have an average compressive or flexural strength equal to or greater than that specified; (2) not more than 20 percent of the specimens tested at the end of 28 days shall have a strength less than that specified. Specimens which are obviously defective shall not be considered in the determination of the strength.

When it appears that the test specimens will fail to conform to the requirements for strength, the Engineer shall have the right to order changes in the concrete sufficient to increase the strength to meet these requirements. When a satisfactory relationship between 7-day and 28-day strengths has been established and approved, the 7-day test results may be used as an indication of the 28-day strengths. However, the 7-day test results will not replace the results of the 28-day tests if the 28-day results fall below the requirement.

501-3.8 MIXING CONCRETE. The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are emptied into the drum. Ready-mixed concrete shall be mixed and delivered in accordance with the requirements of ASTM C94, except that the minimum required revolutions of the mixing speed for transit mixed concrete may be reduced to not less than that recommended by the mixer manufacturer. The number of revolutions recommended by the mixer manufacturer shall be indicated on the manufacturer's serial plate attached to the mixer. The contractor shall furnish test data acceptable to the Engineer verifying that the make and model of the mixer will produce uniform concrete conforming to the provisions of ASTM C94 at the reduced number of revolutions shown on the serial plate.

When mixed at the work site or in a central mixing plant, the mixing time shall not be less than 50 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The mixer shall be operated at the drum speed as shown on the manufacturer's nameplate on the approved mixer. Any concrete mixed less than the specified time shall be discarded at the contractor's expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer. An overload up to 10 percent above the mixer's nominal capacity may be permitted provided concrete test data for segregation and uniform consistency are satisfactory, and provided no spillage of concrete takes place. The batch shall be charged into the drum so that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform, and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks. The time elapsing from the time water is added to the mix until the concrete is deposited

in place at the work site shall not exceed 30 minutes when the concrete is hauled in nonagitating trucks, nor 60 minutes when the concrete is hauled in truck mixers or truck agitators. Retempering concrete by adding water or by other means will not be permitted.

501-3.9 LIMITATIONS OF MIXING. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40 degrees F and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35 degrees F.

When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials. Unless otherwise authorized, the temperature of the mixed concrete shall not be less than 50 degrees F at the time of placement in the forms.

If the air temperature is 35 degrees F or less at the time of placing concrete, the Engineer may require the water and/or the aggregates to be heated to not less than 70 degrees F nor more than 150 degrees F. Concrete shall not be placed on frozen subgrade nor shall frozen aggregates be used in the concrete.

During periods of warm weather when the maximum daily air temperature exceeds 85 degrees F, the following precautions should be taken. The forms and/or the underlying material shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90 degrees F. The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

501-3.10 PLACING CONCRETE.

(a) Side-form Method. For the side-form method, the concrete shall be deposited on the moistened grade to require as little rehandling as possible. Unless truck mixers, truck agitators, or nonagitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, the concrete shall be unloaded into an approved spreading device and mechanically spread on the grade to prevent segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads.

Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

When concrete is to be placed adjoining a previously constructed lane of pavement and when mechanical equipment will be operated upon the existing lane of pavement, the concrete shall be at least 7 days old and at a compressive strength approved by the Engineer. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after 3 days, if approved by the Engineer.

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 15 seconds in any one location, nor shall the vibrators be used to move the concrete.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

(b) Slip-form Method. For the slip-form method, the concrete shall be placed with an approved crawler-mounted, slip-form paver designed to spread, consolidate, and shape the freshly placed concrete in one complete pass of the machine so that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with requirements of the plans and specifications. The concrete should be placed directly on top of the joint assemblies to prevent them from moving when the paver moves over them. Side forms and finishing screeds shall be adjustable to the extent required to produce the specified pavement edge and surface tolerance. The side forms shall be of dimensions, shape, and strength to support the concrete laterally for a sufficient length of time so that no appreciable edge slumping will occur. Final finishing shall be accomplished while the concrete is still in the plastic state.

It is the intent of the specification to produce a high quality, dense, long lasting, and smooth pavement suitable for the high speed operations of roughness-sensitive heavy jet aircraft. This requires that all joints, and particularly all longitudinal joints, meet the specified tolerance throughout their length. The Engineer will designate the paving lanes in an apron, taxiway, or the outer runway paving lanes to be used for the

initial paving operations. In the event that slumping or sloughing occurs behind the paver or if there are any other structural or surface defects which, in the opinion of the Engineer, cannot be corrected within permissible tolerances, the Engineer may halt paving operations until proper adjustment of the equipment or procedures have been made. In the event that satisfactory procedures and pavement are not achieved after not more than 2,000 lineal feet of single lane paving, the contractor shall complete the balance of the work with the use of standard metal forms and the formed method of placing and curing.

501-3.11 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT.

Following the placing of the concrete, it shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale, or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

501-3.12 JOINTS.

(a) General.

(1) Longitudinal and transverse joints. Longitudinal and transverse joints shall be constructed as indicated on the plans and in accordance with these requirements. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. Joints shall not vary more than 1/2 inch from a true line or from their designated position. The vertical surface of the pavement adjacent to all expansion joints shall be finished to a true plane and edged to a

radius of 1/4 inch or as shown on the plans. The surface across the joints shall be tested with a 10-foot straightedge as the joints are finished and any irregularities in excess of 1/4 inch shall be corrected before the concrete has hardened. When required, keyways shall be accurately formed with a template of metal or wood. The gauge or thickness of the material in the template shall be such that the full keyway, as specified, is formed and is in the correct location. Transverse joints shall be at right angles to the centerline of the pavement and shall extend the full width of the slab. The transverse joints in succeeding lanes shall be placed in line with similar joints in the first lane. All joints shall be so prepared, finished, or cut to provide a groove of the width and depth shown on the plans.

(2) Tie bars. Tie bars shall consist of deformed bars installed principally in longitudinal joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals of 30 inches, unless otherwise specified. They shall be held in position parallel to the pavement surface and midway between the surfaces of the slab. When tie bars extend into an unpaved lane, they may be bent at right angles against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. These bars shall not be painted, greased, or enclosed in sleeves.

(3) Dowel bars. Dowel bars or other load transfer units of an approved type shall be placed across transverse or other joints in the manner as specified on the plans. They shall be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. A metal, or other type, dowel expansion cap or sleeve shall be furnished for each dowel bar used with expansion joints. These caps shall be substantial enough to prevent collapse and shall be placed on the ends of the dowels as shown on the plans. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be watertight. The portion of each dowel painted with rust preventative paint, as required under Section 501-2.7, shall be thoroughly coated with asphalt MC-70, or an approved lubricant, to prevent the concrete from binding to that portion of the dowel. If free-sliding plastic-coated or epoxy-coated steel dowels are used, a lubrication bond breaker shall be used except when approved pullout tests indicate it is not necessary. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

(4) Slip-form construction. For slip-form construction, the following shall apply: When keyed construction joints are called for, a

sheet metal keyway liner shall be required. The liner may remain in place permanently and become part of the keyed joint and shall be galvanized, copper clad, or of similar rust-resistant material, of sufficient stiffness to support the upper keyway flange. Two-piece hook bolts may be installed in either the male or female side of the keyed joint providing the installation is made without distorting the keyed dimensions or causing edge slump. If a bent tie bar installation is used, the tie bars shall be inserted through the sheet metal keyway liner only on the female side of the joint. The bent tie bar installation may cause breaking of some small amount of laitance where the bar goes through the liner when the exposed portion of the bar is bent for extension into the adjacent lane. In no case shall a bent tie bar installation for male keyways be permitted which will require chipping away of concrete to perform the straightening of the tie bar. Alternate methods of bar installation may be approved by the Engineer if the keyway can be formed to a tolerance of 1/4 inch in any dimension and without distortion or slumping of the top of the male flange. Transverse joints with dowels are accurately placed and not disturbed during concrete placement. Transverse dowels will require use of an apparatus to firmly hold the dowels perpendicular to the joint and parallel to the slab surface. During the concrete placement operation, it is advisable to place plastic concrete directly on the dowel assembly immediately prior to passage of the paver to help maintain dowel alignment. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Engineer.

(b) Installation. The top of an assembled joint device shall be set at the proper distance below the pavement surface and the elevation shall be checked. Such devices shall be set to the required position and line and shall be securely held in place by stakes or other means during the pouring and finishing of the concrete. The premolded joint material shall be placed and held in a vertical position; if constructed in sections, there shall be no offsets between adjacent units. Dowel bars shall be checked for exact position and alignment as soon as the joint device is staked in place, and the device shall be tested to determine whether it is firmly supported. The maximum permissible tolerance on dowel bar alignment in each plane, horizontal and vertical, shall not exceed 2 percent or 1/4 inch per foot of a dowel bar. The most effective way to obtain proper alignment is with well-fabricated dowel baskets and dowel assemblies. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by mechanical device approved by the Engineer.

When joints in concrete pavements are sawed, the joints shall be cut as shown on the plans. Equipment shall be as described in Section 501-3.1. The circular cutter shall be capable of cutting a groove in a straight line

and shall produce a slot at least 1/8 inch wide and to the depth shown on the plans. When shown on the plans or required by the specifications, the top portion of the slot or groove shall be widened by means of a second shallower cut or by suitable and approved beveling to provide adequate space for joint sealers. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing. Sawing shall be carried on both during the day and night as required. The joints shall be sawed at the required spacing consecutively in sequence of the concrete placement, unless otherwise approved by the Engineer.

(c) Longitudinal Joints.

(1) Construction. Longitudinal construction joints necessary for lane construction shall be formed against suitable side forms (usually made of steel) with or without keyways, as indicated in the plans. Wooden forms may be used under special conditions, when approved by the Engineer. When the concrete is placed using slip-form pavers, the keyway shall be formed in the plastic concrete by means of preformed metal keyway liners which are inserted during the slip-form operations to form the female side of the key and which may be left in place. The dimensions of the keyway forms shall not vary more than plus or minus 1/4 inch from the dimensions indicated and shall not deviate more than plus or minus 1/4 inch from the mid-depth of the pavement. Where butt-type joints with dowels are designated, the dowels for this type shall be painted and greased. The edges of the joint shall be finished with a grooving tool or edging tool, and a space or slot shall be formed along the joint of the dimensions, as indicated, to receive the joint sealing material. Longitudinal construction joints shall be sawed to provide a groove at the top conforming to the details and dimensions indicated on the plans. Provisions shall be made for the installation of tie bars as noted on the plans.

(2) Contraction or weakened-plane type. The longitudinal groove formed or sawed in the top of the slab shall be installed where indicated on the drawings. The groove shall be formed in the plastic concrete with suitable tools or material to obtain the width and depth specified, or it shall be sawed with approved equipment in the hardened concrete to the dimensions required. When the groove is formed in plastic concrete, it shall be true to line with not more than 1/4-inch variation in 10 feet; it shall be uniform in width and depth; and the sides of the groove shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The sawed groove shall be straight and of uniform width and depth. In either case, the groove shall be clean so that spalling will be avoided at intersections with transverse joints. Tie bars shall be installed across these joints where indicated on the plans.

(3) Expansion. Longitudinal expansion joints shall be installed as indicated on the plans. The premolded filler, of the thickness as shown on the plans, shall extend for the full depth and width of the slab at the joint, except for space for sealant at the top of the slab. The filler shall be securely staked or fastened into position perpendicular to the proposed finished surface. A metal cap shall be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has been placed and struck off, the cap shall be carefully withdrawn leaving the space over the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic.

(d) Transverse Joints.

(1) Expansion. Transverse expansion joints shall be installed at the locations and spacing as shown on the plans. The joint shall be installed at right angles to the centerline and perpendicular to the surface of the pavement. The joints shall be installed and finished to insure complete separation of the slabs. Expansion joints shall be of a premolded type conforming to these specifications and with the plans and shall be the full width of the pavement strip.

All concrete shall be cleaned from the top of the joint material. Before the pavement is opened to traffic, this space shall be swept clean and filled with approved joint sealing material.

All devices used for the installation of expansion joints shall be approved by the Engineer. They shall be easily removable without disturbing the concrete and held in proper transverse and vertical alignment. Immediately after forms are removed, any concrete bridging the joint space at the ends shall be removed for the full width and depth of the joint.

When specified, expansion joints shall be equipped with dowels of the dimensions and at the spacing and location indicated on the plans. The dowels shall be firmly supported in place and accurately aligned parallel to the subgrade and the centerline of the pavement by means of a dowel assembly which will remain in the pavement and will ensure that the dowels are not displaced during construction.

Other types of load-transfer devices may be used, when approved by the Engineer.

(2) Contraction. Transverse contraction joints, weakened-plane joints, or both, shall be installed at the locations and spacing as shown on the plans. These joints will be installed by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has

hardened in the same manner as specified in Section 501-3.12(c) (2). Dowel bar assemblies shall be installed, when required, as shown on the plans.

(3) Construction. Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. When the installation of the joint can be planned in advance, it shall be located at a contraction or expansion joint. The joint shall not be allowed within 8 feet of a regular spaced transverse joint. If the pouring of the concrete has stopped, causing a joint to fall within this limit, it shall not be installed, and the fresh placed concrete shall be removed back to the 8 foot limit.

501-3.13 FINAL STRIKE-OFF, CONSOLIDATION, AND FINISHING.

(a) Sequence. The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straightedging, and final surface finish. The addition of superficial water to the surface of the concrete to assist in finishing operations generally will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

(b) Finishing at Joints. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material; it shall be firmly placed without voids or segregation under and around all load-transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as required in Section 501-3.10. After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be operated in a manner to avoid damage or misalignment of joints. If uninterrupted operations of the finishing machine, to, over, and beyond the joints, cause segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the screed is approximately 8 inches from the joint. Segregated concrete shall be removed from the front of and off the joint; the screed shall be lifted and set directly on top of the joint, and the forward motion of the finishing machine shall be resumed. Thereafter, the finishing machine may be run over the joint without lifting the screed, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

(c) Machine Finishing. The concrete shall be spread as soon as it is placed, and it shall be struck off and screeded by an approved finishing machine. The machine shall go over each area as many times and at such intervals as necessary to give the proper consolidation and to leave a surface of uniform texture. Excessive operation over a given area

shall be avoided. When side forms are used, the tops of the forms shall be kept clean by an effective device attached to the machine, and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish. During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. When in operation, the screed shall be moved forward with a combined longitudinal and transverse shearing motion, always moving in the direction in which the work is progressing, and so manipulated that neither end is raised from the side forms during the striking-off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

(d) Hand Finishing. Hand finishing methods will not be permitted, except under the following conditions: In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade; in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete when reinforcement is used.

The screed for the surface shall be at least 2 feet longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and shall be constructed either of metal or of other suitable material covered with metal. Consolidation shall be attained by the use of a suitable vibrator.

(e) Floating. After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated by means of a longitudinal float, using one of the following methods.

(1) Hand Method. The hand-operated longitudinal float shall not be less than 12 feet in length and 6 inches in width, properly stiffened to prevent flexibility and warping. The longitudinal float, operated from foot bridges resting on the side forms and spanning but not touching the concrete, shall be worked with a sawing motion, while held in a floating position parallel to the pavement centerline and passing gradually from one side of the pavement to the other. Forward movement along the centerline of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or soupy material shall be wasted over the pavement edge on each pass.

(2) Mechanical Method. The contractor may use a machine composed of a cutting and smoothing float(s), suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels riding on, and constantly in contact with, the side forms or

pavement subgrade. If necessary, long-handled floats having blades not less than 5 feet in length and 6 inches in width may be used to smooth and fill in open-textured areas in the pavement. Long-handled floats shall not be used to float the entire surface of the pavement in lieu of mechanical methods. When strike-off and consolidation are done by hand and the crown of the pavement will not permit the use of the longitudinal float, the surface shall be floated transversely by means of a long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge 10 feet or more in length. Successive drags shall be lapped one-half the length of the blade.

(f) Straight-edge Testing and Surface Correction. After the pavement has been struck off and consolidated and while the concrete is still plastic, it shall be tested for trueness with a 16-foot straightedge. For this purpose the contractor shall furnish and use an accurate 16-foot straightedge swung from handles 3 feet longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance shall be removed from the surface of the pavement. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

501-3.14 SURFACE TEXTURE. The surface of the pavement shall be finished with either a broom or burlap drag finish for all newly constructed concrete pavements.

(a) Brush or Broom Finish. If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 of an inch in depth. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. Any imperfections resulting from the texturing operation shall be corrected.

(b) Burlap Drag Finish. If a burlap drag is used to texture the pavement surface, it shall be at least 15 ounces per square yard. To obtain a rough-textured surface, the transverse threads of the burlap should be removed approximately 1 foot from the trailing edge. A heavy buildup of grout on the burlap threads produces the desired wide sweeping longitudinal striations on the pavement surface. The corrugations shall be uniform in appearance and approximately 1/16 of an inch in depth.

501-3.15 SKID RESISTANT SURFACES. A skid resistant surface shall be provided by construction of sawcut grooves unless otherwise specified.

Sawcut Grooves. For new concrete pavements that have hardened, transverse grooves shall be saw-cut in the pavement forming a 1/4 inch by 1/4 inch by 1-1/4 inches configuration. The grooves shall be continuous for the entire runway length. They shall be saw-cut transversely in the runway pavement to within 10 feet of the runway pavement edge to allow adequate space for equipment operation. The maximum transverse saw-cut grooves shall not exceed 130 feet. The tolerances for the saw-cut grooves shall meet the following:

Alignment tolerance:

Plus or minus 1 1/2 inches in alignment for 75 feet.

Groove tolerance:

Minimum depth 3/16 inch.

Maximum depth 5/16 inch.

Minimum width 3/16 inch.

Maximum width 5/16 inch.

Center-to-center spacing:

Minimum spacing 1 1/4 inches

Maximum spacing 2 inches.

Saw-cut grooves shall not be closer than 3 inches to transverse paving joints. Grooves may be continued through longitudinal construction joints. Cleanup of waste material shall be continuous during the grooving operation. Waste material may be disposed of by either flushing with water, sweeping, or vacuuming. Waste material must not be allowed to enter the airport storm or sanitary sewer system.

501-3.16 SURFACE TEST. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 16-foot straightedge or other specified device. Areas in a slab showing high

spots of more than 1/4 inch but not exceeding 1/2 inch in 16 feet shall be marked and immediately ground down with an approved grinding machine to an elevation that will fall within the tolerance of 1/4 inch or less. Where the departure from correct cross section exceeds 1/2 inch, the pavement shall be removed and replaced at the expense of the contractor when so directed by the Engineer.

Any area or section so removed shall not be less than 10 feet in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 10 feet in length shall also be removed and replaced.

501-3.17 CURING. Immediately after the finishing operations have been completed and marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured in accordance with one of the methods below. In all cases in which curing requires the use of water, the curing shall have prior right to all water supply or supplies. Failure to provide sufficient cover material of whatever kind the contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period. The following are alternate approved methods for curing concrete pavements.

(a) Impervious Membrane Method. The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of 1 gallon to not more than 150 square feet. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed, but approved means shall be used to insure proper curing for 72 hours. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface.

(b) Polyethylene Films. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting.

The units shall be lapped at least 18 inches. The sheeting shall be placed and weighted to cause it to remain in contact with the surface covered. The sheeting shall have dimensions that will extend at least twice the thickness of the pavement beyond the edges of the pavement. Unless otherwise specified, the sheeting shall be maintained in place for 72 hours after the concrete has been placed.

(c) Waterproof Paper. The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least 18 inches. The paper shall be placed and weighted to cause it to remain in contact with the surface covered. The paper shall have dimensions that will extend at least twice the thickness of the pavement beyond the edges of the slab. The surface of the pavement shall be thoroughly wetted prior to placing of the paper. Unless otherwise specified, the paper shall be maintained in place for 72 hours after the concrete has been placed.

(d) White Burlap-Polyethylene Sheets. The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully wetted and in position for 72 hours after the concrete has been placed.

(e) Curing in Cold Weather. When the average daily temperature is below 40 degrees F, curing shall consist of covering the newly laid pavement with not less than 12 inches of loose, dry hay or straw, or equivalent protective curing authorized by the Engineer, which shall be retained in place for 10 days. The hay or straw shall be secured to avoid being blown away. Admixture for curing or temperature control may be used only when authorized by the Engineer.

When concrete is being placed and the air temperature may be expected to drop below 35 degrees F, a sufficient supply of straw, hay, grass, or other suitable blanketing material such as burlap or polyethylene shall be provided along the work. Any time the temperature may be expected to reach the freezing point during the day or night, the material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. The period of time such protection shall be maintained shall not be less than 10 days. A minimum of 3 days is required when high, early strength concrete is used. The contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the contractor's expense.

501-3.18 REMOVING FORMS. Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has set for at least

12 hours, except where auxiliary forms are used temporarily in widened areas. Forms shall be removed carefully to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated in Section 501-3.17. Major honeycombed areas shall be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than 10 feet in length nor less than the full width of the section of pavement, any remaining portion of the slab adjacent to the joints that is less than 10 feet in length shall also be removed and replaced.

501-3.19 SEALING JOINTS. The joints in the pavement shall be sealed in accordance with Item 605.

501-3.20 PROTECTION OF PAVEMENT. The contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the contractor's employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, or crossovers, etc. The plans or special provisions will indicate the location and type of device or facility required to protect the work and provide adequately for traffic. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the contractor's expense. In order that the concrete be properly protected against the effects of rain before the concrete is sufficiently hardened, the contractor will be required to have available at all time materials for the protection of the edges and surfaces of the unhardened concrete. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

501-3.21 OPENING TO TRAFFIC. The Engineer shall decide when the pavement shall be opened to traffic. The pavement will not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained the specified strength when tested in accordance with ASTM C39 or C78 as required. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening to traffic, the pavement shall be cleaned.

501-3.22 SURFACE TOLERANCES. Extreme care must be exercised in all phases of the operation to assure the pavement will pass the specified tolerances. The following tolerances are applicable:

(a) Lateral deviation from established alignment of the pavement edge shall not exceed plus or minus 0.10 foot in any lane.

(b) Vertical deviation from established grade shall not exceed plus or minus 0.04 foot at any point.

(c) Surface smoothness deviations shall not exceed 1/4 inch from a 16-foot straightedge placed in any direction, including placement along and spanning any pavement joint or edge.

METHOD OF MEASUREMENT

501-4.1 The quantity to be paid for shall be the number of square yards of either plain or reinforced pavement as specified, in place, completed and accepted.

BASIS OF PAYMENT

501-5.1 GENERAL. The accepted quantities of concrete pavement will be paid for at the contract unit price per square yard which price and payment shall be full compensation for furnishing and placing all materials, including any dowels, steel reinforcement, joint material, and texturing, except for saw-cut grooving and for preparing test specimens for laboratory testing.

501-5.2 Grooving shall be paid for at the contract unit price per square foot which price and payment shall be full compensation for furnishing all tools, equipment, labor and materials necessary to complete the item.

Payment will be made under:

Item 501-5.10 P C Concrete Pavement -
per square yard.

Item 501-5.20 Grooving - per square foot.

501-5.3 Price Adjustment

(A) Thickness adjustment. Where the average thickness of pavement is deficient in thickness by more than 0.2 inch but not more than 1.0 inch, payment will be made at an adjusted price as specified in Table 3.

TABLE 3. PAVEMENT DEFICIENCY

Deficiency in Thickness Determined by Cores (Average of 3 tests)	Proportional Part of Contract Price Allowed (Q _t)
Inches	Percent
0.00 to 0.20	100
0.21 to 0.30	80
0.31 to 0.40	72
0.41 to 0.50	68
0.51 to 0.75	57
0.76 to 1.00	50

When the thickness of pavement is deficient by more than 1 inch and in the judgment of the Engineer the area of such deficiency should not be removed and replaced, there shall be no payment for the area retained. The Contractor may, at his option, remove such thin pavement and replace it with pavement of the specified thickness. The replacement pavement will be paid for at the contract unit price per square yard and no payment will be made for the thin pavement, which is removed nor for the cost of removing it.

(B) Flexural Strength Adjustment. When any pay factor for concrete is less than 1.00, payment for the material represented by deficient test results shall be made at a reduced price arrived at by multiplying the contract price per unit of measurement by the appropriate pay factor. If pay factors for payment thickness deficiency and flexural strength deficiency are both used for any given area the reduced price will be determined by successively multiplying the contract unit price by both pay factors.

Any test result below 700 psi will be adjusted as follows:

$$X_a = \frac{X}{0.964}$$

Where: X_a = Adjusted test result

X = Actual test result

The flexural deficiency pay factor shall be computed as follows:

$$Q_f = \frac{\bar{X}}{700}$$

Where: Q_f = pay factor

\bar{X} = average of 4 consecutive test results (use adjusted test result(s) if the actual test was below 700 psi)

(C) Compressive Strength Adjustment. When any pay factor is less than 1.00, pay for the material represented by deficient test results shall be made at a reduced price arrived at by multiplying the contract price per unit of measurement by the appropriate pay factor. If pay factors for pavement thickness deficiency and compressive strength deficiency are both used for any given area, the reduced price will be determined by successively multiplying the contract unit price by both pay factors.

The Compressive Deficiency Pay Factor shall be computed as follows:

$$Q_C = \frac{\bar{X}}{4000}$$

Where: Q_C = Pay Factor

\bar{X} = Average of 4 consecutive test results

MISCELLANEOUS

ITEM 602 BITUMINOUS PRIME COAT

DESCRIPTION

602-1.1 This item shall consist of an application of bituminous material on the prepared base course in accordance with this specification applied at the rate specified by the Project Engineer. The type of bituminous material to be used shall be selected by the Project Engineer from those included in this specification.

602-1.2 QUANTITIES OF BITUMINOUS MATERIAL. The approximate amount of bituminous material per square yard for the prime coat shall be as provided in the Table 1.

TABLE 1. QUANTITIES OF MATERIAL

Material	Amount
Bituminous Material	0.20 to 0.40 gallon per square yard

MATERIALS

602-2.1 BITUMINOUS MATERIAL. The types, grades, controlling specifications, and application temperatures for the bituminous materials are given below. The Project Engineer shall designate the specific material to be used.

LIQUID ASPHALT	SPECIFICATION	APPLICATION TEMPERATURES
RC-70	ASTM D 2028	120° - 160° F.
MC-70	ASTM D 2027	120° - 160° F.
SC-70	ASTM D 2026	120° - 160° F.
RC-250	ASTM D 2028	160° - 200° F.
MC-250	ASTM D 2027	160° - 200° F.
SC-250	ASTM D 2026	160° - 200° F.

CONSTRUCTION METHODS

602-3.1 WEATHER LIMITATIONS. The prime coat shall be applied only when the existing surface is dry or contains sufficient moisture to get uniform distribution of the bituminous material, when the atmospheric temperature is above 60° F., and when the weather is not foggy or rainy. The temperature requirements may be waived, but only when so directed by the Resident Engineer in writing.

602-3.2 EQUIPMENT. The equipment used by the contractor shall include a self-powered pressure bituminous material distributor and equipment for heating bituminous material.

The distributor shall have pneumatic tires of such width and number that the load produced on the surface shall not exceed 650 pounds per inch of tire width and shall be designed, equipped, and operated so that bituminous material at even heat can be applied uniformly on variable widths of surface at readily controlled rates from 0.05 to 2.0 gallons per square yard. The material shall be applied within a pressure range from 25 to 75 pounds per square inch and with an allowable variation from any specified rate not to exceed 5%. Distributor equipment shall include a thermometer for reading temperatures of tank contents.

602-3.3 APPLICATION OF BITUMINOUS MATERIAL. Immediately before applying the prime coat, the full width of the surface to be primed shall be swept with a power broom to remove all loose dirt and other objectionable material.

The application of the bituminous material shall be made by means of a pressure distributor at the temperature, pressure, and in the amounts directed by the Resident Engineer.

Following the application, the primed surface shall be allowed to dry not less than 48 hours without being disturbed or for such additional time as may be necessary to permit the drying out of the prime until it will not be picked up by traffic or equipment. This period shall be determined by the Resident Engineer. The surface shall then be maintained by the contractor until the surfacing has been placed. Suitable precautions shall be taken by the contractor to protect the primed surface against damage during this interval, including supplying and spreading any sand necessary to blot up excess bituminous material.

602-3.4 BITUMINOUS MATERIAL CONTRACTOR'S RESPONSIBILITY. Samples of the bituminous materials that the contractor proposes to use, together with a statement as to their source and character, must be submitted and approved before use of such material begins. The contractor shall require the manufacturer or producer of the bituminous

materials to furnish material subject to this and all other pertinent requirements of the contract. Only satisfactory materials, so demonstrated by service tests, shall be acceptable.

The contractor shall furnish vendor's certified test reports for each carload, or equivalent, of bituminous material shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall not be interpreted as basis for final acceptance. All such test reports shall be subject to verification by testing samples of materials received for use on the project.

602-3.5 FREIGHT AND WEIGH BILLS. Before the final estimate is allowed, the contractor shall file with the Engineer receipted bills when railroad shipments are made, and certified weigh bills when materials are received in any other manner, of the bituminous materials actually used in the construction covered by the contract. The contractor shall not remove bituminous material from the tank car or storage tank until the initial outage and temperature measurements have been taken by the Resident Engineer, nor shall the car or tank be released until the final outage has been taken by the Resident Engineer.

Copies of freight bills and weigh bills shall be furnished to the Resident Engineer during the progress of the work.

METHOD OF MEASUREMENT

602-4.1 The bituminous prime coat to be paid for shall be the number of gallons of the material used as ordered for the accepted work, corrected to 60° F., in accordance with the temperature-volume correction tables for asphalt materials contained in ASTM D-1250.

BASIS OF PAYMENT

602-5.1 Payment shall be made at the contract unit price per gallon for bituminous prime coat. This price shall be full compensation for furnishing all materials and for all preparation, delivering, and applying the materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item 602-5.10 Bituminous Prime Coat - per gallon.

ITEM 603 BITUMINOUS TACK COAT

DESCRIPTION

603-1.1 This item shall consist of supplying and applying bituminous material to a previously prepared, bonded and/or bituminized binder, leveling, or base course or existing pavement in accordance with these specifications and to the width shown on the typical cross section on the plans.

603-1.2 QUANTITY OF MATERIAL. The approximate amount of bituminous material per square yard for the tack coat shall be as provided in the Table 1. The exact amount shall be as ordered by the Resident Engineer.

TABLE 1. QUANTITY OF MATERIAL

Material	Amount
Bituminous Material Including Vehicle or Solvent	0.05 to 0.15 gal. per sq. yd.

MATERIALS

603-2.1 BITUMINOUS MATERIAL. The types, grades, controlling specifications, and application temperatures for the bituminous materials follow. The Project Engineer shall designate the specific material to be used.

TYPE AND GRADE	SPECIFICATION	APPLICATION TEMPERATURES
Cutback Asphalt		
RC-70	ASTM D 2028	120° - 160° F.
MC-70	ASTM D 2027	120° - 160° F.
SC-70	ASTM D 2026	120° - 160° F.

CONSTRUCTION METHODS

603-3.1 WEATHER LIMITATIONS. The tack coat shall be applied only when the existing surface is dry, when the atmospheric temperature is

above 60° F., and when the weather is not foggy or rainy. The temperature requirements may be waived, but only when so directed by the Engineer in writing.

603-3.2 EQUIPMENT. The equipment used by the contractor shall include a self-powered pressure bituminous material distributor and equipment for heating bituminous material.

The distributor shall have pneumatic tires of such width and number that the load produced on the surface shall not exceed 650 pounds per inch of tire width, and it shall be designed, equipped, and operated so that bituminous material at even heat may be applied uniformly on variable widths of surface at readily controlled rates from 0.05 to 2.0 gallons per square yard. The material shall be applied within a pressure range of 25 to 75 pounds per square inch and with an allowable variation from any specified rate not to exceed 5%. Distributor equipment shall include a tachometer, pressure gauges, volume-measuring devices, and a thermometer for reading temperatures of tank contents.

603-3.3 APPLICATION OF BITUMINOUS MATERIAL. Immediately before applying the tack coat, the full width of surface to be treated shall be swept with a power broom to remove all loose dirt and other objectionable material.

The application of the bituminous material shall be made by means of a pressure distributor at the pressure, temperature, and in the amounts directed by the Resident Engineer.

Following the application, the surface shall be allowed to cure without being disturbed for such period of time as may be necessary to permit drying out and setting of the tack coat. This period shall be determined by the Resident Engineer. The surface shall then be maintained by the contractor until the next course has been placed. Suitable precautions shall be taken by the contractor to protect the surface against damage during this interval, including any sand necessary to blot up excess bituminous material.

603-3.4 BITUMINOUS MATERIAL CONTRACTOR'S RESPONSIBILITY. Samples of the bituminous material that the contractor proposes to use, together with a statement as to its source and character, must be submitted and approved before use of such material begins. The contractor shall require the manufacturer or producer of the bituminous material to furnish material subject to this and all other pertinent requirements of the contract. Only satisfactory materials so demonstrated by service tests, shall be acceptable.

The contractor shall furnish vendor's certified test reports for each carload, or equivalent, of bituminous material shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's

certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All such test reports shall be subject to verification by testing samples of material received for use on the project.

603-3.5 FREIGHT AND WEIGH BILLS. Before the final estimate is allowed, the contractor shall file with the Engineer receipted bills when railroad shipments are made, and certified weigh bills when materials are received in any other manner, of the bituminous materials actually used in the construction covered by the contract. The contractor shall not remove bituminous material from the tank car or storage tank until the initial outage and temperature measurements have been taken by the Resident Engineer, nor shall the car or tank be released until the final outage has been taken by the Resident Engineer.

Copies of freight bills and weigh bills shall be furnished to the Resident Engineer during the progress of the work.

METHOD OF MEASUREMENT

603-4.1 The bituminous tack coat to be paid for shall be the number of gallons of the material used as ordered for accepted work, corrected to 60° F., in accordance with the temperature-volume correction tables for asphalt, and asphaltic emulsion materials, contained in ASTM D-1250.

BASIS OF PAYMENT

603-5.1 Payment shall be made at the contract unit price per gallon of bituminous tack coat. This price shall be full compensation for furnishing all materials and for all preparation, delivering, and application of these materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 603-5.10 Bituminous Tack Coat - per gallon.

ITEM 605 JOINT SEALING FILLER

DESCRIPTION

605-1.1 This item shall consist of a resilient and adhesive joint sealing filler capable of effectively sealing joints and cracks in portland cement concrete pavements and structures.

MATERIALS

605-2.1 JOINT SEALING MATERIALS. The joint sealing materials shall conform to one or more of the types listed below for all joints as specified by the Project Engineer.

(a) Federal Specification SS-S-200D, Type H - Sealing Compounds, Two-Component, Elastomeric, Polymer Type, Jet-Fuel-Resistant, Cold Applied.

(b) ASTM D1854 - Jet-Fuel-Resistant Concrete Joint Sealer, Hot-Poured Elastic Type.

(c) ASTM D3405 - Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements on Taxiways and Runways only.

(d) ASTM D3581 - Joint Sealant, Hot-Poured, Jet-Fuel-Resistant type for Portland Cement Concrete Pavements.

Each lot or batch of sealing compound, as specified, shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, batch or lot number, and the safe heating temperature and shall be accompanied by the manufacturer's certification stating that the compound meets the requirements of this specification.

Mixing of components, temperature and application of the above joint sealing materials shall be as recommended by the manufacturer.

(e) ASTM D2628 - Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements for all contraction and expansion joints and longitudinal dummy groove joints.

The size and dimensional tolerances of the joint sealer shall be as shown on the drawings or as specified. The sealer shall consist of preformed strips which shall be heat and blast-resistant and shall not support combustion. They shall be oil and jet-fuel resistant also. Unless detailed on the plans, the shape of any joint sealer, from any manufacturer, shall

be approved by the Engineer prior to delivery to the job site. Such approval shall be requested in writing and shall be accompanied by a 15-foot length of the proposed sealer.

When approved, the material as delivered to the job shall be accompanied by the manufacturer's certification stating that it meets the requirements of ASTM D-2628, except that specimens for the high-temperature recovery test (70 hours/212° F.) shall be tested as received, without talc dusting. The hardness test (type A durometer) shall be made using sufficient plies of buffed samples to achieve the minimum required sample thickness. Samples shall be of sufficient width and length to cover the testing shoe.

The manufacturer shall also certify that, when tested at 70°, ± 5° F. the sealer will resist compression when properly aligned between parallel plates by exerting a pressure of at least 4 pounds per lineal inch when compressed to 80% of its nominal width, and no more than 12 pounds per lineal inch when compressed to 50% of its nominal width.

The lubricant used to install the preformed elastic joint sealer shall be a one-component polychloroprene compound containing only soluble phenolic resins blended together with anti-oxidants and acid acceptors in aromatic hydrocarbon solvent mixture and shall have the following physical properties:

Average net weight per gallon - 7.84 lbs.
Solids Content - 22-28%, by weight.

The viscosity shall be such that the lubricant will perform suitably with the installation equipment.

The lubricant shall remain fluid from 5° F. to 120° F.

Film strength (ASTM D-412) - 2,300 psi minimum tensile strength, 750% minimum elongation before breaking.

The lubricant shall be stored at a temperature of 50° F. to 80° F. Any lubricant not used within 270 days of its manufacture shall be unacceptable.

Each lot of the lubricant shall be delivered in containers plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture and shall be accompanied by the manufacturer's certification as to conformance to this specification.

The Engineer reserves the right to sample and test this material in accordance with ASTM D 2835 subsequent to delivery at the project site.

CONSTRUCTION METHODS

605-3.1 TIME OF APPLICATION. The joints shall be sealed immediately following the curing period or as soon thereafter as weather conditions permit, and before the pavement is opened to traffic, including construction traffic. At the time of application of the sealing compound, the atmospheric and pavement temperature shall be above 40° F. for the installation of preformed joint seal and above 50° F. for application of poured joint sealing material. The weather shall not be rainy or foggy. The temperature requirements may be waived only when so directed by the Engineer in writing.

605-3.2 EQUIPMENT. All equipment necessary for the proper construction of this work shall be on the project and in first-class working condition. The equipment shall be as recommended by the manufacturer of the filler and approved by the Engineer before construction is permitted to start.

The heating apparatus for Hot-Poured sealers shall consist of a heating kettle or tank, constructed as a double boiler, with a space between the inner and outer shells filled with oil, asphalt, or other material for heat transfer. The heater shall be equipped to provide positive temperature control of the sealing material. Direct methods of heating shall not be permitted. The material shall not be heated in excess of the temperature recommended by the manufacturer. Once the material has been heated, it shall be maintained at an even temperature until placed into the joint.

The joint-pouring equipment for Hot or Cold-Poured sealers shall consist of a mechanical-pouring kettle mounted on wheels with a pouring shoe or the pouring shoe may be mounted on a swivel jointed discharge line at the rear of a truck on which the mixing or heating unit is carried. A hand pouring pot shall not be allowed.

The joint sealing equipment for Cold-Poured sealers of two or more components shall consist of a power-driven apparatus capable of extruding the material as a continuous feed. The extruding nozzle tip of the machine shall be of such design as to fill the groove uniformly from the bottom to the top. The joint-sealing machine shall include a mechanical mixer capable of thoroughly mixing the sealing components into a uniform, homogeneous mass.

The installation equipment for the Preformed Elastomeric Joint Material shall be capable of installing the sealer in the upright position, without cutting, nicking, distorting, or otherwise damaging the seal. Lubricant shall be applied to the concrete or the preformed seal, or both, and the

seal shall be installed in a substantially compressed condition and at the depth below the surface of the pavement as shown in the plans. The method of installation shall be such that the joint sealer will not be stretched more than 5 percent of the minimum theoretical length, or compressed more than 2 percent. The method of installation shall be checked for stretching or compression, using transverse joint sealer. The check shall consist of installing sealer in five joints of at least 25 feet in length, removing the sealer immediately after installation, and checking the length. This check may be modified by premarking or precutting the sealer to length prior to installation if this is compatible with the equipment being used. If the measured length of any of these five sealers indicates that the sealer is stretched or compressed beyond these limits, the installation shall be modified to correct the situation. Once satisfactory sealing operations have started, one joint length per every hundred shall be removed and checked. If the limits are exceeded, the joint sealers on either side should be removed until the condition disappears. The affected joints shall be resealed in a satisfactory manner at no cost to the owner, and the method of installation shall be checked again for satisfactory procedure. The seal shall be installed in the longest practicable lengths in longitudinal joints and shall be cut at the joint intersections for continuous installation of the seal in the transverse joints.

The equipment for cleaning joint openings shall consist of such plows, powered and hand brooms or wire brushes, air compressors, sand blasters, and, if necessary, joint cleaning and grooving machines as are necessary to produce a satisfactory clean and dry joint. Similar equipment shall be provided for cleaning joints previously sealed.

605-3.3 PREPARATION OF JOINTS. Immediately before filling, the joints shall be thoroughly cleaned of all laitance, curing compound, protrusions of hardened concrete, dirt, dust, and other objectionable material and the faces of the joints shall be dry.

When joints are to be resealed, the existing joint material shall be removed to the depth as shown on the plans or as directed. When joints are to be resealed with joint sealer other than that originally used, it will be necessary to remove all existing joint sealer and asphalt stains from the joint opening. It may be necessary to widen the joint with a grooving machine so that the joint sealer will develop a satisfactory bond with the clean concrete.

When it is necessary to seal random cracks, they shall be cut, grooved, and cleaned in a manner satisfactory for sealing by methods and equipment similar to that used for the joints.

Joints which are to be sealed with Preformed Elastomeric Joint Material shall be constructed to the width, depth, and shape shown on the plans or as specified. Maximum tolerances shall be $\pm 1/16$ inch for width or beveled edge, and $\pm 1/8$ inch for depth. When contraction joints greater than $3/8$ inch in width are constructed in two stages, the second-stage sawing shall not be done sooner than 72 hours after the concrete at the joint has been placed.

If the joint has opened $1/16$ inch or more as measured at the slab edge at the time of final sawing, the sawed width shall be increased so that the net width will meet the above tolerance when the joint is closed. Any irregularity in the joint face resulting from tearing, spalls, saw misalignment, etc., and which would prevent contact between the lip of the sealer and the joint face, shall be corrected prior to installation of the sealer.

The contractor shall not install any joint sealer material until the Resident Engineer has inspected and approved the condition of the joints immediately prior to the installation of the sealer.

605-3.4 PLACING JOINT SEALER. Sufficient joint sealer shall be placed into the joints so that upon completion of the work, the surface of the sealer in the joint shall be within $1/4$ inch but below the level of the adjacent pavement surface, or at the elevation as directed by the Resident Engineer. The contractor shall "spot up" or refill all unsatisfactory joints before final acceptance. Any excess filler on the surface of the pavement shall be removed and the surface shall be left in a clean condition.

The Preformed Elastomeric Joint Sealer shall be installed in the joints and thoroughly secured in place with the lubricant which shall cover both sides of the sealer over the full area in contact with the sides of the concrete joint. The lubricant may be applied to the concrete or sealer or both. For beveled joints the sealer shall be installed in a compressed condition at the depth of not less than $1/16$ inch nor more than $3/16$ inch below the bottom edge of the bevel. For joints with vertical sides, the joint sealer shall be installed in a compressed condition at a depth of $1/4$ inch $\pm 1/16$ inch, below the level of the pavement surface.

In transverse joints the minimum length of sealer without cuts or splices shall be 25 feet. Sealer shall not be spliced between adjacent joints or slab edge. Where different sizes of sealer intersect, the larger may be notched to accommodate a thorough installation of the smaller.

605-3.5 FIELD TEST. Before sealing the joints, the contractor shall be required to demonstrate that the equipment and procedures for preparing, mixing, and placing the sealing compound will produce a

satisfactory joint seal. The demonstration shall include a preparation of at least two small batches and the application of the resulting material. During the course of the work, any batches that do not have good consistency for application shall be rejected.

METHOD OF MEASUREMENT

605-4.1 The joint sealing filler to be paid for shall be the lineal feet of filler or sealer as specified, in place, complete and accepted. When required in the construction of new concrete pavements or structures, no measurement will be made for direct payment of filler, as the cost of furnishing and installing shall be considered as a subsidiary obligation in the completion of the construction of the concrete pavement.

BASIS OF PAYMENT

605-5.1 Payment will be made at the contract unit price per lineal feet for joint sealing filler except in those cases when the cost of sealing the joints is to be considered a subsidiary obligation in the completion of the concrete pavement. This price shall be full compensation for furnishing all materials and for all preparation, delivering, and application of these materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 605-5.10 Joint Sealing Filler - per lin. ft.

Item 605-5.20 Preformed Elastic Sealer - per lin. ft.

ITEM 609 SEAL COATS AND BITUMINOUS
SURFACE TREATMENTS

DESCRIPTION

609-1.1 This item shall consist of a bituminous surface treatment as a wearing course composed of single (seal coat) or multiple applications of bituminous material and aggregate cover placed on the prepared primed base or properly cured wearing surface, in accordance with these specifications, and shall conform to the dimensions and typical cross section shown on the plans, and with lines and grades established by the Resident Engineer.

609-1.2 QUANTITIES OF MATERIALS PER SQUARE YARD. The approximate amounts of materials per square yard for the bituminous surface treatment shall be as provided in Table 1 for the treatment specified on the plans or in the special provision. The exact amounts to be used shall be determined by the Resident Engineer.

TABLE 1. QUANTITIES OF MATERIALS

MATERIALS	AMOUNTS
<u>First Application:</u>	
Bituminous material	0.15 to 0.25 gallon per square yard.
Aggregate material	35 to 55 pounds per square yard.
<u>Second Application:</u>	
Bituminous material	0.30 to 0.50 gallon per square yard.
Aggregate material	20 to 35 pounds per square yard.
<u>Third Application:</u>	
Bituminous material	0.20 to 0.30 gallon per square yard.
Cover aggregate material	10 to 20 pounds per square yard.

MATERIALS

609-2.1 AGGREGATE MATERIALS. The aggregate material shall be either crushed stone or crushed gravel. The cover material shall be screenings; sand may be used when specified.

If the material is to be crushed stone, it shall be manufactured from sound, hard, durable rock of accepted quality and crushed to specification size. All strata, streaks, and pockets of clay, dirt, sandstone, soft rock, or other unsuitable material accompanying the sound rock shall be discarded and not allowed to enter the crusher.

If the material is to be crushed gravel, it shall consist of hard, durable, fragments of stone or gravel of accepted quality and crushed to specification size. All strata, streaks, and pockets of sand, excessively fine gravel, clay, or other unsuitable material including all stones, rocks, and boulders of inferior quality shall be discarded and not allowed to enter the crusher. The crushing of the gravel shall result in a product in which the material retained on the separate No. 4, 3/8 inch, and 1/2 inch sieves shall have at least 75% of particles with at least one fractured face.

The crushed aggregate shall not contain more than 8%, by weight, of elongated or flat pieces and shall be free from wood, roots, vegetable, organic, or other extraneous matter. The crushed coarse aggregate shall have a percentage of wear not more than 45 at 500 revolutions, as determined by ASTM C 131 (Los Angeles Rattler Test).

The aggregate shall show no evidence of disintegration nor show a total loss greater than 15% when subjected to five cycles of the sodium sulphate accelerated soundness test specified in ASTM C 88.

The crushed aggregate for the applications shall meet the requirements for gradation given in Table 2 when tested in accordance with ASTM C 117 and C 136.

TABLE 2. REQUIREMENTS FOR GRADATION OF AGGREGATE

Aggregate for First Application

Sieve Designation (square openings)	Percentage by Weight passing sieves
1 inch	100
3/4 inch	90-100
1/2 inch	40-70
No. 4	5-15
No. 16	0-6
(IDOT Gradation)	(CA-11)

Aggregate for Second Application

Sieve Designation (square openings)	Percentage by Weight passing sieves
1/2 inch	100
3/8 inch	94-100
No. 4	15-45
No. 16	0-4
(IDOT Gradation)	(CA-16)

Aggregate for Third Application

Sieve Designation (square openings)	Percentage by Weight passing sieves
3/8 inch	100
No. 4	45-85
No. 16	25-65
No. 50	10-30
No. 200	5-15
(IDOT Gradation)	(CA-17)

The gradations in the table represent the limits which shall determine suitability of aggregate for use for the specified applications from the sources of supply. The final gradations decided on, within the limits designated in the table, shall be uniformly graded from coarse to fine.

The cover aggregate used in the third application shall be a light-colored material whose color and reflectivity shall be approved by the Engineer.

The aggregate to be used shall show no evidence of stripping when tested in accordance with ASTM D 1664. The use of antistripping agents for the control of stripping shall be used if necessary.

609-2.2 BITUMINOUS MATERIAL. The types, grades, controlling specifications, and application temperatures for the bituminous materials are given below. The Project Engineer shall designate the specific material to be used.

TYPE AND GRADE	SPECIFICATION	TEMPERATURE
Asphalt Cement		
120 - 150 penetration	ASTM D 946	285° - 350° F.
200 - 300 penetration	ASTM D 946	275° - 325° F.

609-3.1 WEATHER LIMITATIONS. Bituminous material shall not be applied to wet aggregate material or during sand, dust, or rain storms. The pavement shall be free of surface moisture during the contractor's operating periods.

In general, it will be the policy not to permit the application of any bituminous material when the atmospheric temperature is less than 70° F. and the Resident Engineer may require the contractor to delay the application of bituminous material until the atmospheric and pavement surface conditions are satisfactory. No bituminous material shall be placed which cannot be cured for during daylight hours.

609-3.2 OPERATION OF PITS AND QUARRIES. The aggregate material shall be obtained from approved sources. The contractor shall make all necessary arrangements for obtaining the material, and all work involved in clearing and stripping pits or quarries and handling unsuitable material shall be performed by the contractor at his own expense. The material in the pits shall be handled so that a uniform and satisfactory product shall be secured. Unless otherwise directed, pits shall be adequately drained and shall be left in a neat and presentable condition with all slopes dressed uniformly. Quarries shall be left as neat and presentable as practicable.

609-3.3 EQUIPMENT AND ORGANIZATION. Each unit required in the execution of these specifications shall be under the continuous supervision of a competent superintendent thoroughly experienced in this type of work. Experienced operators will be required on all equipment used in hauling and applying bituminous material and aggregates.

All equipment necessary to perform this work properly shall be on the project, in first-class working condition, and approved by the Resident Engineer before construction is permitted to start.

The following equipment will be the minimum required for this type of construction, and additional machinery shall be secured if, in the opinion of the Resident Engineer, it is necessary to fulfill the conditions of these specifications or to complete the item within the time specified:

(a) The distributor shall have pneumatic tires of such width and number that the load produced on the pavement surface shall not exceed 650 pounds per inch of tire width and it shall be designed and operated so that bituminous material at even heat may be applied uniformly on variable widths of surface at readily controlled rates from 0.05 to 2.0 gallons per square yard. The bituminous material shall be applied within a pressure range of 25 to 75 pounds per square inch and with an allowable variation from any specified rate not to exceed 5%. Distributor equipment shall include a tachometer, pressure gauges, volumemeasuring devices, and a thermometer for reading temperatures of tank contents.

(b) The aggregate spreader shall be adjustable to spread accurately and evenly the required amounts per square yard.

(c) The steel-wheel rollers shall be of the self-propelled tandem or three-wheel type rollers. The wheels on the rollers shall be equipped with adjustable scrapers which shall be used when necessary to clean the wheel surfaces. Rollers shall be equipped with tanks and sprinkling apparatus which shall be used to keep the wheels wet and prevent the surfacing materials from sticking.

(d) The pneumatic roller shall consist of pneumatic tires arranged in a manner to provide a satisfactory compacting unit. The roller shall have an effective rolling width of at least 60 inches and shall give a compression of at least 275 pounds per inch of tread width when fully loaded.

(e) A power broom or power blower, broom dragging equipment, and equipment for heating aggregate shall be included, when needed.

The contractor shall supply such auxiliary equipment as needed and all equipment shall meet the approval of the Resident Engineer.

Bituminous binder and aggregate shall not be spread over a greater yardage than can be rolled and finished in one day's operation. The yardage over which the binder is spread in advance of placing the aggregate shall be as determined by the Resident Engineer.

609-3.4 PREPARING UNDERLYING COURSE. The surface of the underlying course shall be prepared, shaped, and conditioned to a uniform grade and section, as shown on the plans and as specified. Loose dirt and other objectionable material shall be removed from the surface.

On those type of bases where a prime coat is required and specified, the prime shall be applied and satisfactorily cured before starting the bituminous surface treatment.

When specified, the contractor shall be required to patch, with premixed material, any holes or other malformations deviating from the true cross section and grade. The premixed material shall be made of the bituminous material specified in the proposal or plans and prepared by the method as directed by the Resident Engineer. All small patches shall be thoroughly hand tamped while the large patches shall be rolled with a power or pneumatic roller.

609-3.5 APPLICATION OF BITUMINOUS MATERIAL. Bituminous material shall be applied upon the properly prepared surface at the rate and temperature specified using a pressure distributor to obtain uniform distribution at all points. To insure proper drainage, the strips shall

begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope. During all applications, the surfaces of adjacent structures shall be protected in such manner as to prevent their being spattered or marred. Bituminous materials shall not be discharged into borrow pits or gutters or upon the airport area.

609-3.6 APPLICATION OF AGGREGATE MATERIAL. Immediately after the application of the bituminous material or when directed, the aggregates at the rate specified for each designated application shall be spread uniformly over the bituminous material with the aggregate equipment specified. Trucks spreading aggregate shall be operated backward so that the bituminous material will be covered before the truck wheels pass over it. The aggregate shall be spread in the same width of application as the bituminous material and shall not be applied in such thickness as to cause blanketing. Back-spotting or sprinkling of additional aggregate material, and pouring additional bituminous material over areas that show up having insufficient cover or bitumen, shall be done by hand whenever necessary. Additional spreading of aggregate material shall be done by means of a motor-patrol grader equipped with broom moldboard, a broom drag, or a power broom, as directed by the Resident Engineer.

Power rollers shall be used immediately after the aggregate is spread. Following the rolling with the steel-wheel roller, the course shall be further rolled with a pneumatic roller to the satisfaction of the Resident Engineer to insure proper embedding into the bitumen. The rolling shall be continued until no more aggregate material can be worked into the surface. In the construction of the second and third application, blading with the wire-broom moldboard attachment or broom dragging shall begin as soon as possible after the rolling has started and after the surface has set sufficiently to prevent excessive marking. Further blading and rolling on the strip being placed and on adjacent strips previously placed, shall be done as often as necessary to keep the aggregate material uniformly distributed. These operations shall be continued until the surface is evenly covered and cured to the satisfaction of the Resident Engineer.

Succeeding applications shall not be applied until the preceding application has set and in no case until at least 24 hours have elapsed. If dust, dirt, or other foreign matter accumulates on the surface between the applications, the contractor shall be required to sweep and clean the surface as specified herein. The bituminous material and the aggregate shall be spread upon the clean and properly cured surface and handled as required. Extreme care shall be taken in all applications to avoid brooming or tracking dirt or any foreign matter on any portion of the pavement surface under construction.

All surplus aggregate from the final application shall be swept off the surface and removed prior to final acceptance of the work.

609-3.7 CORRECTION OF DEFECTS. Any defects, such as raveling, low centers, lack of uniformity, or other imperfections caused by faulty workmanship, shall be corrected to the satisfaction of the Resident Engineer.

All defective materials resulting from over-heating, improper handling, or application shall be removed by the contractor and replaced with approved materials as provided for in these specifications.

609-3.8 BITUMINOUS MATERIAL CONTRACTOR'S RESPONSIBILITY. Samples of the bituminous materials that the contractor proposes to use, together with a statement as to their source and character, shall be submitted and approval obtained before use of such materials begins.

The contractor shall furnish vendor's certified test reports for each carload, or equivalent, of bitumen shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All such test reports shall be subject to verification by testing sample materials as received for use on the project.

609-3.9 FREIGHT AND WEIGH BILLS. Before the final estimate is allowed the contractor shall file with the Engineer receipted bills where railroad shipments are made, and certified weight bills when materials are received in any other manner, of the bituminous and covering materials actually used in the construction covered by the contract. The contractor shall not remove bituminous material from the tank car or storage tank until the initial outage and temperature measurements have been taken by the Resident Engineer, nor shall the car or tank be released until the final outage has been taken by the Resident Engineer by converting the Engineer.

Copies of all freight bills and weigh bills shall be furnished to the Resident Engineer during the progress of the work.

METHOD OF MEASUREMENT

609-4.1 The unit of measurement for bituminous material shall be the gallon. The gallonage to be paid for shall be the number of gallons of bituminous material used as ordered for the accepted work. Gallonage shall be determined by measuring the material at a temperature of

60° F. or by converting the gallonage measured at other temperatures to gallonage at 60° F. in accordance with the temperature-volume correction tables for asphalt, and asphalt emulsion materials contained in ASTM D-1250.

609-4.2 The quantity of aggregate materials for the first application to be paid for shall be the number of tons of aggregate used as ordered for the accepted work.

609-4.3 The quantity of aggregate material for the second application to be paid for shall be the number of tons of aggregate used as ordered for the accepted work.

609-4.4 The tonnage of aggregate for the third application to be paid for shall be the number of tons of aggregate used as ordered for the accepted work.

609-4.5 The tonnage as measured in 609-4.2, 609-4.3, and 609-4.4, are applicable for aggregates having bulk specific gravities between 2.55 and 2.75, as determined by ASTM C 127 and C 128. Proportionate corrections shall be made when the aggregates furnished for the job are outside these limits. Where the specific gravity is below 2.55, the correct quantity for payment shall be the product of the number of tons used multiplied by the ratio of 2.55 to the bulk specific gravity of the job aggregate. Where the specific gravity is above 2.75, the corrected quantity for payment shall be the product of the number of tons used multiplied by the ratio of 2.75 to the bulk specific gravity of the job aggregate.

BASIS OF PAYMENT

609-5.1 Payment shall be made at the contract unit price per gallon for bituminous material for surface treatment and per ton for aggregate for each application. These prices shall be full compensation for furnishing all materials and for all preparation, hauling and application of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

- Item 609-5.10 Bituminous Material - per gallon.
- Item 609-5.20 First Application Aggregate - per ton.
- Item 609-5.30 Second Application Aggregate - per ton.
- Item 609-5.40 Third Application Aggregate - per ton.

ITEM 610 STRUCTURAL PORTLAND CEMENT CONCRETE

DESCRIPTION

610-1.1 This item shall consist of either plain or reinforced structural portland cement concrete, prepared and constructed in accordance with these specifications, at the locations and of the form and dimensions shown on the plans. The concrete shall be composed of coarse aggregate, fine aggregate, portland cement, and water.

MATERIALS

610-2.1 GENERAL. Only approved materials, conforming to the requirements of these specifications, shall be used in the work. They may be subjected to inspection and tests at any time during the progress of their preparation or use. The source of supply of each of the materials shall be approved by the Engineer before delivery or use is started. Representative preliminary samples of the materials shall be submitted by the contractor, when required, for examination and test. Materials shall be stored and handled to insure the preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed therein.

In no case shall the use of pit-run or naturally mixed aggregates be permitted. Naturally mixed aggregate shall be screened and washed, and all fine and coarse aggregates shall be stored separately and kept clean. The mixing of different kinds of aggregates from different sources in one storage pile or alternating batches of different aggregates will not be permitted.

610-2.2 COARSE AGGREGATE. The coarse aggregate for concrete shall meet the requirements of ASTM C 33. The percentage of wear shall be not more than 45 at 500 revolutions as determined by ASTM C 131.

Coarse aggregate shall be well graded from coarse to fine and shall meet one of the gradations shown in Table 1, using ASTM C 136.

610-2.3 FINE AGGREGATE. The fine aggregate for concrete shall meet the requirements of ASTM C 33.

The fine aggregate shall be well graded from coarse to fine and shall meet the grading requirements of Table 2, when tested in accordance with ASTM C 136.

TABLE 1. REQUIREMENTS FOR GRADATION OF COARSE
AGGREGATE

Sieve Designation (square openings)	Percentage by Weight Passing Sieves						
	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4
No. 4 - 3/4 in.	---	---	100	90-100	40-70	---	5-15
No. 4 - 1 in.	---	100	90-100	---	30-60	---	0-10

NOTE: IDOT GRADATIONS CA-11 and CA-7, Respectively

TABLE 2. REQUIREMENTS FOR GRADATION OF
FINE AGGREGATE

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
3/8 inch	----- 100
No. 4	----- 94-100
No. 16	----- 45- 85
No. 50	----- 10- 30
No. 100	----- 0- 10

NOTE: Table 2 is IDOT Gradation FA-2.

Blending will be permitted, if necessary, in order to meet the gradation requirements for fine aggregate. Fine aggregate deficient in the percentage of material passing the No. 50 mesh sieve may be accepted, provided that such deficiency does not exceed 5% and is remedied by the addition of pozzolanic or cementitious materials other than portland cement, as specified in 610-2.6 on admixtures, in sufficient quantity to produce the required workability as approved by the Engineer.

610-2.4 CEMENT. The cement used shall be portland cement conforming to the requirements of the type specified:

- (a) Portland cement ----- ASTM C 150
- (b) Air-entraining portland cement ----- ASTM C 150

The contractor shall furnish vendor's certified test reports for each carload, or equivalent, of cement shipped to the project. The report shall be delivered to the Engineer before permission to use the cement is granted. All such test reports shall be subject to verification by testing sample materials received for use on the project.

610-2.5 WATER. The water used in concrete shall be free from sewage, oil, acid, strong alkalies, vegetable matter, and clay and loam. If the water is of questionable quality, it shall be tested in accordance with the requirements of the applicable ASTM Part 31 tests as deemed necessary by the Engineer. Water known to be of potable quality may be used without testing..

610-2.6 ADMIXTURES. The use of any material added to the concrete mix shall be approved by the Engineer. Before approval of any material, the contractor shall be required to submit the results of complete physical and chemical analyses made by an acceptable testing laboratory. Subsequent tests shall be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

Air-entraining admixtures shall meet the requirements of ASTM C 260. Air-entraining admixtures shall be added at the mixer in the amount necessary to produce the specified air content.

Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C 494, Type A, water-reducing or Type D, water-reducing and retarding. Water-reducing admixtures shall be added at the mixer separately from air-entraining admixtures in accordance with the manufacturer's printed instructions.

610-2.7 PREMOLDED JOINT MATERIAL. Premolded joint material for expansion joints shall meet the requirements of one of the following ASTM D 994, D 1751, or D 1752.

610-2.8 JOINT FILLER. The filler for joints shall meet the requirements of Item 605, unless otherwise specified in the proposal.

610-2.9 STEEL REINFORCEMENT. Concrete reinforcing shall consist of deformed bars of either structural, intermediate, or hard grade billet steel meeting ASTM A 615; deformed bars of rail steel meeting ASTM A 616; or welded wire fabric meeting ASTM A 187. To qualify as deformed, bars shall conform to the requirements of AASHTO M 137.

610-2.10 CALCIUM CHLORIDE. When calcium chloride is permitted by the Engineer in the concrete as an accelerator, it shall meet the requirements of ASTM D 98.

610-2.11 COVER MATERIALS FOR CURING. Curing materials shall conform to one of the following specifications:

- (a) Waterproof Paper for Curing Concrete ----- ASTM C 171
- (b) Polyethylene Sheeting for Curing Concrete -- ASTM C 171
- (c) Burlap Cloth made from Jute or Kenaf ----- ASTM C 171
- (d) Liquid Membrane-Forming Compounds for
Curing Concrete (Type 2) ----- ASTM C 309

CONSTRUCTION METHODS

610-3.1 GENERAL. The contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified herein. All machinery and equipment owned or controlled by the contractor, which he proposes to use on the work, shall be of sufficient size to meet the requirements of the work, and shall be such as to produce satisfactory work; all work shall be subject to the inspection and approval of the Engineer. The contractor shall employ, at all times a sufficient force of workmen of such experience and ability that the work can be prosecuted in a satisfactory and workmanlike manner.

610-3.2 CONCRETE PROPORTIONS. The concrete shall consist of a mixture of coarse aggregate, fine aggregate, portland cement, and water. All aggregates and bulk cement shall be measured by weight. In proportioning aggregates and mixing water, compensation shall be made for the weight of moisture in the aggregates, and this shall be determined periodically.

CONCRETE PROPORTIONS

(Materials for One Cubic Yard of Concrete)

Type of Coarse Aggregate	Net		Weights in Pounds		Slump Range (inches)
	Cement Content (min. bags)	Water Content (max. gallons)	Dry Aggregate		
			Fine Aggre- gate	Total Aggre- gate	
Crushed Stone	6	38	1220-1360	3200	2-4

The proportions in the above table are based on the use of well-graded aggregates. If it is impossible with the aggregates selected to prepare concrete of the proper consistency without exceeding the maximum net water content specified, the total weight of aggregate shall be reduced by the Engineer until concrete of the proper consistency is obtained without exceeding the maximum net water content specified. However, the contractor shall not be compensated for any additional cement which may be required by such adjustment.

The weights specified in the above table were calculated for aggregates of the following bulk specific gravities: Natural sand, 2.65; crushed stone, 2.70. For aggregates of specific gravities differing more than

+ 0.02 from those given above, the weights given in the tables shall be corrected. The quantities shown for cement and water shall control, and the weights of aggregates shall be varied to secure the proper yield based on absolute volumes. When a special mix requiring a reduction in the amount of water is desired, the quantities of aggregate shall be increased to maintain the specified yield.

Yield test, made in accordance with specification ASTM C 138, shall be made by the Engineer for the purpose of determining the cement content per cubic yard of concrete. If at any time such cement content is found to be less than that specified per cubic yard, the batch weights shall be reduced until the amount of cement per cubic yard of concrete conforms to the requirements.

The net mixing water shall be adjusted for the moisture contained in the aggregates, and for the moisture which they will absorb, in order to determine the amount of water to be added at the mixer. The absorption of the coarse and fine aggregates shall be determined by ASTM C 127 and C 128.

When an air-entraining agent or air-entraining portland cement is used, there will be a bulking of the mortar of the concrete due to the amount of entrained air. To keep the cement factor specified at the correct amount, the weight of the fine aggregate shall be reduced, as directed by the Engineer. The reduction in the fine aggregate shall be determined by yield tests as specified. Under average conditions the reduction of the sand should be about 3% of the total weight of the fine and coarse aggregate. The air content of the concrete shall be between 3 and 6%, by volume.

The air content by volume shall be based on measurements made on concrete immediately after discharge from the mixer in accordance with ASTM C 138 or C 231.

610-3.3 CONTROL TESTS. When directed by the Resident Engineer, the contractor shall make test cylinders from the concrete as mixed for the work as herein specified.

Concrete cylindrical test specimens shall be made in accordance with ASTM C 31. The contractor shall cure and store the test specimens under such conditions as directed. The Engineer will make the actual tests on the specimens at no expense to the contractor.

610-3.4 PROPORTIONING AND MEASURING DEVICES. When package cement is used, the quantity for each batch shall be equal to one or more whole sacks of cement. The aggregates shall be measured separately by weight. If aggregates are delivered to the mixer in batch trucks, the exact amount for each mixer charge shall be contained in each batch compartment. Weighing boxes or hoppers shall be approved by the Engineer and shall provide means of regulating the flow of aggregates into the batch box so that the required and exact weight of aggregates can be readily obtained.

610-3.5 CONSISTENCY. The consistency of the concrete shall be checked by the slump test specified in ASTM C 143.

610-3.6 MIXING. Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. Whichever mixing process is used, concrete of the specified proportions and consistency shall be produced.

610-3.7 MIXING CONDITIONS. The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40° F. without permission of the Engineer. If permission is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50° nor more than 100°F. The contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material shall not be permitted.

The delivery of concrete to the job shall be in such manner that batches of concrete will be deposited at uninterrupted intervals.

610-3.8 FORMS. Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the Resident Engineer. Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as designed on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The contractor shall bear responsibility for their adequacy. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes.

The internal ties shall be arranged so that, when the forms are removed, no metal will show in the concrete surface or discolor the surface when exposed to weathering. All forms shall be wetted with water or with a nonstaining mineral oil which shall be applied shortly before the concrete is placed. Forms shall be constructed so that they can be removed without injuring the concrete or concrete surface. The forms shall not be removed before the expiration of at least 30 hours from vertical faces, walls, slender columns, and similar structures; forms supported by falsework under slabs, beams, girders, arches, and similar construction shall not be removed until tests indicate that at least 60% of the design strength of the concrete has developed.

610-3.9 PLACING REINFORCEMENT. All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concreting. Bars shall be fastened together at

intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the contractor when required.

610-3.10 EMBEDDED ITEMS. Before placing concrete, any items that are to be embedded shall be firmly and securely fastened in place as indicated. All such items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The embedding of wood shall be avoided. The concrete shall be spaded and consolidated around and against embedded items.

610-3.11 PLACING CONCRETE. All concrete shall be placed during daylight, unless otherwise approved. The concrete shall not be placed until the depth and character of foundation, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved. Concrete shall be placed as soon as practicable after mixing and in no case later than 45 minutes after water has been added to the mix. The method and manner of placing shall be such to avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. Dropping the concrete a distance of more than 5 feet, or depositing a large quantity at one point, will not be permitted. Concrete shall be placed upon clean, damp surfaces, free from running water, or upon properly consolidated soil.

The concrete shall be compacted with suitable mechanical vibrators operating within the concrete. When necessary, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction. Vibrators shall be manipulated so as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. The vibration at any joint shall be of sufficient duration to accomplish compaction but shall not be prolonged to the point where segregation occurs. Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie, a closed bottom dump bucket, or other approved method and shall not be disturbed after being deposited.

610-3.12 CONSTRUCTION JOINTS. When the placing of concrete is suspended, necessary provisions shall be made for joining future work before the placed concrete takes its initial set. For the proper bonding of old and new concrete, such provisions shall be made for grooves, steps, keys, dovetails, reinforcing bars or other devices as may be prescribed. The work shall be arranged so that a section begun on any day shall be finished during daylight of the same day. Before depositing new concrete on or against concrete which has hardened, the surface of the hardened concrete shall be cleaned by a heavy steel broom, roughened slightly, wetted, and covered with a neat coating of cement paste or grout.

610-3.13 EXPANSION JOINTS. Expansion joints shall be constructed at such points and of such dimensions as may be indicated on the drawings. The premolded filler shall be cut to the same shape as that of the surfaces being joined. The filler shall be fixed firmly against the surface of the concrete already in place in such manner that it will not be displaced when concrete is deposited against it.

610-3.14 DEFECTIVE WORK. Any defective work disclosed after the forms have been removed shall be immediately removed and replaced. If any dimensions are deficient, or if the surface of the concrete is bulged, uneven, or shows honeycomb, which in the opinion of the Engineer cannot be repaired satisfactorily, the entire section shall be removed and replaced at the expense of the contractor.

610-3.15 SURFACE FINISH. All exposed concrete surfaces shall be true, smooth, free from open or rough spaces, depressions, or projections. The concrete in horizontal plan surfaces shall be brought flush with the finished top surface at the proper elevation and shall be struck-off with a straightedge and floated. Mortar finishing shall not be permitted, nor shall dry cement or sand-cement mortar be spread over the concrete during the finishing of horizontal plane surfaces.

When directed, the surface finish of exposed concrete shall be a rubbed finish. If forms can be removed while the concrete is still green, the surface shall be pointed and wetted and then rubbed with a wooden float until all irregularities are removed. If the concrete has hardened before being rubbed, a carborundum stone shall be used to finish the surface. When approved, the finishing can be done with a rubbing machine.

610-3.16 CURING AND PROTECTION. All concrete shall be properly cured and protected by the contractor. The work shall be protected from the elements, flowing water, and from defacement of any nature during the building operations. The concrete shall be cured as soon as it has sufficiently hardened by covering with an approved material. Water-absorptive coverings shall be thoroughly saturated when placed and kept saturated for a period of at least 3 days. All curing mats or blankets shall be sufficiently weighted or tied down to keep the concrete surface covered and to prevent the surface from being exposed to currents of air. Where wooden forms are used, they shall be kept wet at all times until removed to prevent the opening of joints and drying out of the concrete. Traffic shall not be allowed on concrete surfaces for 7 days after the concrete has been placed.

610-3.17 DRAINS OR DUCTS. Drainage pipes, conduits, and ducts that are to be encased in concrete shall be installed by the contractor before the concrete is placed. The pipe shall be held rigidly so that it will not be displaced or moved during the placing of the concrete.

610-3.18 COLD WEATHER PROTECTION. When concrete is placed at temperatures below 40° F., the contractor shall provide satisfactory methods and means to protect the mix from injury by freezing. The aggregates, or water, or both, shall be heated in order to place the concrete at temperatures between 50° and 100° F.

Calcium chloride may be incorporated in the mixing water when directed by the Engineer. Not more than 2 pounds of Type 1 nor more than 1.6 pounds of Type 2 shall be added per bag of cement. After the concrete has been placed, the contractor shall provide sufficient protection such as cover, canvas, framework, heating apparatus, etc., to enclose and protect the structure and maintain the temperature of the mix at not less than 50° F. until at least 60% of the designed strength has been attained.

610-3.19 FILLING JOINTS. All joints which require filling shall be thoroughly cleaned, and any excess mortar or concrete shall be cut out with proper tools. Joint filling shall not be started until after final curing and shall be done only when the concrete is completely dry. The cleaning and filling shall be carefully done with proper equipment and in a manner to obtain a neat looking joint free from excess filler.

METHOD OF MEASUREMENT

610-4.1 The yardage of portland cement concrete to be paid for shall be the number of cubic yards of concrete completed in place and accepted. In computing the yardage of concrete for payment, the dimensions used shall be those shown on the plans or ordered by the Engineer. No measurements or other allowances shall be made for forms, falsework, cofferdams, pumping, bracing, expansion joints, or finishing of the concrete. No deductions in yardage shall be made for the volumes of reinforcing steel or embedded items.

610-4.2 The poundage of reinforcing steel to be paid for shall be the calculated theoretical number of pounds placed, as shown on the plans, complete in place and accepted. The unit weight used for deformed bars shall be the weight of plain square or round bars of equal nominal size. If so indicated on the plans, the poundage to be paid for shall include the weight of metal pipes and drains, metal conduits and ducts, or similar materials indicated and included.

610-4.3 In most instances, structures will be paid for per each under the respective pay items for those structures. In those cases, no measurement nor payment will be made under this item.

BASIS OF PAYMENT

610-5.1 Except when structures are paid for per each under another item, payment shall be made at the contract unit price per cubic yard for structural portland cement concrete and per pound for reinforcing steel. These prices shall be full compensation for furnishing all materials and for all preparation, delivering and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 610-5.10 Structural P C Concrete -
per cubic yard.

Item 610-5.20 Steel Reinforcement - per pound.

ITEM 620 PAVEMENT MARKING

DESCRIPTION

620-1.1 This item shall consist of the painting of numbers, markings, and stripes on the surface of runways and taxiways applied in accordance with these specifications and at the locations shown on the plans, or as directed by the Resident Engineer.

MATERIALS

620-2.1 PAINT. Paint shall meet the requirements of Federal Specification TT-P-85, TT-P-110 or TT-P-1952, as specified by the Project Engineer.

620-2.2 REFLECTIVE MEDIA. Glass spheres shall meet the requirements of Federal Specification TT-B-1325, Type III.

CONSTRUCTION METHODS

620-3.1 WEATHER LIMITATIONS. The painting shall be performed only upon a dry surface, when the atmospheric temperature is above 45 degrees F. and when the weather is not foggy or windy.

620-3.2 EQUIPMENT. All equipment for the work shall be approved by the Engineer and shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, and such auxiliary hand painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type marking machine suitable for application of traffic paint. It shall produce an even and uniform film thickness at the required coverage and shall be designed so as to apply markings of uniform cross sections and clear-cut edges without running or spattering.

620-3.3 PREPARATION OF SURFACE. Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other foreign material which would reduce the bond between the paint and the pavement. The area to be painted shall be cleaned by sweeping and blowing or by other methods as required to remove all dirt, laitance, and loose materials.

Paint shall not be applied to portland cement concrete pavement until the concrete in the areas to be painted is clean of curing material. Sand blasting or high pressure water shall be used to remove curing material from concrete surfaces.

620-3.4 LAYOUT OF MARKINGS. On those sections of pavement where no previously applied markings are available to serve as a guide, the proposed markings shall be laid out in advance of the paint application.

620-3.5 APPLICATION. Markings shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface have been approved by the Resident Engineer.

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate of 90 to 100 square feet per gallon. The addition of thinner will not be permitted.

A period of 14 days minimum shall elapse between placement of a bituminous surface course or seal coat and application of the paint unless paint in accordance with TT-P-1952 is used. When this paint is used, a minimum of 24 hours shall elapse.

The edges of the markings shall not vary from a straight line more than 1/2 inch in 50 feet, and the dimensions shall be within a tolerance of plus or minus 5 percent. Glass spheres shall be distributed to the surface of the marked areas immediately after application of the paint. A dispenser shall be furnished which is properly designed for attachment to the marking machine and suitable for dispensing glass spheres. The spheres shall be applied at the rate of 10 pounds per gallon of paint.

The contractor shall furnish certified test reports for the materials shipped to the project. The reports shall not be interpreted as a basis for final acceptance. The contractor shall notify the Resident Engineer upon arrival of a shipment of paint to the job site. All emptied containers shall be returned to the paint storage area for checking by the Resident Engineer. The containers shall not be removed from the airport or destroyed until authorized by the Resident Engineer.

620-3.6 PROTECTION. After application of the paint, all markings shall be protected from damage until the paint is dry. All surfaces shall be protected from disfiguration by spatter, splashes, spillage, or drippings of paint.

METHOD OF MEASUREMENT

620-4.1 The quantity of runway and taxiway markings to be paid for shall be the number of square feet of painting performed in accordance with the specifications and accepted by the Engineer.

BASIS OF PAYMENT

620-5.1 Payment shall be made at the contract unit price per square foot for runway and/or taxiway painting. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 620-5.10 Pavement Marking - Per Square Foot.

ITEM 625 TAR EMULSION PROTECTIVE SEAL COAT

(For Bituminous Pavements)

DESCRIPTION

625-1.1 This item shall consist of an application of coal-tar pitch emulsion seal coat, with or without mineral aggregate, applied, on an existing previously prepared bituminous wearing course, in accordance with these specifications for the areas shown on the plans or as designed by the Resident Engineer.

625-1.2 QUANTITIES AND COMPOSITION OF MATERIALS PER SQUARE YARD. The approximate amounts and composition of materials per square yard for the seal coat shall be as provided in Table 1. The exact amounts to be used shall be determined by the Resident Engineer.

TABLE 1. QUANTITIES AND COMPOSITION OF MATERIALS

Type of Seal	Method of Application	Application Rates	
		Emulsion * Gal./Sq. Yd.	Sand Lbs./Gal. Emulsion
Emulsion (only)	Distributor or hand	First Application:	
		0.10 - 0.15	----
		Second Application:	
		0.08 - 0.12	----
		Total 2 coats:	
		0.20 - 0.26	----
Sand Slurry	Distributor or hand	Prime Coat:	
		0.075 - 0.10	----
		First Application:	
		0.10 - 0.15	4 - 6
		Second Application:	
		0.10 - 0.15	5 - 7
Sand Slurry	Spreader Box (prime coat by distributor or hand)	Prime Coat:	
		0.075 - 0.10	----
		Single Application:	
		0.25 - 0.50 **	5 - 7

* Undiluted coal-tar pitch emulsion.

** Approximate application rate for 1/16 to 1/8 inch thickness.

MATERIALS

625-2.1 MINERAL AGGREGATE. The mineral aggregate shall be either a natural or manufactured product and shall be composed of clean, hard, durable, uncoated particles, free from lumps of clay and all organic matter. The mineral aggregate shall meet the gradation given in Table 2. The test for gradation shall be made in accordance with ASTM C 136. Stripping characteristics shall be determined in accordance with ASTM D 1664.

TABLE 2. REQUIREMENTS FOR GRADATION OF AGGREGATE

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
No. 16	100
No. 20	85-100
No. 30	15-85
No. 40	2-15
No. 100	0-2

The moisture content of the mineral aggregate at the time of batching shall be such that the material will readily flow into the batching box for correct measurement.

625-2.2 BITUMINOUS MATERIAL. The bituminous material shall be a coal-tar pitch emulsion prepared from a high-temperature coal-tar pitch conforming to the requirements of Fed. Spec. R-T-143. Oil and water gas tars shall not be used even though they comply with R-T-143. The coal-tar pitch emulsion shall conform to all requirements of Im Fed. Spec. R-355.

625-2.3 WATER. The water used for mixing and dampening the pavements shall be clear fresh water having a temperature of 50° F. or higher. The amount of water added to the coal-tar pitch emulsion or to the coal-tar pitch emulsion sand slurry shall not exceed 10% of the coal-tar pitch emulsion.

CONSTRUCTION METHODS

625-3.1 WEATHER LIMITATIONS. The tar emulsion seal coat shall not be applied when the weather is foggy or when rain threatens, nor when the atmospheric or pavement temperature is below 50° F., unless otherwise directed by the Resident Engineer.

625-3.2 EQUIPMENT AND TOOLS. All methods employed in performing the work and all equipment, tools, and machinery used for handling materials and executing any part of the work shall be subject to the approval of the Engineer before the work is started, and whenever found unsatisfactory they shall be changed and improved. All equipment, tools, machinery, and containers used must be kept clean and maintained in satisfactory condition.

Pressure distributors used for the application of the tar emulsion shall be self-propelled, equipped with pneumatic tires, and capable of applying 0.08 to 1.0 gallon per square yard of tar emulsion over the required width of application. Distributors shall be equipped with removable manhole covers, tachometers, pressure gauges, and volume-measuring devices.

Mixing or agitating equipment furnished shall be either a portable power mixer or a tank-type power mixer. A portable mixer for use in drums shall have sufficient power and the impeller blades shall be shaped to thoroughly mix and pull the material upward from the bottom of the drum. Mixing in tanks may be done in round-bottom tanks equipped with a power driven mixer of sufficient capacity to maintain the mineral content of the emulsion in complete suspension.

Suitable types and sizes of pumping equipment shall be available for pumping water and for handling or applying the emulsion. Water will be needed to flush or dampen the pavement surface or to clean the equipment. When compressed-air spray equipment is used for application of the emulsion, heavy-duty air compressors shall be furnished.

Mixing machines for preparing the slurry may be central plant mixers, a transit mixer, or any type mixer, approved by the Engineer, capable of producing a uniform mixture of emulsion and aggregate.

When a transit mixer or other type mixer is used for preparing the slurry, the slurry may be applied with a spreader box into which the slurry is conveyed by a chute. The spreader box shall consist of a rectangular frame, 10 feet or more in width and not less than 8 feet long, equipped for towing, and with a squeegee screed across the inside of the box about three-quarters toward the rear which is adjustable for thickness of application and crown of pavement. The squeegee on the spreader box may be neoprene rubber belting, 1/2-inch thick and 6 to 8 inches in width, held vertically across the width of the box (preferably with 4 inches of "free rubber" for aggregate flexibility) and anchored to an adjustable frame. The front and sides of the box shall be lined with 1/4-inch thick belting to prevent slurry leakage and to assure proper spreading. The slurry box shall be equipped with wheels in order that it may be raised off the pavement and quickly towed into position for use on adjacent lanes.

A suitable spray-type applicator or distributor approved by the Engineer may be used for applying the slurry. This equipment shall be equipped with an agitator to keep the slurry uniformly mixed before and during application and so designed to uniformly spread the slurry on the pavement surface at the specified rates of application.

Other tools or equipment, such as brushes, hand squeegees, hose equipment, aggregate batchers, sand spreaders, tank trucks, water distributors and flushers, power sweepers, power blowers, barricades, etc., shall be provided as required.

625-3.3 PREPARATION OF PAVEMENT SURFACE. Bituminous pavement surfaces which have been softened by petroleum derivatives or have failed due to any other cause shall be removed to the full depth of the damage and replaced with new bituminous concrete similar to that of the existing pavement. Areas of the pavement surface to be treated shall be in a firm consolidated condition and sufficiently cured so that there is no concentration of oils on the surface. This can usually be determined by pouring water on the surface to be treated. If the water, after standing for a short period, picks up a film of oil, the surface is not sufficiently cured for the application of the emulsion. (A 30-day minimum should normally be allowed for curing of new bituminous pavements.)

625-3.4 CLEANING EXISTING SURFACE. Prior to placing the seal coat, the surface of the pavement shall be clean and free from dust, dirt, or other loose foreign matter, grease, oil, or any type of objectionable surface film. When directed by the Resident Engineer, the existing surface shall be swept with hand brooms or with power sweepers or cleaned with a power blower. When required, pavement shall be flushed with a fire hose, if hydrants are convenient, or with a water-flushing truck. To remove accumulations of oil or grease, some sections may require cleaning with a strong caustic solution. The residue from this treatment shall be flushed and washed with pressure streams of water taking extreme care that all caustic is removed from the surface; otherwise, the emulsion will not cure properly. If this does not provide a water break free surface, the affected areas shall be removed and replaced with new pavement. All large cracks shall be cleaned by removing accumulated dirt or any vegetation and by blowing out with compressed air. Cracks larger than 1/16 inch shall be routed out to 3/8 inch and poured with a suitable joint sealer before the emulsion is applied.

All painted stripes or markers on the bituminous surface to be treated shall be removed.

After the pavement surface has been thoroughly cleaned, it shall be flushed with water to provide a damp surface, free from standing water, for the application of the seal coat.

Areas which are to receive a sand-slurry seal shall be primed with undiluted emulsion at the rate of 0.075 to 0.10 gallon per square yard. The primed area shall be allowed to dry thoroughly, and in no case shall the curing period be less than 4 hours.

625-3.5 APPLICATION OF EMULSION. After the pavement surface has been inspected, and approved by the Engineer, the emulsion shall be applied over the dampened pavement, free from standing water, in two coatings in accordance with the method described below in subparagraph (a) Hand Method or (b) Distributor or Applicator. Due to the settling that may take place in transit, the emulsion shall be thoroughly agitated before use by power mixers so that a homogeneous consistency is assured for proper and uniform application.

(a) Hand Method. The emulsion shall be applied in two coats in the amounts per square yard as stated in Table 1. The undiluted material shall be poured in strips on the pavement and spread with a squeegee or brush, smoothing out with a brush. This procedure shall be continued until the entire area is covered. The first coat shall be allowed to dry or cure sufficiently to prevent pickup before the second coat is applied. When spreading the second coat, it shall be spread crosswise to the placing of the first coat when practicable.

(b) Distributor or Applicator. When applied by distributor or approved type of applicator, the emulsion shall be applied uniformly to the surface of the pavement at the prescribed pressures and in the amounts per square yard as specified in Table 1. The emulsion shall be thoroughly mixed before use. When it is necessary to dilute the emulsion in order to aid proper application, the emulsion may be diluted with the minimum amount of clean, fresh water necessary to produce the desired application, but not exceeding 10%. The rate of application of the diluted emulsion shall be increased to provide the amount of undiluted emulsion specified in Table 1.

The first application shall be cured sufficiently to drive over without damage before the second application is applied. When conditions permit, the second application shall be spread crosswise to the first application. During the application, surfaces of adjacent structures shall be protected to prevent them from being spattered or marred. In areas inaccessible to the distributor, application may be by the hand method.

625-3.6 APPLICATION OF SAND SLURRY. When the emulsion and aggregate are blended, the material shall be premixed to produce a slurry seal coat. The quantities of materials to be combined in each batch shall be in accordance with the proportions shown in Table 1. Slurry not diluted with water shall be applied at the rates specified. When necessary to dilute the slurry in order to aid proper application at the correct rate, the emulsion may be diluted with the minimum amount

of water necessary to produce a workable mixture but not exceeding 10%. The rate of application of the diluted emulsion shall be increased to provide the amount of undiluted emulsion specified in Table 1.

Before application, the materials shall be proportioned accurately and mixed by suitable mixing equipment. The emulsion and the water are first charged into the mixer and blended to a desired consistency, then the aggregate shall be added at a slow and uniform rate while the mixing is continued until the batch aggregate is incorporated. After all the constituents are in the mixer, the mixing shall continue for approximately 5 minutes or longer if necessary. The mixing shall produce a smooth, free flowing, homogeneous mixture of uniform consistency. Mixing shall be continuous from the time the bitumen is placed into the mixer until the slurry is applied by distributor truck or poured into the spreading equipment. During the entire mixing process, no breaking, segregating, or hardening of the emulsion, nor balling, lumping, or swelling of the aggregate shall be permitted. When transit mixers are used, the drum shall be rotated at its slowest possible speed.

The application of the slurry shall be either by hand methods using rubber squeegees for spreading, by spreader boxes, or distributor equipment, as specified in 625-3.2, or by any other suitable method approved by the Engineer. The slurry shall be applied at a uniform rate to provide the desired amount. When spreader boxes are used, the seal coat shall be applied in one application. Care shall be taken not to overload the box with slurry, but a sufficient quantity shall be maintained to supply a feed against the full width of the squeegee.

The surface of the pavement shall be dampened (but free of standing water) immediately before each application of the seal coat. Each application shall be allowed to dry thoroughly, and in no case shall the curing period be less than 4 hours.

When in the opinion of the Engineer certain areas will be subjected to intensive fuel or oil spillage, a final application of straight emulsion may be made at the rate of 0.075 to 0.10 gallon per square yard.

625-3.7 CURING. The applied emulsion seal coat shall be allowed to cure for not less than 24 hours, during which time all traffic shall be excluded from the area that has been sealed.

625-3.8 HANDLING. The emulsion shall be continuously circulated or agitated from the time it has been mixed until its application on the pavement surface. The distributor or applicator, pumps, and all tools shall be maintained in satisfactory working condition. Spray bar nozzles, pumps, or other equipment can be cleaned with coal-tar toluene or xylene.

625-3.9 EMULSION MATERIAL CONTRACTOR'S RESPONSIBILITY. Samples of the emulsion that the contractor proposed to use, together with a statement as to its source, must be submitted and approved before use of such material begins. The contractor shall furnish manufacturer's certification that each consignment of the emulsion shipped for the work meets the requirements of Fed. Spec. R-355. The report shall be delivered to the Engineer. The manufacturer's certification for the emulsion shall not be interpreted as a basis for final acceptance. All such reports shall be subject to verification by testing samples of the emulsion received for use on the project.

METHOD OF MEASUREMENT

625-4.1 The unit of measurement shall be the number of square yards of pavement sealed with coal-tar pitch emulsion performed in accordance with the specifications and accepted by the Engineer.

BASIS OF PAYMENT

625-5.1 Payment shall be made at the contract unit price per square yard for the area sealed with coal-tar pitch emulsion. These prices shall be full compensation for furnishing all materials and for all preparation, mixing, and applying of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 625-5.10 Tar Emulsion Seal Coat - per sq. yd.

DIVISION III

FENCING (WIRE FENCE)

ITEM 161 WIRE FENCE WITH STEEL POSTS

(Class C Fence)

DESCRIPTION

161-1.1 This item covers the requirements for furnishing materials and constructing new wire fences and gates with steel posts in accordance with the details included herein and as shown on the plans. The class of fence to be erected shall be either Class C, woven wire fencing surmounted by two strands of barbed wire as indicated on the plans and in the bid proposal.

MATERIALS

161-2.1 WIRE.

(a) Woven Wire (Zinc-coated). The woven wire fencing shall be 7-bar, 36 or 39-inch field fence with top and bottom wires No. 10 ASW gauge, and filler and stay wires No. 12 1/2 ASW gauge. Stay wires shall be spaced 6 inches apart. All wire shall be smooth galvanized steel wire conforming to Fed. Spec. RR-F-221, Type B. All wires shall be two-dip and spaced as shown on the plans.

(b) Barbed Wire (Zinc-coated). Zinc-coated barbed wire shall be 2-strand twisted No. 12 1/2 ASW gauge galvanized steel wire with 4-point barbs of No. 14 ASW gauge galvanized steel wire. All wire shall conform to Fed. Spec. RR-F-221, Type A. The barbs shall be spaced approximately 4 inches apart.

(c) Bracing Wire (Zinc-coated). Wire used for cable for bracing shall be No. 9 smooth galvanized soft wire.

161-2.2 FENCE POSTS, GATES, RAILS, BRACES, AND ACCESSORIES. These items, when specified, shall conform to the requirements of Fed. Spec. RR-F-183 and shall be zinc coated.

161-2.3 CONCRETE. Concrete shall be produced and placed in accordance with Item 610.

CONSTRUCTION METHODS

161-3.1 GENERAL. The fence shall be constructed in accordance with the details on the plans and as specified herein using new materials, and all work shall be performed in a workmanlike manner satisfactory to the Engineer. Prior to the beginning of the work or upon the request of the contractor, the Resident Engineer shall locate the position of the work by establishing and marking the property line or fence line. When directed, the contractor shall span the opening below the fence with barbed wire fastened to stakes of the required length at locations of small natural or drainage ditches where it is not practical to conform the fence to the general contour of the ground surface. The new fence shall be permanently tied to the terminals of existing fences whenever required by the Project Engineer. The finished fence shall be plumb, taut, true to line and ground contour, and complete in every detail. When directed, the contractor shall stake down the woven wire fence at several points between posts.

When directed, in order to keep stock on adjoining property enclosed at all times, the contractor shall arrange the work so that construction of the new fence will immediately follow the removal of existing fences. The length of unfenced section at any time shall not exceed 300 feet or such length that the stock can be kept in the proper field. The work shall progress in this manner and at the close of the working day the newly constructed fence shall be tied to the existing fence. Any openings in the fence shall be guarded when stock is using the adjoining property.

161-3.2 CLEARING FENCE LINE. The site of the fence shall be sufficiently cleared of obstructions, and surface irregularities shall be graded so that the fence will conform to the general contour of the ground. The fence line shall be cleared to a minimum width of 2 feet on each side of the centerline of the fence. This clearing shall consist of the removal of all stumps, brush, rocks, trees, or other obstructions which will interfere with proper construction of the fence. Stumps within the cleared area of the fence shall be placed a uniform distance above ground, as specified in the plans. When shown on the plans or as directed by the Resident Engineer, the existing fences which coincide with, or are in a position to interfere with, the new fence location shall be removed by the contractor as a part of the construction work, unless such removal is listed as a separate item in the bid schedule. All holes remaining after post and stump removal shall be refilled with suitable soil, gravel, or other material acceptable to the Resident Engineer and shall be compacted properly with tampers.

The work shall include the handling and disposal of all material cleared, excavated or removed, regardless of the type, character, composition, or condition of such material encountered.

161-3.3 INSTALLING POSTS. All posts shall be spaced as shown on the plans. Corner, brace, anchor, end, and gate posts shall be set in concrete bases as shown on the plans. The top of the base shall be slightly above the ground surface, trowel finished, and sloped to drain. Holes of full depth and size for the concrete bases for posts shall be provided even if blasting of rock or other obstructions is necessary. All line posts may be either driven or set in dug holes to a penetration of 2 feet 3 inches. All post setting shall be done carefully and to true alignment. Dirt removed for placing posts, anchor bars, flanges, etc., shall be replaced, tamped, and leveled. When posts are driven, care shall be exercised to prevent marring or buckling of the posts. Damaged posts shall be replaced at the contractor's expense. No extra compensation will be made for rock excavation. Rock excavation shall not be grounds for extension of time.

161-3.4 BRACING. All corner, anchor, end, and gate posts shall be braced as shown on the plans. Anchor posts shall be set at approximately 500-foot intervals and braced to the adjacent posts.

161-3.5 INSTALLING WIRE. All barbed wire and woven wire shall be placed on the side of the posts away from the airport, or as directed, at the height indicated on the plans. The woven wire shall be carefully stretched and hung without sag and with true alignment. Care shall be taken not to stretch the wire so tightly that it will break in cold weather or pull up corner and brace posts. All horizontal wires shall be fastened securely to each post by fasteners or clips designed for use with the posts furnished. The woven wire shall be wrapped around end, corner, and gate posts, and the ends of all horizontal wires shall be tied with snug, tight twists. The wire shall be secured to prevent slipping up and down the post. Barbed wire strands shall be stretched and each strand secured to each post to prevent slipping out of line or becoming loose. At end, corner, and gate posts the barbed wire shall be securely wrapped and anchored once about the post from outside and secured against slipping by tying the ends with snug, tight twists. However, on spans of less than 100 feet both ends of the span need not be wrapped around the posts. The bottom wire of the woven wire fencing shall clear the ground by not more than 4 inches or less than 1 inch at any place.

161-3.6 SPLICING WIRE. Splices in barbed and woven wire will be permitted if made with an approved galvanized bolt-clamp splice or a wire splice made as follows: The ends of each wire shall be carried 3 inches past the splice tool and wrapped around the other wire for at least six turns in opposite directions. After the tool is removed, the space occupied by it shall be closed by pulling the ends together. The unused ends of the wire shall be cut close to make a neat, workmanlike job.

161-3.7 INSTALLING GATES. The gates shall be hung on gate fittings as shown on the plans. They shall be attached in such a manner that the gate cannot be lifted off the hinges. Gates shall be erected to swing in the direction indicated and shall be provided with gate stops, as specified or as shown on the plans. Gates shall be erected at suitable places, as directed by the Resident Engineer or as shown on the plans.

161-3.8 EXISTING FENCE CONNECTIONS. Wherever the new fence joins an existing fence, either at a corner or at the intersection of straight fence lines, a corner or anchor post shall be set at the junction and braced and anchored the same as herein described for corner posts.

If the connection is made at other than the corner of the new fence, the last span of the old fence shall contain a brace span.

161-3.9 CLEANING UP. The contractor shall remove from the vicinity of the completed work all tools, building, equipment, etc., used during construction.

METHOD OF MEASUREMENT

161-4.1 Fence, Class C, shall be measured in place from outside to outside of end posts or corner posts and shall be the length of fence actually constructed, except for the space occupied by the gates.

Driveway gates and walkway gates shall be measured in units for each gate installed and accepted.

BASIS OF PAYMENT

161-5.1 Payment shall be made at the contract unit price per linear foot for Class C wire fence. This price shall be full compensation for furnishing all materials and for all preparation, erection, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made at the contract unit price per each for each size for driveway or for walkway gates. This price shall be full compensation for furnishing all materials and for all preparation, erection, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 161-5.10 Fence, Class C - per linear foot.

Item 161-5.20 Walkway Gates - per each.

Item 161-5.30 Driveway Gates - per each.

ITEM 162 CHAIN-LINK FENCES

(Class E)

DESCRIPTION

162-1.1 This item covers the requirements for furnishing materials and constructing new chain-link fences and gates in accordance with the details included herein and as shown on the plans. The class of fence to be erected shall be Class E chain link fencing, as indicated on the plans and in the bid proposal.

The fence shall be the product of a manufacturer who has demonstrated by actual installation of a similar nature that its product is of the type required. The contractor shall include all supplementary parts necessary or required for a complete and satisfactory installation within the true meaning and intent of the drawings. All runs of the fence shall present the same general appearance and the product of one manufacturer only will be accepted, except for items which do not influence the appearance of the completed fence. No used, rerolled, or open-seam steel shall be permitted in posts, gate frames, rails or braces.

MATERIALS

162-2.1 FABRIC. The chain-link fence fabric shall be of the following types, as specified:

Zinc coated steel
Aluminum coated steel
Aluminum alloy
Vinyl coated

(a) The fabric may be woven with either zinc coated steel wire, aluminum coated steel wire, vinyl coated steel wire or aluminum alloy wire in a 2-inch mesh. Coated wire and aluminum-alloy wire shall have a diameter of 0.148 inches. The outside diameter of coated wire includes the thickness of the coating. The fabric shall meet the following requirements:

(1) Zinc coated steel fabric shall conform to the requirements of AASHTO M 181, Type I, Class B. The fabric shall be galvanized after weaving.

(2) Aluminum coated steel fabric shall conform to the requirements of AASHTO M 181. The unit weight of coating shall be determined in accordance with AASHTO T 213. The aluminum coated steel fabric shall be given a clear organic coating after fabrication.

(3) Aluminum alloy fabric shall be made from wire conforming to the requirements of AASHTO M 181.

(4) Vinyl coated fabric shall conform to the requirements of AASHTO M 181, Type IV bonded. Bonding shall be done by the thermal fusion method.

The vinyl coating shall be self extinguishing and shall not support combustion when subject to the Horizontal Flame Test of ASTM D 470.

The color of the coating shall be dark green and shall meet the approval of the Engineer.

162-2.2 BARBED WIRE. All wires shall be spaced as shown on the plans. Barbed wire may be either galvanized steel barbed wire or aluminum coated steel barbed wire consisting of 2 strands of 12 1/2-gage wire with 4-point barbs of 14-gage wire spaced 5 inches apart conforming to the following requirements:

(a) Barbed Wire (Zinc-coated). Galvanized barbed wire shall conform to the Specifications for zinc-coated (galvanized) steel barbed wire, AASHTO M 280, Class 3 with a minimum coating of 0.80 ounce per square foot of wire surface.

(b) Barbed Wire (Aluminum-coated). Aluminum-coated steel barbed wire shall conform to the Specifications for galvanized steel barbed wire, except the wire shall be aluminum coated. The wire shall have not less than 0.25 ounce coating of aluminum alloy per square foot of uncoated surface. The weight of the aluminum alloy coating shall be determined in accordance with AASHTO T 213.

162-2.3 FENCE POSTS, POST TOPS AND EXTENSIONS, RAILS, GATES, BRACES, STRETCHER BARS, AND CLIPS. When these items are furnished for use in conjunction with zinc coated steel fabric, or aluminum coated steel fabric, they shall be of zinc coated steel. When these items are furnished for use in conjunction with aluminum alloy fabric, they shall be of aluminum alloy conforming to the requirements of AASHTO M 181.

(a) Metal posts (line, corner, end, pull and gate posts) shall be the shapes, dimensions and weight shown on the plans. When vinyl coated fabric is used, the posts shall be vinyl coated in accordance with the same requirements as the coating of the fabric. Posts shall be galvanized prior to vinyl coating.

(1) Steel pipe, Type A shall be hot-dipped galvanized conforming to the requirements of ASTM A 120.

(2) Steel pipe, Type B, shall be manufactured from cold rolled electric resistance welded, heated and tempered steel. The steel strip used in the manufacture of the pipe shall conform to ASTM A 569 or ASTM A 607. The wall thickness shall not be less than that shown on the plans. The product of the yield strength and section modulus of the pipe shall not be less than that of pipe meeting the requirements of ASTM A 120.

The protective coatings shall be as follows:

(1) External and internal hot-dipped zinc coating according to ASTM A 120.

(2) External coating shall be in-line hot-dipped zinc coating after fabrication followed by a chromate conversion coating with an electrostatic thermoplastic finish. The zinc coating shall be not less than .9 ounces per square foot of surface. The chromate coating weight shall be 30 micrograms \pm .0002 inches.

The internal surface shall be given corrosion protection by in-line application of a full zinc base organic coating after fabrication. The coating shall be 87% zinc powder by weight and capable of providing galvanic protection. The thickness shall be a minimum of .5 mil. The external protective coating shall be capable of withstanding the following tests:

Exposure Test	ASTM Designation	Exposure Time
Salt Spray	ASTM B 117	1000 Hrs. min.
Humidity	ASTM D 2247	500 Hrs. min.
Weathering	ASTM G 23	500 Hrs. min.

The internal protective coating shall be capable of withstanding exposure to salt spray, ASTM B 117, for a minimum of 500 hours.

(3) Steel pipe, Type C shall be manufactured by roll forming aluminized steel type 2 strip and electric resistance welding into tubular form.

The outside of the weld area shall be metallized with commercially pure aluminum to a thickness sufficient to provide resistance to corrosion equal to that of the remainder of the outside of the tube. The aluminum coating weight shall be a minimum of 0.75 ounces per square foot, triple spot test, 0.70 ounces per square foot, single spot test, as measured in accordance with ASTM A 428. The steel strip used in the manufacture of the pipe shall conform to ASTM A 787 Type 1 and have a minimum yield strength of 50,000 psi. The weight of the pipe shall not be less than that shown on the plans and the product of the yield strength and section modulus of the pipe shall not be less than that of pipe meeting the requirements of ASTM A 120.

(4) Structural shapes shall be fabricated from steel conforming to the requirements of AASHTO M 281, Grades A or B. Rolled formed sections shall be fabricated from steel conforming to the requirements of ASTM A 570, Grades 36 thru 50, with a maximum tensile strength of 80,000 pounds per square inch. All structural shapes and rolled formed sections shall be galvanized in accordance with AASHTO M 111, using zinc of any grade conforming to the requirements of AASHTO M 120. The zinc coating shall be not less than 2.0 ounces per square foot of surface.

(5) Square hollow structural tubing shall conform to the requirements of ASTM A 500, Grade B or ASTM A 501. The tubing shall be galvanized inside and outside in accordance with AASHTO M 111, using zinc of any grade conforming to the requirements of AASHTO M 120. The zinc coating shall be not less than 2.0 ounces per square foot of surface.

(b) Metal Braces. Metal braces shall have the shapes, dimensions and weight shown on the plans. They shall conform to the Specifications for metal posts, either steel pipe, structural shape or rolled formed section and shall be galvanized as specified for metal posts. When vinyl coated fabric is used, the braces shall be vinyl coated in accordance with the same requirements as the coating of the fabric. Braces shall be galvanized prior to vinyl coating.

(c) Gates. The gate frames shall consist of steel pipe, Type A, Type B or Type C having the diameter and weight shown on the plans conforming to the Specifications for steel pipe line posts. The fabric

shall be of the same material as used in the fence. When vinyl coated fabric is used, the gate frames shall be vinyl coated in accordance with the same requirements as the coating of the fabric. The pipe for the frames shall comply with all the requirements specified above for steel pipe, Type A, or steel pipe, Type B, prior to vinyl coating.

162-2.4 WIRE TIES AND TENSION WIRE. Wire fabric ties, wire ties, and tension wire furnished for use in conjunction with a given type of fabric shall be of the same material identified with the fabric type. Zinc-coated steel wire, aluminum-coated steel wire, and aluminum alloy wire shall conform to requirements of AASHTO M 181.

162-2.5 MISCELLANEOUS FITTINGS AND HARDWARE. Miscellaneous fittings and hardware shall be of design standard with the manufacturer. Miscellaneous fittings and hardware furnished for use with other than aluminum alloy fabric shall be as follows:

- (a.) Bolts and Nuts. All bolts and nuts shall conform to the requirements of ASTM A 307 and shall be zinc-coated in accordance with AASHTO M232 or M276, Class 50.
- (b.) Fittings. All other fittings shall be made of malleable cast iron or pressed steel and shall be galvanized in accordance with AASHTO M 232. When vinyl coated fabric is used, fittings shall be vinyl coated in accordance with the same requirements as the coating of the fabric. Fittings shall be galvanized prior to vinyl coating.

162-2.6 WELDING. Structural members of gates which are in contact shall be fully welded by a method that will procure a continuous weld on all sides and faces of joints at exposed edges. Surplus welding material shall be removed.

162-2.7 CONCRETE. Concrete shall be produced and placed in accordance with Item 610.

CONSTRUCTION METHODS

162-3.1 GENERAL. The fence shall be constructed in accordance with the details on the plans and as specified herein using new materials, and all work shall be performed in a workmanlike manner satisfactory to the Engineer. Prior to the beginning of the work or upon the request of the contractor, the Resident Engineer shall locate the position of the work by establishing and marking the property line or fence line. When directed, the contractor shall span the opening below the fence with barbed wire fastened to stakes of the required length at locations of small natural or drainage ditches where it is not practical to conform the

fences to the general contour of the ground surface, as required. The new fence shall be permanently tied to the terminals of existing fences whenever required by the Resident Engineer. The finished fence shall be plumb, taut, true to line and ground contour, and complete in every detail. When directed, the contractor shall be required to stake down the chain-link fence at several points between posts.

When directed, in order to keep stock on adjoining property enclosed at all times, the contractor shall arrange the work so that construction of the new fence will immediately follow the removal of existing fences. The length of unfenced section at any time shall not exceed 300 feet or it shall be of such length that the stock can be kept in the proper field. The work shall progress in this manner and at the close of the working day the newly constructed fence shall be tied to the existing fence. Openings in the fence shall be guarded when stock is using the adjoining property.

162-3.2 CLEARING FENCE LINE. The site of the fence shall be sufficiently cleared of obstructions, and surface irregularities shall be graded so that the fence will conform to the general contour of the ground. The fence line shall be cleared to a minimum width of 2 feet on each side of the centerline of the fence. This clearing shall consist of the removal of all stumps, brush, rocks, trees, or other obstructions which will interfere with proper construction of the same fence. Stumps within the cleared area of the fence line shall be grubbed or excavated. The bottom of the fence shall be placed a uniform distance above the ground, as specified on the plans. When shown on the plans or as directed by the Resident Engineer, the existing fences which coincide with, or are in a position to interfere with, the new fence location shall be removed by the contractor as a part of the construction work, unless such removal is listed as a separate item in the bid schedule. All holes remaining after post and stump removal shall be refilled with suitable soil, gravel, or other material acceptable to the Resident Engineer and shall be compacted properly with tampers.

The work shall include the handling and disposal of all material cleared, excavated, or removed, regardless of the type, character, composition, or condition of such material encountered.

162-3.3 INSTALLING POSTS. All posts shall be spaced not more than 10 feet apart as shown on the plans. Terminal (end, corner, pull, and brace) and gate posts shall be set 36 inches in concrete bases as shown on the plans. All line posts shall be set 30 inches in concrete bases as shown on the plans. The top of the concrete bases shall be slightly above the ground, trowel finished, and sloped to drain away from the posts. Holes of full depth and size for the concrete bases for posts shall be dug to the size and depth as shown on the plans.

Blasting of rock or other obstructions shall be done if necessary. All post settings shall be done carefully so that all posts shall be vertical and in true alignment and rigidly secured in position.

On terminal (end, corner, pull, and brace) and gate posts, the post tops and brace rail clamps around the posts shall be placed before setting the posts in concrete bases. In setting the gate posts, great care must be taken to make sure that gate posts are set the exact distance apart as shown on the plans. For example, posts for a 6-foot gate must be set so as to leave an opening exactly 6 feet wide. A line drawn across from the top of one gate post to the other must be level, regardless of the grade at the ground line.

If the ground is not level, the upgrade gate post shall be set first to get the proper height for the downgrade gate post. The concrete bases for end, corner, pull, brace, and gate posts shall be placed first and allowed to cure for 14 days. The concrete bases for line posts shall be allowed to cure for 7 days. Stretcher bar bands and truss bands as specified on the plans shall be spread and slipped on end, corner, pull, brace, and gate posts as the next operation. Post tops are then inserted on all other posts. No extra compensation shall be made for rock excavation. Rock excavation shall not be grounds for extension of time.

162-3.4 INSTALLING TOP RAILS. To start the installation, a length of top rail shall be run through the first couple of post tops; a rail clamp shall be assembled on the end, corner, or gate post, as the case may be. The end of the rail already placed shall be butted into the clamp and fastened. The top rail shall be installed along the run of the fence and the various sections joined with sleeve couplings. At not more than every 100 feet an expansion coupling shall be placed to take care of expansion and contraction of the rail. The rail shall be clamped in the end, corner, or gate post at the end of the run of the installation of top rail.

162-3.5 INSTALLING BRACES. All horizontal braces shall be attached together with truss rods at all terminal (end, corner, and pull) and gate posts to the brace posts as shown on the plans.

162-3.6 INSTALLING FABRIC. The fabric shall be unrolled on the outside of the fence line with the bottom edge of the fabric against the posts. The various rolls shall be spliced by bringing the ends close together and weaving in a picket in such a way that it will engage both of the roll ends and catch with each twist each separate mesh of the end pickets of both rolls of fabric. The fabric shall be raised and tied loosely to the top rail with a temporary tie wire at intervals of about 20 feet. The fabric shall be installed by a method approved by the Engineer. One method used is given below.

(a) At end, corner, or gate posts, the stretcher bar shall be slipped through the end picket of the fabric and the stretcher bar bands at the same time. Then the bolts in the stretcher bar band shall be tightened. Additional rolls of fabric shall be spliced and placed as the erection progresses along the fence.

(b) In long sections, the fence shall be stretched at intervals of about 100 feet. After the stretching is complete, the fabric shall be tied to the top rails with No. 6 gauge galvanized wire clips securely clinched at the back of the rail. The fastenings shall be spaced not more than 24 inches on centers for the top rail.

(c) The fabric shall be attached to the line posts with No. 6 gauge galvanized wire clips securely clinched to the back of the line posts. The fastenings shall be spaced more than 14 inches on centers for line posts. The topmost clip shall be placed on the line post as near the top of the fabric as possible and the lowest clip as near the bottom of the fabric as possible.

(d) At terminal (end, corner, and pull) and gate posts the fabric shall be fastened with stretcher bars and bands. The fastenings shall be spaced not more than 14 inches on centers for terminal (end, corner, and pull) and gate posts. The topmost band shall be placed on these posts as near the top of the fabric as possible and the lowest band as near the bottom of the fabric as possible.

Standard chain-link fence stretching equipment shall be provided for stretching the fabric before tying it to the rails and posts. The stretching and tying operations shall be repeated about every 100 feet until the run of fence is completed. Equipment of one type for performing the stretching operation may be composed of four pieces of lumber (2 x 4's or larger) cut into a slightly shorter length than the width of the fabric. The pieces shall be bored for six bolts of about 1/2 or 5/8-inch diameter and shall be assembled as shown on the plans. One pair shall be used for stretching the fabric and both pairs shall be used for making a closure of a run of the fence.

Before making a closure, the other end of the run shall be fastened to the end, corner, or gate post as described previously. The operation of making a closure of a run shall be as follows. The stretching equipment as described above shall be clamped on the ends of the fabric parallel to each other and about 5 feet apart when the tension is first applied. The stretching shall continue until the slack has been removed from both sections of the fabric. If the ends overlap, the fabric shall be cut to match. The ends shall be joined by the insertion of a picket similar to the method of connecting two rolls of fabric.

162-3.7 INSTALLING GATES. The gates shall be hung on gate fittings as shown on the plans. The lower hinge (ball and socket type) shall be placed on top of the concrete footing in which the gate post is set; the concrete in the footings shall extend up to the bottom of the lower hinge. The sockets for the cane or foot bolts shall be set in concrete so that the plunger pin will fit perfectly in the socket when the gate is in a closed position. Gates shall be erected to swing in the direction indicated and shall be provided with gate stops as specified or as shown on the plans. All hardware shall be thoroughly secured, properly adjusted, and left in perfect working order. Hinges and diagonal bracing in gates shall be adjusted so that the gates will hang level.

162-3.8 EXISTING FENCE CONNECTIONS. Wherever the new fence joins an existing fence, either at a corner or at the intersection of straight fence lines, a corner post with a brace post shall be set at the junction and braced the same as herein described for corner posts or as shown on the plans.

If the connection is made at other than the corner of the new fence, the last span of the old fence shall contain a brace span.

162-3.9 CLEANING UP. The contractor shall remove from the vicinity of the completed work all tools, buildings, equipment, etc., used during construction.

METHOD OF MEASUREMENT

162-4.1 Fences, Class E, shall be measured in place from outside to outside of end posts or corner posts and shall be the length of fence actually constructed, except the space occupied by the gates. Driveway gates and walkway gates shall be measured in units for each gate installed and accepted.

BASIS OF PAYMENT

162-5.1 Payment will be made at the contract unit price per linear foot for chain-link fence. This price shall be full compensation for furnishing all materials and for all preparation, erection, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made at the contract unit price per each for driveway or for walkway gates. This price shall be full compensation for furnishing all materials, and for all preparation, erection, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 162-5.10 Fence, Class E - per linear foot.

Item 162-5.20 Driveway Gates - per each.

Item 162-5.30 Walkway Gates - per each.

DIVISION IV

DRAINAGE PIPE

ITEM 701 PIPE FOR STORM SEWERS AND CULVERTS

DESCRIPTION

701-1.1 This item shall consist of pipe of the types, classes, sizes, and dimensions required on the plans, furnished and installed at the places designated on the plans and profiles, or by the Resident Engineer, in accordance with these specifications and with the lines and grades given.

The item shall include the bid price per linear foot of pipe in place, the cost of common excavation and backfill, the cost of furnishing and installing all trench bracing, all fittings required to complete the pipe drain as shown on the plans, and the material for and the making of all joints, including all connections to existing drainage pipe and structures.

MATERIALS

701-2.1 GENERAL. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

Zinc-Coated Corrugated Steel Pipe (Type I or II)	ASTM A 760
Galvanized Steel Corrugated Structural Plates and Fasteners for Pipe, Pipe- Arches, and Arches	ASTM A 761
Precoated (Polymeric) Galvanized Steel Sewer and Drainage Pipe	ASTM A 762
Vitrified Clay Pipe	ASTM C 700
Non-Reinforced Concrete Pipe	ASTM C-14
Reinforced Concrete Pipe	ASTM C 76
Reinforced Concrete D-Load Pipe	ASTM C 665
Reinforced Concrete Arch Pipe	ASTM C 506
Reinforced Concrete Elliptical Pipe	ASTM C 507
Precast Reinforced Concrete Box Sections	ASTM C 789 and C 850
Bituminous-Coated Corrugated Steel Pipe and Pipe Arches	AASHTO M 190
Corrugated Aluminum Alloy Culvert Pipe	AASHTO M 196

Bituminous-Coated Corrugated Aluminum Alloy Culvert Pipe	AASHTO M 196 and M 190
Bituminous-Coated Structural Plate Pipe, Pipe Arch, and Arches	AASHTO M 167 and 243
Aluminum Alloy Structural Plate for Pipe, Pipe Arch, and Arches	AASHTO M 219
Asbestos-Cement Storm Drain Pipe	ASTM C 663
Polyvinyl Chloride (PVC) Pipe	ASTM D 3034
Corrugated Polyethylene Drainage Tubing	AASHTO M 252

When harmful concentrations of petroleum fuels are wasted to the piping, pipe containing bituminous products in its coating and/or paving, nor pipe jointing made with material, such as rubber, that would also be adversely affected shall not be used.

701-2.2 MORTAR. Mortar for pipe joints and connections to other drainage structures shall be composed of 1 part, by volume, of portland cement and 2 parts of mortar sand. The portland cement shall conform to the requirements of ASTM C 150, Type 1. The sand shall conform to the requirements of ASTM C 144. Hydrated lime may be added to the mixture of sand and cement in an amount equal to 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C-6.

701-2.3 CONCRETE. Concrete for pipe cradles shall conform to the requirements of Item 610.

701-2.4 OAKUM PACKING. Oakum for joints in bell and spigot pipe shall be made from hemp (Cannabis Sativa) line, or Benares Sunn fiber, or from a combination of these fibers. The oakum shall be thoroughly corded and finished.

701-2.5 RUBBER GASKET JOINTS. Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C 443. Rubber gaskets for PVC pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and pre-coated galvanized pipe shall conform to the requirements of ASTM C 1056, for the "RE" closed cell grades.

701-2.6 COMPRESSION JOINTS. Materials for compression joints for vitrified clay pipe shall meet the requirements of ASTM C 425.

701-2.7 JOINT-SEALING COMPOUND. Poured filler for joints shall conform to the requirements of ASTM D 1190.

CONSTRUCTION METHODS

701-3.1 EQUIPMENT. All equipment necessary and required for the proper construction of storm sewers and culverts shall be on the project, in first-class working condition, and approved by the Resident Engineer before construction is permitted to start.

The contractor shall provide appropriate hoisting equipment to handle the pipe while unloading and placing it in its final position without damage to the pipe.

The contractor shall provide hand tampers and pneumatic tampers to obtain the required compaction of the pipe bed and the backfill, as specified.

701-3.2 EXCAVATION.

(a) Common. The contractor shall do all common excavation to the depth shown on the plans. Common excavation shall consist of all excavation not included under rock excavation.

(b) Rock. The contractor shall do all rock excavation to the specified depth shown on the plans plus the required additional depth for bedding. Rock excavation shall consist of the removal of boulders and detached rock, 1/2 cubic yard in volume or greater, and of all rock in place in ledge or masses which can be removed only by the use of bars and sledges or by blasting.

Where rock, or soil containing rocks or gravel, hard pan, or other unyielding foundation material is encountered in trench excavation, the pipe shall be bedded in accordance with the requirements of one of the classes of bedding but with the following additions: The hard unyielding material shall be excavated below the elevation of the bottom of the pipe or pipe bell to a depth of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. The cushion shall consist of a fine compressive material, such as silty clay or loam, lightly compacted, and shaped as required for the specified class of bedding. The cost of furnishing and placing the cushion material shall be included in the bid price per cubic yard for rock excavation. Before any rock is removed, the Resident Engineer shall have the opportunity to obtain the necessary data to determine the yardage to be used for payment. The bottom of the trench shall be excavated to a horizontal section as far as practicable.

(c) General. Excavated material not required or acceptable for backfill shall be disposed of by the contractor as directed by the Resident Engineer. Common excavation shall not be carried below the required depth; but when it is, the trench shall be backfilled at the contractor's expense with material approved by the Resident Engineer and compacted to the density of the surrounding earth material as determined by the compaction control tests in Division VII.

When directed, unstable soil shall be removed for the full width of the trench and replaced with sand or with approved granular material. The Resident Engineer shall determine the depth of removal of unstable soil and the amount of backfill necessary. The backfill shall be compacted and shaped to a firm but slightly yielding condition to form the bed for the pipe. When not specified in the special provisions, the cost of removing unstable soil and replacing it with approved material shall be covered by a change order or a supplemental agreement for te cubic yards of excavation and of approved material.

The depth of cut shown on the plans is from the surface grade to the invert of the pipeline. In case the depth of cut is changed from that shown on the plans, the change shall not exceed 6 inches without a revision in the contract unit price per linear foot of pipe. However, if the depth of cut is changed more than 6 inches, compensation or deduction of work involved, whether increased or decreased, shall be provided for in a change order or a supplemental agreement.

The minimum width of the trench at te top of the pipe, when placed, shall be a width which will permit the proper construction of joints and compaction of backfill around the pipe. The sides of the trench shall be vertical, unless otherwise approved by the Resident Engineer. The maximum allowable width of the trench shall not exceed 12 inches on each side of the pipe when placed, unless otherwise approved by the Resident Engineer. The bed for the pipe shall be so shaped that at least the lower quarter of the pipe circumference shall be in continuous contact with the bottom of the trench.

The contractor shall do such trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to governing laws. The bracing, sheathing, or shorting shall not be removed in one operation but shall be done in successive stages as determined by the Engineer to prevent overloading of the pipe during backfilling operations. The cost of the bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot for the pipe.

701-3.3 CRADLES. When the Resident Engineer finds the bottom of the trench to be an insufficient foundation for the pipe, he shall determine the locations and dimensions of the necessary cradles to properly support the pipe. The design details for the cradles shall be as shown on the plans.

701-3.4 LAYING AND INSTALLING PIPE.

(a) Clay Pipe and Concrete Pipe. The contractor shall provide the necessary mason's lines and supports to insure installation of the pipe to line and grade, as staked by the Resident Engineer. The contractor's facilities for lowering the pipe into the trench shall be such that neither the pipe nor the trench will be damaged or disturbed.

The Engineer or his authorized representative shall inspect all pipe before it is laid, and reject any section that is damaged by handling or is defective to a degree which will materially affect the function and service of the pipe.

The laying of the pipe in the finished trench shall be started at the lowest point and proceed upgrade. When bell and spigot pipe is used, the bell shall be laid upgrade. If tongue and groove pipe is used, the grooved end shall be laid upgrade.

The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. The pipe shall be protected from water during placing and until the mortar in the joints has thoroughly set.

When bell and spigot pipes are used, spaces for the pipe bells shall be dug in the pipe subgrade to accommodate the bells. These spaces shall be deep enough to insure that the bells do not bear the load of the pipe; they shall not be excessively wide in relation to the longitudinal direction of the trench. When the pipes are laid, the barrel of each section of pipe shall be in contact with the quadrant-shaped bedding throughout its full length, exclusive of the bell, to support the entire load of the pipe.

Pipe shall not be laid on frozen ground.

When placing concrete pipe constructed with elliptical reinforcing, the pipe shall be oriented in accordance with the manufacturer's markings of top or bottom.

The upgrade end of pipelines not terminated in a structure shall be plugged or capped as approved by the Resident Engineer.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and relaid without extra compensation.

The contractor shall provide, as may be necessary, for the temporary diversion of steam flow in order to permit the installation of the pipe under dry conditions.

(b) Corrugated Steel and Aluminum Pipe. Corrugated steel pipe shall be laid with separate sections joined firmly together with coupling bands conforming to the requirements of ASTM A 670. Corrugated aluminum alloy pipe couplings shall conform with the requirements of AASHTO M 196.

Proper facilities shall be provided for lowering the pipe when it is to be placed in a trench. The pipe shall be laid carefully and true to lines and grades on a bed which is uniformly firm throughout its length. Any pipe which is not in true alignment, or which shows any undue settlement after being laid or is damaged, shall be taken up and relaid without extra compensation.

The pipe shall be placed so that the element of the cylindrical pipe constituting the centerline of the paved section shall coincide with the flow line of the culvert or sewer. Sections of paved pipe shall be laid so that the flow line is smooth and continuous across joints.

All pipe shall be handled so as to prevent bruising, or breaking of the spelter coating or the bituminous coating. All spots on the pipe where the spelter or bituminous coating has been injured or destroyed shall be painted with two coats of asphaltic paint, or otherwise repaired in a satisfactory manner.

701-3.5 MORTAR. The mortar shall be of the desired consistency for calking and filling the joints of the pipe or for calking and filling between the pipe and the drainage structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

701-3.6 PIPE JOINTS. Pipe joints for clay or concrete pipe may be of the bell and spigot type or the tongue and groove type unless one type is specified by the Resident Engineer. One of the following methods of jointing pipe shall be used:

(a) Cement Mortar Joints.

(1) Bell and spigot pipe. The first pipe shall be bedded to the established grade line, placing the bell end upstream. The interior surface of the bell shall be carefully cleaned with a wet brush, and the lower portion of the bell filled with mortar to such a depth as to bring the inner surfaces of the abutting pipe flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into the bell so that the sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with a sufficient amount of additional mortar. The cement mortar shall be protected from rapid drying from exposure to sun or wind by suitable covering such as damp burlap kept moist for at least 24 hours. If the mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint should be wrapped or bandaged with cheesecloth to hold the mortar in place.

(2) Tongue and groove pipe. The first pipe shall be bedded carefully to the established grade line with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the second pipe. The grooved end of the first pipe shall be carefully cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned carefully with a wet brush, and while in a horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall then be inserted in the grooved end of the first pipe until mortar is squeezed out on the interior and exterior surfaces. Sufficient mortar shall be used to completely fill the joint and to form a bead on the outside. The cement mortar shall be protected from rapid drying from exposure to sun or wind by suitable covering such as a damp burlap kept moist for at least 24 hours. If the mortar is not sufficiently stiff to prevent appreciable slump before setting, some method shall be provided to hold the mortar in place.

(b) Cement Grout Joints.

(1) Bell and spigot pipe. The pipe shall be bedded and installed as described in (a)(1) above, with the exception of placing mortar. Suitable means shall be furnished for centering the spigot into the bell. The joint shall be sealed with cement grout poured or pumped into diaper bands. Diaper bands shall be made from a suitable fabric of sufficiently close weave to prevent the loss of cement from the grout but shall not be waterproof. The longitudinal edges of the bands shall be rolled and hemmed in a manner to contain a steel wire or strap along each edge. The width of the band shall be such that it will tie back of the bell and yet extend over the joint.

The length shall extend to at least 90% of the outside diameter of the pipe, but the steel wires or straps shall be of sufficient extra length so the ends can be twisted or fastened together at the top of the pipe to hold the diaper tight against the pipe. After securing the band, an inspection shall be made to insure that the band is positioned completely around the pipe and that the joint is covered. The fabric of the band shall be dipped in cement mortar before placing, but the fabric shall not be dry nor the mortar set before pouring the joint. The cement grout shall consist of the same materials as specified for mortar but shall contain sufficient water to maintain a free-pouring consistency. The grout shall be poured between the band and the pipe through the openings in the diaper at the bottom of the pipe. The pouring of grout shall alternate from side to side of the pipe, and successive pourings shall fill the joint in almost equal lifts on each side. Care shall be exercised to seal the joint at the bottom of the pipe. The diaper shall be left in place. No backfilling shall be done until the joints have been inspected and approved.

(2) Tongue and groove pipe. The pipe shall be bedded and installed as described in (a)(2) above, with the exception of placing the mortar. Suitable means shall be furnished for centering the tongue into the groove. The joint shall be sealed with cement grout poured or pumped into diaper bands. The bands shall meet the requirements of (b)(1) above. The diaper band shall be approximately 8 inches in width and shall be placed symmetrically over the joint. The sealing of the joint shall meet the requirements of (b)(1) above. No backfilling shall be done until the joints have been inspected and approved.

(c) Rubber Gasket Joints. The gasket shall be installed in accordance with the manufacturer's instructions.

(d) Composition Gasket Joints. The gasket shall be installed in accordance with the manufacturer's instructions.

(e) Joint-sealing Compound. Joint-sealing compound, hot-pour, mineral-filled, shall be used in filling joints of bell and spigot sewer pipe. The bell and spigot pipe shall be installed and centered so that the annular space is uniform. This annular space shall be calked with oakum joint packing and then shall be sealed with a joint compound conforming to the requirements of ASTM D 1190. The oakum shall be packed into the joint so as to leave a space, measured from the end of the bell, for pouring the compound. The space shall be at least 1 inch for pipes 15 inches or less in diameter, shall be at least 1 1/2 inches for pipes 18 to 24 inches in diameter, and shall be at least 2 inches for pipes larger than 24 inches in diameter. When jointing pipe in its final position, a suitable joint runner previously coated to facilitate removal shall be placed around the pipe, leaving an opening at the top of the runner. The joint

shall be poured until completely filled with the compound; the pouring shall be made as rapidly as possible without entrapping air. After the compound has cooled and set, the runner may be removed. The joint shall be inspected for unfilled spaces or unsatisfactory jointing. Alternate joints may be poured before the pipe is lowered into the trench. In this case, the joint shall be poured with the pipe in a vertical position without the use of the runner. The compound shall be thoroughly set before the pipe is moved. When previously jointed, the pipe shall be handled carefully so as not to move or deform the jointing.

(f) PVC and Polyethylene Pipe. Joints for PVC pipe shall conform to the requirements of ASTM D 3212. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M 252.

(g) Asbestos-Cement Pipe. Fittings for asbestos cement pipe shall conform to the requirements of ASTM C 663.

701-3.7 BACKFILLING. All trenches and excavations shall be backfilled within a reasonable time after the pipes are installed, unless other protection of the pipe is directed. The backfill material shall be selected granular material from excavation or borrow; material which is placed at the sides of the pipe and 1 foot over the top shall be material which can be readily compacted. It shall not contain stones retained on a 3-inch sieve, frozen lumps, chunks of highly plastic lay, or any other material which is objectionable to the Engineer. The material shall be moistened or dried, if necessary, to be compacted by the method in use. Backfill material shall be approved by the Resident Engineer.

The backfill shall be placed in loose layers not to exceed 6 inches in depth along each side of the pipe. Special care shall be taken to secure thorough compaction under the haunches and at the sides of the pipe. This backfill shall be brought up evenly on each side of the structure to an elevation of 1 foot over the top of the pipe, or such greater elevation as directed by the Resident Engineer. Backfilling shall be done in a manner to avoid injurious top or side pressures on the pipe.

In embankments and for other areas outside of pavements, the fill shall be compacted at each side of the pipe for a lateral distance equal to twice the outside diameter or 12 feet, whichever is less, and carried up to an elevation of at least 1 foot above the top of the pipe. The backfill shall be compacted to the density required for embankments in unpaved areas under Item 152. Under paved areas, the subgrade and any backfill shall be compacted to the density required for embankments for paved areas under Item 152.

Movement of construction machinery over a culvert shall be at the contractor's risk. Any pipe damaged thereby shall be replaced at the expense of the contractor.

701-3.8 CONNECTIONS. Where the plans call for connections to existing or proposed structures, these connections shall be watertight and made so that a smooth uniform flow line will be obtained throughout the drainage system.

701-3.9 CLEANING AND RESTORATION OF SITE. After the backfill is completed, the contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankment, shoulders, or as ordered by the Resident Engineer. Except for paved areas of the airport, the contractor shall restore all disturbed areas to their original condition.

After all work is completed, the contractor shall remove all tools and other equipment, leaving the entire site free, clear, and in good condition.

Performance of the work described in this section is not payable directly but shall be considered as a subsidiary obligation of the contractor covered under the contract unit price for the pipe.

701-3.10 INSPECTION. Prior to final approval of the drainage system, the Engineer, accompanied by the contractor's representative, shall make a thorough inspection, by an appropriate method, of the entire installation. Any indication of defects in material or workmanship, or obstruction to flow in the pipe system, shall be further investigated and corrected. Defects due to the contractor's negligence shall be corrected by the contractor without additional compensation and as directed by the Engineer.

METHOD OF MEASUREMENT

701-4.1 The footage of pipe to be paid for shall be the number of linear feet of pipe in place, completed, and approved to be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured.

701-4.2 When specified, the volume of concrete for pipe cradles to be paid for shall be the number of cubic yards of concrete complete in place and accepted as determined from the dimensions shown on the plans or as ordered by the Engineer.

701-4.3 When encountered, rock required to be removed shall be computed by the cubic yard for the specified width of the trench and to a depth of 4 inches below the bed or the pipe. No payment shall be made for the cushion material placed for the bed of the pipe or for additional backfill material.

BASIS OF PAYMENT

701-5.1 Payment will be made at the contract unit price per linear foot for each kind of pipe of the type, class, and size designated; at the contract unit price per cubic yard of concrete for pipe cradles; and at the contract unit price per cubic yard for rock excavation. These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 701-5.10 Concrete for Pipe Cradles - per cu. yd.

Item 701-5.20 Rock Excavation - per cubic yard.

Item 701-5.30 (Size) inch (Type of pipe)-per lin. ft.

(.40, 50, .60,, .90 as required)

ITEM 705 PIPE UNDERDRAINS FOR AIRPORTS

DESCRIPTION

705-1.1 This item shall consist of pipe underdrains of the type, classes, sizes, and dimensions required on the plans, furnished and installed at the places designated on the plans and profiles, or by the Resident Engineer, in accordance with these specifications and with the lines and grades given.

The item shall include in the bid price per linear foot of pipe in place, the cost of excavation, the cost of furnishing and installing all trench bracing, all fittings required to complete the underdrain as shown on the plans, and the material for the making of all joints including all connections to existing drainage pipes and structures.

The bid price per linear foot of pipe shall include all backfill made with earth excavated from the immediate trench. When a granular backfill, as called for on the plans or as ordered by the Resident Engineer, is used to replace material excavated from the trench, it shall be bid and paid for separately as porous backfill No. 1 and/or No. 2, per cubic yard in place and compacted.

MATERIALS

705-2.1 GENERAL. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements. The Project Engineer may specify other materials upon written approval of the Engineer.

705-2.2 VITRIFIED CLAY CRADLE INVERT PIPE. Vitriified clay cradle invert pipe shall meet the requirements of ASTM C 700.

705-2.3 PERFORATED VITRIFIED CLAY PIPE. Perforated vitrified clay pipe shall conform to the requirements of ASTM C 700, except that nothing in the specifications shall exclude the use of plain end perforated clay pipe equipped with approved type joint fasteners. The fasteners shall be capable of maintaining the alignment of the pipe and securing a taut but elastic joint between the sections of pipe when laid. Fasteners may consist of wire clips or other devices which will produce a satisfactory joint.

705-2.4 PERFORATED CONCRETE PIPE. Perforated concrete pipe shall conform to the requirements of ASTM C 444.

705-2.5 POROUS CONCRETE PIPE. Porous concrete pipe shall conform to the requirements of ASTM C 654.

705-2.6 PERFORATED CORRUGATED STEEL PIPE. Perforated corrugated steel pipe shall conform to the requirements of Fed. Spec. WW-P-405.

705-2.7 ASBESTOS-BONDED, PERFORATED CORRUGATED STEEL PIPE. Asbestos-bonded perforated corrugated steel pipe shall conform to the requirements of Fed. Spec. WW-P-405.

705-2.8 ASPHALT-COATED, PERFORATED CORRUGATED STEEL PIPE. Asphalt-coated perforated corrugated steel pipe shall conform to the requirements of Fed. Spec. WW-P-405.

705-2.9 ASPHALT-COATED, ASBESTOS-BONDED, PERFORATED CORRUGATED.

(a) Steel Pipe. Asphalt-coated, asbestos-bonded, perforated corrugated steel pipe shall conform to the requirements of Fed. Spec. WW-P-405.

(b) Perforated Corrugated Aluminum Alloy Pipe. Perforated corrugated aluminum alloy pipe shall conform to the requirements of Fed. Spec. WW-P-402.

(c) Asphalt-coated Perforated Corrugated Aluminum Alloy Pipe. Asphalt-coated, perforated corrugated aluminum alloy pipe shall conform to the requirements of Fed. Spec. WW-P-402.

705-2.10 BITUMINIZED-FIBER PIPE.

(a) Bituminous-fiber pipe and fittings for use as outfalls and connections to perforated pipe shall conform to the requirements of ASTM D-2418.

(b) Perforated bituminous-fiber pipe shall conform to the requirements of ASTM D-2418.

705-2.11 PERFORATED ASBESTOS-CEMENT PIPE. Perforated asbestos-cement pipe shall conform to the requirements of ASTM C 508.

705-2.12 CORRUGATED POLYETHYLENE (PE) TUBING AND IGS FITTINGS. Corrugated polyethylene (PE) tubing and IGS fittings (perforated and non-perforated) shall conform to the requirements of ASTM F 405, Heavy Duty Tubing, for 6 inch diameter tubing and ASTM F 667, Grade P33 or P34, for 8, 10, 12 and 15 inch diameter tubing.

All perforated polyethylene (PE) tubing shall be wrapped or covered with a filter fabric envelope as specified in Section 705-2.13.

705-2.13 FILTER FABRIC ENVELOPES FOR PERFORATED (PE) TUBING. The Geotechnical fabric filter cloth used for fabric envelopes of perforated corrugated polyethylene (PE) tubing pipe underdrains as specified in Section 705-2.12 shall consist of woven or nonwoven

filaments of polypropylene, polyester, nylon or polyethylene. Nonwoven fabric may be needle punched, heat-bonded, resin-bonded or combinations thereof. The filaments must be dimensionally stable (i.e., filaments must maintain their relative position with respect to each other) and resistant to delamination. The filaments must be free from any chemical treatment or coating that might significantly reduce porosity and permeability.

The fabric shall comply with the following physical properties:

Weight (oz./sq.yd.)	-	3.5 min.	-	ASTM D 1910
Grab tensile strength (lbs.)	-	100 min.*	-	ASTM D 1682
Grab elongation at min. grab				
tensile strength (%)	-	20 min-70 max*	-	ASTM D 1682
Equivalent opening size (EOS)	-	70-100**	-	CW-02215-77
				Corps of Engineers

* For woven fabric, test results shall be referecned to orientation with warp or fill, whichever case may be. Both woven and nonwoven fabrics shall be tested wet.

** Manufacturer's certification of fabric to meet requirements.

(a) Handling and Storage. Fabric shall be delivered to the jobsite in such a manner to facilitate handling and incorporation into the work without damage. In no case shall the fabric be stored and exposed to direct sunlight that might significantly diminish its strength or toughness. Torn or punctured fabric shall not be used.

705-2.14 MORTAR. Mortar for pipe connections to other drainage structures shall be composed of 1 part, by volume, of portland cement and 2 parts of mortar sand. The portland cement shall conform to the requirements of ASTM C 150, Type 1. The sand shall conform to the requirements of AASHTO M 45. Hydrated lime may be added to the mixture of sand and cement in an amount equal to 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C 6.

705-2.15 POROUS BACKFILL. Porous backfill shall be free of clay, humus, or other objectionable matter, and shall also conform to particle size specified.

Sieve Designation (square openings)	Percentage By Weight Passing Sieves	
	Porous Material	Porous Material
	No. 1	No. 2
1 1/2 inch	-----	100
1 inch	-----	90-100
3/8 inch	100	25-60
No. 4	90-100	5-40
No. 8	-----	0-20
No. 16	45-80	-----
No. 50	10-30	-----
No. 100	0-10	-----

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for Porous Material No. 1. The coarser granular material shall meet the gradation given in the tabulation for Porous Material No. 2.

CONSTRUCTION METHODS

705-3.1 EQUIPMENT. All equipment necessary and required for the proper construction of pipe underdrains shall be on the project, in first-class working condition, and approved by the Resident Engineer before construction is permitted to start.

The contractor shall provide hand tampers and pneumatic tampers to obtain the required compaction of the pipe bed and backfill, as specified.

705-3.2 EXCAVATION. The contractor shall do all necessary excavation to the depth shown on the plans. The excavation shall be unclassified and shall be performed regardless of the material encountered.

When rock or noncushioning material is encountered in trench excavation, a cushion at least 4 inches thick shall be placed between the rock and the bottom of the pipe. The cushion shall consist of clean sand or equivalent granular material. The cost of furnishing and placing the cushion material shall be included in the bid price per linear foot of pipe. When rock is encountered, the bottom of the trench shall be excavated to a horizontal section as far as is practicable.

Excavated material not required or acceptable for backfill shall be disposed of by the contractor as directed by the Resident Engineer. The

excavation shall not be carried below the required depth; when this is done, the trench shall be backfilled at the contractor's expense with material approved by the Resident Engineer and compacted to the density of the surrounding earth material, as determined by the compaction control tests in Division VII.

The depth of cut shown on the plans is from the surface grade to the invert of the pipeline. In case the depth of cut is changed from that shown on the plans, the change shall not exceed 6 inches without a revision in the contract unit price per linear foot of pipe. However, if the depth of cut is changed more than 6 inches, compensation or deduction of work involved, whether increased or decreased, shall be provided for in a change order or a supplemental agreement.

The minimum width of the trench at the top of the pipe, when placed, shall be a width which will permit the proper construction of joints and compaction of backfill around the pipe, but shall be at least equal to the outside diameter of the pipe plus 6 inches on each side of the pipe.

The bed for the pipe shall be so shaped that at least the lower quarter of the pipe shall be in continuous contact with the bottom of the trench. Spaces for the pipe bell shall be excavated accurately to size to clear the bell so that the barrel supports the entire weight of the pipe.

The contractor shall do such trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to governing laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the contractor after the completion of the backfill to at least 12 inches over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot for the pipe.

705-3.3 LAYING AND INSTALLING PIPE.

(a) Clay or Concrete Types of Pipe. The contractor shall provide the necessary mason's lines and supports to insure installation of the pipe to line and grade, as staked by the Resident Engineer. The contractor's facilities for lowering the pipe into the trench shall be such that neither the pipe nor the trench will be damaged or disturbed.

The Engineer shall inspect all pipe before it is laid, and reject any section that is damaged by handling or is defective to a degree which will materially affect the function and service of the pipe.

The laying of the pipe in the finished trench shall be started at the lowest point and laid upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozed ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and relaid without extra compensation.

(b) Metal, Fiber, or Asbestos-cement Types of Pipe. The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of corcumferential joints pointing upgrade, and with lingitudinal laps on the sides. Any metal in the pipe or bands which is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

The sections of bituminized-fiber pipe shall be securely fastened together with suitable fittings. When the fiber couplings are tapered, they shall provide a tight, driven fit.

The sections of asbestos-cement pipe shall be securely fastened together with suitable couplings. The use of plastic couplings with asbestos-cement underdrain pipe shall provide a permanently tight joint.

During installation, the asphalt-protected pipes shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

(c) All Types of Pipe. The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the Resident Engineer.

Unless otherwise shown on the plans, a 4-inch bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

705-3.4 MORTAR. The mortar shall be of the desired consistency for calking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

705-3.5 JOINTS IN CLAY OR CONCRETE PIPE. When open or partly open joints are required or specified, they shall be constructed as indicated on the plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, hemp, iakum, or mortar, whichever is specified, shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 or as indicated on the plans. This backfill shall be placed so its thickness will be not less than 3 inches nor more than 6 inches, unless otherwise shown on the plans.

When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2, as shown on the plans or as directed by the Resident Engineer.

When the original material excavated from the trench is pervious and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the plans or as directed by the Resident Engineer.

705-3.6 BACKFILLING.

(a) Earth. All trenches and excavations shall be backfilled within a reasonable time after the pipes are installed, unless other protection of the pipe is directed. The backfill material shall be selected material from excavation or borrow; material which is placed within a nominal pipe diameter distance at the sides of the pipe and 1 foot over the top shall be material which can be readily compacted. It shall not contain stones retained on a 3-inch sieve, frozen lumps, chunks of highly plastic clay, or any other material which is objectionable to the Resident Engineer. The material shall be moistened or dried, if necessary to be compacted by the method in use. Backfill material shall be approved by the Resident Engineer. Special care shall be taken in placing the backfill. Great care shall be used to obtain thorough compaction under the haunches and along the sides to the top of the pipe.

The backfill shall be placed in loose layers not exceeding 6 inches in depth under and around the pipe, and not exceeding 8 inches over the pipe. Successive layers shall be added and thoroughly compacted by hand

and pneumatic tampers, approved by the Resident Engineer, until the trench is completely filled and brought to the proper elevation. Backfilling shall be done in a manner to avoid injurious top or side pressures on the pipe.

In embankments and for other areas outside of pavements, the backfill shall be compacted to the density required for embankments in unpaved areas under Item 152. Under paved areas, the subgrade and any backfill shall be compacted to the density required for embankments for paved areas under Item 152.

(b) Granular Material. When granular backfill is required, its placement in the trench and about the pipe shall be as shown on the plans. Special care shall be taken in placing the backfill. The granular backfill shall not contain a damaging amount of foreign matter, nor shall earth from the sides of the trench or from the windrow be allowed to filter into the backfill. When required by the Resident Engineer, a template shall be used to properly place and keep separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches in depth and compacted by hand and pneumatic tampers to the requirements as given for earth backfill. Backfilling shall be done in a manner to avoid injurious top or side pressure on the pipe. The granular backfill shall be made to the elevation of the trench, as shown on the plans.

When perforated pipe or cradle invert pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

When porous backfill is to be placed in paved or adjacent areas prior to the completion of grading or subgrade operations, the backfill material shall be placed immediately after laying the pipe. The depth of this granular backfill shall be not less than 12 inches, measured from the top of the underdrain. During subsequent construction operations, this minimum backfill of 12 inches in depth shall not be disturbed until such time as the underdrains are to be completed. When the underdrains are to be completed, the unsuitable material shall be removed until the porous backfill is exposed. That part of the porous backfill which contains objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any such unsuitable material shall be borne by the contractor.

Whenever a granular subbase blanket course is to be used under pavements which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material

over the underdrains shall be placed in the trench up to an elevation of 2 inches above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material which remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

705-3.7 CONNECTIONS. When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made so that a smooth uniform flow line will be obtained throughout the drainage system.

705-3.8 CLEANING AND RESTORATION OF SITE. After the backfill is completed, the contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Resident Engineer. Except for paved areas of the airport, the contractor shall restore all disturbed areas to their original condition.

After all work is completed, the contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

Performance of the work described in this section is not payable directly but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit price for the underdrain.

METHOD OF MEASUREMENT

705-4.1 The footage of pipe to be paid for shall be the number of linear feet of pipe underdrains in place, completed, and approved to be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured.

705-4.2 The yardage to be paid for shall be the number of cubic yards of porous backfill No. 1 and/or No. 2, complete in place and accepted, and shall be determined from the dimensions given on the plans by typical trench sections indicating the placement of porous backfill or dimensions ordered by the Resident Engineer.

BASIS OF PAYMENT

705-5.1 Payment will be made at the contract unit price per linear foot for pipe underdrains of the type, class, and size designated; at the contract unit price per cubic yard for porous backfill No. 1; and at the contract unit price per cubic yard for porous backfill No. 2. These prices shall be full compensation for furnishing all materials and for all preparation, hauling, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 705-5.10 Porous Backfill No. 1 - per cubic yard.

Item 705-5.20 Porous Backfill No. 2 - per cubic yard.

Item 705-5.30 (Size) inch (Type of Pipe)-per lin. ft.

(.40, .50, .60,, .90 as required)

DRAINAGE STRUCTURES

ITEM 751 MANHOLES, CATCH BASINS, INLETS AND INSPECTION HOLES

DESCRIPTION

751-1.1 This item shall consist of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the Project Engineer.

MATERIALS

751-2.1 BRICK. The brick shall conform to the requirements of AASHTO M 91.

751-2.2 MORTAR. The mortar for brick masonry and similar work shall be composed of 1 part of portland cement and 2 parts of mortar sand, by volume. The portland cement shall conform to the requirements of ASTM C 150. The sand shall conform to the requirements of AASHTO M 45. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C 6. The water shall be clean and free of deleterious amounts of acids, alkalies, or organic material. If the water is of questionable quality, it shall be tested in accordance with AASHTO T 26.

751-2.3 CONCRETE. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item 610.

751-2.4 PRECAST CONCRETE PIPE MANHOLE RINGS. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C-478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches nor more than 48 inches.

751-2.5 CORRUGATED METAL. Corrugated metal shall conform to the requirements of Fed. Spec. WW-P-405.

751-2.6 FRAMES, COVERS, AND GRATES. The castings shall conform to one of the following requirements:

- (a) Gray iron castings shall meet the requirements of ASTM A 48-76.

(b) Malleable iron castings shall meet the requirements of ASTM A 47-77.

(c) Steel castings shall meet the requirements of ASTM A 27-82.

(d) Structural steel for grates and frames shall conform to the requirements of ASTM A 148-82.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned and given two coats of approved bituminous paint. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A 123-78.

751-2.7 STEPS. The steps or ladder bars shall be gray or malleable cast iron, galvanized wrought iron, or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of bituminous paint, when directed.

CONSTRUCTION METHODS

751-3.1 UNCLASSIFIED EXCAVATION.

(a) The contractor shall do all excavation for structures and structure footings to the lines and grades or elevations, shown on the plans, or as staked by the Engineer. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the Resident Engineer may order, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.

(b) Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Resident Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special

care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

(c) The contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

(d) Unless otherwise provided, bracing, sheathing, or shoring involved in the construction of this item shall be removed by the contractor after the completion of the structure. Removal shall be effected in a manner which will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

(e) After each excavation is completed, the contractor shall notify the Resident Engineer to that effect; and concrete or reinforcing steel shall be placed after the Resident Engineer has approved the depth of the excavation and the character of the foundation material.

751-3.2 BRICK STRUCTURES.

(a) Foundations. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Item 610. The foundation shall be built to the correct elevation and shall be finished to cause the least possible resistance to flowing water.

(b) Laying Brick. All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it which can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and relaid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

(c) Joints. All joints shall be slushed with mortar at every course, but slushing alone will not be considered adequate for making an acceptable joint. Exterior faces shall be laid up in advance of backing. Exterior faces shall be back plastered or pargeted with a coat of mortar not less than 3/8-inch thick before the backing is laid up. Prior to pargeting, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than 1/4-inch nor more than 1/2-inch wide and whatever width is adopted shall be maintained uniform throughout the work.

(d) Pointing. Face joints shall be neatly struck, using the weather joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

(e) Cleaning. Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing down with water and, if necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of clean fresh water.

(f) Curing and Cold Weather Protection. In hot or dry weather, or when directed by the Resident Engineer, the brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost in the brick or when the air temperature is below 50° F. unless the contractor has on the project ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60° F. for the duration of the curing period.

751-3.3 CONCRETE STRUCTURES. Concrete structures shall be built on prepared foundations, conforming to the dimensions and form indicated on the plans. The construction shall conform to the requirements specified in Item 610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the Resident Engineer before the concrete is poured.

All invert channels shall be constructed and shaped accurately so as to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped downward toward the outlet.

751-3.4 PRECAST CONCRETE PIPE STRUCTURES. Precast concrete pipe structures shall be constructed on prepared or previously placed slab foundations and shall conform to the dimensions and locations shown on the plans. All precast concrete pipe sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily, and all jointing and connections shall be cemented

with mortar. The top of the upper precast concrete pipe member shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal steps which are embedded or built into the side walls shall be aligned and placed at vertical intervals of 12 inches. When a metal ladder replaces the steps, it shall be securely fastened into position.

751-3.5 CORRUGATED METAL STRUCTURES. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. The structures shall be prefabricated. Standard or special fittings shall be furnished to provide pipe connections or branches of correct dimensions. The connections or branches shall be of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. When indicated, the structures shall be placed on a reinforced concrete base. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to which can be fastened a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans.

751-3.6 INLET AND OUTLET PIPES. Inlet and outlet pipes shall extend through the walls of the structures for a sufficient distance beyond the outside surface to allow for connections but shall be cut off flush with the wall on the inside surface, unless otherwise directed. For concrete or brick structures, the mortar shall be placed around these pipes so as to form a tight, neat connection.

751-3.7 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES, AND FITTINGS. All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the Resident Engineer, and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are to be placed upon previously constructed masonry, the bearing surface or masonry shall be brought true to line and grade and shall present an even bearing surface in order that the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed and approved by the Resident Engineer. All units shall set firm and secure.

After the frames or fittings have been set in final position and the concrete or mortar has been allowed to harden for 7 days, then the grates or covers shall be placed and fastened down.

751-3.8 INSTALLATION OF STEPS. The steps shall be installed as indicated on the plans or as directed by the Resident Engineer. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is poured. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar has hardened for at least 7 days. After this period has elapsed, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete pipe structures, they shall be cast into the sides of the pipe at the time the pipe sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches.

In lieu of steps, prefabricated ladders may be installed. In the case of brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. In the case of metal structures, the ladder shall be secured by welding the top support and grouting the bottom support into drilled holes in the foundation or as directed.

751-3.9 BACKFILLING.

(a) After a structure has been completed, the area around it shall be filled with approved material, in horizontal layers not to exceed 8 inches in loose depth, and compacted to the density required in Item 152, and as determined by compaction control tests specified in Division VII. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the Resident Engineer.

(b) Backfilling shall not be placed against any structure until permission is given by the Resident Engineer. In the case of concrete, such permission shall not be given until the concrete has been in place 7 days, or until tests made by the laboratory under supervision of the Resident Engineer establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

(c) Backfill shall not be measured for direct payment. Performance of this work shall be considered as a subsidiary obligation of the contractor covered under the contract unit price for the structure involved.

751-3.10 CLEANING AND RESTORATION OF SITE. After the backfill is completed, the contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Resident Engineer. The contractor shall restore all disturbed areas to their original condition.

After all work is completed, the contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

METHOD OF MEASUREMENT

751-4.1 The number of manholes, catch basins, inlets, and inspection holes of each size and type shall be counted and measured by the unit.

BASIS OF PAYMENT

751-5.1 The accepted number of manholes, catch basins, inlets, and inspection holes will be paid for at the contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

- Item 751-5.10 Inlets - per each.
- Item 751-5.20 Manholes - per each.
- Item 751-5.30 Catch Basins - per each.
- Item 751-5.40 Inspection Holes - per each.

ITEM 752 CONCRETE CULVERTS, HEADWALLS, AND
MISCELLANEOUS DRAINAGE STRUCTURES

DESCRIPTION

752-1.1 This item shall consist of either plain or reinforced concrete culverts, headwalls, and miscellaneous drainage structures constructed in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the Resident Engineer.

MATERIALS

752-2.1 CONCRETE. Plain and reinforced concrete shall meet the requirements of Item 610.

CONSTRUCTION METHODS

752-3.1 UNCLASSIFIED EXCAVATION.

(a) Trenches and foundation pits for structures or structure footings shall be excavated to the lines and grades or elevations shown on the plans or as staked by the Resident Engineer. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximate only; and the Resident Engineer may order, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.

(b) Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Resident Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall not be made until just before the concrete or reinforcing steel is to be placed.

(c) The contractor shall do all bracing, sheathing, or shoring necessary to perform and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

(d) Unless otherwise provided, bracing, sheathing, or shoring involved therewith shall be removed by the contractor after the completion of the structure. Removal shall be effected in a manner which will not disturb or mar finished concrete. The cost of removal shall be included in the unit price bid for structure.

(e) After each excavation is completed, the contractor shall notify the Resident Engineer to that effect, and concrete or reinforcing steel shall be placed after the Resident Engineer has approved the depth of the excavation and the character of the foundation material.

752-3.2 BACKFILLING.

(a) After a structure has been completed, backfilling with approved material shall be accomplished by applying the fill in horizontal layers not to exceed 8 inches in loose depth, and compacted to the density required in Item 152, and as determined by compaction control tests specified in Division VII.

(b) No backfilling shall be placed against any structure until permission is given by the Resident Engineer. In the case of concrete, such permission shall not be given until the concrete has been in place 7 days, or until tests made by the laboratory under the supervision of the Resident Engineer establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

(c) Fill placed around concrete culverts shall be deposited on both sides at the same time and to approximately the same elevation. Care shall be taken to prevent any wedging action against the structure, and all slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent wedge action.

(d) Backfill will not be measured for direct payment. Performance of this work under the contract is not payable directly but shall be considered as a subsidiary obligation of the contractor, covered under the contract unit price for each type and size of structure.

752-3.3 WEEP HOLES. Weep holes shall be constructed when and as shown on the plans.

752-3.4 CLEANING AND RESTORATION OF SITE. After the backfill is completed, the contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankment, shoulders, or as ordered by the Resident Engineer. The contractor shall restore all disturbed areas to their original condition. After all work is completed, the contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

METHOD OF MEASUREMENT

752-4.1 The number of concrete culverts, headwalls, and miscellaneous drainage structures of each size and type shall be counted and measured by the completed unit.

BASIS OF PAYMENT

752-5.1 The accepted number of concrete culverts, headwalls, and miscellaneous drainage structures of each size and type will be paid for at the contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor, equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item 752-5.10 (Describe Special as Required) - per ea.

Item 752-5.20 Headwalls, Type ____ - per each.
(.30, .40, .50 as required)

Item 752-5.60 Conc. Pipe End Section (dia)-per ea.
(.65, .70, .75, .80,, .95 as required)

ITEM 754 CONCRETE GUTTERS, DITCHES, AND FLUMES

DESCRIPTION

754-1.1 This item shall consist of portland cement concrete gutters, ditches, and flumes constructed in accordance with these specifications at the specified locations in accordance with the dimensions, lines, and grades as shown on the plans or required by the Resident Engineer.

MATERIALS

754-2.1 CONCRETE. Plain and reinforced concrete shall meet the requirements of Item 610.

754-2.2 JOINTS. Joint filler materials and premolded joint material shall conform to Item 610 or Item 605 unless otherwise specified.

CONSTRUCTION METHODS

754-3.1 PREPARING SUBGRADE. Excavation shall be made to the required width and depth, and the subgrade upon which the item is to be built shall be compacted to a firm uniform grade. All soft and unsuitable material shall be removed and replaced with suitable approved material. When required, a layer of approved granular material, compacted to the thickness indicated on the plans, shall be placed to form a subbase. The underlying course shall be checked and accepted by the Resident Engineer before placing and spreading operations are started.

754-3.2 PLACING. The forms for and the mixing, placing, finishing, and curing of concrete shall conform to the requirements of Item 610 and shall be in accordance with the following requirements.

The concrete shall be tamped and spaded until it is consolidated and mortar entirely covers and forms the top surface. The surface of the concrete shall be floated smooth and the edges rounded to the radii shown on the plans. Before the concrete is given the final finishing, the surface shall be tested with a 10-foot straightedge, and any irregularities of more than 1/4 inch in 10 feet shall be eliminated.

The concrete shall be placed with dummy-grooved joints not to exceed 15 feet apart, except where shorter lengths are necessary for closures, but no section shall be less than 4 feet long.

Expansion joints of the type called for in the plans shall be constructed to replace a dummy groove at spacings of approximately 75 feet. When the gutter is placed next to concrete pavement, expansion joints in the gutter shall be located opposite expansion joints in the pavement. When a gutter abuts a pavement or other structure, an expansion joint shall be placed between the gutter and the other structure.

Forms shall not be removed within 24 hours after the concrete has been placed. Minor defects shall be repaired with mortar containing 1 part cement and 2 parts fine aggregate.

The operations of depositing, compacting, and finishing the item shall be conducted so as to build a satisfactory structure. If any section of concrete is found to be porous, other than minor defects which may be plastered, or is otherwise defective, it shall be removed and replaced by the contractor without additional compensation.

754-3.3 BACKFILLING. After the concrete has set sufficiently, the spaces adjacent to the structure shall be refilled to the required elevation with material specified on the plans and compacted by mechanical equipment to at least 90% density, as determined by compaction control test specified in Division VII.

754-3.4 CLEANING AND RESTORATION OF SITE. After the backfill is completed, the contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Resident Engineer. The contractor shall restore all disturbed areas to their original condition.

After all work is completed, the contractor shall remove all tools and equipment, leaving the entire site free, clear and in good condition.

Performance of the work described in this section is not payable directly but shall be considered as a subsidiary obligation of the contractor, covered under the contract until price for the structure.

METHOD OF MEASUREMENT

754-1.1 Concrete gutters, paved ditches, and flumes shall be measured by the number of linear feet of gutter, ditches, or flume measured along the centerline of each respective type of structure.

BASIS OF PAYMENT

754-5.1 Payment will be made at the contract unit price per linear feet for concrete gutter, paved ditches, and flumes completed and accepted in accordance with the plans and these specifications. These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 754-5.10 Concrete gutter - per linear foot.

Item 754-5.20 Paved ditches - per linear foot.

Item 754-5.30 Concrete flumes - per linear foot.

DIVISION V

TURFING

ITEM 901 SEEDING

DESCRIPTION

901-1.1 This item shall consist of seeding the areas shown on the plans or as directed by the Resident Engineer in accordance with these specifications.

MATERIALS

901-2.1 SEED. The kinds of grass, legume, and cover-crop seed furnished shall be those stipulated in the special provisions. Seed shall conform to the requirements of Fed. Spec. JJJ-S-181.

Seed shall be furnished separately or in mixtures in standard containers with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The contractor shall furnish the Resident Engineer duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within 6 months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed.

901-2.2 LIME. Lime, if specified, shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 mesh sieve and 50% will pass through a No. 100 mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide.

901-2.3 FERTILIZER. Fertilizer, if specified, shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified in the special provisions, and shall meet the specified requirements of the applicable State and Federal laws. They shall be

furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- (a) A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- (b) A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- (c) A granular or pellet form suitable for application by blower equipment.

901-2.4 SOIL FOR REPAIRS. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the Resident Engineer before being placed.

CONSTRUCTION METHODS

901-3.1 ADVANCE PREPARATION AND CLEANUP. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches in any diameter, sticks, stumps, and other debris which might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the contractor shall repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches as a result of grading operations and, if immediately prior to seeding, the top 3 inches of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

However, when the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches. Clods shall be

broken and the top 3 inches of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 DRY APPLICATION METHOD

(a) Liming. Lime, if required, shall be applied separately and prior to the application of any fertilizer or seed and only on seedbeds which have previously been prepared as described above. The lime shall then be worked into the top 3 inches of soil after which the seedbed shall again be properly graded and dressed to a smooth finish.

(b) Fertilizing. Following advance preparations and cleanup, and liming if required, fertilizer shall be uniformly spread at the rate which will provide not less than the minimum quantity stated in the special provisions.

(c) Seeding. Grass seed shall be sown at the rate specified on the plans or in the special provisions immediately after fertilizing, and the fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

(d) Rolling. After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawnroller, weighing 40 to 65 pounds per foot of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot of width for sandy or light soils.

901-3.3 WET APPLICATION METHOD

(a) General. The contractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

(b) Spraying Equipment. The spraying equipment shall have a container or water tank equipped with a liquid level guage calibrated to read in increments not larger than 50 gallons over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at alltimes until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons per minute at a pressure of 100 pounds per square inch. The pump shall be mounted in a line which will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and included vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 feet to 100 feet. One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet in length shall be provided to which the nozzles may be connected.

(c) Mixtures. Lime, if required, shall be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds of lime shall be added to and mixed together in the relative proportions specified, but not more than a total of 220 pounds of these combined solids shall be added to and mixed with each 100 gallons of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. Brackish water shall not be used at any time. The contractor shall identify to the Resident Engineer all sources of water at least 2 weeks prior to use. The Resident Engineer may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The contractor shall not use any water from any source which is disapproved by the Resident Engineer following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within 2 hours from the time they were mixed or they shall be wasted and disposed of at locations acceptable to the Resident Engineer.

(d) Spraying. Lime, if required, shall be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime shall be worked into the top 3 inches, after which the seedbed shall again be properly graded and dressed to a smooth finish.

Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray which shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to insure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area. Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

On surfaces which are to be mulched as indicated by the plans or designated by the Resident Engineer, seed and fertilizer applied by the spray method need not be raked into the soil or rolled. However, on surfaces on which mulch is not to be used, the raking and rolling operations will be required after the soil has dried.

901-3.4 MAINTENANCE OF SEEDED AREAS. The contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the Resident Engineer. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

The Project Engineer may specify the season(s) in which the seeding may be done by dates. When either the dry or wet application method outlined above is used for work done out of season, it will be required that the contractor establish a good stand of grass of uniform color and density to the satisfaction of the Resident Engineer. If at the time when the contract has been otherwise completed it is not possible to make an adequate determination of the color, density, and uniformity of such stand of grass, payment for the unaccepted portions of the areas seeded out of season will be withheld until such time as these requirements have been met.

METHOD OF MEASUREMENT

901-4.1 The quantity of seeding to be paid for shall be the number of acres seeded, limed and fertilized as specified, measured on the ground surface, completed and accepted.

BASIS OF PAYMENT

901-5.1 The quantity, determined as provided above, will be paid for at the contract unit price per acre, or fraction thereof, for the pay item listed below, which price and payment shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

Item 901-5.10 Seeding - per acre.

ITEM 904 SODDING

DESCRIPTION

904-1.1 This item shall consist of furnishing, hauling, and placing approved live sod on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the Resident Engineer.

MATERIALS

904-2.1 SOD. Sod furnished by the contractor shall have a good cover of living or growing grass. This shall be interpreted to include grass that is seasonally dormant during the cold or dry seasons and capable of renewing growth after the dormant period. All sod shall be obtained from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matted turf relatively free of weeds or other undesirable foreign plants, large stones, roots, or other materials which might be detrimental to the development of the sod or to future maintenance. At least 70% of the plants in the cut sod shall be composed of the species stated in the special provisions, and any vegetation more than 6 inches in height shall be mowed to a height of 3 inches or less before sod is lifted. Sod, including the soil containing the roots and the plant growth showing above, shall be cut uniformly to a thickness not less than that stated in the special provisions.

904-2.2 LIME. Lime, if specified, shall conform to the requirements of 901-2.2.

904-2.3 FERTILIZER. Fertilizer, if specified, shall conform to the requirements of 901-2.3.

904-2.4 WATER. The water shall be sufficiently free from oil, acid, alkali, salt, or other harmful materials that would inhibit the growth of grass. It shall be subject to the approval of the Resident Engineer prior to use.

904-2.5 SOIL FOR REPAIRS. The soil for fill and topsoiling of areas to be repaired shall conform to the requirements of 901-2.4.

CONSTRUCTION METHODS

904-3.1 GENERAL. Areas to be solid, strip, or spot sodded shall be shown on the plans. Areas requiring special ground surface preparation such as tilling and those areas in a satisfactory condition which are to remain undisturbed shall also be shown on the plans.

Suitable equipment necessary for proper preparation of the ground surface and for the handling and placing of all required materials shall be on hand, in good condition, and shall be approved by the Resident Engineer before the various operations are started. The contractor shall demonstrate to the Resident Engineer before starting the various operations that the application of required materials will be made at the specified rates.

904-3.2 PREPARING THE GROUND SURFACE. After grading of areas has been completed and before applying fertilizer and limestone, areas to be sodded shall be raked or otherwise cleared of stones larger than 2 inches in any diameter, sticks, stumps, and other debris which might interfere with sodding, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes occurs after grading of areas and before beginning the application of fertilizer and ground limestone, the contractor shall repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.

904-3.3 APPLYING FERTILIZER AND GROUND LIMESTONE. Following ground surface preparation, fertilizer shall be uniformly spread at a rate which will provide not less than the minimum quantity of each fertilizer ingredient, as stated in the special provisions. If use of ground limestone is required, it shall then be spread at a rate which will provide not less than the minimum quantity stated in the special provisions. These materials shall be incorporated into the soil to a depth of not less than 2 inches by discing, raking, or other methods acceptable to the Resident Engineer. Any stones larger than 2 inches in any diameter, large clods, roots, and other litter brought to the surface by this operation shall be removed.

904-3.4 OBTAINING AND DELIVERING SOD. After inspection and approval of the source of sod by the Resident Engineer, the sod shall be cut with approved sod cutters to such a thickness that after it has been transported and placed on the prepared bed, but before it has been compacted, it shall have a uniform thickness of not less than 2 inches. Sod sections or strips shall be cut in uniform widths, not less than 10 inches, and in lengths of not less than 18 inches, but of such length as may be readily lifted without breaking, tearing, or loss of soil. Where strips are required, the sod must be rolled without damage with the grass folded inside. The contractor may be required to mow high grass before cutting sod.

The sod shall be transplanted within 24 hours from the time it is stripped, unless circumstances beyond the contractor's control make storing necessary. In such cases, sod shall be stacked, kept moist, and protected from exposure to the air and sun and shall be kept from freezing. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. Where the

soil is too dry, permission to cut sod may be granted only after it has been watered sufficiently to moisten the soil to the depth the sod is to be cut.

904-3.5 LAYING SOD. Sodding shall be performed only during the seasons when satisfactory results can be expected. Frozen sod shall not be used and sod shall not be placed upon frozen soil. Sod may be transplanted during periods of drought with the approval of the Resident Engineer, provided the sod bed is watered to moisten the soil to a depth of at least 4 inches immediately prior to laying the sod.

The sod shall be moist and shall be placed on a moist earth bed. Pitch forks shall not be used to handle sod, and dumping from vehicles shall not be permitted. The sod shall be carefully placed by hand, edge to edge and with staggered joints, in rows at right angles to the slopes, commencing at the base of the area to be sodded and working upward. The sod shall immediately be pressed firmly into contact with the sod bed by tamping or rolling with approved equipment to provide a true and even surface, and insure knitting without displacement of the sod or deformation of the surfaces of sodded areas. Where the sod may be displaced during sodding operations, the workmen when replacing it shall work from ladders or treaded planks to prevent further displacement. Screened soil of good quality shall be used to fill all cracks between sods. The quantity of the fill soil shall not cause smothering of the grass. Where the grades are such that the flow of water will be from paved surfaces across sodded areas, the surface of the soil in the sod after compaction shall be set approximately 1 inch below the pavement edge. Where the flow will be over the sodded areas and onto the paved surfaces around manholes and inlets, the surface of the soil in the sod after compaction shall be placed flush with pavement edges.

On slopes steeper than 1 vertical to 2 1/2 horizontal and in V-shaped or flat-bottom ditches or gutters, the sod shall be pegged with wooden pegs not less than 12 inches in length and have a cross-sectional area of not less than 3/4 square inch. The pegs shall be driven flush with the surface of the sod.

904-3.6 WATERING. Adequate water and watering equipment must be on hand before sodding begins, and sod shall be kept moist until it has become established and its continued growth assured. In all cases, watering shall be done in a manner which will avoid erosion from the application of excessive quantities and will avoid damage to the finished surface.

904-3.7 ESTABLISHING TURF.

(a) General. The contractor shall provide general care for the sodded areas as soon as the sod has been laid and shall continue until final inspection and acceptance of the work.

(b) Protection. All sodded areas shall be protected against traffic or other use by warning signs or barricades approved by the Resident Engineer.

(c) Mowing. The contractor shall mow the sodded areas with approved mowing equipment, depending upon climatic and growth conditions and the needs for mowing specific areas. In the event that weeds or other undesirable vegetation are permitted to grow to such an extent that, either cut or uncut, they threaten to smother the sodded species, they shall be mowed and the clippings raked and removed from the area.

904-3.8 REPAIRING. When the surface has become gullied or otherwise damaged during the period covered by this contract, the affected areas shall be repaired to re-establish the grade and the condition of the soil, as directed by the Resident Engineer, and shall then be resodded as specified in 904-3.5.

METHOD OF MEASUREMENT

904-4.1 This item shall be measured on the basis of the area in square yards of the surface covered with sod and accepted.

BASIS OF PAYMENT

904-5.1 This item will be paid for on the basis of the contract unit price per square yard for sodding, which price shall be full compensation for all labor, equipment, material, staking, and incidentals necessary to satisfactorily complete the items as specified.

Payment will be made under:

Item 904-5.10 Sodding - per square yard.

ITEM 905 TOPSOILING

DESCRIPTION

905-1.1 This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the Resident Engineer.

MATERIALS

905-2.1 TOPSOIL. Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches or more in diameter), clay lumps or similar objects. Brush and other vegetation which will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sods and herbaceous growth such as grass and weeds are not to be removed but shall be thoroughly broken up and intermixed with the soil during handling operations. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh sieve as determined by the wash test in accordance with AASHTO T 11.

Natural topsoil may be amended by the contractor with approved materials and methods to meet the above specifications.

905-2.2 INSPECTION AND TESTS. Within 10 days following acceptance of the bid, the Resident Engineer shall be notified of the source of topsoil to be furnished by the contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in 905-2.1.

CONSTRUCTION METHODS

905-3.1 GENERAL. Areas to be topsoiled shall be shown on the plans. If topsoil is available to the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the Resident Engineer before the various operations are started.

905-3.2 PREPARING THE GROUND SURFACE. Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other means approved by the Resident Engineer, to a minimum depth of 2 inches to facilitate bonding of the topsoil to the covered subgrade soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and properly compacted condition to prevent, insofar as practical, the formation of low places or pockets where water will stand.

905-3.3 OBTAINING TOPSOIL. Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the Resident Engineer. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the contractor shall remove this material from the designated areas and to the depth as directed by the Resident Engineer. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the Resident Engineer. Unless otherwise specified, any topsoil stockpiled by the contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoiling purposes, shall be removed and placed by the contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the contractor shall locate and obtain the supply, subject to the approval of the Resident Engineer. The contractor shall notify the Resident Engineer sufficiently in advance of operations in order that necessary measurements and tests can be made. The contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.

905-3.4 PLACING TOPSOIL. The topsoil shall be evenly spread on the prepared areas to a uniform depth of 2 inches after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turving operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the contractor. After spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the Resident Engineer. The compacted topsoil surface shall conform to the required lines, grades, and cross sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

METHOD OF MEASUREMENT

905-4.1 The yardage of topsoil obtained on the site to be paid for shall be the number of cubic yards of topsoil measured in its original position and stripped or excavated. The yardage of topsoil stockpiled by others and removed for topsoiling by the contractor to be paid for shall be the number of cubic yards of topsoil measured in the stockpile. Topsoil shall be measured by volume in cubic yards computed by the method of end areas.

905-4.2 The yardage of topsoil obtained off the site to be paid for shall be the number of cubic yards of topsoil measured in its original position and stripped or excavated. Topsoil shall be measured by volume in cubic yards computed by the method of end areas.

BASIS OF PAYMENT

905-5.1 Payment will be made at the contract unit price per cubic yard for topsoiling (obtained on the site). This price shall be full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

905-5.2 Payment will be made at the contract unit price per cubic yard for topsoiling (obtained off the site). This price shall be full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 905-5.10 Topsoiling (from On Site) - per cubic yard.

Item 905-5.20 Topsoiling (from Off Site) - per cubic yard.

ITEM 908 MULCHING

DESCRIPTION

908-1.1 This item shall consist of furnishing, hauling, placing, and securing mulch on surfaces indicated on the plans or designated by the Resident Engineer.

MATERIALS

908-2.1 MULCH MATERIAL. Acceptable mulch shall be the materials listed below or any approved locally available material that is similar to those specified. Low grade, musty, spoiled, partially rotted hay, straw, or other materials unfit for animal consumption will be acceptable. Mulch materials, which contain matured seed of species which would volunteer and be detrimental to the proposed overseeding, or to surrounding farm land, will not be acceptable. Straw or other mulch material which is fresh and/or excessively brittle, or which is in such an advanced stage of decomposition as to smother or retard the planted grass, will not be acceptable.

(a) Hay. Hay shall be native hay, Sudan grass hay, broomsedge hay, legume hay, or similar hay or grass clippings.

(b) Straw. Straw shall be the threshed plant residue of oats, wheat, barley, rye, or rice from which grain has been removed.

(c) Stalks. Stalks shall be the whole or shredded stems of corn, cane, kafir, sorghum, broomcorn, hemp, flax, sunflowers, castor beans, potato vines, tobacco, or other coarse stemmy material.

(d) Manure. Manure shall be fresh or partially decomposed strawy stable manure containing not over 25% of solid material by volume.

(e) Forest Litter. Forest litter shall be the surface layer of leaves, twigs, needles, and small branches from local woods. Forest litter shall be removed in such a way as to avoid injury to the trees.

(f) Hay Mulch Containing Seed. Hay mulch shall be mature hay containing viable seed of native grasses or other desirable species stated in the special provisions or as approved by the Resident Engineer. The hay shall be cut and handled so as to preserve the maximum quantity of viable seed. Hay mulch which cannot be hauled and spread immediately after cutting shall be placed in weather-resistant stacks or baled and stored in a dry location until used.

(g) Manufactured Mulch. Cellulose-fiber or wood-pulp mulch shall be products commercially available for use in spray applications.

(h) Asphalt Binder. Asphalt binder material shall conform to the requirements of AASHTO M 140, Type SS-1 or RS-1, as appropriate.

908-2.2 INSPECTION. Within 5 days after acceptance of the bid, the Project Engineer shall be notified of sources and quantities of mulch materials available and the contractor shall furnish him with representative samples of the materials to be used. These samples may be used as standards with the approval of the Engineer and any materials brought on the site which do not meet these standards shall be rejected.

CONSTRUCTION METHODS

908-3.1 MULCHING. Before spreading mulch, all large clods, stumps, stones, brush, roots, and other foreign material shall be removed from the area to be mulched. Mulch shall be applied immediately after seeding. The spreading of the mulch may be by hand methods, blower, or other mechanical methods, provided a uniform covering is obtained.

Mulch material shall be furnished, hauled, and evenly applied on the area shown on the plans or designated by the Resident Engineer. Straw or hay shall be spread over the surface to a uniform thickness at the rate of 2 to 3 tons per acre to provide a loose depth of not less than 1 1/2 inches nor more than 3 inches. Other organic material shall be spread at the rate directed by the Resident Engineer. Mulch may be blown on the slopes and the use of cutters in the equipment for this purpose will be permitted to the extent that at least 95% of the mulch in place on the slope shall be 6 inches or more in length. When mulches applied by the blowing method are cut, the loose depth in place shall be not less than 1 inch nor more than 2 inches.

908-3.2 SECURING MULCH. The mulch shall be held in place by light discing, a very thin covering of topsoil, small brush, pins, stakes, wire mesh, asphalt binder, or other adhesive material approved by the Resident Engineer. Where mulches have been secured by either of the asphalt binder methods, it will not be permissible to walk on the slopes after the binder has been applied. The contractor is warned that in the application of asphalt binder material he must take every precaution to guard against damaging or disfiguring structures or property on or adjacent to the areas worked and that he will be held responsible for any such damage resulting from his operations.

If the "Peg and String" method is used, the mulch shall be secured by the use of stakes or wire pins driven into the ground on 5-foot centers or less. Binder twine shall be strung between adjacent stakes in straight lines and crisscrossed diagonally over the mulch, after which the stakes shall be firmly driven nearly flush to the ground to draw the twine down tight onto the mulch.

908-3.3 CARE AND REPAIR.

(a) The contractor shall care for the mulched areas until final acceptance of the project. Such care shall consist of providing protection against traffic or other use by placing warning signs, as approved by the Resident Engineer, and erecting any barricades that may be shown on the plans before or immediately after mulching has been completed on the designated areas.

(b) The contractor shall be required to repair or replace any mulching that is defective or becomes damaged until the project is finally accepted. When, in the judgment of the Resident Engineer, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications, the cost of the necessary repairs or replacement shall be borne by the contractor. However, once the contractor has completed the mulching of any area in accordance with the provisions of the specifications and to the satisfaction of the Resident Engineer, no additional work at his expense will be required, but subsequent repairs and replacements deemed necessary by the Resident Engineer shall be made by the contractor and will be paid for as additional or extra work.

(c) If the "Asphalt Spray" method is used, all mulched surfaces shall be sprayed with asphalt binder material so that the surface has a uniform appearance. The binder shall be uniformly applied to the mulch at the rate of approximately 8.0 gallons per 1,000 square feet, or as directed by the Resident Engineer, with a minimum of 6.0 gallons and a maximum of 10 gallons per 1,000 square feet depending on the type of mulch and the effectiveness of the binder securing it. Bituminous binder material may be sprayed on the mulched slope areas from either the top or the bottom of the slope. An approved spray nozzle shall be used. The nozzle shall be operated at a distance of not less than 4 feet from the surface of the mulch and uniform distribution of the bituminous material shall be required. A pump or an air compressor of adequate capacity shall be used to insure uniform distribution of the bituminous material.

(d) If the "Asphalt Mix" method is used, the mulch shall be applied by blowing, and the asphalt binder material shall be sprayed into the mulch as it leaves the blower. The binder shall be uniformly applied to the mulch at the rate of approximately 8.0 gallons per 1,000 square feet

or as directed by the Resident Engineer, with a minimum of 6.0 gallons and a maximum of 10 gallons per 1,000 square feet depending on the type of mulch and the effectiveness of the binder securing it.

METHOD OF MEASUREMENT

908-4.1 Mulching shall be measured in square yards on the basis of the actual surface area acceptably mulched.

BASIS OF PAYMENT

908-5.1 Payment will be made at the contract unit price per square yard for mulching. This price shall be full compensation for furnishing all materials and for placing and anchoring the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 908-5.10 Mulching - per square yard.

DIVISION VI

LIGHTING INSTALLATION

ITEM 101 INSTALLATION OF AIRPORT
ROTATING BEACONS

DESCRIPTION

101-1.1 This item shall consist of airport rotating beacons furnished and installed in accordance with this specification at the location and shall conform to the design and dimensions shown in the plans. This work shall include the mounting, leveling, wiring, painting, servicing, and testing of the beacon and all materials and incidentals necessary to place the beacons in operating condition as a completed unit to the satisfaction of the Engineer. This item shall include a mounting platform if specified in the plans.

EQUIPMENT AND MATERIALS

101-2.1 GENERAL.

(a) Airport lighting equipment and materials covered by these specifications shall have the prior approval of the Federal Aviation Administration, Airports Service, Washington, D. C. 20590, and shall be listed in Advisory Circular 150/5345-1, Approved Airport Lighting Equipment (latest revision).

(b) All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

101-2.2 BEACON. The airport rotating beacon shall conform to FAA Advisory Circular 150/5345-12 (latest revision), Specification for L-801 Airport and Heliport Beacon.

101-2.3 PANEL BOARDS AND BREAKERS. Panel boards and breakers shall conform to the requirements of Federal Specification W-P-115.

101-2.4 WEATHERPROOF CABINETS. The weatherproof cabinets shall conform to National Electrical Manufacturers Association standards and shall be constructed of steel not less than No. 16 USS gauge.

101-2.5 WIRE. Wire in conduit rated up to 5,000 volts shall conform to Advisory Circular 150/5345-7 (latest revision), Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

101-2.6 CONDUIT. Rigid steel conduit and fittings shall conform to the requirements of Federal Specification WW-C-581.

101-2.7 PAINT.

(a) Red lead priming paint for ungalvanized metal surfaces and the mixing thereof shall conform to the 97% grade in Federal Specification TT-R-191. The red lead shall be furnished in paste form and delivered to the job in the original unbroken packages bearing the marker's name and brand. The raw linseed oil, turpentine, and drier shall be in accordance with the Federal Specifications listed below:

Raw Linseed Oil	TT-L-215
Turpentine	TT-T-801
Drier; Paint, Liquid, Type I	TT-D-651

(b) Priming paint for galvanized metal surfaces shall be zinc dust-zinc oxide primer paint conforming to Federal Specification TT-P-641. If necessary, add not more than 1/2 pint of turpentine to each gallon.

(c) Orange paint for the body and the finish coats on metal and wood surfaces shall consist of a ready-mixed non-fading paint meeting the requirements of Federal Specification TT-E-489, Class B. The color shall be in accordance with Federal Standard 595, Aviation Gloss Orange Number 12197.

(d) White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to Federal Specification TT-P-102.

(e) Priming paint for wood surfaces shall be mixed on the job by thinning the above specified orange or white paint with 1/2 pint of raw linseed oil to each gallon.

CONSTRUCTION METHODS

101-3.1 PLACING THE BEACON. The beacon shall be mounted on a beacon tower, platform, or building roof as shown in the plans.

101-3.2 HOISTING AND MOUNTING. The beacon shall be hoisted to the mounting platform by using suitable slings and hoisting tackle. Before fastening the beacon to the mounting platform, the mounting holes shall be checked for correct spacing. Beacon base or mounting legs shall not be strained or forced out of position to fit incorrect spacing of mounting holes. The beacon base shall be raised first, set in position, and bolted in place. The drum shall then be raised and assembled to the base.

101-3.3 LEVELING. After the beacon has been mounted in place, it shall be accurately leveled. The leveling shall be checked in the presence of the Resident Engineer and shall be to his satisfaction.

101-3.4 SERVICING. Before placing the beacon in operation, the contractor shall accomplish the following:

(a) Clean and polish all glassware, both inside and outside, using a type of cleaner which will not scratch the lens, and clean the interior of the beacon.

(b) Clean interior of beacon base and check for alignment of parts.

(c) Clean and polish slip rings. Apply a very small amount of vaseline to the slip rings, operate about 1/2 hour, then wipe the surplus off the rings. Remove the brushes and lubricate the chamber of brush holders.

(d) Grease gears of rotating mechanism where gears are accessible. Check to see if gears mesh properly, and turn the motor shaft by hand to ascertain if action of gear train is free. Check and adjust the clutch tension. The clutch should be not quite tight enough to stall the motor when the lamp-rotating element is held fast. Fill grease fittings with grease conforming to the manufacturer's or Engineer's recommendations.

(e) Set brushes for free motion on slip rings, and adjust springs to 1 or 2 pounds pressure to provide firm contact.

(f) Secure lamps properly in the sockets.

101-3.5 BEAM ADJUSTMENT. After the beacon has been mounted and leveled, the elevation of the beams shall be adjusted. The final beam adjustments shall be made at night so that results can be readily observed. The beams shall be adjusted to the elevation directed by the Engineer or as shown in the plans, except that, in no case shall the elevation of the beams be less than 2° above the horizontal.

101-3.6 BEACON MOUNTING PLATFORM. Where the beacon is to be mounted at a location other than the beacon tower and where a special mounting platform is required, the construction of this mounting platform and any necessary lightning protection equipment shall be in accordance with the details shown in the plans.

101-3.7 WIRING. The contractor shall furnish all necessary labor and materials and shall make complete above ground electrical connections in accordance with the wiring diagram furnished with the project plans.

If underground cable for the power feed from the transformer vault to the beacon site and duct for this cable installation under paved areas is required, the cable and duct shall be installed in accordance with and paid for by linear foot measurement as described in Item 108, Installation of Underground Cable for Airports, and Item 110, Installation of Airport Underground Electrical Duct.

Unless otherwise specified, the contractor shall connect the tell-tale relay mechanism in the beacon to energize the tower obstruction light circuit when failure of the beacon service (Primary) lamp occurs.

If lightning protection is specified in the plans or proposal as a part of this item, it shall be in accordance with 103-2.3, 103-2.4, 103-2.5, 103-2.6, and 103-3.4 in Item 103, Installation of Airport Beacon Towers.

101-3.8 PANEL AND CABINET. Unless otherwise specified, the contractor shall furnish and install at the top of the beacon tower or mounting platform a circuit-breaker panel consisting of four 15-ampere breakers mounted in a weather-proof cabinet to provide separate protection for the circuits to the beacon lamps, motor, obstruction lights, and other equipment. The cabinet shall be located on the side of the beacon platform, as directed by the Resident Engineer.

101-3.9 CONDUIT. All exposed wiring shall be run in not less than 1/2 inch galvanized rigid steel conduit. No conduit shall be installed on top of a beacon platform floor. All conduit shall be installed to provide for drainage. If mounted on a steel beacon tower, the conduit shall be fastened to the tower members with "Wraplock" straps, clamps, or approved fasteners, spaced approximately 5 feet apart. The conduit shall be fastened to wooden structures with galvanized pipe straps and with galvanized wood screws not less than No. 8 nor less than 1 1/4 inches long. There shall be at least two fastenings for each 10-foot length.

101-3.10 BOOSTER TRANSFORMER. If shown in the plans or specified in job specifications, a booster transformer to compensate for voltage drop to the beacon shall be installed in a suitable weatherproof housing under or on the tower platform or at the base of the tower. The installation shall be as indicated in the plans and described in the proposal. If the booster transformer is required for installation in the transformer vault, it shall be installed in accordance with and paid for as described in Item 109, Installation of Airport Transformer Vault and Vault Equipment.

101-3.11 PHOTOELECTRIC CONTROL. If shown in the plans or specified in job specifications, the contractor shall furnish and install an automatic control switch at the location indicated in the plans. The switch shall be a photoelectric type. It shall be a standard commercially available unit suitable for aviation service. It shall be installed, connected, and adjusted in accordance with the manufacturer's instructions.

101-3.12 OBSTRUCTION LIGHTS. Unless otherwise specified, the contractor shall install on the top of the beacon tower or mounting platform two L-810 obstruction lights on opposite corners. These lights shall be mounted on conduit extensions to a height of not less than 4 inches above the top of the beacon. They shall be connected in series into the tell-tale circuit with the necessary relay and wiring connections.

101-3.13 PAINTING. If construction of a wooden mounting platform is stipulated in the proposal as part of this item, all wooden parts of the platform shall be given one priming coat of white or aviation-orange paint after fabrication but before erection and one body and one finish coat of aviation-orange paint after erection. Steel mounting platforms shall be given one priming coat of red lead before erection and one body and one finish coat of aviation-orange paint after erection. All equipment installed under this contract and exposed to the weather shall be given one body and one finish coat of aviation-orange or white paint as required. This shall include beacon (except glass surfaces), beacon base, breaker cabinet, all conduit, and transformer cases. It shall not include lightning rods or obstruction light globes.

The paint shall be applied uniformly in the proper consistency by skilled painters. The finished paint shall be free from sags, holidays, and smears. Each coat of paint shall be given ample time to dry and harden before the next coat of paint is applied. A minimum of 3 days shall be allowed for drying on wood surfaces, and a minimum of 4 days shall be allowed for drying on metal surfaces. Painting shall not be done in cold, damp, foggy, dusty, or frosty atmospheres, or when air temperature is below 40° F., nor started when the weather forecast indicates such conditions for the day.

All surfaces shall be cleaned before painting. The surfaces shall be dry and free from scale, grease, rust, dust, and dirt when paint is applied. All knots in wood surfaces shall be covered with shellac immediately before applying the priming coat of paint. Nail holes and permissible imperfections shall be filled with putty.

The ready-mixed paint shall be thinned for the priming and body coats in accordance with the manufacturer's recommendations. In the absence of such recommendations, the following shall apply:

(a) Body Coats (for Both Wood and Steel Surfaces) - Add 1/2 pint of turpentine to each gallon of ready-mixed paint for body coats.

(b) Finish Coats (for Both Wood and Steel Surfaces) - The ready-mixed paint shall be used as it comes from the container for finish coats.

101-3.14 TESTING. The installation shall be fully tested in operation as a completed unit prior to acceptance. These tests shall include operation of the lamp-changer operation and taking megger and voltage readings. The insulation resistance to ground of the beacon supply circuit shall be not less than 50 megohms when measured ungrounded. Testing equipment shall be furnished by the contractor. Tests shall be conducted in the presence of the Resident Engineer and shall be to his satisfaction.

METHOD OF MEASUREMENT

101-4.1 The quantity to be paid for under this item shall be the number of beacons installed as completed units in place, accepted, and ready for operation.

BASIS OF PAYMENT

101-5.1 Payment will be made at the contract unit price for each completed and accepted job. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item 101-5.10 Airport Rotating Beacon - per each

ITEM 103 INSTALLATION OF AIRPORT BEACON TOWERS

DESCRIPTION

103-1.1 This item shall consist of an airport beacon tower of the type specified or shown in the plans, furnished and installed in accordance with this specification at the location and shall conform to the design and dimensions shown in the plans. This work shall include the clearing of the site, erection of the tower, installation of lightning protection, painting, and all incidentals necessary to place it in operating condition as a completed unit to the satisfaction of the Engineer.

EQUIPMENT AND MATERIALS

103-2.1 GENERAL. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

103-2.2 TOWER. The steel beacon tower shall conform to one of the following:

(a) Unarco - Rohn Model 65 Beacon Tower, of the height specified, with safety climbing kit and safety service platform, or an approved equal of the type specified in the proposal or shown in the plans.

(b) Military Specification MIL-T-8637; Tower and Extension, Aerial Navigation Beacon, of the height specified in the proposal, less wind cone bracket. (Heights of 51, 62, 75, 91, 108, 129, and 152 feet are standard.)

103-2.3 LIGHTNING ROD. The lightning rod shall consist of a galvanized steel, copper, or copper-clad rod with the upper end drawn to a point and of sufficient length to extend from the point of fastening to not less than 6 inches above the top of the beacon.

103-2.4 DOWN CONDUCTOR. The down conductor cable for lightning protection shall consist of No. 8 AWG or larger bare stranded copper wire.

103-2.5 GROUND ROD. The ground rod shall be of the diameter and length specified in the plans. It shall be copper or copper clad.

103-2.6 GROUND CLAMP. Ground clamp shall be similar and equal to the Type GR as manufactured by the Burndy Engineering Company.

103-2.7 PAINT.

(a) Priming paint for galvanized steel towers shall be zinc, dust-zinc oxide primer paint conforming to Federal Specification TT-P-641. If necessary, add not more than 1/2 pint of turpentine to each gallon.

(b) Priming paint for steel towers, not galvanized, shall be red lead, and the mixing thereof shall conform to the 97% grade Federal Specification TT-R-191. The red lead shall be furnished in paste form and delivered to the job in the original unbroken packages bearing the maker's name and brand. The raw linseed oil, turpentine, and drier shall be in accordance with the Federal Specifications listed below:

Raw Linseed Oil	TT-L-215
Turpentine	TT-T-801
Drier; Paint, Liquid, Type II	TT-D-651

(c) Orange paint for the body and finished coats on metal and wood surfaces shall consist of a ready-mixed nonfading paint meeting the requirements of Federal Specification TT-E-489, Class B. The color shall be in accordance with Federal Standard 595, Aviation Gloss Orange Number 12197.

(d) White paint for steel tower shall be ready-mixed paint conforming to Federal Specification TT-P-102.

CONSTRUCTION METHODS

103-3.1 CLEARING AND GRADING. The site on which the beacon tower is to be erected shall be cleared and leveled. All trees and brush shall be removed from the area within a distance of 25 feet from the tower or as called for in the job plans. Stumps shall be removed to a depth of 18 inches below finished grade and the excavation filled with earth and tamped. If a transformer vault or other structure is included as part of the installation, the area shall be cleared to a distance of 25 feet from these structures. The ground near the tower shall be leveled to permit the operation of mowing machines. The leveling shall extend at least 2 feet outside the tower legs or base. All debris removed from the tower site shall be disposed of by the contractor to the satisfaction of the Resident Engineer and in accordance with Federal, state, or local regulations.

103-3.2 EXCAVATION AND FILL. Excavation for the tower footings shall be carried to a minimum of 4 inches below the footing depth. The excess excavation below the footing depth shall then be backfilled with gravel or crushed stone and compacted to the required level. The footing plates shall be installed, and a thickness of not less than 18 inches of the same gravel or crushed stone shall be placed immediately above the footing plates in layers of not over 6 inches. Each layer above the footing plates shall be thoroughly tamped in place. The remainder of the backfill may be of excavated earth placed in layers not to exceed 6 inches. Each layer shall be thoroughly compacted by tamping.

Where solid rock is encountered, which prevents the carrying of the foundation legs to the required depth but which is of sufficient strength to use holddown bolts, the tower anchor posts shall be cut off at the required length and the holddown bolts shall be installed as indicated in the plans with the approval of the Engineer. Each tower leg shall be anchored to the rock by means of two 7/8-inch diameter by 3-foot long expansion or split bolts and shall be grouted with neat portland cement into holes drilled into the natural rock. Except as required for rock foundations, the footing members shall not be cut off or shortened. If excavated material is of such character that it will not readily compact when backfilled, the Resident Engineer may order the excavation backfilled with concrete or other suitable material.

The concrete footing for tubular beacon towers shall be installed in accordance with the manufacturer's recommendations. Portions of the footing in the topsoil layer shall not be included in the footing height.

103-3.3 ERECTION. Detail erection drawings furnished by the manufacturer shall be strictly followed during construction. All towers shall be erected in sections from the ground up unless otherwise specified. In final assembly, all bolts and fastenings shall be installed, and the structure shall be plumb, true, square, and level. Nuts shall be taken up to a firm bearing after which the bolts shall, if necessary, be cut to proper length to protrude three full threads. Approved locknuts shall be placed on each bolt over the regular nut. Ladder bolts shall be inserted with the head to the outer face of the tower. Diagonal, leg, and handrail bolts shall be installed with nuts on the outer face of the tower, unless otherwise specified. Bent parts shall be straightened before erection without damage to the protective coating. Surfaces abraded or bared of protective coating shall be painted with the proper priming paint as specified in these specifications.

The contractor shall install the ladder on the side of the tower adjacent to the driveway or most accessible approach to the tower.

Tubular beacon towers shall be erected in accordance with the manufacturer's recommendations. The safety cable shall be located on the side of the tower adjacent to the driveway or most accessible approach to the tower.

103-3.4 LIGHTNING PROTECTION. The contractor shall furnish and install a lightning rod, down conductor, and at least one ground plate or rod for each beacon tower. The lightning rod shall be installed at the top of the tower with the tip of the rod extending not less than 6 inches above the top of the beacon.

Down-conductor cables shall be securely fastened to the surface of the tower leg at 5-foot intervals with suitable bronze fasteners having bronze or noncorrosive metal bolts. Sharp turns or bends in the down conductor will not be permitted.

All connections of cable to cable, cable to lightning rods, and cable to ground plates or rods shall be made with approved type solderless connectors or noncorrosive metal and shall be of substantial construction.

The down-conductor cable shall be securely attached to ground rods or plates placed at least 2 feet away from the tower foundations.

The ground rod shall be driven into the ground so that the top is at least 6 inches below grade. The down-conductor shall be firmly attached to the ground plate or rod by means of a ground connector or clamp. Plates shall be embedded in the area of permanent moisture.

The complete lightning protection installation shall be accomplished to the satisfaction of the Resident Engineer. The resistance to ground of any part of the lightning protection system shall not exceed 25 ohms.

103-3.5 PAINTING. The contractor shall furnish all materials and labor for painting the beacon tower. The color scheme for the steel tower shall be as shown in the plans.

(a) Parts to be Painted. Tower parts (except those parts to be exposed to earth) shall not be treated or primed before erection. All tower parts placed below ground level or within 12 inches above ground level shall be given two coats of approved bituminous paint.

The paint shall be applied uniformly in the proper consistency by skilled painters. The finished paint shall be free from sags, holidays, and smears. Division lines between colors shall be sharply defined. Each coat of paint shall be given ample time to dry and harden before the next coat is applied. A minimum of 4 days shall be allowed for drying on

metal surfaces. Painting shall not be done in cold, damp, foggy, dusty, or frosty atmospheres, or when air temperature is below 40° F., nor started when the weather forecast indicates such conditions for the day (24 hour period).

All surfaces shall be cleaned before painting. The surfaces shall be dry and free from scale, grease, rust, dust, and dirt when paint is applied.

The number of coats of paint applied shall be in accordance with the following instructions:

(b) Steel Towers, Galvanized. One priming coat of zinc dust-zinc oxide primer after erection and one body and one finish of white or orange paint (as required by the color scheme) applied after erection.

(c) Steel Towers, Not Galvanized. One priming coat of red lead priming paint and one body and one finish coat of white or orange paint (as required by the color scheme) applied after erection.

The above specified orange and white ready-mixed paints shall be thinned for the body coats in accordance with the manufacturer's recommendations. In the absence of such recommendations, the following shall apply:

(d) Body Coats. Add not more than 1/2 pint of turpentine to each gallon of ready-mixed paint for body coats.

(e) Finish Coats. The ready-mixed paint shall be used as it comes from the container for finish coats.

METHOD OF MEASUREMENT

103-4.1 The quantity to be paid for under this item shall be the number of airport beacon towers installed as completed units in place, accepted, and ready for operation.

BASIS OF PAYMENT

103-5.1 Payment will be made at the contract unit price for each completed and accepted job. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item 103-5.10 Beacon Tower, in Place - per each.

ITEM 107 INSTALLATION OF AIRPORT 8-FOOT
AND 12-FOOT WIND CONES

DESCRIPTION

107-1.1 This item shall consist of an airport wind cone furnished and installed in accordance with this specification at the location and in accordance with the dimensions, design, and details shown in the plans.

The work shall include the furnishing and installation of a support for mounting the wind cone, the specified wire, and a concrete foundation. The item shall also include all cable connections, conduit and conduit fittings, the furnishing and installation of all lamps, ground rod and ground connection, the testing of the installation, and all incidentals necessary to place the wind cone in operation as a completed unit to the satisfaction of the Resident Engineer.

EQUIPMENT AND MATERIALS

107-2.1 GENERAL.

(a) Airport lighting equipment and materials covered by these specifications shall have the prior approval of the Federal Aviation Administration, Airports Service, Washington, D. C. 20590, and shall be listed in FAA Advisory Circular 150/5345-1 (latest revision), Approved Airport Lighting Equipment.

(b) All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Resident Engineer.

107-2.2 WIND CONES.

(a) The 12-foot wind cone shall conform to Military Specification MIL-I-7854, Indicator Assemblies, Wind Cone, Unlighted and Externally Lighted. It shall be mounted on a hinged support conforming to the requirements of FAA Advisory Circular 150/5345-27 (latest revision), Specification for Wind Cone Assemblies.

(b) The 8-foot wind cone and hinged steel pole shall conform to the requirements of FAA Advisory Circular 150/5345-27 (latest revision), Specification for Wind Cone Assemblies.

107-2.3 WIRE. Wire in conduit rated up to 5,000 volts shall conform to FAA Advisory Circular 150/5345-7 (latest revision), Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

107-2.4 CONDUIT. Rigid steel conduit and fittings shall conform to the requirements of Federal Specification WW-C-581.

107-2.5 CONCRETE. The concrete for foundations shall be proportioned, placed, and cured in accordance with Item 610, Structural Portland Cement Concrete.

107-2.6 PAINT.

(a) Red lead priming paint for ungalvanized metal surfaces, and the mixing thereof, shall conform to the 97% grade Federal Specification TT-R-191. The red lead shall be furnished in paste form and delivered to the job in the original unbroken packages bearing the maker's name and brand designation. The raw linseed oil, turpentine, and drier shall be in accordance with the Federal Specifications listed below:

Raw Linseed Oil	TT-L-215
Turpentine	TT-T-801
Drier; Paint, Liquid, Type I	TT-D-651

(b) Priming paint for galvanized metal surfaces shall be zinc dust-zinc oxide primer paint conforming to Federal Specification TT-P-641. If necessary, add not more than 1/2 pint of turpentine to each gallon.

(c) Orange paint for the body and the finish coats on metal and wood surfaces shall consist of a ready-mixed nonfading paint meeting the requirements of Federal Specification TT-E-489, Class B. The color shall be in accordance with Federal Standards 595, Aviation Gloss Orange Number 12197.

(d) White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to Federal Specification TT-P-102.

(e) Priming paint for wood surfaces shall be mixed on the job by thinning the above specified aviation-orange or white paint by adding 1/2 pint of raw linseed oil to each gallon.

CONSTRUCTION METHODS

107-3.1 INSTALLATION. The hinged support or hinged pole shall be installed on a concrete foundation as shown in the plans.

107-3.2 COUNTERWEIGHT. The contractor shall furnish and install a counterweight on the hinged support for the 12-foot wind cone. The counterweight may consist of lead weights which may be furnished with the "A" frame assembly or it may consist of concrete poured around the bottom of the hinged support. Where concrete is used, the counterweight shall be approximately 12 inches wide by 24 inches deep and should weigh approximately 500 pounds. The counterweight should be 25 to 50 pounds less than the weight needed to balance the assembly. The counterbalancing should operate to the satisfaction of the Resident Engineer.

107-3.3 ELECTRICAL CONNECTION. The contractor shall furnish all labor and materials and shall make complete electrical connections in accordance with the wiring diagram furnished with the project plans.

If underground cable from the transformer vault to the wind cone site and duct for this cable installation under paved areas is required, the cable and duct shall be installed in accordance with and paid for by linear foot measurement as described in Item 108, Installation of Underground Cables for Airports, and Item 110, Installation of Airport Underground Electrical Duct.

107-3.4 BOOSTER TRANSFORMER. If shown in plans or specified in job specifications, a booster transformer to compensate for voltage drop to the lamps shall be installed in a suitable weatherproof housing. The booster transformer shall be installed as indicated in the plans and described in the proposal. If the booster transformer is required for installation in the transformer vault, it shall be installed in accordance with and paid for as described in Item 109, Installation of Airport Transformer Vault and Vault Equipment.

107-3.5 GROUND CONNECTION AND GROUND ROD. The contractor shall furnish and install a ground rod, grounding cable, and ground clamps for grounding the "A" frame of the 12-foot assembly or pipe support of the 8-foot support near the base. The ground rod shall be of the diameter and length specified in the plans and shall be copper or copper clad. The ground rod shall be driven into the ground adjacent to the concrete foundation so that the top is at least 6 inches below grade. The grounding cable shall consist of No. 8 AWG bare stranded copper wire or larger and shall be firmly attached to the ground rod by means of a ground connector or clamp. The other end of the grounding cable shall be securely attached to a leg of the "A" frame or to the base of the pipe support with noncorrosive metal and shall be of substantial construction. The resistance to ground shall not exceed 25 ohms.

107-3.6 PAINTING. Three coats of paint shall be applied (one prime, one body, and one finish) to all exposed material installed under this item except the fabric cone, obstruction light globe, and lamp reflectors. The wind cone assembly, if painted on receipt, shall be given one finish coat of paint in lieu of the three coats specified above. The paint shall meet the requirements of Federal Specification TT-E-489, Class B. The color shall be in accordance with Federal Standard 595, Aviation Gloss Orange Number 12197.

107-3.7 LAMPS. The contractor shall furnish and install four 200-watt, 115-volt general lighting service lamps in the reflectors for the 12-foot cone or four 150-watt, 115-volt lamps for the 8-foot cone. A clear 100-watt, 107-watt, or 116-watt, 115-volt traffic signal lamp with a medium screw base, or a 100-watt, A-21 bulb, 115-volt, medium prefocus base lamp shall be furnished and installed in the obstruction light as required.

107-3.8 CHAIN AND PADLOCK. The contractor shall furnish and install a suitable operating chain for lowering and raising the hinged top section. The chain shall be attached to the pole support in a manner to prevent the light fixture assembly from striking the ground in the lowered position.

A padlock shall also be furnished by the contractor on the 8-foot wind cone for securing the hinged top section to the fixed lower section. Keys for the padlock shall be delivered to the Resident Engineer.

METHOD OF MEASUREMENT

107-4.1 The quantity to be paid for under this item shall be the number of wind cones installed as completed units in place, accepted, and ready for operation.

BASIS OF PAYMENT

107-5.1 Payment will be made at the contract unit price for each completed and accepted job. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

- Item 107-5.10 8-Foot Wind Cone - per each.
- Item 107-5.20 12-Foot Wind Cone - per each.

ITEM 108 INSTALLATION OF UNDERGROUND CABLE
FOR AIRPORTS

DESCRIPTION

108-1.1 This item shall consist of underground cable furnished and installed in accordance with this specification at the locations and in accordance with the design, dimensions, and details shown in the plans. This item shall include the excavation and backfill of the trench and the installation of cable and counterpoise wire in trench, duct or conduit. It shall include splicing, cable marking, and testing of the installation and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the Engineer. This item shall not include the installation of the duct or conduit.

EQUIPMENT AND MATERIALS

108-2.1 GENERAL.

(a) Airport lighting equipment and materials covered by these specifications shall have the prior approval of the Federal Aviation Administration, Airports Service, Washington D. C. 20591, and shall be listed in FAA Advisory Circular 150/5345-1 (latest revision), Approved Airport Lighting Equipment.

(b) All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the Engineer.

108-2.2 CABLE. Underground cable shall conform to the requirements of Specification for L-824, Underground Electrical Cables for Airport Lighting Circuits. The following types are covered in Specification L-824:

(a) Type A -- Single and multiple conductor cable with 600-volt performance type insulation with an overall neoprene jacket.

(b) Type B -- Single and multiple conductor cable with 5,000-volt "Ozone Resistant" insulation with an overall neoprene jacket.

(c) Type C -- Single and multiple conductor cable with 600 volt or 5,000 volt, cross-linked polyethylene insulation. Multiple conductor cables will have a jacket applied overall.

All cable for airport lighting service shall be stranded viz: 600-volt-7-strand; 5,000-volt--19 strand. For power cable, conductor size shall not be smaller than No. 8 AWG. Control cable, conductor size shall not be less than No. 12 AWG. These limits on conductor sizes shall not apply to leads furnished by manufacturers of transformers and fixtures.

If telephone control cable is specified, copper shielded, polyethylene insulated and jacketed, No. 19 AWG telephone cable conforming to the United States Department of Agriculture, Rural Electrification Administration (REA) Bulletin 345-14, REA Specification for Fully Color-Coded, Polyethylene Insulated, Double Polyethylene-Jacketed Telephone Cables for Direct Burial, shall be used.

Where counterpoise conductors are to be installed and where soil conditions would adversely affect bare copper wire, thermoplastic wire conforming to Federal Specification J-C-30, Type TW, 600-volt, may be used.

Cable type, size, number of conductors, strand and service voltage shall be specified in the plans and/or proposal.

108-2.3 BARE COPPER WIRE (Counterpoise). Bare copper wire for counterpoise installations shall be stranded wire conforming to ASTM Specifications B3 and B8.

108-2.4 CABLE CONNECTIONS. In-line connections of underground primary cables shall be of the type called for in the plans or in the proposal, and shall be one of the types listed below. When the plans or the proposal permit a choice of connection, the contractor shall indicate in the bid the type of connection he proposes to furnish.

(a) The Cast Splice. A cast splice, employing a plastic mold and using epoxy resin equal to that manufactured by Minnesota Mining and Manufacturing Company, "Scotchcast" Kit No. 82-A, or as manufactured by Hysol Corporation, "Hyseal Epoxy Splice" Kit No. E1135, for potting the splice is approved. This means of splicing is the only type approved for telephone control cable.

(b) The Vulcanized Splice. A vulcanized splice employing Joy Manufacturing Company's Vulcanizing Kit No. X-1604-8 or equal is approved for field vulcanized splices. The proper molds for various cable sizes shall be used.

(c) The Field-attached Plug-in Splice. Shall conform to Specification for L-823 Plug and Receptacle, Cable Connectors, employing connector kits, is approved for field attachment to single conductor cable.

(d) The Factory-molded Plug-in Splice. Specification for L-823 Connectors, Factory-Molded to Individual Conductors, are approved.

(e) The Taped Splice. Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape are approved. The rubber tape should meet the requirements of Military Specification MIL-I-3825 and the plastic tape should comply with Military Specification MIL-I-7798 or Federal Spec. HH-I-595. In all of the above cases, connections of cable conductors shall be made using crimp connectors utilizing a crimping tool designed to make a complete crimp before the tool can be removed. No. 19 AWG telephone control wires may be connected by means of wrapped and soldered splice, 3M Company Moisture Proof UR Type Connector, or equal, or by a method approved by the Engineer.

108-2.5 CONCRETE. Concrete for cable markers shall conform to Specification Item 610, "Structural Portland Cement Concrete."

CONSTRUCTION METHODS

108-3.1 GENERAL. The contractor shall install the specified cable at the approximate locations indicated in the airport lighting layout plans. The Resident Engineer shall indicate specific locations.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual insulating transformers. The contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections, unless otherwise authorized in writing by the Engineer or shown in the plans.

108-3.2 INSTALLATION IN DUCT OR CONDUIT. This item includes the installation of the cable in duct or conduit as described below. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be in accordance with the latest National Electric Code, or the code of the local agency having jurisdiction.

The contractor shall make no connections or joints of any kind in cables installed in conduits or ducts.

The duct or conduit shall be installed as a separate item in accordance with Item 110, Installation of Airport Underground Electrical Duct. The contractor shall make sure that the duct is open, continuous, and clear of debris before installing cable. The cable shall be installed in a manner to

prevent harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a duct under the same contract, all cable shall be pulled in the duct at the same time. The pulling of a cable through ducts or conduits may be accomplished by handwinch or power winch with the use of cable grips or pulling eyes. Pulling tensions should be governed by recommended standard practices for straight pulls or bends. A lubricant recommended for the type of cable being installed shall be used where pulling lubricant is required. Duct or conduit markers temporarily removed for excavations shall be replaced as required.

108-3.3 TRENCHING. Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Road patrols or graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 18 inches below finished grade, except as follows:

(a) When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches unless otherwise specified.

(b) Minimum cable depth when crossing under a railroad track, shall be 42 inches unless otherwise specified.

The contractor shall excavate all cable trenches to a width not less than 6 inches. The trench shall be widened where more than two cables are to be installed parallel in the same trench. Unless otherwise specified in the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock excavation is encountered, the rock shall be removed to a depth of at least 3 inches below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. The contractor shall ascertain the type of soil or rock to be excavated before bidding. All excavation shall be unclassified.

108-3.4 INSTALLATION IN TRENCHES. The contractor shall not use a cable plow for installing the cable. Mechanical cable-laying equipment may be used in conjunction with a trenching machine if specified on project plans and specifications; and it should provide for physical inspection of cable prior to backfilling. Sharp bends or kinks in the cable shall not be permitted.

Cables shall be unreeled in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end.

Where two or more cables are laid parallel in the same trench, they shall be placed laterally a minimum distance of 3 inches apart, and the trench shall be widened sufficiently to accomplish this.

Cables crossing over each other shall have a minimum of 3-inch vertical displacement with the topmost cable depth at or below the minimum required depth below finished grade.

Not less than 1 foot of cable slack shall be left on each side of all connections, isolation transformers, light units, and at all other points where cable is connected to field equipment. The slack cable shall be placed in the trench in a series of S curves. Additional slack cable shall be left in runway light bases, handholes, manholes, etc., where it is required to bring the cable above ground level to make connections. The amount of slack cable shall be stipulated by the Resident Engineer, or as shown in the plans and specifications.

108-3.5 BACKFILLING. After the cable has been installed, the trench shall be filled 3 inches in depth, loose measurement, and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. This layer shall not be compacted. The second layer shall be 5 inches deep, loose measurement, and shall contain no particles that would be retained on a 1-inch sieve. The remainder of the backfill shall be excavated or imported mineral and shall not contain stone or aggregate larger than 4 inches maximum diameter. The third and subsequent layers of the backfill shall not exceed 8 inches in maximum depth, loose measurement.

The second, and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent undisturbed soil, and to the satisfaction of the Resident Engineer. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required.

Trenches shall not be excessively wet and shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except when sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement. Any excess excavated material shall be removed and disposed of in accordance with instructions issued by the Resident Engineer.

108-3.6 RESTORATION. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the trenching, storing of dirt, cable laying, pad construction, and other work shall be restored to its original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging or mulching. All such work shall be performed in accordance with the FAA Standard Turfing Specifications. The contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance.

108-3.7 CABLE MARKERS. The location of runway light circuits shall be marked by a concrete slab marker, 2 feet square and 4 inches thick, extending approximately 1 inch above the surface. Each cable run from the line of runway lights to the equipment vault shall also be marked at approximately every 200 feet along the cable run, with an additional marker at each change of direction of cable run. All other cable buried directly in the earth shall be marked in the same manner. The contractor shall not install slab markers where cable lies in straight lines between obstruction light poles which are spaced 300 feet apart, or less. Cable markers shall be installed immediately above the cable. The contractor shall impress the word "CABLE" and directional arrows on each cable marking slab. The letters shall be approximately 4 inches high and 3 inches wide, with width of stroke 1/2 inch and 1/4 inch deep.

The location of each underground cable connection, except at lighting units or insulating transformers, shall be marked by a concrete marker slab placed above the connection. The contractor shall impress the work "SPlice" on each slab. He also shall impress additional circuit identification symbols on each slab if so desired by the Resident Engineer.

108-3.8 SPLICING. Connections of the type shown in the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

(a) Cast Splices. These shall be made by using crimp connectors for joining conductors. Molds shall be assembled, and the compound shall be mixed and poured in accordance with manufacturer's instructions and to the satisfaction of the Resident Engineer.

(b) Vulcanized Splices. These shall be made by using crimp connectors for joining conductors. The splice shall be made, using compounds furnished by the manufacturer, in accordance with his instructions and to the satisfaction of the Resident Engineer.

(c) Field-attached Plug-in Splices. These shall be assembled in accordance with manufacturer's instructions. These splices shall be made by plugging directly into mating connectors. In all cases the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1 1/2 inches on each side of the joint.

(d) Factory-molded Plug-in Splices. These shall be made by plugging directly into mating connectors. In all cases, the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1 1/2 inches on each side of the joint.

(e) Taped Splices. A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch of bare conductor on each side of the connector. Use a sharp knife to pencil insulation and jacket at approximately the same angle as a pencil point. Care must be taken to avoid nicking or injuring the conductor during removal of insulation or penciling. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape stretching it just short of its breaking point. Throughout the rest of the splice less tension should be used. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately 1 inch over the original jacket.

Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

If shielded cable is to be spliced, prepare cable as for a regular taped splice, except that the neoprene jacket shall be removed a distance not less than 5 inches from the beginning of the penciled portion. Carefully unwrap the shielding tape from that portion where jacket has been removed and cut off so that it extends about 1 inch from end of the jacket. Proceed with the taped splice as described above and tape up to 1/4 inch from the shield on both ends. Build up rubber tape to a thickness equal to the insulation thickness or 5/16 inch over connector.

Next wrap one-half lapped layer of semi-conducting tape (Scotch No. 13 Semi-Conducting Tape, or equal) over splicing tape and 1/4 inch onto the shielding tape. Wrap a fine, flat shielding braid one-half lapped over the splice extending 1/2 inch onto the metallic shielding. Solder ends of braid to metallic shielding tape. A bonding wire, (Minimum No. 14 stranded copper) equal to the current carrying capacity of the metallic shield, should have the individual strands wrapped around the metallic shield at both ends of the splice. These strands should be tack soldered to the shield in several places. The cable sheath should be replaced by wrapping with two one-half lapped layers of vinyl tape extending 2 inches onto the cable jacket.

The above described splice is for a straight-through splice with continuity of shielding.

108-3.9 BARE COUNTERPOISE WIRE INSTALLATION AND GROUNDING FOR LIGHTING PROTECTION. If shown in the plans or specified in job specifications, a stranded bare copper wire, No. 8 AWG minimum size, shall be installed for lightning protection of the underground cables. The bare counter-poise wire shall be installed in the same trench for the entire length of the insulated cables it is designed to protect, and shall be placed at a distance of approximately 4 inches from the insulated cable. The counterpoise wire shall be securely attached to each light fixture base or mounting stake. The counterpoise wire shall also be securely attached to copper or copper-clad ground rods installed not more than 1,000 feet apart around the entire circuit. The ground rods shall be of the length and diameter specified in the plans, but in no case shall they be less than 8-feet long nor less than 5/8 inches in diameter.

The counterpoise system shall terminate at the transformer vault or at the power source. It shall be securely attached to the vault or equipment grounding system. The connections shall be made as shown in the project plans and specifications.

108-3.10 TESTING. The contractor shall furnish all necessary equipment and appliances for testing the underground cable circuits after installation. The contractor shall test and demonstrate to the satisfaction of the Engineer the following:

(a) That all lighting power and control circuits are continuous and free from short circuits.

(b) That all circuits are free from unspecified grounds.

(c) That the insulation resistance to ground of all nongrounded series circuits is not less than 50 megohms.

(d) That the insulation resistance to ground of all nongrounded conductors of multiple circuits is not less than 50 megohms.

(e) That all circuits are properly connected in accordance with applicable wiring diagrams.

(f) That all circuits are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.

METHOD OF MEASUREMENT

108-4.1 The quantity of trench to be paid for shall be the linear feet of trench, including the excavation, backfill, and reconditioning, completed, measured as excavated, and accepted as satisfactory.

When specified in the proposal, separate measurement shall be made for trenches of various specified widths.

108-4.2 The footage of cable or counterpoise wire installed to be paid for shall be the number of linear feet of cable or counterpoise wire installed in trenches, duct or conduit, measured in place, completed, ready for operation, and accepted as satisfactory. Separate measurement shall be made for each cable or counterpoise wire installed.

BASIS OF PAYMENT

108-5.1 Payment will be made at the contract unit price for trenching, cable and bare counterpoise wire installed in trench, duct, or conduit in place by the contractor and accepted by the Engineer. This price shall

be full compensation for furnishing all materials and for all preparation and installation of these materials, backfilling and compacting trenches, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item 108-5.10 Cable Trench - per lin. ft.

Item 108-5.20 Underground Cable - per lin. ft.

Item 108-5.30 Bare Counterpoise Wire - per lin. ft.

ITEM 109 INSTALLATION OF AIRPORT
TRANSFORMER VAULT AND VAULT EQUIPMENT

DESCRIPTION

109-1.1 This item shall consist of an airport transformer vault or a prefabricated metal housing constructed and installed in accordance with this specification at the location and in accordance with the design and dimensions shown in the plans. This work shall also include the installation of conduits in floor and foundation, painting and lighting of the vault or metal housing, and the furnishing of all incidentals necessary to produce a completed unit. Included as a separate part under this item or as a separate item where an existing vault is to be utilized shall be the furnishing of all vault equipment, wiring, electrical buses, cable, conduit, potheads, and grounding systems. This work shall also include the painting of equipment and conduit; the marking and labeling of equipment and the labeling or tagging of wires; the testing of the installation; and the furnishing of all incidentals necessary to place it in operating condition as a completed unit to the satisfaction of the Engineer.

EQUIPMENT AND MATERIALS

109-2.1 GENERAL.

(a) Airport lighting equipment and materials covered by these specifications shall have the prior approval of the Federal Aviation Administration, Airports Service, Washington, D. C. 20591, and shall be listed in FAA Advisory Circular 150/5345-1 (latest revision) Approved Airport Lighting Equipment.

(b) All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

VAULT AND PREFABRICATED METAL HOUSING

109-2.2 CONCRETE. The concrete for the vault shall be proportioned, placed, and cured in accordance with Item 610, Structural Portland Cement Concrete, using 3/4-inch maximum size coarse aggregate.

109-2.3 REINFORCING STEEL. Reinforcing steel bars shall be intermediate or structural grade deformed-type bars and shall meet the requirements of ASTM A 615.

109-2.4 BRICK. Brick shall conform to ASTM C-62, Grade SW.

109-2.5 ASBESTOS CEMENT DUCT. Asbestos cement duct and fittings shall be in accordance with Federal Specification W-C-571.

109-2.6 FIBER CONDUIT. Fiber conduit and fittings shall be in accordance with Federal Specification W-C-581.

109-2.7 RIGID STEEL CONDUIT. Rigid steel conduit and fittings shall be in accordance with Federal Specification WW-C-581.

109-2.8 LIGHTING. Vault or metal-housing light fixtures shall be of a vaporproof type.

109-2.9 OUTLETS. Convenience outlets shall be heavy-duty duplex units designed for industrial service.

109-2.10 SWITCHES. Vault or metal-housing light switches shall be single-pole switches.

109-2.11 FLOOR DRAINS. The floor drains shall be similar to type Z-798-A (or equal), as manufactured by the Z. A. Zurn Manufacturing Company.

109-2.12 PAINT.

(a) Red lead priming paint for ungalvanized metal surfaces, and the mixing thereof, shall conform to the 97% grade specified in Federal Specification TT-R-191. The red lead shall be furnished in paste form and delivered to the job in the original unbroken packages bearing the maker's name and brand. The raw linseed oil, turpentine, and drier shall be in accordance with the Federal Specifications listed below:

Raw Linseed Oil	TT-L-215
Turpentine	TT-T-801
Drier; Paint, Liquid, Type I	TT-D-651

(b) White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to Federal Specification TT-P-102.

(c) Priming paint for wood surfaces shall be mixed on the job by thinning the above specified white paint by adding 1/2 pint of raw linseed oil to each gallon.

(d) Paint for the floor, ceiling, and inside walls shall be in accordance with Fed. Spec. TT-E-487. Walls and ceiling shall be light gray and the floor shall be medium gray.

(e) The roof coating shall be hot asphalt material in accordance with Federal Specification SS-R-451.

109-2.13 HIGH-VOLTAGE BUS. High-voltage bus shall be standard weight 3/8-inch IPS copper tubing or it may be insulated copper cable of the size and voltage rating specified.

109-2.14 BUS CONNECTORS. Connectors shall be similar to Burndy Type NT (or equal) for copper tubing. Connectors for insulated bus cable shall be of the proper size and type for the service intended.

109-2.15 BUS SUPPORTS. Bus supports shall be similar to Westinghouse No. 527892 (or equal), insulated for 7,500 volts, single clamp type for 2-bolt flat mounting.

109-2.16 GROUND BUS. Ground bus shall be 1/8 X 3/4 inch copper bus bar.

109-2.17 SQUARE DUCT. Duct shall be square similar to that manufactured by the Square D Company (or equal), or the Trumbull Electric Manufacturing Company (or equal). The entire front of the duct on each section shall consist of hinged or removable cover for ready access to the interior. The cross sections of the duct shall be not less than 4 X 4 inches except where otherwise shown in the plans.

109-2.18 GROUND RODS. Ground rods shall be copper or copper-clad of the length and diameter specified in the plans.

109-2.19 POTHEADS. Potheads shall be similar to G&W Type N, Shape C (or equal), unless otherwise specified. Potheads shall be furnished with plain insulator bushings and conduit couplings. Potheads shall have a rating not less than the circuit voltage.

109-2.20 PREFABRICATED METAL HOUSING. The prefabricated metal housing shall be a McGraw-Edison transclosure housing or equal. It shall include any electrical apparatus such as mounting rails, channels, metal bus clamps, insulators, bushings, clips and other applicable packages as may be required. The size and type of transclosure shall be as specified in the special provisions. Also included in this item shall be a concrete pad in accordance with the details shown on the construction plans.

109-2.21 FAA-APPROVED EQUIPMENT. Certain items for airport lighting equipment installed in vaults or translosures are covered by individual FAA equipment specifications. The specifications are listed below:

Advisory Circular 150/5345-3 (latest revision), Specification for L-821 Panels for Remote Control of Airport Lighting.

Advisory Circular 150/5345-5 (latest revision), Circuit Selector Switch.

Advisory Circular 150/5345-7 (latest revision), Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits.

Advisory Circular 150/5345-10 (latest revision), Specification for L-828 Constant Current Regulators.

Advisory Circular 150/5345-13 (latest revision), Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.

109-2.22 OTHER ELECTRICAL EQUIPMENT. Constant-current regulators, distribution transformers, oil switches, cutouts, relays, terminal blocks, transfer relays, circuit breakers, and all other regularly used commercial items of electrical equipment not covered by FAA equipment specifications shall conform to the applicable rulings and standards of the Institute of Electrical and Electronic Engineers or the National Electrical Manufacturers Association. When specified, test reports from a testing laboratory indicating that the equipment meets the specifications shall be supplied. In all cases, equipment shall be new and a first-grade product. This equipment shall be supplied in the quantities required for the specific project and shall incorporate the electrical and mechanical characteristics specified in the proposal and plans.

109-2.23 WIRE. Wire in conduit rated up to 5,000 volts shall conform to Advisory Circular 150/5345-7 (latest revision), Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

(a) Control Circuits. Wire shall be not less than No. 12 AWG and shall be insulated for 600 volts. If telephone control cable is specified, No. 19 AWG telephone cable conforming to the United States Department of Agriculture, Rural Electrification Administration (REA) Bulletin 345-14 shall be used.

(b) Power Circuits.

1. 600 volts maximum--Wire shall be No. 6 AWG or larger and shall be insulated for at least 600 volts.

2. 3,000 volts maximum--Wire shall be No. 6 AWG or larger and shall be insulated for at least 3,000 volts.

3. Over 3,000 volts--Wire shall be No. 6 AWG or larger and shall be insulated for at least the circuit voltage.

CONSTRUCTION METHODS

CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

109-3.1 GENERAL. The contractor shall construct the transformer vault or prefabricated metal housing at the location indicated in the plans. Vault construction shall be reinforced concrete, concrete masonry, or brick wall as specified. The metal housing shall be prefabricated equipment enclosure to be supplied in the size specified. The mounting pad or floor details, installation methods, and equipment placement are shown in the plans.

The contractor shall clear, grade, and seed the area around the vault or metal housing for a minimum distance of 10 feet on all sides. The slope shall be not less than 1/2 inch per foot away from the vault or metal housing in all directions.

109-3.2 FOUNDATION AND WALLS.

(a) Reinforced Concrete Construction. The contractor shall construct the foundation and walls in accordance with the details shown in the plans. Unless otherwise specified, internal ties shall be of the mechanical type so that when the forms are removed the ends of the ties shall be at least 1-inch beneath the concrete surface; the holes shall be plugged and finished to prevent discoloration. Reinforcing steel shall be placed, as shown in the drawings, and secured in position to prevent displacement during the concrete placement.

The external surfaces of the concrete shall be thoroughly worked during the placing operation to force all coarse aggregate from the surface. Thoroughly work the mortar against the forms to produce a smooth finish free from air pockets and honeycomb.

The surface film of all pointed surfaces shall be removed before setting occurs. As soon as the pointing has set sufficiently, the entire surface inside and outside of the vault shall be thoroughly wet with water and rubbed with a No. 16 carborundum stone, or equal quality abrasive, bringing the surface to a paste. All form marks and projections shall be

removed. The surface produced shall be smooth and dense without pits or irregularities. The materials which have been ground into a paste during the rubbing process shall be spread or brushed uniformly over the entire surface (except the interior surfaces that are to be painted shall have all paste removed by washing before painting) and permitted to reset. Final exterior finish shall be obtained by rubbing with No. 30 carborundum stone, or an equal quality abrasive. The surface shall be rubbed until the entire surface is smooth and uniform in color.

(b) Brick and Concrete Construction. When this type of construction is specified, the foundation shall be concrete conforming to the details shown in the plans. The outer edge of the foundation at the floor level shall be beveled 1 1/2 inches at 45°. Brick walls shall be 8 inches thick, laid in running bond with every sixth course a header course. Brick shall be laid in cement mortar (1 part masonry cement and 3 parts sand) with full mortar bed and shoved joints. All joints shall be completely filled with mortar, and facing brick shall be back-parged with mortar as work progresses. All joints shall be 3/8-inch thick, exterior joints tooled concave, and interior joints struck flush. Both interior and exterior brick surfaces shall be cleaned and nail holes, cracks and other defects filled with mortar. When specified, a nonfading mineral pigment mortar coloring shall be added to the mortar. Steel reinforcing bars, 3/8-inch in diameter and 12 inches long, shall be set vertically in the center of the brick wall on not more than 2-foot centers to project 2 1/2 inches into the concrete roof slab. Lintels for supporting the brickwork over doors, windows, and louvers shall consist of two 4 X 3 X 3/8 inch steel angles. Lintels shall be painted with one coat of red lead before installation, and all exposed parts shall be painted similar to doors and window sash after installation.

Window sills may be concrete poured in place or precast concrete as indicated in the plans. All exposed surfaces shall have a rubbed finish as specified under reinforced concrete construction. After completion, all interior and exterior faces of walls shall be scrubbed with a solution of muriatic acid and water in the proportions of not less than 1 part acid to 10 parts of water. All traces of efflorescence, loose mortar, and mortar stain shall be removed, and the walls washed down with clear water.

(c) Concrete Masonry Construction. When this type of construction is specified, the foundation shall be concrete conforming to the details shown in the plans. The concrete masonry units shall be standard sizes and shapes and shall conform to ASTM C 90 and shall include the closures, jambs, and other shapes required by the construction as shown in the plans. Standard construction practice shall be followed for this type of work including mortar, joints, reinforcing steel for extensions into roof slab, etc. Plaster for interior walls, if specified, shall be portland cement plaster.

109-3.3 ROOF. The roof shall be reinforced concrete as shown in the plans. Reinforcing steel shall be placed as shown in the drawing and secured in position to prevent displacement during the pouring of the concrete. The concrete shall be poured monolithically and shall be free of honeycombs and voids. The surface shall have a steel-trowled finish and shall be sloped as shown in the drawing. The underside of the roof slab shall be finished in the same manner as specified for walls.

One brush or mop coat of hot asphalt roof coating shall be applied to the top surface of the roof slab. The asphalt material shall be heated to within the range specified by the manufacturer and immediately applied to the roof. The finished coat shall be continuous over the roof surface and free from holidays and blisters. Smears and dribbles of asphalt on the roof edges and building walls shall be removed.

109-3.4 FLOOR. The floor shall be reinforced concrete as shown in the drawings. When present, all sod, roots, refuse, and other perishable material shall be removed from the area under the floor to a depth of 8 inches, unless a greater depth is specified in the invitation for bids. This area shall be backfilled with materials consisting of sand, cinders, gravel, or stone. Fill shall be placed in layers not to exceed 4 inches and shall be thoroughly compacted by tamping or rolling. A layer of building paper shall be placed over the fill prior to placing concrete. The floor surfaces shall have a steel-trowled finish. The floor shall be level unless a drain is specified, in which case the floor shall be pitched 1/4 inch per foot downward toward the drain. A 1/4 inch asphalt felt expansion joint shall be placed between floor and foundation walls. The floor shall be poured monolithically and shall be free of honeycombs and voids.

109-3.5 FLOOR DRAIN. If shown in the plans, a floor drain and dry well shall be installed in the center of the floor of the equipment room. The dry well shall be excavated 4 X 4 feet square and to a depth of 4 feet below the finished floor elevation and shall be backfilled to the elevation of the underside of the floor with gravel - which shall all pass a 2-inch mesh sieve and shall all be retained on a 1/4 inch mesh sieve. The gravel backfill shall be placed in 6 inch maximum layers, and the entire surface of each layer shall be tamped either with a mechanical tamper or with a hand tamper weighing not less than 25 pounds and having a face area of not more than 36 square inches nor less than 16 square inches. The drain inlet shall be set flush in the concrete floor. The drain shall have a clear opening of not less than 8 inches in diameter.

109-3.6 CONDUITS IN FLOOR AND FOUNDATION. Conduits shall be installed in the floor and through the foundation walls in accordance with the details shown in the plans. All underground conduit shall be

painted with a bituminous compound. Conduit shall be installed with a coupling or metal conduit adapter flush with the top of the floor. All incoming conduit shall be closed with a pipe plug to prevent the entrance of foreign material during construction. Space conduit entrances shall be left closed.

109-3.7 DOORS. Doors shall be metal-clad fireproof Class A doors conforming to requirements of the National Electric Code and local electrical codes.

109-3.8 PAINTING. The floor, ceiling, and inside walls of concrete construction shall first be given a hardening treatment, after which the contractor shall apply two coats of paint as specified below, except that interior face brick walls need not be painted. The hardening treatment shall consist of applying two coats of either a commercial floor hardener or a solution made by dissolving 2 pounds of magnesium fluosilicate or zinc sulphate crystals in 1 gallon of water. Each coat shall be allowed to dry at least 48 hours before the next application. After the second treating coat has dried, the surfaces shall be brushed clean of all crystals and thoroughly washed with clear water. Paint for walls and ceiling shall be a light gray color approved by the Project Engineer. The floor paint shall be a medium gray color approved by the Project Engineer. Before painting, the surfaces shall be dry and clean. The first coat shall be thinned by adding 2/3-quart of spar varnish and 1/3-quart of turpentine to each gallon of paint. The second coat shall be applied without thinning. All doors, lintels, and windows shall be cleaned to remove any rust or foreign material and shall be given one body and one finish coat of white paint. Bare metal surfaces shall be given a prime coat of red lead prior to the body and finish coats.

109-3.9 LIGHTS AND SWITCHES. The contractor shall furnish and install a minimum of two duplex convenience outlets in the vault room. Where a control room is specified, at least two duplex outlets shall be installed.

INSTALLATION OF EQUIPMENT IN VAULT OR PREFABRICATED METAL HOUSING

109-3.10 GENERAL. The contractor shall furnish, install, and connect all equipment, equipment accessories, conduit, cables, wires, buses, grounds, and support necessary to insure a complete and operable electrical distribution center for the airport lighting system as specified herein and shown in the plans. When specified, an emergency power supply and transfer switch shall be provided and installed.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and local code agency having jurisdiction.

109-3.11 POWER SUPPLY EQUIPMENT. Transformers, regulators, booster transformers, and other power supply equipment items shall be furnished and installed at the location shown in the plans or as directed by the Resident Engineer. The power supply equipment shall be set on steel "H" sections, "I" beams, channels, or concrete blocks to provide a minimum space of 1-1/2 inches between the equipment and the floor. The equipment shall be placed so as not to obstruct the oil-sampling plugs of the oil-filled units; and nameplates shall, so far as possible, not be obscured.

If specified in the plans and specifications, equipment for an alternate power source or an emergency power generator shall be furnished and installed. The alternate power supply installation shall include all equipment, accessories, an automatic changeover switch, and all necessary wiring and connections. The emergency power generator set shall be the size and type specified.

109-3.12 SWITCHGEAR AND PANELS. Oil switches, fused cutouts, relays, transfer switches, panels, panel boards, and other similar items shall be furnished and installed at the location shown in the plans or as directed by the Resident Engineer. Wall or ceiling-mounted items shall be attached to the wall or ceiling with galvanized bolts of not less than 3/8-inch diameter engaging metal expansion shields or anchors in masonry or concrete vaults.

109-3.13 DUCT AND CONDUIT. The contractor shall furnish and install square-type exposed metallic ducts with hinged covers for the control circuits in the vault. These shall be mounted along the walls behind all floor-mounted equipment and immediately below all wall-mounted equipment. The hinged covers shall be placed to open from the front side with the hinges at the front bottom.

Wall brackets for square ducts shall be installed at all joints 2 feet or more apart with intermediate brackets as specified. Conduit shall be used between square ducts and equipment or between different items of equipment when the equipment is designed for conduit connection. When the equipment is not designed for conduit connection, conductors shall enter the square-type control duct through insulating bushings in the duct or on the conduit risers.

109-3.14 CABLE ENTRANCE AND HIGH-VOLTAGE BUS SYSTEM. Incoming underground cable from field circuits and supply circuits will be installed outside the walls of the transformer vault as a separate item under Item 108. The contractor installing the vault equipment shall bring the cables from the trench or duct through the entrance conduits into the vault and make the necessary electrical connections. For the incoming and outgoing high-voltage load circuits, the contractor shall furnish and install rigid metallic conduit risers, surmounted by potheads, from floor level to the level as shown in the plans.

The incoming high-voltage power supply service to the vault shall enter below the floor of the vault and shall rise from the floor level in a rigid metallic conduit riser, surmounted by a pothead, as described above. Using insulated high-voltage cable, the incoming power service shall be connected from the pothead to the oil-fused cutouts or to the specified disconnecting switch or equipment. From the oil-fused cutouts or disconnecting device, the insulated service conductors shall be connected to the overhead voltage bus system of the vault. The high-voltage bus system shall utilize the materials specified and shall be mounted and installed in accordance with the requirements of the National Electrical Code or the local code agency having jurisdiction.

109-3.15 WIRING AND CONNECTIONS. The contractor shall make all necessary electrical connections in the vault in accordance with the wiring diagrams furnished and as directed by the Resident Engineer. In wiring to the terminal blocks, the contractor shall leave sufficient extra length on each control lead to make future changes in connections at the terminal block. This shall be accomplished by running each control lead the longest way around the box to the proper terminal. Leads shall be neatly laced in place.

109-3.16 MARKING AND LABELING. All equipment, control wires, terminal blocks, etc., shall be tagged, marked, or labeled as specified below:

(a) Wire Identification. The contractor shall furnish and install self-sticking wire labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks. Wire labels, if used, shall be of the self-sticking preprinted type and of the manufacturer's recommended size for the wire involved. Identification markings designated in the plans shall be followed. Tags, if used, shall be of fiber not less than 3/4 inch in diameter and not less than 1/32 inch thick. Identification markings designated in the plans shall be stamped on tags by means of small tool dies. Each tag shall be securely tied to the proper wire by a nonmetallic cord.

(b) Labels. The contractor shall stencil identifying labels on the cases of regulators, breakers, and distribution and control relay cases with white oil paint as designated by the Resident Engineer. The letters and numerals shall be not less than 1 inch in height and shall be of proportionate width. The contractor shall also mark the correct circuit designations in accordance with the wiring diagram on the terminal marking strips which are a part of each terminal block.

METHOD OF MEASUREMENT

109-4.1 The quantity of vaults to be paid for under this item shall consist of the number of vaults constructed in place and accepted as a complete unit.

109-4.2 The quantity of prefabricated metal housings to be paid for under this item shall consist of the number of housings constructed in place and accepted as a complete unit.

109-4.3 The quantity of vault equipment to be paid for under this item shall consist of all equipment installed, connected, and accepted as a complete unit ready for operation.

BASIS OF PAYMENT

109-5.1 Payment will be made at the contract unit price for each completed and accepted vault or prefabricated metal housing equipment installation. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 109-5.10 Construct Transformer Vault - per each.

Item 109-5.20 Erect Prefabricated Vault - per each.

Item 109-5.30 Install Vault Equipment - per lump sum.

ITEM 110 INSTALLATION OF AIRPORT
UNDERGROUND ELECTRICAL DUCT

DESCRIPTION

110-1.1 This item shall consist of underground electrical ducts installed in accordance with this specification at the locations and in accordance with the dimensions, designs, and details shown in the plans. This item shall include the installation of all underground electrical ducts or underground conduits. It shall also include all trenching, backfilling, removal, and restoration of any paved areas; manholes, concrete encasement, mandreling installation of steel drag wires and duct markers, capping, and the testing of the installation as a completed duct system ready for installation of cables, to the satisfaction of the Engineer.

EQUIPMENT AND MATERIALS

110-2.1 GENERAL. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the Engineer.

110-2.2 BITUMINOUS FIBER DUCT. Bituminous fiber duct and fittings shall conform to the requirements of Federal Specification W-C-581 or W-C-575 and shall be one of the following, as specified in the proposal:

- (a) Type I, for concrete encasement.
- (b) Type II, for direct burial.

110-2.3 ASBESTOS CEMENT DUCT. Asbestos cement duct and fittings shall conform to the requirements of Federal Specification W-C-571 and shall be one of the following, as specified in the proposal:

- (a) Type I, for concrete encasement.
- (b) Type II, for direct burial.

110-2.5 STEEL CONDUIT. Rigid steel conduit and fittings shall conform to the requirements of Federal Specification WW-C-581.

110-2.6 CONCRETE. Concrete shall conform to Item 610, Structural Portland Cement Concrete, using 1-inch maximum size coarse aggregate.

110-2.7 PLASTIC CONDUIT. Plastic conduit and fittings shall conform to the requirements of Federal Specification W-C-1094 and shall be one of the following, as specified in the proposal:

(a) Type I - Suitable for underground use either directly in the earth or encased in concrete.

(b) Type II - Suitable for either above ground or underground use.

CONSTRUCTION METHODS

110-3.1 GENERAL. The contractor shall install underground ducts at the approximate locations indicated in the construction plans. The Resident Engineer shall indicate specific locations as the work progresses. Ducts shall be of the size, material, and type indicated in the plans or specifications. Where no size is indicated in the plans or specifications, the ducts shall be not less than 4 inches inside diameter. All duct lines shall be laid so as to grade toward handholes, manholes and duct ends for drainage. Grades shall be at least 3 inches per 100 feet. On runs where it is not practicable to maintain the grade all one way, the duct lines shall be graded from the center in both directions toward manholes, handholes, or duct ends. Pockets or traps where moisture may accumulate shall be avoided.

The contractor shall mandrel each duct. An iron-shod mandrel, not more than 1/4-inch smaller than the bore of the duct shall be pushed through each duct by means of jointed conduit rods. The mandrel shall have a leather or rubber gasket slightly larger than the duct hole.

All ducts installed shall be provided with a No. 10 gauge galvanized iron or steel drag wire for pulling the permanent wiring. Sufficient length shall be left in manholes or handholes to bend the drag wire back to prevent it from slipping back into the duct. Where spare ducts are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed by the duct manufacturers, or with hardwood plugs conforming accurately to the shape of the duct and having the larger end of the plug at least 1/4-inch greater in diameter than the duct.

All ducts shall be securely fastened in place during construction and progress of the work and shall be plugged to prevent seepage of grout, water, or dirt. Any duct section having a defective joint shall not be installed.

All ducts, except steel conduit, installed under runways, taxiways, aprons, and other paved areas shall be encased in a concrete envelope.

Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for ducts may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of road patrols or graders shall not be used to excavate the trench. The contractor shall ascertain the type of soil or rock to be excavated before bidding. All excavation shall be considered unclassified.

110-3.2 DUCTS ENCASED IN CONCRETE. Unless otherwise shown in the plans, concrete-encased ducts shall be installed so that the top of the concrete envelope is not less than 18 inches below the finished subgrade where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches below finished grade where installed in unpaved areas. Ducts under paved areas shall extend at least 3 feet beyond the edges of the pavement or 3 feet beyond any underdrains which may be installed alongside the paved area. Trenches for concrete encased ducts shall be opened the complete length before concrete is laid so that if any obstructions are encountered, proper provisions can be made to avoid them. All ducts for concrete encasements shall be placed on a layer of concrete not less than 3 inches thick prior to its initial set. Where two or more ducts are encased in concrete, the contractor shall space them not less than 3 inches apart (measured from outside wall to outside wall) using spacers applicable to the type of duct. As the duct laying progresses, concrete not less than 3 inches thick shall be placed around the sides and top of the duct bank. End bells or couplings shall be installed flush with the concrete encasement where required.

When specified, the contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where otherwise shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot intervals.

110-3.3 DUCTS WITHOUT CONCRETE ENCASEMENT. Trenches for single-duct lines shall be not less than 6 inches nor more than 12 inches wide, and the trench for 2 or more ducts installed at the same level shall be proportionately wider. Trench bottoms for ducts without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the duct along its entire length.

A layer of fine earth material, at least 4 inches (loose measurement) shall be placed in the bottom of the trench as bedding for the duct. The bedding shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4-inch sieve. The bedding material shall be tamped until firm.

Unless otherwise shown in the plans, ducts for direct burial shall be installed so that the tops of all ducts are at least 18 inches below the finished grade.

When two or more ducts are installed in the same trench without concrete encasement, they shall be spaced not less than 4 inches apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches apart in a vertical direction.

Trenches shall be opened the complete length before duct is installed so that if any obstructions are encountered, proper provisions can be made to avoid them.

110-3.4 DUCT MARKERS. The location of all ducts shall be marked by an in-pavement duct marker approved by the Engineer. The markers shall be located above all ducts or duct banks, except where ducts terminate in a handhole, manhole, or building.

110-3.5 BACKFILLING. After concrete-encased ducts have been properly installed and the concrete has had time to set, the trench shall be backfilled in at least two layers with excavated material not larger than 4 inches in diameter and thoroughly tamped and compacted to at least the density of the surrounding undisturbed soil. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required.

Trenches shall not be excessively wet and shall not contain pools of water during backfilling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface: except that, when sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of in accordance with instructions issued by the Resident Engineer.

For ducts without concrete encasement, 8 inches of sand, soft earth, or other fine fill (loose measurement) shall be placed around the ducts and carefully tamped around and over them with hand tampers. The remaining trench may be filled with regular run of excavated material and thoroughly tamped as specified above.

110-3.6 RESTORATION. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas

disturbed by the trenching, storing of dirt, cable laying, pad construction and other work shall be restored to its original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, sprigging, or mulching. All such work shall be performed in accordance with the Standard Turfing Specifications. The contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance.

METHOD OF MEASUREMENT

110-4.1 The quantity of underground duct to be paid for under this item shall be the number of linear feet of duct banks installed, measured, in place, completed, and accepted. Separate measurement shall be made for the various types and sizes and number of ducts in each duct bank.

BASIS OF PAYMENT

110-5.1 Payment will be made at the contract unit price for each type and size of single-way or multi-way duct bank completed and accepted. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

- Item 110-5.10 2-Way Concrete Encased Duct -
per linear foot.
- Item 110-5.20 4-Way Concrete Encased Duct -
per linear foot.
- Item 110-5.30 6-Way Concrete Encased Duct -
per linear foot.

(.40, .50, .60, as required)
- Item 110-5.70 4" Steel Duct, direct burial -
per linear foot.
- Item 110-5.80 4" Steel Duct, jacked -
per linear foot.

ITEM 125 INSTALLATION OF AIRPORT
LIGHTING SYSTEMS

DESCRIPTION

125-1.1 This item shall consist of airport lighting systems furnished and installed in accordance with this specification, the referenced specification, and the latest revision of the applicable FAA Advisory Circulars. The systems shall be installed at the location and in accordance with the dimensions, design, and details shown in the plans. This item shall include the furnishing of all equipment, materials, services, and incidentals necessary to place the systems in operation as completed units to the satisfaction of the Engineer.

125-1.2 Additional details pertaining to a specific system covered in this item are contained in the latest revision of the FAA Advisory Circulars listed in paragraphs 125-1.3 through 125-1.8.

125-1.3 FAA Advisory Circular 150/5340-4 (latest revision), Installation Details for Runway Centerline and Touchdown Zone Lighting Systems.

125-1.4 FAA Advisory Circular 150/5340-14 (latest revision), Economy Approach Lighting Aids.

125-1.5 FAA Advisory Circular 150/5340-18 (latest revision), Taxiway Guidance Sign System.

125-1.6 FAA Advisory Circular 150/5340-24 (latest revision), Runway and Taxiway Edge Lighting System.

125-1.7 FAA Advisory Circular 150/5340-25 (latest revision), Visual Approach Slope Indicator (VASI) Systems.

125-1.8 FAA Advisory Circular 150/5340-27 (latest revision), Air-to-Ground Radio Control of Airport Lighting Systems.

EQUIPMENT AND MATERIALS

125-2.1 GENERAL.

(a) Airport lighting equipment and materials covered by these specifications shall have the prior approval of the Federal Aviation Administration, Airports Service, Washington, D. C. 20591, and shall be listed in FAA Advisory Circular 150/5345-1 (latest revision), Approved Airport Lighting Equipment.

(b) All other equipment and materials covered by other referenced specifications shall be subject to acceptance through the manufacturer's certification of compliance with the applicable specifications.

(c) Lists of the equipment and materials required for a particular system are contained in the applicable FAA Advisory Circulars.

125-2.2 TAPE. Rubber and plastic electrical tapes shall be Scotch Electrical Tape Numbers 23 and 88, respectively, as manufactured by the Minnesota Mining and Manufacturing Company, or an approved equal.

125-2.3 CONCRETE. Concrete for backfilling shall be proportioned, placed, and cured in accordance with Item 610, Structural Portland Cement Concrete, using a 3/4-inch maximum size course aggregate.

125-2.4 CONDUIT. Rigid steel conduit and fittings shall conform to the requirements of Federal Specification WW-C-581.

125-2.5 SQUEEZE CONNECTORS. Squeeze connectors, if specified, shall be equal to Crouse-Hinds Company, type CGB cable connector with neoprene rubber bushing.

125-2.6 TEES. Large radius bend tees, if specified, shall be equal to Crouse-Hinds Company No. ET-43.

CONSTRUCTION METHODS

125-3.1 GENERAL. The installation and testing details for the systems shall be as specified in the latest revision of the applicable FAA Advisory Circulars.

125-3.2 PLACING LIGHTS. The light fixtures shall be installed at the approximate location indicated in the plans. The exact location shall be as directed by the Resident Engineer.

METHOD OF MEASUREMENT

125-4.1 The quantity of lights to be paid for under this item shall be the number of each type installed as completed units in place, ready for operation, and accepted by the Engineer.

BASIS OF PAYMENT

125-5.1 Payment will be made at the contract unit price for each complete light installed in place by the contractor and accepted by the

Engineer. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item 125-5.05 MIRL, Stake Mounted - per each.

Item 125-5.10 MIRL, Base Mounted - per each.

Item 125-5.15 MITL, Stake Mounted - per each.

Item 125-5.20 MITL, Base Mounted - per each.

Item 125-5.25 High Intensity Runway Lights -
per each.

Item 125-5.30 M. I. Threshold Lights -
Stake Mounted - per each.

Item 125-5.35 M. I. Threshold Lights -
Base Mounted - per each.

Item 125-5.40 Taxi Guidance Signs,
(No.) Module(s) - per each.

(.41, .42, .43,, .49 as required)

Item 125-5.50 VASI-2 - per each.

Item 125-5.55 VASI-4 - per each.

Item 125-5.60 VASI-6 - per each.

Item 125-5.65 REILS - per each.

(Pay Items may be expanded to include others)

DIVISION VII

TESTING

TEST 611 COMPACTION CONTROL TESTS

GENERAL

611-1.1 DESCRIPTION. This specification shall govern the determination of the maximum density, field density, and percent compaction of those materials for which a minimum percent compaction is specified. It covers the basic procedures to be followed in performing the test for maximum density, field density, and percent compaction. In all cases density shall be stated as the dry weight in pounds per cubic foot.

611-2.1 MAXIMUM DENSITY. Maximum density is defined as the maximum dry weight in pounds per cubic foot obtained when a material is mixed with different percentages of water and compacted in a standard manner. The percentage of water at which maximum density is obtained is termed the optimum moisture content.

611-2.2 LABORATORY COMPACTION TESTS. The maximum density shall be determined by the appropriate method shown below:

(a) Where All of the Material Passes a No. 4 Sieve. Use ASTM D 1557, Method A (or B) for areas designed for aircraft weighing 60,000 pounds or more, and ASTM D 698, Method A (or B) for areas designed for aircraft weighing less than 60,000 pounds.

(b) Where the Material Contains Particles Larger Than a No. 4 Sieve. Use ASTM D 1557, Method C (or D) for areas designed for aircraft weighing 60,000 pounds or more and ASTM D 698, Method C (or D) for areas designed for aircraft weighing less than 60,000 pounds.

(c) Where the Material Contains Particles Larger than 3/4 Inch. Follow the replacement procedure given in the note under Method C of ASTM D 698 or D 1557.

611-3.1 FIELD DENSITY. Field density refers to the dry density expressed in pounds per cubic foot of a layer of compacted material in place at the site as determined by a sample representative of the compacted layer. The field density shall be determined in accordance with ASTM D 1556, ASTM D 2167, ASTM D 2922 or other methods approved by the Engineer.

611-4.1 PERCENT COMPACTION. The percent compaction is defined as the density of the compacted layer expressed as a percentage of the maximum density of the material when tested in accordance with these specifications.

611-4.2 COMPUTATION. The percentage of compaction is computed by the formula:

$$\text{Percent compaction} = \frac{\text{Field density}}{\text{Maximum density}} \times 100$$