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 EBASCO SERVICES INCORPORATED  
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 EBASCO SPECIFICATION FCR-C-294  
 EMBANKMENTS, EROSION CONTROL, AND CHANNELS RCI-C-349  
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(This specification is applicable to Seismic Category I and Non-Seismic Structures. For Classification see Applicable Drawings.)

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PURCHASER: \_\_\_\_\_  
 OWNER: CAROLINA POWER & LIGHT COMPANY  
 OPERATING COMPANY: CAROLINA POWER & LIGHT COMPANY  
 PROJECT: SHEARON HARRIS NUCLEAR POWER PLANT  
 UNIT NO.: 1, 2, 3 & 4 NOMINAL KW 900,000 KW PER UNIT  
 LOCATION: WAKE COUNTY, NORTH CAROLINA  
 SELLER: \_\_\_\_\_

THIS DOCUMENT IS DELIVERED IN ACCORDANCE WITH AND IS SUBJECT TO THE PROVISIONS OF SECTION X OF THE CONTRACT BETWEEN CAROLINA POWER & LIGHT COMPANY AND EBASCO SERVICES INCORPORATED DATED SEPTEMBER 1, 1970, AS AMENDED.

Prepared under the supervision of Andrew A Ferlito, NC PE No. 4935  
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Original	10/8/73	S N Goyal	J L Ehasz	1, 2, 4, 5, 6, 8, 10, 11, 13 & 15	5/17/73
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Ebasco Specification  
 Embankment, Dams, Dikes, and Channels

Project Identification No. CAR-SH-CH-4

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EBASCO SERVICES INCORPORATED

EBASCO SPECIFICATION  
EMBANKMENTS, DAMS, DIKES AND CHANNELS

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1. SCOPE

The scope of work of this specification covers the stripping of the base for embankments, the excavation of cutoff trenches, the channels, the preparation of embankment foundation and the placement of embankment material in the Class I dams including Main Dam, Aux Dam and Aux Separating Dike, and Cofferdams. The sequence of construction shall be governed by the Owner's construction schedule. R3

2. STANDARDS AND DEFINITIONS

.1 Standards

Equipment and/or services furnished in accordance with this specification shall comply with all Federal and State laws and local ordinances of the place of installation and with the following codes to the extent referenced herein. Unless otherwise noted, the document with addenda, amendments, and revisions in effect on the date of the contract will apply. Later editions may be used by mutual consent in writing between the Contractor and Owner.

- a - ASTM Designation D698 "Moisture-Density Relation of Soils Using 5.5 lb Rammer and 12 In. Drop" R2
- ASTM Designation D2049, "Relative Density of Cohesionless Soils"
- ASTM Designation D1556, "Density of Soil in Place by the Sand-cone Method." R1
- ASTM Designation D2167, "Density of Soil in-Place by the Rubber-Balloon Method."
- ASTM Designation D2937, "Density of Soil in Place by the Drive-Cylinder Method."
- ASTM Designation D2922, "Determining the Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)." R4
- ASTM Designation D2216, "Laboratory Determination of Moisture Content of Soil."
- ASTM Designation D3017, "Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)." R2
- ASTM Designation C88, "Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate."
- ASTM Designation C131, "Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine."
- b - Ebasco Specifications CAR-SH-CH-3, "Clearing and Grubbing"
- CAR-SH-CH-6, "Concrete"
- CAR-SH-CH-8, "Excavation, Backfill, Filling and Grading"
- CAR-SH-CH-11, "Drilling and Grouting"

.2 Definitions

a - Owner

In this specification, the word "Owner" shall mean the individual appointed by the Owner and charged with technical acceptance of the work for the Owner, or his authorized agents, engineers, assistants and inspectors acting severally within the scope of the particular duties and authorities delegated to them.

b - Engineer

In this specification, the word "Engineer" shall mean the Design Engineer, Ebasco Services Incorporated.

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3. DIVERSION SYSTEMS

R1

In general, the design and construction of temporary cofferdams for stream diversion and dewatering operations shall be the responsibility of the Contractor, however, minimum top elevations and locations shown on the drawings and general requirements given below shall apply. The design, construction and dewatering schemes shall be submitted to the Owner for review prior to start of construction.

.1 Foundation Preparations

All pervious material shall be excavated at least to an effective width of 15 ft to establish watertightness beneath the cofferdam. In addition, any soft or unstable material shall be excavated to establish a suitable foundation.

.2 Materials

Material used as fill for cofferdam shall be selected by the Contractor and shall be any selected impervious material similar to that specified for dam and dike core material hereinafter in Paragraph 10.2c. These materials may be obtained from local borrow pits or excavations and as approved by the Owner.

.3 Placement

Cofferdam material placed above water level shall be compacted with suitable rollers to assure watertightness and stability.

R1

.4 Dewatering

It shall be the responsibility of the Contractor to provide a dry excavation by means of well points, sumps or by whatever means necessary before construction of any embankment.

4. STRIPPING

After clearing by others in accordance with Specification CAR-SH-CH-3, "Clearing and Grubbing," the areas within the base of the embankments, dams, dikes and channels, etc shall be grubbed free of all stumps, debris, etc and stripped to the minimum depth as indicated on the drawings.

All stumps, trash and perishable matter shall be destroyed by burning as per CAR-SH-CH-3, Section 4 or otherwise disposed of as directed by the Owner. Other materials shall be wasted at locations shown on the drawings or designated by the Owner if unsuitable for use in any portions of the embankments. Material suitable for use in the embankments shall be moved directly to the embankment fill areas or with Owner's approval stockpiled at locations shown on the drawings, or where approved by the Owner.



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5. EXCAVATION

As indicated on the drawings the excavations shall be carried to firm residual soil, weathered rock or suitable rock. The weathered rock level of excavation is defined as the material that cannot be removed on a production basis with the blade of a D-8 tractor-dozer. The suitable rock level of excavation is defined as the rock material that cannot be removed on a production basis with a single tooth ripper of a D-8 tractor or equal.

6. CUTOFF TRENCHES

The provisions of the paragraphs under this section apply to the cutoff trenches for the dams and dikes.

Unless otherwise stated, excavation, including blasting and disposal of material, shall be in accordance with Specification CAR-SH-CH-8 "Excavation, Backfill, Filling and Grading."

.1 Excavation

Excavation within the cutoff trenches shall extend to satisfactory, undetached nonweathered bedrock defined on the drawings as suitable rock as determined in Section 5. During the excavation of cutoff trenches, any water which may be encountered shall be kept drained or pumped from such trenches. Dimensions shall be as indicated on the drawings or as specified herein. Side slopes shall be reasonably smooth and uniform and shall be cleaned of all loose and protruding material. If blasting is necessary to remove unsuitable rock above final foundation grade, or to reach final grade the depth and spacing of blast holes, type and quantity of explosive and location of blasting operations shall be such as to provide a clean and unfractured foundation surface as established by the Engineer and Owner, with a minimum amount of disturbance to the underlying rock. Blasting shall be performed in accordance with Section 7 and 8 of the Specification CAR-SH-CH-8. All loose or detached rock shall be removed from the base and side walls of the cutoff trench, where in rock, by picking and barring and wedging and/or other suitable means. Sharp corners of rock strata shall be bevelled off to avoid sharp reentrant angles in the core or filter. Pockets of earth shall be excavated by hand methods and soft erodible seams shall be cleaned out, also by hand methods, preparatory to final washing. R.

.2 Special Excavation

Overhanging rock faces and rock faces steeper than 1 horizontal to 2 vertical along the longitudinal direction of the abutment contact shall be cut back to provide satisfactory abutment contact slopes for the core section of the embankments. Unless otherwise directed by the Owner, such rock faces shall be cut back to the slopes of 1 horizontal to 2 vertical or flatter.

6. CUTOFF TRENCHES (Cont'd)

.2 Special Excavation (Cont'd)

It is intended that the preceding requirements of the above paragraph will be applied to faces 6 in. and higher and limited to a maximum of 4 ft in height. Where, in the opinion of the Owner, it is not possible or desirable to meet these requirements by excavation, the foundations shall be solidly faced with Class D concrete to provide slopes of 1 horizontal to 2 vertical.

For faces 4 ft and over the area shall be filled with Class D concrete to meet the above requirements.

Wherever the final excavated cutoff trench bottom surface dips downstream by more than 1 vertical to 8 horizontal in the transverse direction Class D concrete shall be placed to prevent the core foundation from exceeding this maximum permissible transverse slope.

.3 Initial Cleaning

Pressure washing of the rock surfaces shall be done prior to foundation grouting to assure a clean surface as determined by the Owner with every effort being made to flush open joints and seams. All soil, muck, small rock fragments and other foreign materials shall be removed. The washing shall be so conducted as to clean from higher portions of the foundation towards lower areas where the debris shall be loaded and removed. The quantity and pressure of the wash water shall be subject to the approval of the Owner. Where the nature of the rock is such that it may be softened by washing with water, blow pipes and compressed air shall be used. Any water which accumulates in depressions shall be removed prior to foundation grouting. RI

After completion of initial cleaning and approval by the Owner, drilling and grouting in accordance with Specification CAR-SH-CH-11 shall proceed.

.4 Inspection and Mapping

After completion of excavation and initial cleaning of the embankment foundations in accordance with the requirements of Paragraphs 6.1 and 6.3 prior to grouting the Owner may require that portions of foundations be further cleaned off with air and/or water jet under high pressure for inspection and geologic mapping. Such clean off is separate and distinct from clean up prior to foundation grouting as required in Paragraph 6.3. The Owner will determine whether any unsound or otherwise unsuitable material is present and may direct additional excavation which shall be carried out by the Contractor in accordance with Paragraph 6.1, following which the Owner may direct that the required surface shall again be cleaned off for inspection. This procedure shall be repeated until a foundation satisfactory to the Engineer and the Owner is reached. RI

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6. CUTOFF TRENCHES (Cont'd)

.5 Final Cleaning

Upon completion of foundation grouting in accordance with Specification CAR-SH-CH-11, the base and sides shall be thoroughly cleaned of all mud, debris, cement, etc, accumulated during the grouting operation. Such final cleanup shall not be performed within 200 ft. of grouting operations and the cleaning methods shall be in accordance with the provisions of Paragraph 6.3.

R5

.6 Final Surface Treatment

Within 24 hours of completion of the final cleanup of any portion of the cutoff trenches, a final surface treatment shall be performed on the bottom and rock portions of the sides of the cutoff trenches prior to any embankment placement. The final surface treatment specified for the bottom rock surface of the dam cutoff trench shall also be used for contact surfaces of class F concrete fill and the sides and top of the concrete encasement for the diversion pipes within the bottom of the cutoff trench. In areas where there are large joints or fractures that have not been filled during grouting operations, slush grout consisting of 1:1:1 (by vol) sand, cement grout shall be thoroughly worked into all pot holes, depressions, cleaned out seams, joints and fractures by rodding or by the use of pencil vibrators prior to the final surface treatment.

R6

R5

The final surface treatment for the west auxiliary dam cutoff trench shall consist of spraying a 1:1 (by volume) grout one quarter (1/4) inch thick over the entire base of the cutoff trench. A similar surface treatment in stages, as the embankment placement progresses, shall be performed on the rock portions of the sides of the cutoff trench within 24 hours of additional cleanup of each stage prior to surface treatment. Where the slope of the sides is such that the surface treatment grout will run, sag, slough off, or will not adhere to the sides of the trench, surface treatment by application of shotcrete as per specification CAR-SH-CH-6. 'Concrete', shall be applied in a minimum thickness of one (1) inch.

After approximately one hour and while the surface treatment grout or shotcrete is still tacky, but before it has set, the base layers of selected impervious core material, as specified in Paragraph 10.2 shall be placed over the treated surface and compacted as specified in Paragraph 10.7.

The final surface treatment for the main dam cutoff trench shall consist of spraying a 1:1 (by volume) grout one quarter (1/4) inch thick over the entire base of the cutoff trench. Any reentrant corners or pockets in the rock portions of the sides of the cutoff trench shall be filled with a minimum of three (3) inch thick shotcrete reinforced with 6x6-4/4 welded wire mesh adequately supported at spacings to be determined by the Owner, or with Class D concrete to form a reasonably smooth and uniform surface for proper placement and compaction of embankment material against the sides of the cutoff trench.



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6. CUTOFF TRENCHES (Cont'd)

.6 Final Surface Treatment (Cont'd)

The above stated surface treatment on either the upstream or the downstream side of the cutoff trench of the main dam is not necessary if both the fine and coarse filters on that side are extended to the bottom of the cutoff trench.

After approximately one hour and while the surface treatment on the base of the main dam cutoff trench is still tacky, but before it has set, the base layers of selected impervious core material, as specified in Paragraph 10.2 shall be placed over the treated surface in the zone of the core as shown on the drawings and compacted as specified in Paragraph 10.7. The base layers of filter materials as specified in Paragraph 11.2 shall also be placed simultaneously with the core material as shown on the drawings and compacted as specified in Paragraph 11.5. Subsequently, additional selected impervious core material and filter material shall be placed and compacted as specified in Paragraph 10.7 and 11.5 so that the total compacted thickness of materials is 24 in.

7. CHANNELS

The provisions of the paragraphs under this section apply to Auxiliary Channel, Emergency Service Water Intake and Discharge Channels, Cooling Tower Makeup Water Intake Channel and all other channels as shown on the drawings.

In addition to the general requirements as laid down here, all additional specific requirements pertaining to excavation as defined in Specification CAR-SH-CH-8 "Excavation, Backfill, Filling and Grading," and all applicable provisions of Paragraph 9 and 10 of this Specification pertaining to embankments not specified herein shall also apply.

.1 Excavation

Excavation for Emergency Service Water Intake Channel shall be made to firm residual soil and all sandy silty alluvium in the bed and sides shall be removed. The channel shall be finished to final grade and lines by placing compacted select impervious material and random fill as shown on the drawings.

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7. CHANNELS (Cont'd)

.1 Excavation (Cont'd)

Excavation for other channel shall be made to the lines and grades indicated on the drawings and excavation made below the lines shall be backfilled with compacted select impervious material as specified in paragraph 7.6. R3

Where it becomes necessary to excavate beyond the indicated lines of excavation in order to remove boulders or other interfering objects the voids remaining after the removal of such boulders or interfering objects shall be backfilled with select impervious material only if and as directed by the Owner.

When the void is below the bottom of channel, if directed by the Owner, suitable material shall be placed and compacted to a density of not less than 95 percent Standard Proctor compaction as determined by ASTM designation D698. With the approval of Owner, Class D concrete shall be used to fill up voids in rock. R1 R2

In-place density shall be determined as specified in Paragraph 10.4. R4

Where the inside slope of the channel is made by placing compacted fill, material shall be placed at least 3 feet beyond the lines and thereafter the channel shall be finished to the lines by trimming the excess material. R1

.2 Special Slope Conditions

If during the progress of excavation, material is encountered which, in the opinion of the Owner, cannot maintain the slopes shown on the drawings, the Owner will direct the Contractor to excavate beyond the line shown on the drawings. Should the Contractor be directed to excavate beyond the slopes and lines shown on the drawings, said lines will be extended to include such ordered excavation.

.3 Disposition of Excavated Material

It is intended that the material obtained from the excavations shall be used as fill and backfill for various embankments, dams, dikes and structures. Before using the excavated material all organic material, rubbish and other objectionable or unsuitable material contained therein shall be first removed.

Material suitable for use in the embankments shall be placed directly in the embankments or, if approved by the Owner, stockpiled at locations as directed. Materials unsuitable for use in any portion of embankments shall be wasted at locations shown on the drawings, or wasted at proximity of the work as directed by the Owner.

.4 Grading

Grading of channels, shall conform to the following tolerances:

Tolerances for the Service Water Channels shall generally be of zero above and 6 in. below the specified grade for:

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7. CHANNELS (Cont'd)

.4 Grading (Cont'd)

- a - The channel bottom (measured vertically)
- b - The channel side slopes (measured normally)

Tolerances for all other channels shall generally be zero above and 12 in. below or as directed by the Owner.

Regardless of the construction tolerances specified the excavation and grading for all channels above low-water line shall be performed so that the finished surfaces are in uniform planes with no continuous abrupt breaks in the surface.

.5 Channel Embankment

channel embankment where required shall be constructed by placing compacted random fill and/or select impervious material to the lines as indicated on the drawings.

Random fill shall conform to the provisions of Paragraphs 12.1 and 13.1 of specification CAR-SH-CH-8, "Excavation, Backfill, Filling and Grading."

Select impervious material and compaction shall conform to the provisions of Paragraphs 7.6 herein.

.6 Select Impervious Material

Select impervious material shall be clayey and silty residual soils, predominantly (over 90%) derived from claystones and siltstones, obtained from excavations or borrow areas from or the vicinity of Plant, Auxiliary Dam and Spillway and Auxiliary Dike, and shall be free of stones larger than 3 in. and 95% of the material shall pass thru 3/4 in. screen.

Select impervious material shall be compacted in layers not more than 8 in. compacted thickness to 95 percent of Standard Proctor Density and in-place density shall be determined as specified in Paragraph 10.4. Layers up to 12 inches compacted thickness may be permitted by the Owner when found satisfactory by testfill program performed on a similar material.

8. EMBANKMENT FOUNDATIONS

The provisions of the paragraphs under this section apply to the embankment foundations outside the limits of the cutoff trenches and under the shells, core and transition zones of the embankments.

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8. EMBANKMENT FOUNDATIONS (Cont'd)

.1 Excavation

All pockets of organic matter or excessively wet or soft material or other unsuitable materials shall be removed over such areas and to such depths as shown on drawings or as the Owner shall judge to be necessary.

In particular the sandy silty alluvium located in the foundation of Auxiliary Dam and all soil under the Main Dam shall be removed and used as random fill or wasted at a location shown on the drawings or as approved by the Owner.

.2 Surface Preparation

Under all dams and dikes all large boulders which project more than 6 in. above grade and which would interfere with the proper placement and compaction of filter or core material adjacent thereto shall be removed. Abrupt depressions or holes shall be filled with selected impervious core material as specified in Paragraph 10.2c and shall be tightly rammed into place by means of air tampers in accordance with the provisions specified in Paragraph 10.6. The entire surface beneath the core and transition zone shall be prepared in accordance with Section 10.6 prior to placement of materials. No special surface preparation under rockfill zones of embankment is required.

R6

9. EMBANKMENTS - GENERAL

The provisions of the paragraphs under this section apply to all embankments dams and dikes, as defined in the scope.

.1 Construction Slopes

The embankments shall be constructed to the lines and grades shown on the drawings, observing the tolerance limits given in this paragraph. All embankments shall be built up in continuous, nearly horizontal layers. Where necessary for construction purposes, longitudinal-end slopes not steeper than 25 percent will be permitted. Transverse slopes shall not be steeper than 5 percent. The top of the core during construction shall be kept slightly crowned transversely for drainage. If the embankment is constructed in stages in the longitudinal direction, immediately before a latter stage of construction is begun the fill placed earlier shall be cut back a minimum of 3 ft measured normal to the surface and into the previous stage to

R2



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9. EMBANKMENT - GENERAL (Cont'd)

.1 Construction Slopes (Cont'd)

expose material that has not been affected by wetting, drying, erosion, relaxation, or frost action.

.2 Sequencing

All the embankment zones at any particular cross-section shall be brought up approximately simultaneously. The core zone shall be constructed slightly ahead of the adjacent transition zones, this amount, however, being limited to a maximum of 2 ft. Placement of the transition zones shall also lead that of the compacted rockfill zones by a maximum amount of 2 ft. The riprap layers may either be brought up with the remainder of the embankment or placed afterwards as a separate operation.

.3 Tolerances

Except for riprap, for which the theoretical zone thickness shall be taken as the minimum thickness permitted, material in any embankment zone will be allowed to be placed up to one foot on either side of the theoretical zone boundaries shown on the drawings.

.4 General Conformance

No material shall be placed in any zone of the embankments that does not conform to the provisions of this specification without the permission of the Owner. The Contractor shall not be permitted to place a cover of fine material on the completed lifts of the rockfill, transition material or riprap zones to facilitate hauling. Any haul roads constructed on any zone of the embankments by the Contractor, containing material that does not conform to the provisions of this specification shall be removed by the Contractor at his own expense, and shall be replaced with the material specified for that zone.

No material shall be placed in the core when either the material or foundation on which they are to be placed are excessively wet, frozen, improperly compacted or otherwise unsuitable. No brush, roots, ice, snow, perishable or other unsuitable material shall be placed in the embankments.

The Contractor may be required to suspend operations at any time, when in the judgment of the Owner, satisfactory work cannot be performed on account of rain, cold weather, or other unsatisfactory conditions.

It shall be the responsibility of the Contractor to provide a dry excavation by means of well points, sumps or by whatever means necessary before construction of all embankments.

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10. EMBANKMENT CORE

.1 Source

Impervious material for the core of all dams and dikes may be obtained from borrow areas shown on the drawings or designated by the Owner or from earth stockpiled from stripping and excavation of the cutoff trenches, channels and spillway approach channels, provided that it meets the gradation requirements hereinafter.

.2 Materials

- a - Materials used in the core of the Class I dams and dikes shall conform to the following gradation requirements:

Maximum Size	6 in.
Larger than 3 in.	10 percent maximum
Passing 200 mesh	40 percent
Plasticity Index	10

- b - The tolerance on percent passing #200 mesh and the PI requirement shall allow 10 percent of test values to fall below the specified values. The absolute minimum for the percent passing the #200 mesh shall be 30 percent for the Class I dams and dikes and 20 percent for all other dams and dikes. The absolute minimum for the PI shall be 5 for the Class I dams and dikes.
- c - Selected impervious core material, free of large stones, shall be used in restricted areas such as in filling holes or depressions, around pipes, diversion conduits etc and against rock surfaces. This material shall conform to the gradation requirements specified above for the respective embankment, except that the maximum size shall be 3 in. and not more than 10 percent of the material shall be larger than 1 in.

.3 Placement

On all bedding surfaces prepared as specified herein, the incoming material shall be placed in a continuous uniform layer or dumped in windrows or ridges lengthwise along the embankment, being placed in areas required for maintaining the proper level of the embankment and so spaced that the windrows can be spread to a uniform layer. Stones shall be spaced out and amply bedded in the finer materials. Any lumps or clods shall be pulverized. Raking across the core to remove oversize material shall not be permitted. Oversize material should not be brought on to the embankments. However, once there, oversize material shall be removed by raking along the axis of the embankment and shall be loaded and removed from the core section.

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10. EMBANKMENT CORE (Cont'd)

.4 Compaction

All core materials shall be compacted in 8 in. maximum compacted lifts to a density ranging from 97 percent to 100 percent of the maximum density obtained in the Standard Proctor Compaction Test (ASTM D698 - Method A, B, C or D to be used shall be determined by the Owner). The specific requirements will be as indicated on the drawings. Ten percent of the test densities will be allowed to fall below the specified requirement. The absolute minimum density allowed will be 5 percent less than the required percentage of Proctor Density given on the drawings.

R1  
R2 R

At the option of the Owner in-place density shall be tested by either one of the following four methods, ASTM designation D1556, D2167, D2937 or D2922 - Method B. If ASTM D2922 is used to determine in-place density one calibration test for the equipment shall be performed after every ten tests. The calibration test shall be performed by comparison with in-place density test by ASTM D1556, D2167 or D2937 as designated by the Owner. The calibration test shall be performed on a similar material for which the equipment is used in the field. The calibration test frequency may be reduced, by the Owner, from one in ten to one in 25 after a review of the performance of the equipment after at least ten calibration tests (i.e. 100 tests) on each piece of equipment have been performed and the deviation of density when compared with ASTM D1556, D2167 or D2937 is not more than  $\pm 2\%$ .

R1 R

R5

The rollers to be used for compacting the impervious materials shall be of the sheepsfoot or wedgefoot type. Other types of rollers which the Contractor proposes to use shall be subject to the approval of the Owner. In any event, the embankment shall be so constructed as to be uniformly dense and to the minimum density requirement.

10. EMBANKMENT CORE (Cont'd)

.5 Moisture Control

The material placed in each layer before being compacted by rolling shall contain within  $\pm 2$  percent the amount of moisture required for maximum degree of compaction as determined by the Owner, and the moisture content shall be uniform throughout the thickness of the layer. The application of water to the material, if required, shall be performed at the stockpiles, supplemented as required either by sprinkling the preceding layer prior to placing new material thereon or by sprinkling and mixing the new material in place prior to rolling or by a combination of the two methods. No material having a water content greater than 2 percent above the optimum, except as provided in Paragraphs 10.6 and 10.7 shall be placed on the embankment nor shall any material be placed if the surface of the embankment has moisture more than 2 percent greater than optimum. Such surfaces shall be dried out by harrowing or by discing and aerating prior to placing new material.

Moisture content of the material shall be determined by either one of the following methods ASTM designation D2216 or D3017 or by "speedy" moisture tester, microwave oven or field stove method at the option of the Owner. If ASTM D3017, "Speedy" moisture tester, microwave oven or field stove method is used to determine moisture content one calibration or check test for the method by comparison with the test by ASTM D2216 shall be performed after every ten tests.

R4 R5

For ASTM D3017, "Speedy" moisture tester, microwave oven or field stove method calibration or check test shall be performed on a similar material for which the method is used in the field. If the calibration or check test indicates a deviation of more than  $\pm 2\%$  moisture content the method will be discontinued. The calibration or check test frequency may be reduced from one in ten to one in 25 by the Owner after a review of the performance of the equipment or method after at least 10 calibration or check tests (i.e. 100 tests) on each piece of equipment or method have been performed and the deviation of moisture content when compared with ASTM D2216 is not more than  $\pm 2\%$ .

R5

Any sun-dried, hardened foundation surface or smooth bedding surface shall be prepared for new material by discing or plowing so as to loosen the entire surface to a depth of 2 in. Water shall be added, if necessary to the material at the time of scarifying so that it shall be within  $\pm 2$  percent of optimum water content for compaction. Immediately after such scarifying the next layer of material shall be placed over the base and compacted as specified in Paragraph 10.4. The top of surface of freshly placed and rolled layers ordinarily will require no preparation other than moistening ahead of the new layer when the new material is drier than -2 percent of optimum water content.

R5

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10. EMBANKMENT CORE (Cont'd)

.6 Local Compaction

In test pits, stump holes, depressions in rock, restricted areas around conduits, pipes, walls and at other locations where it is impractical to compact the fill by rolling, it shall be tamped in 4 in. compacted layers with mechanical tampers, or by other suitable means approved by the Owner to obtain compaction equal to that specified in Paragraph 10.4. Selected impervious core material as specified in Paragraph 10.2c shall be used at such locations and shall have a moisture content, generally 1 to 2 percent in excess of that specified in Paragraph 10.5.

.7 Local Placement

Selected impervious core material, specified in Paragraph 10.2c, to be placed over the prepared cutoff trench surfaces, shall be placed in approximately horizontal layers not more than 8 in. in thickness when compacted and shall have a moisture content generally 1 to 2 percent in excess of that specified in Paragraph 10.5. The first 24 in. or three lifts of such material placed in cutoff trench or elsewhere as directed by the Owner shall be compacted by heavy pneumatic tired construction vehicles in such a manner that the material is forced into all the irregularities of the surfaces, and such that compaction equal to that specified in Paragraph 10.4 is obtained. Where material is being placed against abutment surfaces the construction surface of the selected impervious core material shall be sloped away from the abutment for a distance of at least 10 ft at an inclination of 1 vertical to 6 horizontal or steeper to allow for direct compaction of the material against the abutment surface. Where, because of small irregularities in the foundation surface, compaction of selected impervious core material by pneumatic tired equipment is impracticable or undesirable as determined by the Owner, such material shall be compacted as specified in Paragraph 10.6. R2

11. EMBANKMENT TRANSITION FILTERS

Transition filter zone for Main Dam shall contain two filters, fine filter and coarse filter, and locally transition filter along the downstream portion of the cutoff trench. The transition zone for Auxiliary Dam shall contain only one filter. R2

.1 Source

The source of filter materials shall be established by the Owner. R1



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11. EMBANKMENT TRANSITION FILTERS (Cont'd)

1.2 Materials

The filters shall consist of processed, very well graded coarse mixtures of cohesionless materials obtained from hard, dense durable rock such as granite, sandstone or conglomerate and not from claystone or siltstone, and shall be graded as given below.

- a - Transition filter zones for Main Dam shall conform to the following gradation:

R2

Sieve U S Standard Sq Mesh	Percentage by Weight Passing		
	Fine Filter	Coarse Filter	Transition Filter
6 in.	-	100	
3 in.	-	86-100	100
1-1/2 in.	-	66-84	82-100
1/2 in.	100	50-68	65-90
3/8 in.	96-100	44-62	60-85
No. 4	83-100	32-46	50-75
No. 8	70-93	18-30	40-65
No. 40	36-54	0-10	16-40
No. 100	16-32	-	10-25
No. 200	0-10	-	0-10



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11. EMBANKMENT TRANSITION FILTERS (Cont'd)

.2 Materials (Cont'd)

b - Transition filter zone for Auxiliary Dam shall conform to the following gradation:

<u>Sieve U S Standard</u> <u>Sq Mesh</u>	<u>Percentage by</u> <u>Weight Passing</u>
3 in.	100
1-1/2 in.	82-100
1/2 in.	65-90
No. 4	50-75
No. 8	40-65
No. 40	16-40
No. 100	10-25
No. 200	0-10

.3 Placing and Compacting

Filter materials shall be placed in 16 in. layers and shall be compacted by a smooth drum vibratory roller, imparting a minimum dynamic force of 40,000 lb. R2 R1

The material shall be compacted to a relative density ranging from 75 percent to 80 percent as determined from tests conducted in accordance with the provisions of ASTM D2049, "Relative Density of Cohesionless Soils." At the option of the Owner, in-place density shall be tested as specified in Paragraph 10.4. R1 R4

The specific requirements for relative density will be as indicated on the drawings. Ten percent of the test densities will be allowed to fall below the specified requirement. The absolute minimum relative density allowed will be 10 percent less than the required percentage of the relative density given on the drawings.

.4 Local Compaction

In restricted areas, around conduits, pipes, walls and other locations where it is impractical to compact the filter material by rolling, it shall be tamped in 8 in. compacted layers with mechanical tampers, or by other suitable means approved by Owner, to obtain compaction equal to that specified in Paragraph 10.2. R1

11. EMBANKMENT TRANSITION FILTERS (Cont'd)

.5 Local Placement

Transition filter material, specified in Paragraph 11.2, to be placed along the downstream portion of the prepared cutoff trench surfaces in the main dam, shall be placed in approximately horizontal layer not more than 8 in. in thickness when compacted. The first 24 in. or three lifts of such material placed in cutoff trench of Main Dam shall be compacted by a smooth drum vibratory roller, imparting a minimum dynamic force of 40,000 lb such that compaction equal to that specified in Paragraph 11.3 is obtained.

12. COMPACTED ROCKFILL AND RANDOM ROCKFILL

.1 Source

All rockfill for the Main Dam shall be obtained from its spillway excavations. All random rockfill for the Auxiliary Dam and Dike shall be random rock materials from the general plant area, cutoff trench, spillway and channel excavations.

.2 Materials - Rockfill

The rockfill for Main Dam shall consist of fresh granitic type rock fragments of which a minimum of 75 percent shall range in size from 6 in. to 24 in. The maximum rock size shall not exceed 24 in. in any direction and shall not be greater than 90 percent of lift thickness.

The rock fragments shall be free of clay, silt and debris. They shall be dense, sound and resistant to abrasion. Soft, laminated or weakly jointed blocks displaying any tendency to slake in water shall not be used. The excavation operation shall be set up to yield a well graded rockfill material meeting the above requirements.

.3 Materials - Random Rockfill

The rock to be used as random rockfill for the construction of Auxiliary Dam and Auxiliary Dike shall be random fill of fresh rock and weathered rock as may be obtained from the excavation of general plant area structures, channels, spillway or cutoff trench.

The rock to be used may include sandstone, siltstone and claystone of which a minimum of 75 percent shall range in size from 1/4 in. to 24 in. The maximum size of rock shall not be greater than 90 percent of the lift thickness and the excavation operation shall be set up to yield a well graded random rockfill material meeting the above requirements.

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12. COMPACTED ROCKFILL AND RANDOM ROCKFILL (Cont'd)

.4 Placement

All rockfill and random rockfill shall be placed in layers not exceeding the thickness established during the test fill operations, and shall be compacted uniformly over the entire surface of each lift in the manner established during test fill.

Finer rock shall be placed adjacent to the filter layers, and graded toward the coarser materials to the outside. The coarsest rock shall be placed along the outside slope lines. The outside slopes shall be roughly dressed so as to form a reasonably uniform surface. Through this process an oversize zone shall be established as indicated on the drawings. Materials up to a maximum of 125 percent of the established lift thickness will be accepted in this zone.

Special care shall be exercised in placing rockfill in all areas within 3 ft of structures to avoid damage to such structures.

.5 Test Fill and Compaction

Before placement of any rockfill and random rockfill a test fill section for each consisting of representative materials from the proposed areas shall be constructed to assure the specified gradation and compaction, and to establish a method of construction using vibratory rollers having a dynamic force of not less than 40,000 lb. The test fill area shall be located on level ground which may be located within the rockfill zone. The minimum dimensions of the test fill shall be 40 ft wide by 55 ft long, not including ramps that shall be provided for access of compaction equipment at each end. Various combinations of rollers, layer thickness and roller passes shall be tried. For each layer thickness tested, settlement readings shall be taken after each pass at a number of points on the fill and the average plotted against layer thickness. R2

Grain size distribution tests before and after compaction shall be performed to determine the breakdown of the rockfill or random rockfill materials. In-place density and percolation tests shall be conducted after compaction. Strength tests shall be performed on test fill materials, if the fines in the test fill are higher than the specified percentage. R2

The final choice of compaction equipment, layer thickness, frequency of vibration, speed of travel, and number of passes to be used for compacted rockfill in the embankments will be determined by the Engineer and the Owner based upon these results, as well as appearance and response to rolling. The compacted layer thickness for rockfill or random rockfill shall not exceed three (3) feet. R1

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12. COMPACTED ROCKFILL AND RANDOM ROCKFILL (Cont'd)

.6 Local Compaction

In restricted areas, around conduits, pipes, walls and other locations indicated on the drawings where it is impractical to compact the rockfill or random rockfill by rolling, crushed rock as specified for bedding Type C in Paragraph 13.2b shall be tamped in 8 in. layers with mechanical tampers, or by other suitable means approved by Owner, to obtain 70 percent relative density as determined from tests conducted in accordance with the provisions of ASTM D2049, "Relative Density of Cohesionless Soils." At the option of the Owner, in-place density shall be tested as specified in Paragraph 10.4.

R1

R2

R2 R

13. RIPRAP AND BEDDING

Riprap on bedding will be provided on faces of the embankments for protection of slopes against wave action.

.1 Source

The source for riprap and bedding materials shall be established by the Owner. R1

.2 Materials

Riprap and bedding materials shall consist of sandstone, conglomerate or granitic rock fragments that are dense blocky, resistant to abrasion and free of cracks, seams and other defects that would tend to increase their destruction by water and frost actions. To determine the suitability of riprap materials, Los Angeles Abrasion Test in accordance with the provisions of ASTM C131, Sodium Sulfate Soundness Test in accordance with the provisions of ASTM C88 and Accelerated Expansion Test in accordance with the procedure described herein shall be performed on the riprap materials. R2

Procedure for Accelerated Expansion Test: Soak 10-12 lb of rock fragments grading 3 to 3/4 inch in ethylene glycol in a plastic or glass container at room temperature. Examine the rock pieces daily for a maximum period of 15 days for any signs of deterioration. Rocks withstanding this test for the full period of the test will be acceptable.

- a - Riprap shall be classified as Type A, Type B and Type C riprap and shall be well graded as specified below:

Type A riprap shall have seventy percent of rock ranging in sizes from 24 in. to 48 in. The average size shall not be less than 30 in. and the dimension in any direction shall not be less than 18 in. R2



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13. RIPRAP AND BEDDING (Cont'd)

.2 Materials (Cont'd)

a - (Cont'd)

Type B riprap shall have seventy percent of the rock ranging in size from 12 in. to 24 in. The average size shall not be less than 16 in. and the dimension in any direction shall not be less than 10 in.

R2

Type C riprap shall have seventy percent of rock ranging from 8 in. to 16 in. The average size shall not be less than 10 in. and the dimension in any direction shall not be less than 6 in.

In all the types of riprap mentioned above, slabs or rocks slivers with maximum dimensions larger than twice the respective specified average dimension will not be accepted.

b - Bedding

The riprap shall be bedded on a continuous layer of crushed rock bedding where indicated on the drawings and to the thickness as shown on drawings conforming to the following gradation requirements:

R2

<u>Size</u>	<u>Percentage By Weight Passing</u>			R
	<u>Bedding Type A for Riprap Type A</u>	<u>Bedding Type B for Riprap Type B</u>	<u>Bedding Type C for Riprap Type C</u>	
12 in.	100	-	-	
6 in.	83-100	100	-	
3 in.	66-81	78-100	100	
1-1/2 in.	50-66	56-76	76-90	
3/4 in.	32-49	34-50	50-65	
3/8 in.	16-32	17-34	25-40	
No. 4	0-16	0-17	12-22	
No. 8	-	-	0-10	



13. RIPRAP AND BEDDING (Cont'd)

.3 Placement

The rock for riprap, if placed concurrently with embankment fill need not be hand placed, but may be dumped in such a manner as to ensure that the individual sections will be interlocked and form a rough surface so that the completed riprap is stable, without tendency to slide and with no unreasonably large protrusions from or hollows in the surface or unfilled spaces within the riprap. The inclusion of rock spalls or gravel in the mass in an amount not in excess of that required to fill voids in the riprap will be permitted.

R2

If the riprap is placed in a separate operation, it shall be placed to its full slope thickness as indicated on the drawings in one operation and in such a manner as to avoid displacing the underlying materials. Dumping riprap in several sloping layers will not be permitted. The individual sections must be carefully placed so that the riprap will be interlocked and form a rough surface.

R2