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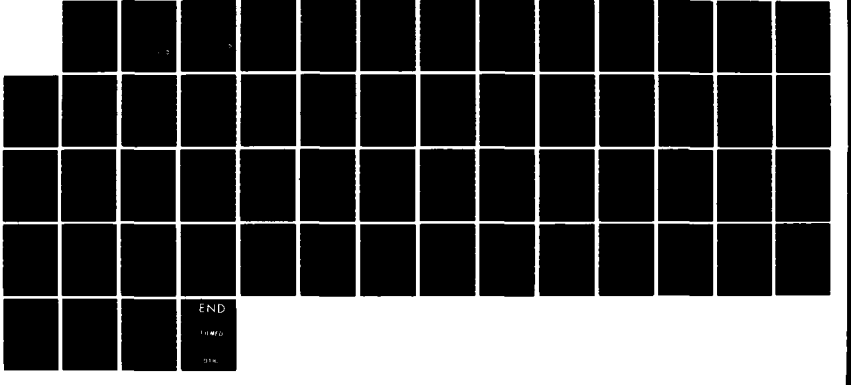
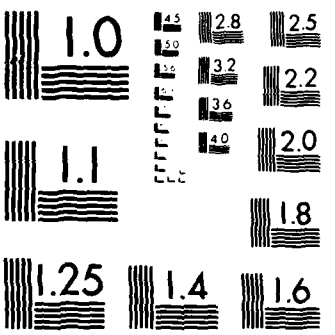
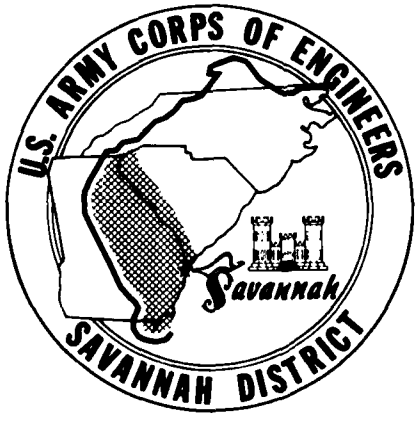




COOPER RIVER REDIVERSION PROJECT

ST. STEPHEN POWERPLANT
ST. STEPHEN, SOUTH CAROLINA

ENGINEERING CONSIDERATIONS AND INSTRUCTIONS FOR FIELD PERSONNEL



U.S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

JULY 1979

(1)

COOPER RIVER REDIVERSION PROJECT

ST. STEPHEN POWER PLANT

ENGINEERING CONSIDERATIONS

AND

INSTRUCTIONS FOR FIELD PERSONNEL

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U. S. ARMY ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS

July 1979

COOPER RIVER REDIVERSION PROJECT

ST. STEPHEN POWER PLANT

ENGINEERING CONSIDERATIONS

AND

INSTRUCTIONS FOR FIELD PERSONNEL

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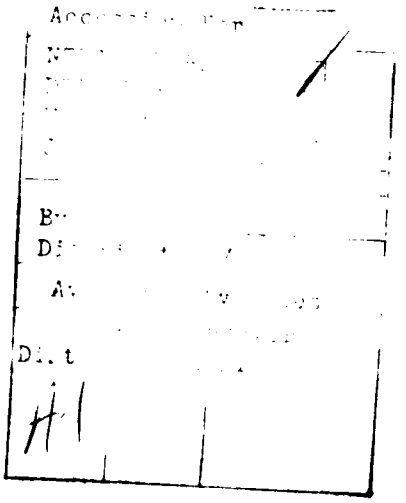

COOPER RIVER REDIVERSION PROJECT
CONSTRUCTION OF ST. STEPHENS POWERPLANT

ENGINEERING CONSIDERATIONS

AND

INSTRUCTIONS FOR FIELD PERSONNEL

PART I

INTRODUCTION

PURPOSE

1. General. This manual is intended to serve as a technical guide for the Resident Engineer and his personnel, together with such personnel of the Construction Division who are directly responsible for the construction. These engineering considerations and instructions are intended to explain the various considerations and assumptions, especially regarding field conditions, involved in the design and in the preparation of the contract plans and specifications. They are also for the purpose of commenting upon and explaining certain requirements of the specifications and to establish the requirements necessary to provide adequate Government acceptance testing. The information presented in this manual is based on the plans and specifications which govern in the event of any discrepancy with the material presented herein. For additional important information on soils, geology, and related design concepts and assumptions, etc., reference is made to the following project Reports and Design Memoranda: DM 1 General; DM 6 Site Selection and Geology; DM 12 Construction Materials; Powerhouse Foundation Analysis. Particular attention must be given to the latest editions of EM 1110-2-1906, "Laboratory Soils Testing" and EM 1110-2-1911, "Construction Control for Earth and Rock-Fill Dams."

INSPECTION OF EARTHWORK CONSTRUCTION

2. Most Corps civil works projects utilize a method type of specification for embankment construction. However, during review meetings conducted during the design of this project, it was decided that an end result specification would be used. The specifications have been so prepared. Even though end results are specified and supporting data is required, it is important to determine if these results are truly representative of typical work accomplished. To assure this is accomplished and that first hand knowledge of satisfactory perfomance by the Contractor is gained, it is essential that, as required by paragraph 4.a. of EM 1110-2-1910, the Government have

qualified inspectors present during most construction operations and especially during initial and critical phases of individual operations.

3. Contractor quality control operations will, if properly implemented, assist in achieving the desired quality of construction, particularly on those operations where the specifications contain product requirements such as the gradation of a filter drain. However, Government staff must be present to witness the operations on which procedures are specified and to perform Government acceptance tests to check the Contractor's construction and quality control.

4. Regarding Contractor quality control, ER 1180-1-6 states in paragraph 6.a., "The Government is responsible for all phases of the construction project, including the activities necessary to assure that the Contractor has complied with the requirements of the contract plans and specifications..." and in paragraph 6.a.(2),

> "In contrast to the Contractor's quality control the Government is responsible for quality assurance. This includes checks, inspections, and test of the products which comprise the construction processes used in the work, and the finished work for the purpose of determining whether the Contractor's quality control is effective and he is meeting the requirements of the contract. These activities are to assure that defective work or materials are not incorporated in the construction."

Relating these requirements then to earthwork construction, the Government is required to perform tests on soil and rock materials which are to be utilized in embankment construction (products); inspect the placement and compaction of the materials, checking items such as specified equipment, construction techniques, placement requirements, and to perform acceptance tests on the compacted embankment (finished work). Careful field control by the Contracting Officer is extremely important since certain results from the field tests may indicate that the Contractor modify his operations to the best advantage of both the Government and himself.

ENGINEERING INSPECTIONS

5. Engineering inspections during construction are required by higher authority. Savannah District and South Atlantic Division design personnel are to visit earthwork sites during construction operations as a regular part of their design responsibility in order to determine whether field conditions are as they were expected to be, to assist field personnel in interpreting the plans and specifications and to observe, firsthand, problems which may not

have been fully evaluated in the original design. Savannah District Engineering Division has the District level design responsibility for the St. Stephens Powerplant and references in this publication to Engineering Division will mean Savannah District Engineering Division unless specifically noted otherwise. References to Construction Division will mean the Resident Engineer's Office.

6. It is desirable to make engineering inspections during periods of critical construction operations. Table I contains a schedule of features considered critical for this project. When possible, the Engineering Division should be notified at least 1 week in advance of the beginning of each feature.

7. In addition to the scheduled visits, field personnel are instructed to call for visits by design personnel whenever conditions are encountered which appear to materially differ from those which were anticipated in the design. It is the intention of the Engineering Division to expeditiously handle such requests and qualified personnel will normally be on the job with 24 to 48 hours.

PLAN OF OPERATION

8. The specifications require that the Contractor submit several plans for various operations. Although it is the responsibility of the Construction Division to approve such plans, it is often found helpful to have an Engineering Division review of the key phases of the Contractor's proposed operations. When approving any plan of proposed operations or equipment, approval should be given on a tentative basis subject to its being revised as necessary to produce the results required by the specifications. The Contracting Officer should reserve the right to modify the plan whenever the operations are not producing the desired results, including such items as the equipment being used not being satisfactory and/or insufficient quantity.

CONSTRUCTION FOUNDATION REPORT

9. A foundation report shall be prepared for areas as required by ER 1110-1-1801, Construction Foundation Reports. Geologic Mapping shall be in accordance with the procedures set forth in ETL 1110-2-203, Geologic Mapping Procedures, Open Excavations. It has been requested that the preparation of this report be the responsibility of the Savannah District Geology Section. Since a considerable manpower effort in the field will be required for data gathering for the report, as much lead time as possible should be provided SASEN-FG to allow for the scheduling and allocation of manpower consistent with other workloads.

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

10. An embankment Criteria and Performance Report will be prepared for the St. Stephen Powerplant as required by ER 1110-2-1901 dated August 1972. This report will be a joint effort with input from both Savannah District Engineering and the project office personnel. Field personnel will maintain and assemble data and photographs and also draft the field construction portion of the report. Field test data, changes, problems, construction sequences, instrumentation data, etc., as well as typical operations shall be accurately noted and recorded by the Resident's staff for future use. Frequent photographs should be taken of construction operations, particularly of any problems. All test data, notes, photographs, etc., shall be readily accessible to design personnel (SASEN). Also, the embankment engineer should maintain such records and notes as necessary to draft his portion of the report and to assist SASEN personnel in incorporating the portion of the report relating to construction activities and problems. The drafting of the design and criteria portion of the report, consolidation of data, drafting, and reproduction will be by SAS.

TABLE 1

SCHEDULE OF FIELD INSPECTIONS BY DESIGN PERSONNEL

ST. STEPHENS POWER PLANT

DISCIPLINE SASEN-	CONSTRUCTION FEATURE TO BE INSPECTED
FS/FG	Continuous ineraction on all phases of instrumentation will be required - See Specification Section 2H and Plates PF-5, PF-6, and PF-7.
FS/FG	Initiation of Slurry Trench Excavation.
FS	Initiation of Slurry Trench Backfill.
FS	Initial installation of overburden dewatering system (To El. 14).
FS/FG	Initial installation of deep watering wells.
FS	Initial dewatering of overburden dewatering system.
FS/FG	Initial Dewatering of deep dewatering wells.
FS	Initial excavation and stockpiling for powerhouse inside slurry trench.
FS/FG	Excavation reaches approximately EL-23 (just above top of shale).
FG	Excavation proceeds below EL-23 (into shade).
FG	Excavation reaches approximately EL-41 (top of limestone).
FG-FS	Completion of foundation preparation.
FS	Initation of each backfill zone.
FS	Driving of sheet pile.
FG	Initial installation of relief wells.
FS	Initial installation of switchyard drilled pier foundations.
FS	Approximately 50 percent completion of intake cannal levees (see Plate PP-4, Note 8).
FS/FG	Initial installation of stone protection (including plastic filter fabric).
FS	Initial pole installation for 115kV transmission lines.
FS	Initial pile installation for 115kV transmission lines.

PART II

INSTRUCTIONS ON SOILS AND GEOLOGY TECHNICAL SPECIFICATIONS

SECTION 2A - CONTROL OF WATER DURING CONSTRUCTION

2.6 It is anticipated that discharges from dewatering systems for the powerhouse excavation will result in rather large quantities. For this reason it is considered best to discharge this water into the tailrace canal excavation, if such excavation has started at the time the dewatering systems go into use. If the tailrace canal is not ready at that point in time, the dewatering system should be discharged into the existing natural drainage downstream of the project, until such time as the tailrace canal in the area is complete. Discharge after completion of the tailrace canal should be into the tailrace canal.

5.1 The contract provisions for the maintenance of the groundwater level of a minimum of 5 feet below powerhouse excavation at all times will require dewatering to essentially commence concurrent with excavation. The provisions for maintenance of groundwater a minimum of 10 feet below the bottom of the shale in the excavation is intended to prevent uplift forces that could possible damage the shale foundation layer. Design computations presented in the foundation report indicate that the deep dewatering wells should maintain groundwater surface at a depth in excess of 10 feet during excavation. Therefore, no particular problems are anticipated in meeting this requirement. However, foundation piezometers should be routinely monitored and if the water level rises to within 10 feet, the functioning of all the wells should be checked and any necessary repairs should be promptly made. It is suggested that information regarding the elevation of the groundwater below the shale and the quantities of discharge from the wells be routinely monitored and evaluated in order to detect in advance if the wells may be losing capacity.

6.4 The original design called for six deep dewatering wells. During the latter stages of the preparation of the plans and specifications, two additional wells were added. The reason for the two additional wells was to provide an additional margin of safety in the case of failure of a well. It is anticipated that if one of the wells becomes blocked or otherwise fails to function, the remaining wells should be able to handle the dewatering of the lower aquifer. However, should a well become inoperative, it must be replaced and repaired as soon as possible; therefore, a replacement pump is required to be available. During the period when the well is inoperative, careful attention should be given to measure the quantity of discharge from the remaining wells, the groundwater elevation beneath the shale layer should also be carefully monitored during any period when a well is out of operation.

Page 2A-9 For Submittal Data, in the table, the Dewatering Plan Submittal listed for paragraph 5.2 is redundant and should have been deleted during amendment stage. The dewatering information will be submitted as "control of water procedures" required in paragraph 3.

SECTION 2C - SLURRY TRENCH

General. The slurry trench is an integral part of the dewatering system. During design considerable attention was given to the dewatering of the powerhouse excavation. A number of schemes, as outlined in the powerhouse foundation analysis, were studied. The slurry trench scheme was finally settled upon because it had the advantage of allowing the least disturbance of the groundwater regime surrounding the excavation. Therefore, the primary purpose and benefit of the slurry trench is for construction dewatering. However, its presence is used to advantage for cut-off around the powerhouse permanent construction. It is noted that impervious core extends from the powerhouse to tie into the slurry trench limits. Also, the slurry trench cuts across the intake and tailrace canals. Its presence adds benefits and is intended to help control seepage around the powerhouse. The slurry trench will have no effect on aquifer II. Section 2A of the specifications covers dewatering of aquifer II.

3.6 Specifications require a working surface elevation of 56 for the slurry trench. This has been raised from elevation 50 as shown in the Powerhouse Foundation Analysis. In slurry trench construction it is important that the slurry in the trench be maintained such that a positive head is created on the existing groundwater table. Certain of the borings in the vicinity of the slurry trench alignment indicated groundwater above elevation 50. Therefore, the working surface elevation of 56 is intended to maintain a positive head on all anticipated groundwater around the perimeter of the powerhouse. In the unlikely event that groundwater conditions above elevation 56 are encountered, Engineering Division should be contacted regarding a possible raising of the working surface.

4. CHARACTER OF OVERBURDEN MATERIALS: (a). The intent of this paragraph is to describe to the Contractor the nature of the materials through which the slurry trench is to be excavated. Since it is essential that the slurry trench be excavated to it full depth in one complete operation, the presence of hard layers and discontinuous zones of rock could have considerable influence on the ability of the Contractor to excavate the slurry trench and in the time and cost required to accomplish the work. The area of most concern is in the vicinity of Boring No. 70 in which a rock zone was encountered. Excavation through this rock may require chipping or breaking by use of a chopping bit or other such tool. (b) The slurry trench is required to extend to top of shale. However, should the Contractor not be able to excavate through the approximate 2-foot thick sandstone cap on top of the shale, Engineering Division personnel should be contacted regarding a decision to possibly terminate the slurry trench at the top of the sandstone cap. This would only be considered if a good contact with the sandstone could be assured.

A more detailed discussion of the overburden materials is included in paragraph 1A-5B FOUNDATION CONDITIONS, in Section 1A of the specifications. Also refer to paragraph 3 in Section 2D of instructions for field personnel.

5. Slurry trench construction is a specialized engineering procedure. The procedure, though not complicated, involves certain techniques which are best developed through experience with similar installations. It is important that the Contractor possess the proper experience and expertise to monitor and accomplish the work. Consequently, it is essential that only competent personnel be utilized. Since this work is highly specialized, the success and expeditious completion of the result depends largely on the slurry trench specialist. For this reason, the provisions of paragraph 5, are included. Information copies of submittals required under this paragraph should be forwarded to Foundations and Materials Branch, Soils Section (EN-FS), Savannah District, as soon as possible after receipt.

7. Test procedures and test equipment required for the determination of the character of construction materials are described in API (American Petroleum Institute) Code RP 13B. The values selected for use in the project have been used in numerous projects within the South Atlantic Division and no problems are anticipated with the Contractor meeting these requirements.

7.1.5 Since the primary function of the slurry trench is to provide a seepage cut-off during construction, the backfill material gradation is not especially critical except for those areas in which the dikes cross the slurry trench. Consequently, in areas where permanent works or levees cross the slurry trench, a processed backfill is specified in order to reduce the probability of differential settlement. Such settlement could lead to possible arching in the vicinity of the slurry trench.

7.1.5.1 The intent of this paragraph is that the top of the processed backfill material extend at least 20 feet beyond the toes of all the permanent levees. The side slopes on this material, when used as backfill, will probably assume angles of repose on the order of 1V on 7H to 1V on 10H. Consequently, the backfill of the processed material will need to begin in these areas at a sufficient distance that the backfill surface extends at least 20 feet beyond any levee toes. Remaining backfill may be any material that is excavated from the slurry trench provided it meets the gradation requirements for the amount of material passing the No. 200 sieve. For areas in the slurry trench in which processed backfill is not used, settlement and strength in the slurry trench is not a critical design consideration.

7.2.1 (a) The excavation equipment utilization in this contract is the responsibility of the Contractor. A number of combinations are possible. The important factor is that whatever equipment is used, it must produce straight vertical walls. Bucket weight is also an important consideration due to the need to excavate possible dense material at depth under the influence of the buoyant effect of the slurry.

7.2.1 (b) Attention is called to the specification requirements for chopping bits, ripping blocks and other devices as necessary to accomplish excavation to the full required depth of the trench. Because of the presence of dense sand layers and possible rock in the vicinity of Boring No. 70 these and other types of devices will likely be required for excavation to full depth. Since the slurry trench is essentially circular, it is anticipated that a dragline will at best be a marginally acceptable piece of equipment for excavation. Special slurry trench clamshells would be expected to perform this work more satisfactorily than a dragline.

7.4.1 If excavation is accomplished with a device such as a slurry trench clamshell, no problems are anticipated in excavating the curved portion of the slurry trench. However, if a dragline is used, the Contractor may elect to construct the various sides of the slurry trench as four separate and distinct overlapping segments. For this reason, the specifications contain provisions that a minimum overlap of 5 feet be made at any corner in order to obtain the full and continuous depth of material. Special attention should be given to taking probings and samples in these areas of overlap, if this construction procedure is used, so that the Resident Engineer is assured that no discontinuous areas or "windows" exist in the slurry trench.

7.4.2 Typically, in slurry trench construction, the level of the slurry is maintained within about 2 feet of the ground surface. However, as mentioned previously, it was necessary to raise the working surface elevation because of the possibility of high groundwater along the alignment. The minimum requirement of 1 foot above groundwater is intended to provide a positive head on the slurry walls at all times. To further assure positive head, the slurry is to be maintained at the surface of the working surface. (This is not to infer that the slurry cannot on occasion be between a foot and 6 inches below the surface.) However, this requirement of maintaining the slurry at the top of the bench should be enforced. Experience by Mobile District has indicated that it is possible to work the slurry at the top of the trench. It is important to repeat that the slurry surface must be maintained above the static groundwater head even if it requires giving consideration to changing the working surface elevation. Small dikes parallel to the slurry trench excavation may be necessary to contain the slurry in certain areas.

7.5.1.3 Sampling. When samples of the trench bottom are required, the splitspoon sampler shall be pushed or driven with sufficient energy to penetrate any sand or material that may be lying in the bottom of the trench. The material in the bottom of the trench which is retained in the splitspoon should be inspected to see if it is sand or the shale contact to determine if additional cleaning is required. The splitspoon may be attached to any equipment such as the air lift or any rod or beam that is long enough or rigid enough to adequately sample the bottom. Boring logs and records of blow counts will not be required for the sampling process.

7.6.1 Contractors normally prefer to construct backfill mixing areas parallel to the slurry trench. These areas typically are about 50 feet wide and immediately adjacent to the slurry trench. The areas are usually diked off from the slurry trench excavation. Mixing areas should be allowed to be located anywhere convenient to the Contractor. Though the locations of the mixing areas is not critical, it is possible some problems in locating mixing areas will occur in that portion of the project where a fill is necessary to maintain the working surface elevation. For this reason the contract drawings specify a "minimum" width of fill. This minimum width is considered that necessary for construction only, without mixing room. The Contractor may wish to construct the fill surface wider for his own benefit such that mixing areas can be located on the top of the fill surface. This can be allowed as long as the excavation slope is not steepened.

7.6.2 The specifications require the backfill operations to be continuous beginning at the initiation of backfilling of the trenches in the direction of the excavation. Another reference is paragraph 7.6.2 which requires the Contractor to backfill continuously from the initial backfill to the opposite end of the trench. This is not to infer that this has to be a 24-hour per day operation. It does mean that the Contractor should not stop work on the slurry trench due to any undue interruptions such as shortage of equipment and personnel. If for any reason work on any phase of the slurry trench is stopped, including weekends and holidays, the slurry within the trench shall be maintained as specified in paragraph

7.4.2 Slurry. The maintenance of the slurry during any shutdown of a day or longer is considered important. Failure to properly maintain the slurry could result in loss of portions of the trench walls.

8. TESTING:

a. The contractor is required to perform all tests to assure the quality of the slurry and other phases of the overall work. The Government is to perform assurance testing utilizing contractor furnished equipment. Specifications do not require specific number of tests to be run by the Government. Enough tests should be run to assure the accuracy of the Contractor's testing program. The Contractor is required to sample and test the slurry twice daily. One sampling and testing series should be performed at the beginning of the first shift of the day, particularly when the Contractor is operating only one shift, or when there has been a shutdown due to holidays, weekends, etc. The frequency of Government assurance testing should be the largest during any initial phase of the Contractor's operation and they should then be taken at such frequency as to verify Contractor test results.

b. Daily testing requires a series of tests to assure that the slurry and backfill are meeting certain requirements. One of the tests required is the Methylene Blue Absorption test. This test is an indicator of the number of pounds of bentonite per barrel of mixture. However, it should not be anticipated that the computed value of pounds per barrel from this test will, in all cases, equal the number of pounds of betonite per barrel as determined by the mixing procedure specified under paragraph 7.1.1.1. However, it is considered a good idea that correlations be developed during the progress of the job using known values of pounds of bentonite per barrel from the mixing process versus companion sample results from Methylene Blue Absorption Test. The Methylene Blue Absorption Test can then be used as an indicator as to when the bentonite mixture in the trench is becoming too lean. While the mixture of 20 pounds of bentonite per 42 gallon barrels of slurry is required, it is anticipated that in most cases the Methylene Blue Absorption Test will indicate somewhere between 17 and 18 pounds per barrel. This is based on experience with a recent slurry trench used in Savannah District. However, when values fall below 17 and 18 pounds per barrel, it is considered necessary to check the mixing operations to make sure sufficient bentonite is being added.

8.1 The vertical sampling interval is specified at every 15 feet of depth. The sampling location along the alignment of the trench is not specified and should be determined by Construction Division personnel for representative results.

SECTION 2D - STRIPPING, EXCAVATION, STOCKPILING AND FOUNDATION PREPARATION

General. It is expected that all soil, sandstone, and shale will be excavated that is overlying the limestone in the powerhouse area. Refer to paragraph 1A-38 FOUNDATION CONDITIONS on page 1A-76 of the specifications for a description of the soil and rock.

1. BORINGS. Most of the station numbers on the boring logs are baseline stations, not canal centerline stations. Refer to plate P1-6 for the location of the baseline.

3. OVERBURDEN. The overburden includes all the material that overlies the limestone at approximate elevation -41.0 msl. There are some rock lenses in the overburden soils overlying the shale. It is not anticipated that these rock remnants will cause any difficulty during excavation. Refer to paragraph C - OVERBURDEN SOILS on page 1A-77 of the specifications for a description of these rock remnants. You can also refer to a description of the overburden on paragraph 36 in Supplement No. 1 of Design Memorandum 6, Site Selection and Geology.

b. Blasting (para. 3.3). It is not anticipated that any blasting will be necessary during excavation.

c. Shale Protection (para 3.4). This is Shale I that is described in paragraph 4(1) on page 1A-77a of the specifications. In some areas a sandstone "cap" overlies this shale.

4. STOCKPILING:

a. The intent of the design is to obtain from required excavations, fill materials for the various embankment zones around and adjacent to the powerhouse. Each material is to be excavated from certain predefined areas. Both general descriptions of the types of materials and the elevations from which they are to be excavated are contained in paragraph 4. Nevertheless, some selective loading and placement will be required during construction.

b. Material availability is not anticipated to be a problem as there is an overall surplus of material on the project. However, care should be exercised to assure that sufficient materials meeting requirements of the Zone II and Impervious Fill are obtained. Since Zone I fill is essentially a random material, any type of satisfactory materials can be used and there should be no problem in obtaining this material.

c. The classification and quality of material should be the predominant factor in determining into which stockpile excavated material should be placed. For example, impervious materials are required to be stiff and firm, red, brown and gray clay, silt and clayey sands. They are anticipated to be excavated from the upper overburden above elevation 55 in the powerhouse area. While most of these materials may be suitable for use as Impervious Fill, should materials not meeting the classification requirements of Impervious Fill be obtained in these zones, this material should be placed in another stockpile appropriate to the materials being encountered.

d. As mentioned previously, the two critical zones are Zone II Fill, which needs to be relatively strong silty or clayey sand with moderately good drainage characteristics, and Impervious Fill which needs to be a good impervious type material. When there is any question as to the classification of either Impervious or Zone II Fill, the materials should be placed in the Zone I stockpile since this is essentially a random zone. It should be pointed out that stockpiled materials for use in various embankment zones must meet the appropriate classification as specified in SECTION 2F EMBANKMENT AND SHEET PILING.

5. Foundation Preparation. The intent of foundation preparation is to furnish a clean, sound surface, free of drummy rock, and rock underlain at shallow depth by joints, weathered seams and other structural defects. Field personnel should inspect the foundation immediately prior to placement of concrete. Placement of concrete on the foundation should be made in the presence of a representative of the Contracting Officer. Photographs and a written record describing, in detail, the foundation should be made and filed for use in preparing the supplemental "Foundation Report." There are no separate payment items for overburden or shale foundation clean-up.

SECTION 2E - RELIEF WELLS

1. General. The purpose of the relief wells is to prevent excessive uplift pressures in the bottom of the powerhouse. The exact positions of the relief wells are pinpointed on plate PF-6 of the specifications. Relief well detail is shown on plate PF-7.

2.2 The intent of paragraph 2.2 is to simply list, in accordance with Unified Soil Classification System, all those materials which are satisfactory for use as fill in some portion of the embankment work. This paragraph also puts limits on those materials which may be used as impervious and Zone II materials. Further guidance and requirements as to usage of material in specific zones is contained in paragraph 4.

4.6 Several of the gradations of the processed material were changed by amendment during the bidding period. In all cases the gradations were opened up to allow easier production by suppliers, thus reducing costs. Since there are limited quantities of special backfill, the gradation and production procedure was modified to eliminate production of a separate gradation while meeting design requirements. The intent of the gradation is to provide strength and low permeability.

6. PLACEMENT:

Paragraphs 6.3 and 6.4 require the placing of the more impervious soils of the Impervious and Zone I Fills in certain areas. Such placement will require some control in the field. However, it is considered that the materials could be placed easier in the proper zones if some selective stockpiling was done during excavation under specification SECTION 2D. For example, if the Contractor were excavating impervious material and the particular material is separated such that the highly impervious material were in one stockpile and the less impervious material were in another, then this would facilitate selective placement in the backfill operations by simply accessing the proper stockpile.

7. MOISTURE CONTROL:

a. The development of design shear strengths for the various materials is dependent upon control of the fill within a certain moisture range. The specified moisture range for Zone I, and Zone II and Impervious Fill is between -2 and +3 percentage points of optimum moisture content. The Contractor is notified in paragraph 7.2 that excavated materials should be expected to be considerably wet of optimum as a large portion of these materials will be excavated from beneath the existing groundwater table. Processing for drying will be required. Experience indicates that the drying would best be facilitated at the stockpile. It is also felt that drying on the fill will be very difficult and time consuming because of the very small work areas in which backfilling for the powerhouse excavation must be placed. If the weather during excavation is conducive to drying of materials at the stockpile as the stockpiles are constructed, it is felt that it would be very advantageous to disc and dry at

this time. If this procedure is used, then when backfill operations begin, the material would then be in a range such that very little if any moisture control would be needed. Fill placement would then be expedited. The fact that drying at the stockpile is anticipated is pointed out in the last sentence of paragraph 7.2.

b. Paragraph 7.4 requires sprinkling of special backfill drainage zone and select material prior to compaction. Experience indicates that this work is best accomplished by spray bars attached to the equipment or by water trucks immediately preceding the compaction equipment. It is important that the water reach the material in such a time that it does not lie on the surface or drain through before the compaction equipment crosses the area. However, if the Contractor elects to spray the material, care should be taken to assure that the fines are not washed out, thus affecting the gradation of the material. If the spraying procedure is used, careful attention should be paid to gradation tests obtained when field density tests are performed to assure that the in-place gradation is within the specified limits.

9. COMPACTION:

Since the specifications are an "end result type" rather than a "method type," the type of compaction equipment used on any particular zone of embankment is left to the option of the Contractor so long as that equipment provides the proper density and meets the other specification requirements regarding shearing of the fill, rutting, pumping, etc. It is expected that two or more types of compaction equipment will be required. It is anticipated that the impervious material will be best compacted with a sheepsfoot roller. Since the Zone I material may contain silty sands and some clay, a rubber-tired or sheepsfoot roller will likely be satisfactory. The Zone II materials will likely be best compacted by rubbertired equipment. Processed materials will be best compacted by vibratory compaction, however rubber-tired equipment would also likely be adequate. Attempts to use vibratory rollers on silty sand materials should be discouraged as our experience indicates that either a considerable number of passes are required to achieve the required densities or densities are not obtained regardless of the number of passes. This condition is most probable when the amount of fines exceed about 12 to 15 percent.

8.5 If the Contractor's proposed compaction equipment does not meet the contract requirements, the specifications require that he construct a test fill utilizing the material he intends to compact with the equipment. If this situation arises, guidance regarding the number of passes, lift thickness, rolling speed, and the monitoring

of test fill construction operations will be provided by the Savannah District Foundations and Materials Branch upon request of the Project Office.

8.6 The disc harrows are required to have hydraulically adjustable carriages such that they be towed with discs clear of the ground and so they can be adjusted for various cutting depths. This feature is important and should be required on any discing equipment prior to its being approved. This is because certain construction operations, such as discing out smooth surfaces, may require discing that would have to be controlled at shallow depths. Also this paragraph requires the harrows to be able to cut through the loose lift and scarify the previous lift. This requirement does not preclude the need for scarifying as required in section 2F, paragraph 6.7 of the specifications.

15.a. Paragraph 15 discusses the various quality control requirements regarding the soil testing for the various zones. Though this section is self-explanatory, quality assurance testing will be required to confirm the results of the Contractor's tests. Quality assurance tests should be performed with sufficient frequency that the field personnel are confident in the results being obtained and reported by the Contractor. When there is any question about results being obtained by the Contractor, the Government should exercise its right under paragraph 15.3.6 to designate the location of any suspect area.

b. Certain compaction control procedures are specified. Basically, the one or two-point compaction control method is required for Zone I, Zone II and impervious materials. For the cohesionless and processed materials which should not be expected to exhibit normal parabolic shaped compaction curves, another method is specified. It is recommended that in order to provide consistency between the Government and the Contractor testing, the families of curves used for the Zone I, Zone II, and impervious materials and the families of gradation curves used for the cohesionless and processed materials, be developed jointly utilizing the same techniques between the Contractor and the Government. The best methods to accomplish this is to obtain a representative sample or samples of the material and split and quarter the samples. The Government lab takes one quarter of the sample and the Contractor takes another quarter. The remaining material is again split and quartered until sufficient samples are obtained.

c. The families of curves must be mutually satisfactory and should be developed jointly between the Contractor and the Government such that all compaction control by both groups can be compared to the same families of curves. Otherwise, confusion may exist as to the acceptability of some of the testing results.

d. Regarding the frequency of quality assurance testing, it is not possible to say exactly how many tests will be required.

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However, it is recommended that the frequency of quality assurance testing be the largest when the Contractor is developing his family of curves and initially conducting in-place tests on a specific type of material. Once the field personnel have developed a certain confidence in the results they are getting from the Contractor, then the frequency of testing can be reduced. It is recommended that a minimum of one field density test on each of the various zones of material and a minimum of one gradation test, where required, be performed by quality assurance personnel each day in which these fill placement operations are conducted. This frequency is recommended at least during the initial phases of the operation. Should there be any questions about the development of the various families of curves, Savannah District Engineer Division, will be willing to furnish techincal assistance.

Note: "In order to maintain sufficient checks on the Contractor's testing and record actual properties of the materials used in the job, certain sampling and testing must be accomplished.

At least once a month duplicate samples of each type of fill material being tested by the Contractor should be obtained and sent to SAD Lab for testing. Appropriate records should be maintained so lab results can be compared to the Contractor's test results for the same material.

Testing should include as a minimum, sieve analysis, Atterberg limits if appropriate, specific gravity, and laboratory compaction.

In addition to monthly duplicate sampling, a number of chunk type record samples should be obtained from the various fill materials, except the processed granular materials. These samples should be tested in SAD Lab for the full range of tests necessary to determine the engineering parameters to compare with design assumptions. If requested, appropriate tests on record samples will be requisitioned by SASEN-FS upon notification that the samples have been obtained. Otherwise, minimum testing should include: natural density and moisture content, sieve analysis and Atterberg limits (if appropriate), specific gravity, laboratory compaction, triaxial shear, and consolidation with the time curves. SASEN-FS will develop and furnish a plan showing proposed record sample locations and will assist in supervising the obtaining of the samples if requested. Since the contract currently contains no provision for record sampling support by the Contractor, this will either have to be done by contract modification or by Government forces. If a modification to the contract is the procedure chosen, SASEN-FS can furnish appropriate verbage.

Copies of all test data results from both monthly duplicate samples and record tests should be furnished SASEN-FS for future use in the Embankment Criteria and Performance Report."

SECTION 2H - INSTRUMENTATION

The responsibility for furnishing and installing all instrumentation is the Contractor's with the exception of the permanent piezometers. The Government will furnish certain piezometer equipment, to be installed by the Contractor, and will also supervise the installation of the permanent piezometers. It is the intent of the Savannah District Engineering Division to provide the supervision for the installation of all permanent piezometers. All remaining instrumentation work is to be furnished and installed by the Contractor.

5.a. Under the requirements of paragraph 5.5.5 regarding the permanent piezometer installation, the Contractor is required to give at least 3 weeks advance notice from the date that he intends to initiate installation of the permanent piezometers. The Contractor is to provide the drill rigs, labor, and all miscellaneous equipment not specified to be furnished by the Government. Since the Savannah District will only be able to furnish one individual to supervise this work, the Contractor is limited to installing no more than two piezometers at any one time. This will insure proper inspection of the piezometer installation. To allow the Contractor to install any more than two piezometers at one time would mean the Government would likely not be able to inspect it as specified and the Contractor could contend that he was being delayed by the Government.

b. Paragraph 5.2 requires that the Contractor furnish someone with experience in installation of piezometers to supervise and control the installation of temporary piezometers. Since these piezometers have an important function of monitoring groundwater during construction activities, the qualifications of this individual must be carefully reviewed to assure he has sufficient experience so that once the piezometers are installed, they will function as they are intended.

5.6 The contractor is responsible for the reading of all instrumentation. The periodic reading of the piezometers outside the limits of the slurry trench is important in order to determine what, if any, effect the construction dewatering is having on surrounding groundwater conditions. Such data could provide the basis of Government's position in case of any claim against the Goverment for damage to surrounding wells. It is noted that piezometer readings are to be reviewed both by the field office and Savannah District Engineering Division.

8. The contract drawings indicate the inclinometer locations. Inclinometers are neither furnished nor installed by the Contractor. All the Contractor is required to provide is a inclinometer opening.

As soon as these openings are complete up to the final concrete limits, the Savannah District should be notified. The Savannah District will then schedule and procure the services necessary to install the inclinometers in the openings. Savannah District will also take initial readings on the inclinometers and obtain an inclinometer read-out unit for use in reading the instruments. The inclinometer read-out unit will be turned over to the Operations personnel upon completion of the project.

9.7 Should additional piezometers, inclinometers or other instrumentation be installed, or should instrumentation be located at locations other than those shown on the plans, appropriate records must be kept and appropriate entries should be made on all the "as-built" drawings.

SECTION 2U - ENVIRONMENTAL PROTECTION

1. General. Because of the environmental concerns surrounding the Cooper River Rediversion Project, it is imperative the Contracting Officer continually monitor all aspects of the Contractor's operations to insure strict compliance with all the requirements of this section of the specifications. All Government field personnel should be familiarized with the requirements of this section and instructed to continually observe for non-compliance. When non-compliance is discovered, the Contractor should be notified and corrective action taken immediately. Field personnel should be apprised of the Contractor's proposals for implementing the requirements of this section and they should continually check to insure that the Contractor is adhering to the proposed plan.

2. Environmental laws (Paragraphs 3, 4, 9.1, 13.3, 13.4, 13.6, and 14). The Contractor and his subcontractors must comply with all Federal, State and local laws and regulations concerning environmental pollution control and abatement (paragraph 3.). The Resident Engineer must become familiar with these laws and regulations in order to be able to identify any non-compliance by the Contractor. The Resident Engineer should contact the Environmental Analysis Branch, District Office, for guidance concerning the laws for the protection of the environment applicable to the construction work under this contract.

3. Landscape and tree protection (Paragraphs 7.2 and 7.3). Attention is directed to paragraphs 7.2 and 7.3 regarding the protection of the landscape and trees to be left during clearing operations.

4. Contractor plant area (Paragraph 7.4.) Care shall be exercised in the location of haul roads, storage and equipment yards, parking areas and similar facilities to avoid damage to natural amenities. Contractor operations shall be controlled so that no unnecessary destruction of trees and ground cover occur. Stumps, rocks, debris and unused material shall not be pushed to the edges of construction areas, including haul roads, and left there, but shall be transported and placed in spoil areas as soon as uncovered.

5. Burning operations (paragraph 13.3). The Resident Engineer should insure that the Contractor provides adequate fire fighting equipment at the sites of burning operations. He should also see that fires are guarded at all times and are under constant surveillance until extinguished. Note that burning is to be aided by air supplied by mechanical blowers.

PART III

SOILS AND GEOLOGY DRAWINGS

1. Plate PF-1, Excavation and Construction Dewatering-Plan. The sizing of the temporary bypass drainage ditch is intended to be conservative, as potential flows are not precisely known. In the event the flow from the intake canal is too great to be carried by the ditch as show, it should be widened away from the slurry trench. The intent of Note 2 is to design the bridge or culvert so that there would be no backup of water behind the culvert due to hydraulic losses. This will probably mean the Contractor will have to widen the ditch at the bridge or culvert to pass the same flow as the open ditch. Note 3 is intended to give the Contractor leeway to increase the berm width, thereby increasing his slurry trench construction room if needed. However, the elevation 56 berm should not be increased toward the inside of the excavation. This would result in steeper excavation slopes than shown. He may increase the berm width by increasing the width of excavation of fill as applicable away from the center of the excavation.

2. Plate PF-2, Excavation and Construction Dewatering-Section and Details. In Section BB, note that the tops of shale and limestone elevations are specified only as a range. Borings indicate the actual top elevations vary somewhat across the site. It is expected that they will fall within these ranges; however, it is the intent of the excavation scheme to excavate so that the limestone is exposed in the bottom of the excavation and that there is a 2-foot cover of overburden material over the shale for the berm at approximately elevation -23. This cover is to protect the shale from breaking down under the operation of weather and the Contractor's equipment. The stability of the 1V on 1.5H excavated slopes shown on Section AA and in the Tailrace Retaining Wall and Excavation Plan is marginal theoretically; however, experience has shown that with proper dewatering these slopes and these materials can stand on much steeper slopes for extended periods of time. If slides or extensive sloughing occur, Savannah District Engineering Division should be notified so that remedial measures can be taken. The purpose of the temporary surcharge over the slurry trench shown in the surcharge detail is to accelerate consolidation of the slurry backfill and minimize accidents which could occur due to soft ground at the surface.

3. Plate PF-4, Embankment and Backfill Sections.

a. Section AA. The impervious fill and sheet piling form a continuous cutoff from the powerhouse structure to the powerhouse slurry trench. This should be sufficient to prevent seepage in an upstream to downstream direction. Seepage which may enter the ground

outside the powerhouse slurry trench will have a much longer path and is not expected to be significant. Note in Section EE and FF that the 2-foot blanket of overburden left over the shale must be excavated for the width of the impervious core before Impervious Fill is placed. This provides a positive seepage cutoff contact between the impervious material and the shale. This blanket should not be removed until immediately prior to placing Impervious Fill. This will minimize problems of weathering to the shale.

b. Section BB. In Section BB the four narrow bands of Zone II fill will probably have to be placed, in vertical lifts ahead of the Select Material. This Zone II Fill's purpose is to act as a filter between the Select Material and the shale. On the left side of Section BB, note that there are two Filter Material zones. The upper 8-foot wide zone is to filter the Zone II and Pervious Fill. The small lower zone is near the end of the 3-foot thick pervious blanket shown in Section EE. Also note that beneath the tailrace slab, no filter material is required between the Pervious Fill and Select Material.

4. Plate PF-4A, Embankment and Backfill-Sections.

a. Section DD. In Section DD on the left side of the powerhouse near the bottom, note the Special Backfill. This is the only place this material is used in the job. It is special because of its impervious properties necessary to prevent seepage below the powerhouse, and also for its high strength. It has special compaction requirements also.

b. Section KK and LL. Note that in Section KK and LL there is a layer of Zone II fill just on top of the shale. Although the 2-foot blanket of overburden material that must be left there until backfill commences may classify as suitable Zone II material, it should still be removed and backfilled according to specifications to achieve required densities.

c. Section TT. Section TT is identical to Section PP on plate PP-11. The main reason for showing also Section TT is to show where the conditions shown in Section QQ no longer apply.

5. Plate PF-5, Construction Instrumentation.

Savannah District Engineering will assist in reviewing the Contractor's submittals on instrumentation and will periodically review the Contractor's instrumentation for conformance to specifications. Though the Contractor is required to read instruments on a regular basis, supplementary readings by the field may be necessary.

Though, in addition to temporary, some of the permanent instrumentation (specifically piezometers) is shown on this plan, it will all be used to monitor construction conditions and is therefore considered construction instrumentation. Elevations of the tips and seals shown in the upper right table may be modified during drilling, depending on soil conditions encountered. P-18 is an existing opentube piezometer and will be read for as long as possible during construction. A pneumatic type piezometer will be installed adjacent to P-18, called P-18A, and readings will be taken simultaneously until P-18 is abandoned. P-18 will not be abandoned until just before concrete must be poured for the powerhouse. It is important during excavation and backfill, when piezometer risers are being shortened and lengthened, that the top of the tube be established precisely each time the length is changed. This should be done with the Contractor's surveyor. The piezometers outside the slurry trench are to be installed and functional before slurry trench construction in order that the groundwater table in the vicinity of the slurry trench can be measured and also to obtain background readings for sufficient length of time before dewatering starts. In Note 3 the ten additional piezometers are to be located during excavation between elevations 56 and 14, equally around the excavation to check the effectiveness of the Contractor's dewatering methods between these elevations.

6. Plate PF-6, Permanent Instrumentation Facilities.

Only permanent piezometers are shown on this plate. Some are not installed until after backfill is complete. Also, some of the piezometers shown here were also shown on plate PF-6, as they were considered part of the construction instrumentation. P-18A is the only possible exception. Though it is installed during construction, and read regularly after P-18 is abandoned, it is tabulated on plate PF-6. Piezometers beneath the powerhouse structure are pneumatic, gas operated. During construction, their tubing will be led though steel casing in the concrete pours. Though this tubing will be coiled or bundled, the end should be readily accessible as they shall be read regularly. A device for reading pneumatic piezometers is being purchased by Savannah District and will be furnished the Contracting Officer. This device will be loaned to the Contractor so that he may make his periodic readings. However, the Contractor shall make it available to the Contracting Officer personnel in the event we may want to take readings of our own. Though the Contractor provides casing in the retaining walls for the inclinometers, the inclinometer tubing itself will be furnished by Savannah District and installed after completion of the retaining walls. The contractor is not required to make readings on the inclinometers. This will be done by Savannah District and field personnel. It is important that the reference points are located within lines of sight of the

horizontal and vertical control points. Future obstructions must also be considered to the greatest extent possible when locating these reference points.

7. Plate PP-1A, Tailrace Disposal Area.

The purpose of this plate is only to show disposal area DA-8L, which is on the left side of the tailrace canal outside of the Powerhouse contract area. This disposal area is in the Tailrace Canal contract area and operations in this disposal area by the powerhouse contractor will have to be carefully coordinated with those operations of the Tailrace Canal contractor. In the event that the tailrace levees are already in place, the powerhouse contractor need only to dispose his material against the levees within the lines and grades shown. This includes putting material up on the outside slope of the left bank levee. However, if the levees are under construction or have not yet been constructed when the powerhouse contractor wishes to dispose material in this area, he must not disturb, operate, or dispose material within the outside toe lines of the levee on the left bank of the canal. His operations may have to be adjusted so that disposal of material will not be completed until after the tailrace canal contractor has completed the levees.

PART IV

CONCRETE AND CONCRETE MATERIALS

1. REFERENCES:

a. Section 3A. "Concrete, General," Technical Provisions - St. Stephen Powerplant and contract drawings.

b. EM 1110-2-2000, "Standard Practice for Concrete."

c. Design Memorandum 12, "Construction Materials."

2. SAMPLING, TESTING AND APPROVALS:

a. Cement and Pozzolan. No cement of pozzolan will be used until tests are satisfactory and will not be accepted at the site of the work unless received with all seals intact. Cement may be retested if not used within 6 months after original test. Caution should be exercised when storing and mixing pozzolans with cement at the job site. It would be desirable to store pozzolan and cement in completely separate tanks. Storage tanks should be kept locked with access allowed only under supervision of responsible personnel. Guidelines on chemical and physical properties of pozzolans are contained in CRD-C200 and CRD-C255.

b. Admixtures. Concrete placing shall not be scheduled to begin until at least 60 days after the Government has been notified of the admixture source. However, concrete placing may begin earlier than the scheduled date provided all admixture samples have been procured, tested, and approved and other requirements of the specifications are met. Air-entraining admixture must be retested if stored at the site longer than 6 months or subjected to freezing. Use of an accelerator, retarder, or water-reducing admixture must be approved or directed by the Contracting Officer. Accelerators are not needed in mass concrete and should be restricted to thin sections which are required to have high early strength and which may be exposed to mean temperatures below 40 degrees F. at the end of the protection period.

c. Aggregates. It is very important that the aggregate be cleaned and tested for compliance with specification gradation requirements before submission for mix design studies, as unsatisfactory samples will only result in delay and additional expense to the Contractor and the Government.

d. Water. Where appearance is important, there must be no permanent staining of concrete surfaces. The Contracting Officer shall approve the method of removing stains and deposits from such surfaces.

e. Curing. All methods of curing must be approved by the Concracting Officer. The Contractor should present his plans for curing well before concreting begins. During construction these operations must be continually checked.

f. Reinforcement. Placement schedules and shop drawings of reinforcing shall be submitted to the Resident Engineer for review and approval. Arc welding cannot be used to make connections between reinforcing steel and crossing bars, ties, stirrups, spirals, and supports. The Contracting Officer's representative will accept steel delivered to site based on certified copies of mill test reports for applicable specification requirements. The Division Lab can perform the tension tests required in paragraph 3B-5.4.2.3.2 of the Technical Provisions if the Contractor wishes. The Contractor pays for these tests.

3. CONCRETE PLANT:

a. The concrete batch plant and other equipment necessary for batching, mixing, transporting, and placing concrete must be checked thoroughly for compliance with the specification requirements well in

advance of concrete placement in order that sufficient time will be available to effect any necessary adjustments or replacements. Telephone or other equally acceptable means of communication which is required between mixing plant and specific point of concrete placement, not just site location, should be tested for adequacy well in advance of proposed use.

b. Permission to continue placing should be contingent on continuing attention by the Contractor to keeping the plant in proper operating condition. Government personnel should check to assure that scales and recorders are in calibration and that all parts are functioning properly.

4. CONCRETE PLACEMENT:

a. Placement of concrete requires careful attention to assure that the desired results are obtained. Specific items which have been sources of trouble in the past are excessive lift thickness, transporting concrete within the form by vibrators rather than hand shovel or direct placement from concrete bucket, under and over vibration, failure to hand spade and rod the concrete adjacent to the forms, failure to maintain placing temperatures consistently within specification limits, failure to maintain desired rate of placement, and inadequate forms resulting in leaking and/or kicked forms. The provisions of the project specifications should be thoroughly understood and faithfully followed.

b. Although pozzolan used as a replacement for part of the cement produces concrete with a reduction in both temperature rise and drop, this reduction should not be considered in determining the maximum

specified placing temperature, since economy is the only consideration for using pozzolan in a structure. Contractor methods of controlling specified placing temperature shall be approved by the Contracting Officer.

c. There have been many cases of joint leakage resulting from faulty installation or later breakage of waterstops. To eliminate such failures particular care must be exercised to insure that waterstops are properly installed and protected. Adequate provisions must be made to support and protect waterstops against damage during progress of the work. Particularly where concrete containing large size (3-inch) aggregate is deposited by bottom-dump buckets, extraordinary care must be employed in dumping buckets and in vibrating the concrete adjacent to the waterstops to insure that the waterstops are not damaged and that they are in correct position and properly embedded in the concrete.

d. Pumping concrete by positive displacement pumps, such as the Pumpcrete machine, is an excellent method for transporting concrete of medium consistency. Pumps may be approved when the aggregate size, slump, and length of line are within the manufacturer's recommendations for the equipment proposed. Aluminum for use as concrete pump pipe will not be allowed.

e. Belt conveyors may be approved if they have speeds in excess of 500 feet per minute with high belt tension, small head and tail pulleys, and mixing hoppers and wipers at each transfer and placing point to minimize segregation and grout spillage. However, a careful examination should be made of the proposed system to insure that it incorporates all

the features described above. Do not approve belt systems having pulleys with diameters exceeding 6 inches without a satisfactory field demonstration.

5. CONCRETE PLACEMENT ZONES: The plans and specifications should be carefully studied to assure that the concrete mixes are placed in the correct structure locations. Different design mixes will be required in the intake and tailrace channel structures, powerhouse and erection bay substructures, and powerhouse and erection bay structures and superstructures. The mixes will vary in the structure according to cement types, concrete strength and size of aggregate. Any problems in determining the correct design mix should be referred to Engineering.

6. CONSTRUCTION JOINT PREPARATION: (Reference a, paragraph 12). Careful attention should be given to preparation of concrete surfaces prior to additional concrete placement. Excess water shall be blown from the surface by air jets or removed by sponges.

7. CONTRACTION JOINTS: (Reference a, paragraph 16.1). It is the intent of the specifications that the contraction joints in the walls and roof of the galleries have chamfered edges.

8. FINISHING: Finishing of concrete requires careful attention to insure the desired appearance is obtained. The provisions of the project specifications and paragraph 5-4 of reference EM 1110-2-2000 should be closely followed.

9. CURING: Failure to provide complete, continuous curing is frequently reported. It is essential that curing be initiated promptly in full compliance with the applicable approved method and be maintained

uninterrupted for the entire curing period. If curing water stains the concrete the Contractor shall be required to submit his remedial procedures as soon as possible for review.

10. DEFECTIVE WORK: Any concrete considered defective shall be reported in writing immediately to the District Office for resolution.

11. QUALITY OF CONCRETE: Concrete strength is as shown below. Compressive strength shall be developed in 28 days (90 days when bulk pozzolan is used). These concrete design mixes should be closely coordinated with Section 3A of the contract specifications and also the concrete outline drawings.

a. 5000 psi. Prestressed roof panels are contractor's designed mixes.

b. 3000 psi.

(1) 3" Maximum Size Aggregate.

(a) Miscellaneous exterior concrete specified or shown on drawings as payment item 3A.03 that is over 2'-0" in thickness.

(b) General concrete except beams or columns specified or shown on drawings as payment items 3A.02 or 3A.02FL that is over 2'-0" in thickness.

(2) 1-1/2" Maximum Size Aggregate.

(a) Concrete in blockouts specified or shown on drawings as payment items 3A.04 or 3A.04FL.

(b) Miscellaneous exterior concrete specified or shown on drawings as payment item 3A.03 that is 2'-0" or less in thickness.

(c) General concrete specified or shown on drawings as payment items 3A.02 or 3A.02FL that is 2'-0" or less in thickness or a beam or column.

(3) 3/8" Maximum Size Aggregate. Separate concrete floor finishes and stair treads specified or shown on drawings as payment item 3A.06 or 3A.06FL.

c. 2500 psi, 3" Maximum Aggregate, Pozzolan. All mass concrete specified or shown on drawings as payment item 3A.01 or 3A.01FL.

d. 2000 psi.

(1) 3/4" Maximum Size Aggregate. Porous concrete in the turbine floor and around pit liner drains specified or shown on drawings as payment item 3A.07.

(2) 100 pcf Maximum Dry Weight. Lightweight concrete fill on precast roof deck specified or shown on drawings as payment item 3A.08.

e. Grout.

(1) Nonshrink grout for setting turbine stay rings, generator sole plates, and other heavy equipment shall be 3000 psi, designed by the Government.

(2) Nonshrink grout for thrust blocks shall be 3000 psi, contractor designed mixes.

(3) Plain grout for setting columns, beams, crane rails, light machinery and equipment, etc. has no strength requirement.

(4) Plain mortar for rock on which concrete is to be placed shall be 2000 psi.

12. CONCRETE MIX DESIGN: Concrete mixes shall be designed by the SAD Laboratory based upon requirements of the Concrete Specifications,

Section 3A, Construction Materials DM 12, and information contained in these instructions. The mixes will be designed in accordance with applicable portions of EM 1110-2-2000, "CONCRETE." It will be the responsibility of the field personnel to initiate the mix design request to the Division Laboratory. The field shall coordinate the mix designs with Engineering Design and furnish information to the laboratory as required. Requirements for field control of the various concrete mixes will be determined by the field laboratory.

PART V

STRUCTURAL DESIGN AND ERECTION CONSIDERATIONS

1. REFERENCES:

a. Technical Provisions and Contract Drawings - St. Stephen Powerplant.

b. Cooper River Powerplant - Analysis of Design.

2. STABILITY ANALYSIS:

a. Each monolith was assumed as an independent structure, but due to large earth forces applied in the longitudinal direction from the embankments the Erection Bay and Fish Lift structures were unstable. For stabilization, grouted thrust blocks were provided at all contraction joints to transmit the unbalanced longitudinal forces to the embankment.

b. Design assumptions prohibit backfilling against the Erection Bay and Fish Lift structures until all substructures are constructed and grouted thrust blocks installed. The north wall of the Fish Lift and south wall of the Erection Bay are designed to resist longitudinal forces transmitted through thrust blocks.

3. CONSTRUCTION JOINTS AND WATERSTOPS:

a. Joints. Five-foot vertical lifts are used except for special areas such as the draft tubes and floor levels. For ease of construction, vertical construction joints in the draft tube slab were selected along the line of fillets. Other vertical joints were located to minimize shrinkage stresses. Because of a possibility of differential foundation settlement some vertical joints in the substructure were staggered. Reinforcing steel was placed across joints in the two bottom

lifts because of a tendency of the construction joints to open. Since the Contractor selected vertical construction joint Option 2, drawings PS3A-PS7A apply instead of drawings PS3-PS-7.

b. Waterstops. Waterstops in contraction joints are hollow center, 3-bulb, polyvinyl chloride (PVC). These are also provided to act as grout stops for the contraction joint thrust blocks. Also steel plate waterstops are placed in vertical joints around water passages and in certain other vertical and horizontal construction joints where shown on drawings. Waterstops in the vertical joints forming the spiral case are attached to the turbine pit liner for watertightness.

c. Special Floor Treatment. The turbine room floor and the storage area at elevation 2.0 constitute the spiral case and draft tube roofs respectively. These floors will be subject to seepage from below. The porous concrete in these floors is to collect this seepage which will be conveyed to gutters through perforated drainage angles embedded in the porous concrete.

4. ERECTION BAY:

a. Erection Floor. The floor slab in the erection area at elevation 57 was designed for a live load of 1,000 psf plus an estimated transformer load of 90 kips. The rotor load (350 kips) is supported by the column below.

b. Gate Repair. Design live load for the gate repair platform at elevation 57 was 500 psf.

c. Maintenance Shop and Heavy Storage. The maintenance shop and heavy storage areas at elevation 37 were designed for a live load of 300 psf.

d. Elevator Machine Room. This floor at elevation 67.5 was designed for a live load of 300 psf plus an uplift force of 15,000 lbs caused by the elevator hoisting machinery.

e. Emergency Generator. The floor for this room at elevation 72 is designed for a live load of 300 psf.

f. Intake Deck. The intake deck for erection and generator bays at elevation 86 was designed for a live load of 300 psf plus a HS 20 loading with 30 percent impact.

g. Other Areas. Most other floors in the erection bay are designed for 100 psf live loads.

5. GENERATOR BAYS:

a. Control Bay. Control bay floors at elevation 18 and elevation 57 were designed for live loads of 200 psf. The elevation 37 slab has a design live load of 300 psf.

b. Turbine Floor. The turbine floor at elevation 37 is designed for a live load of 1000 psf.

c. Generator Access. The generator access floor at elevation 57 has a design live load of 200 psf.

d. Draft Tube. The draft tube deck at elevation 57 is designed for a live load of 300 psf.

e. Miscellaneous Slabs. Most slabs in other areas are designed for live loads of 100 psf.

6. ROOF: The high roof is constructed of single tees spanning a distance of 64'-0" and are formed of lightweight concrete (115 pcf) to minimize dead load deflection. The low roof is constructed of double tees spanning 30'-0" formed of standard weight concrete since dead load deflection is not critical for this span. The tees are anchored at upstream walls and have sliding joints at downstream walls to allow for expansion and contraction. Design live load was 30 psf. Cast-in-place concrete diaphragms are provided to tie all precast tees into a solid deck.

7. FISH LIFT:

a. General. The Fish Lift is a reinforced concrete structure consisting of downstream approach channel, gated entrance channel, holding pool with moveable fish crowder, gated lift chamber with lifting brail for raising fish and an exit channel. It provides a means of transferring fish from the tailrace canal to the intake canal and Lake Moultrie.

b. Live Loads. Design live loads are 100 psf except in the following areas:

(1) the access decks at elevation 57 and elevation 86 are designed for a HS-20 truck load

(2) the control room at elevation 86 for 200 psf

(3) the elevation 97 roof for 50 psf

8. INTAKE AND TAILRACE SLABS AND WALLS:

a. Retaining Walls. The first two monoliths of the north intake wall and all of the south tailrace wall were designed as gravity walls. The other walls were designed as cantilever walls. The 30-foot monoliths were analyzed as single units and are stable independently of the slabs.

b. Channel Slabs. Weep holes are provided to relieve uplift pressure under rapid drawdown conditions and are considered 50 percent efficient. Drawdown in the intake is due to hurricane conditions. Although the intake is not thick enough for this case, the likelihood of the hurricane level dropping instantaneously was considered so remote that 1'-6" thickness was judged to be adequate. For the tailrace slab, drawdown was based on a shutdown of all generators. The tailrace slab is thick enough for rapid drawdown under this condition.

9. GATES:

a. Trashracks. Each of the nine intake passageways will be provided with trashracks. There are 36 identical interchangeable leaves, using four in each passageway. The leaves are to be handled by the auxiliary hoist lifting beam of the intake gantry crane. When a trashrack slot is being used by the bulkhead, the trashrack leaves will be stored in the bulkhead storage slots.

b. Intake Bulkheads.

(1) Permanent Bulkhead. One permanent bulkhead consisting of four identical interchangeable leaves is provided. It uses slots provided for the trashracks and is handled by the auxiliary hoist lifting beam of the intake deck gantry crane. The leaves will be stored beneath the intake deck in storage slots downstream of the trashrack guide slots.

(2) Temporary Bulkheads. Two temporary bulkheads, consisting of three identical interchangeable leaves each, are provided. These bulkheads use only the center water passage intake gate slots of each unit. Therefore, additional embedded frames had to be added only to the center gate slots. The bulkheads are to be handled by the auxiliary hoist lifting beam of the gantry crane.

c. Intake Gates. Each gate consists of three sections bolted together in the field. They are designed to be interchangeable in any of the nine intake passages. Six gates, sufficient for closure of two units, are provided. The gates will be stored in their slots on dogging devices during normal plant operations. The gates are operated and transferred to different slots by the intake gantry crane using a lifting beam. When the spiral case is to be filled, the intake gate is cracked under an unbalanced head. The crane capacity is 50 tons, which exceeds the capacity (35 tons) required for cracking the gate.

d. Draft Tube Gates. Six draft tube gates, each consisting of two interchangeable leaves, are provided to permit simultaneous unwatering of two unit waterways. Gate leaves are handled by the draft tube gantry crane using a lifting beam and must be raised or lowered in slots under balanced head conditions. Nine draft tube gate leaves can be stored in dogged positions beneath the draft tube deck. The three remaining leaves will be stored at the plant maintenance yard.

e. Fish Lift Stoplogs. Eight interchangeable leaves are provided for use in the four stoplog slots. All eight leaves are used for dewatering the entrance channel, by placing two leaves in slot number two

and three each in slots number three and four. For dewatering the crowder channel and lift chamber, leaves are placed in stoplog slots number one and two. For dewatering the holding pool, slot number one is used. The leaves are handled by mobile road crane and stored in the plant maintenance yard.

10. SWITCHYARD:

a. Tunnel. The cable tunnel for main power leads and transformer control extends from the Erection Bay to the switchyard. Since waterproofing was not furnished, the tunnel is sloped towards the powerhouse to carry seepage water to the station drainage system.

b. Structures. Structures consist of the takeoff tower, shield wire towers, switch supports, bus supports, and supports for potential transformers (P.T.), current transformers (C.T.), carrier current potential devices (CCPD) and other miscellaneous equipment. The takeoff tower supports the conductors and shield wires connected to the transmission line towers and also the conductor drops to the bus level and the Phase "B" line trap. The shield wire towers support the shield wires providing overhead protection to the switchyard. Except for reinforced concrete pads for the OCB's and transformers, all foundations are reinforced concrete drilled pier type. Design loadings on conductors are for a maximum working tension of 2000# and on shield wires are for a maximum working tension of 1000#.

PART VI

MECHANICAL

1. Powerhouse Elevator: The powerhouse elevators for the St. Stephen Powerplant are being supplied under the general construction contract rather than as Government-furnished equipment under a supply contract. It is important to note that the contract specifications require that installation and tests of the elevators shall be performed under the direct supervision of a competent manufacturer's representative. This provision of the specifications should be strictly adhered to. Normally when the elevator is Government-furnished the general contractor is not allowed to use the elevator during construction; however, the District would not object to use of the elevator during construction provided finish painting of the elevator is delayed until after construction use is completed and provided the elevator is otherwise acceptable to the Government. Corps of Engineers personnel will be allowed to use the elevators to the maximum possible extent.

2. Diesel Electric Generator Unit and Appurtenances: The Engineering Division should be advised at least 30 days in advance of the date that the unit is to be field tested in order that personnel from the District Office witness the tests.

3. Installation of Government-furnished Equipment and Transportation and Storing Materials and Equipment Installed by Others: The Contractor

should be required to submit for approval a plan of storage of equipment and materials at the site. The plan should be in sufficient detail to show compliance with requirements of specifications paragraph 15H-4. The plan should provide for using the services of erection engineers provided by supply contracts. The erection engineer and representative of generator manufacturer should be requested to inspect the storage facilities and equipment for proper storage at the beginning of storage and at other times as conditions indicate. The storage plan should be monitored by Government inspection of items stored to assure that the equipment and especially the Government-furnished equipment does not deteriorate or become lost. The Contractor is contractually responsible for proper storage of the Government-furnished equipment but the risk involved for several million dollars worth of equipment and difficulty of proving responsibility in cases of equipment failure indicates need for an active inspection program. If the storage plan is found to be deficient, corrective action should be taken regardless of whether the Contractor is contractually required to correct the storage plan.

3.1 Particular emphasis should be placed on proper storage of all Government-furnished equipment but especially those items of equipment which require indoor heated storage. It is anticipated that considerable quantities of indoor storage will be required. Some of the equipment will require electrical connection to equipment heaters which will require careful coordination to insure that all such equipment is properly stored. Also, periodic recorded surveillance will be required

on these items to insure that the heaters are functioning and proper storage is realized. Boxed or crated shipments that must be stored several months should not be opened upon receipt at the project unless the shipment container shows signs of damage or loss or there is reason to question the contents. Opening of the shipments may disturb any storage protection provided by the supplier and increase the possibility of contents being misplaced or lost. If the shipment container is opened for inspection, it should be reclosed in the manner as received. Protective coatings, dehumidification materials and packing should be replaced if removal is necessary. Machine surfaces should be protected with a corrosion preventative material for lengthy storage. Protective materials such as "Cosmaline" may allow corrosion to develop under the material when stored several months without humidity control. The surfaces should be inspected periodically for development of corrosion. If corrosion develops, the protective coating, and rust should be removed and recoated with a suitable protective coating.

3.2 In addition to storage requirements, it is imperative that erection engineer services be fully utilized during installation on all supply contracts which provide for this service. Experience has shown this service to be very beneficial to the Government.

4. Intake and Draft Tube Gantry Cranes: The intake and draft tube gantry cranes are being purchased under a supply contract. The Powerhouse Contractor will assemble and install the cranes and the crane

supply bus in accordance with the manufacturer's drawings and as directed by the manufacturer's supervising erector. The parts have match marks or other marks to insure correct assembly. The Contractor will install the wiring supplied by the crane manufacturer and make all connections to the equipment terminals as shown on the manufacturer's shop drawings. Reference is made to Paragraph 15H-8.5

4.1 Lubricants will be furnished by the crane supplier.

Shop and Field Tests: District Design personnel should be notified when tests are to be performed and invited to witness their shop and field tests.

5. Insulating and Lubricating Oil Systems: The oil storage tanks must be installed prior to closing in the Oil Storage and Oil Purification rooms.

5.1 Paragraph 15G-1.1 of the contract specifications states that the oil will be furnished by the Government and shall be loaded in place by the Contractor. The Resident Engineer should inform the District Office sufficiently in advance for need of these oils with consideration given to the time required for procuring and shipment of oil to the site. Not less than 60 days notice would be desirable. Ninety days notice is preferable.

5.2 In accordance with paragraph 15A-3.6, the Contractor is required to provide with the preventive maintenance instructions the recommended oil and/or grease for each item of equipment requiring lubrication. This is an important requirement in that this information will be needed at a later date when oils and greases for maintenance of the equipment must be procured by Corps of Engineers personnel.

5.3 Insulating and lubricating oil supply and return lines require flushing until the lines are clean. Requirements are discussed in paragraph 15A-9 of the specifications.

5.4 Procedures for testing the piping are outlined in paragraph 15A-8. The Contractor should furnish all equipment required to make complete tests and should notify the Contracting Officer at least 48 hours before starting any test. The Contractor is required to replace lost or spilled oil with new oil of the same type.

5.5 At least a one gallon sample of all bulk deliveries of oils should be taken at delivery on submittal for testing by Government to insure compliance with contract specifications. Insure that all samples are adequately identified at sampling.

6. Overhead Traveling Powerhouse Crane: Broadline Corporation is supplying the powerhouse bridge crane under a supply contract; however, the Powerhouse Contractor will assemble and install the crane in

accordance with the manufacturer's shop drawings and as directed by the manufacturer's supervising erection engineers. The Powerhouse Contractor must cooperate fully with the erection engineers and must perform all the work under their direction. Details of installing, servicing, and testing the crane are discussed in paragraph 15H-7 of the specifications. Also see paragraph 15H-3. Parts will have match marks or other marks to insure proper assembly.

6.1 Attention is called to the fact that the crane must be installed in place before the roof framing of the generator room is erected.

6.2 Lubricants will be furnished by the crane supplier.

Shop and Field Tests: District Design personnel should be notified when tests are to be performed and invited to witness their shop and field tests.

7. Fish Lift Piping Systems and Mechanical Equipment: Attention is drawn to paragraph 15J-3 which states that the arrangement and assembly of all hydraulic circuitry and its components shall be accomplished by or under the direct supervision of a firm thoroughly experienced in providing such services.

7.1 The Contractor will provide two framed-behind glass copies of approved hydraulic and electrical control schematic diagrams and mount them where directed by the Contracting Officer.

7.2 Attention is drawn to paragraph 15J-4, which requires submission of a detailed erection procedure for the fish crowder; weir gates 7 and 8 and associated hydraulic cylinders, shafts and connections; and lift chamber gates 1 and 2 and associated hydraulic cylinders, shafts and connections.

7.3 The hydraulic system will be filled with a petroleum-base hydraulic fluid which must meet the requirements of MTL-L-17672.

7.4 Field Tests. District personnel should be notified when tests are to be performed and invited to witness their field tests.

8. Site Visits by Engineering Division Personnel: Higher authority has instructed that all Districts have an adequate program for visits to construction activities by engineering design personnel. Design personnel are required to visit the site during construction operations as a regular part of the design procedure in order to determine whether field conditions are as they were expected to be, to assist field personnel in interpreting the plans and specifications, and to observe first hand problems which may not have been fully evaluated in the original design. A schedule such visits is being prepared and will be coordinated with Resident Engineer (Field) personnel.

8.1 In addition to the scheduled visits, field personnel are encouraged to call for visits by design personnel whenever conditions are encountered which appear to differ from those which were anticipated in the design.

Part VII

ELECTRICAL

1. Installation of Goverment-Furnished Equipment and Transportation and Storing Materials and Equipment Installed by Others: The Contractor should be required to submit for approval a plan of storage of equipment and materials at the site. The plan should be in sufficient detail to show compliance with requirements of specifications Sections 15H and 16C. The plan should provide for using the services of erection engineers provided by supply contracts. The erection engineer and representative of generator manufacturer should be requested to inspect the storage facilities and equipment for proper storage at the beginning of storage and at other times as conditions indicate. The storage plan should be monitored by Government inspection of items stored to assure that the equipment and especially the Government-furnished equipment does not deteriorate or become lost. The Contractor is contractually responsible for proper storage of the Government-furnished equipment but the risk involved for several million dollars worth of equipment and difficulty of proving responsibility in cases of equipment failure indicates need for an active inspection program. If the storage plan is found to be deficient, corrective action should be taken regardless of whether the Contractor is contracturally required to correct the storage plan.

1.1 Particular emphasis should be placed on proper storage of all Government-furnished equipment, but especially those items of equipment which require indoor heated storage. It is anticipated that considerable quantities of indoor storage will be required. Some of the equipment will require electrical connection to equipment heaters which will require careful coordination to insure that all such equipment is properly stored. Also, periodic recorded surveillance will be required on these items to insure that the heaters are functioning and proper storage is being realized. Boxed or crated shipments that must be stored several months should not be opened upon receipt at the project unless the shipment container shows signs of damage or loss or there is reason to question the contents. Opening of the shipments may disturb any storage protection provided by the supplier and increase the possibility of contents being misplaced or lost. If the shipment container is opened for inspection, it should be reclosed in the manner as received. Protective coatings, dehumidification materials and packing should be replaced if removal is necessary. Machine surfaces should be protected with corrosion preventative material for lengthy storage. Protective materials such as "Cosmaline" may allow corrosion to develop under material when stored several months without humidity control. The surfaces should be inspected periodically for development of corrosion. If corrosion develops, the protective coating and rust should be removed and recoated with a suitable protective coating.

2. Switchyard: The top 3 feet of the switchyard earth is to be fill material of low resistivity. A source for this fill has not yet been selected.

2.1 Elevation measurements should be made on the four corners of oil circuit breaker pads and on other equipment structures. These measurements should be recorded and turned over to the powerhouse superintendent as historical data. Make measurements after equipment installation and line connections.

2.2 The switchyard ground mat resistance should be measured separately and tied together with the intake canal grid. These values should be recorded for historical data.

3. Construction of Microwave System: This is to be a furnish and install contract. Actual start and completion dates on the towers must be reported to FAA by Engineering. Resident Engineer should give that date to Engineering as soon as it is available from the Contractor.

4. Installation Tests and Data: It is important that final installation data be taken and recorded on all electrical and mechanical equipment. The data includes, but is not limited to the following:

a. Generator sole plate elevations.

b. All turbine-generator shaft alignment and run-out data.

c. Rotor clearance.

d. Wicket gate clearances, all surfaces.

e. Generator insulation and pole drop measurements.

f. Voltage regulator sensitivity and response measurements.

g. Governor response measurements, including opening and closing times and load rejection curves.

h. As-left setting of all gauges, thermometers, pressure switches, limit switches, alarm devices, etc.

i. Insulation resistance of all motors and transformers.

j. Results of tests on insulating and lubrication oils.

k. Protective relay settings.

l. All measurements made on equipment as recommended in the various construction manuals.

m. Doble test data.

n. Response times and sensitivity values of load control equipment.

o. Ground mat resistance measurements of the intake canal grid separately and tied to the switchyard grid.

The above list is not complete, but is intended to indicate in general the type of data required. The data is needed as a historical reference to be used by operating personnel to detect changes or determine the condition of equipment. The data also could be of value in the event of contract disputes that may refer to the condition or adequacy of installation.

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