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SSC Electrical Service Requirements and Option Studies

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1.0 BACKGROUND

DOE Order 4540.1B, "Utility Acquisition and Management," includes guidance for a "Utility Service Requirements and Option Study." This study is to identify all available energy supply sources and options that can meet present and planned utility requirements of the site in order to acquire the most economical and reliable service. A summary of the completed option study and recommendations must be provided to DOE Headquarters Public Utilities Branch for review and concurrence. Option studies were part of DOE's site selection process both as to the choice of site for the facility, and the method of accomplishment proposed by the State of Texas in responding to the site selection and environmental impact processes for the Dallas/Fort Worth site. A question arises as to whether or to what extent these studies must be resubmitted in connection with the procurement of the power.

2.0 STUDY REQUIREMENTS

2.1 Service Requirements

2.1.1 Present Service

N/A. No present Service

2.1.2 Future Service Requirements

This is a wholly new facility, so all loads are future loads. See Element Specification (Level 3B) for the A. C. Power Requirements for the SSC, Document #C13–00027, May 1992.

2.2 All Available Sources of Supply

2.2.1 Utility Capacity Status. Reserve margin adequacy; and major new plant additions.

See Texas response to DOE/ER–0315 "Invitation for Site Proposals for the SSC," April 1987. Response documents are Texas Proposal for the Dallas–Ft. Worth Site, Vol. 8 with Appendix, Utilities, September 1987. Further studies in great depth are contained in State of Texas, Supplemental Site Specific Data, Volume 3, Appendix A, Utilities, March 1988. These are evaluated and rated as GOOD in DOE/ER–0392, SSC Site Evaluations, p. 95, November 1988. "Ample electrical power with good stability and reliability is currently available or planned to be available at the site. ..."

2.2.2 Utility Financial Status. Planned/anticipated major plant closures, service area's economic development pattern; and ability to switch to alternate fuels.

See 2.2.1, above.

2.2.3 Available Opportunities for Changes in Service. Cogeneration capabilities; transmission services; interties; third–party financing; types of services; and rate provisions.

See 2.2.1, above.

2.2.4 On site Utility Distribution System. Adequacy and capacity to meet projected loads.

N/A. New facility, no existing on site distribution.

2.2.5 Allocations from Power Administrations. Electric power allocations available to Federal agencies.

Defer to Exeter.

2.2.6 Regulatory Climate. Federal, State and local regulatory bodies.

Defer to Exeter.

3.0 STUDY BENEFITS

Studies along these lines have been undertaken and continuously updated and made more site–specific since the initial Cornell study in the Spring of 1983. These studies include DOE/ER–0213 "Report of the Reference Designs Study Group on the Superconducting Super Collider," including Appendix C, "Conventional Facilities," May 1984; "Report of the DOE Review Committee on the Reference Designs Study for the Superconducting Super Collider," May 1984; Fermilab SSC Design, March 1984; SSC–SR–2020 "Conceptual Design of the Superconducting Super Collider," including Appendix C, "Conventional Facilities," March 1986; DOE/ER–0267 "Report of the DOE Review Committee on the Conceptual Design of the Superconducting Super Collider," May 1986. These earlier studies are the basis for the requirements in DOE/ER–0315 "Invitation for Site Proposals for the SSC," April 1987, including the 708 clarifying Questions and Answers. In connection with the site selection process, extensive and detailed Supplemental Site Specific Data for the Best Qualified List of sites were requested from the states by DOE and reviewed by DOE. Following site selection further, site–specific studies resulted in SSCL–SR–1056 "Site–Specific Conceptual Design of the Superconducting Super Collider," July 1990; and "Report of the DOE Review Committee on the Site–Specific Conceptual Design of the Superconducting Super Collider," July 1990. In addition to these studies, numerous specific studies have been carried out either in support of the studies noted above, or to address specific design questions. Many of these are listed in the SSC Report Log. Relevant studies not included in the Log will be noted where appropriate, below.

4.0 SSC SITUATION

The system requirements are specified in the Element Specification (Level 3B) for the A. C. Power Requirements of the SSC, #C13–00027, May 1992. Operational schedules are defined in the Integrated Project Schedule (IPS), and summarized in the Level 3B Specification. Backing up the Specification are unpublished studies prepared in response to the DOE ESIAT panel, and load flow analyses of various options. The latter have been carried out both in–house and, in parallel, by the electrical department of Sverdrup Corporation under an existing subcontract.

5.0 NEED FOR STUDY

See 2.2, above. There are no significant technical concerns still outstanding. Remaining issues are procurement items. A question to be resolved is whether it is sufficient to reference the option studies already made and reviewed by the DOE, or will it be necessary to write a narrative to thread through them.

6.0 SCHEDULE

The urgency of proceeding with the procurement of the grid connections is well stated. We believe that the option studies are all in hand for proceeding with these connections, particularly the extensive studies by TNRLC in connection with the site selection and the responses to ESIAT. In view of the long lead times for

environmental assessments and permitting, details of the acquisition strategy for the internal Laboratory distribution should be decoupled from the grid connection procurement.

7.0 OPTION STUDY EXECUTION

In view of the urgency of the task, as noted in Schedule #6, above, September is quite late. The option studies catalogued above are all available at SSCPO and SSCL. To expedite packaging the studies to satisfy DOE Order 4540.1B it would be helpful for the R&FM contractor to be positioned at Dallas to facilitate interaction with cognizant personnel and relevant documentation. In that way a completed option study and recommendations could be provided to DOE Headquarters Public Utilities Branch for review and concurrence in August, concurrent with issuance of the RFP for the grid connections and initial power contract.

8.0 BY SSCL

8.1 How Did You Arrive at the Distribution System Configuration Selected?

See #4, above, "SSC Situation."

8.1.1 Why Do We Need East & West Substations?

See #3, above, "Study Benefits." Also see "Invitation for Site Proposals Questions and Answers," Questions 500 and 94.

8.1.2 Why 345 kV at East and West Substations?

Sound Engineering Practice. The 345 kV level is a primary element of the distribution grid. Any outage or serious disturbance at this level would result in disruption of service over a very wide area and large customer base. Therefore, single point failures must be precluded by a much higher level of redundancy, reliability and stability than would be required for the lower voltage subdistributions. Sound engineering dictates connection at the highest voltage level available (345 kV) to achieve the high levels of reliability and stability required for Collider operation.

Energy Conservation. The SSCL system operates at an average energy usage level of approximately 250 MVA. If the system were supplied at 138 kV, the I^2R loss in the lines is a factor of 6.25 as great at 138 kV as at 345 kV.

Stability. The operating cycle of the accelerator complex causes instantaneous peak variations on the order of 160 MVA. The 345 kV grid is more stable against these variations both because of its higher voltage, and because of its greater capacity. The percentage voltage ripple seen by the 138 kV system is 2.5 times that seen by the 345 kV system.

Reliability. The higher voltage and rigidity of the 345 kV circuit relative to the 138 kV circuits makes the 345 kV grid less subject to disturbances and outages, such as lightning strikes which are a serious source of disturbances in this area.

8.1.3 Is 345 kV on the West and 138 kV on the East Feasible?

Supply voltages of 345 kV on the West and 138 kV on the East are possible, but not practicable, for the reasons cited in 8.1.2, above.

8.1.4 Should This Be Reconsidered, if the E345 kV Line is not Provided When Needed? Are Contingency Plans Identified?

The design of the distribution system allows for an outage of the East substation, allowing essential services to continue to operate, though precluding operation of the facility. Though not a desirable situation, delay of the E345 kV line would not be an insurmountable obstacle, provided it were not delayed beyond the commissioning date for the facility. The E345 kV line was projected to be constructed prior to and without reference to the advent of the SSC. Every indication from responsible officials indicates that this line remains an integral part of the strategy of the grid operator to provide reliable, stable power to the growing Metroplex on the committed schedule. It is also a part of the site commitment of the State of Texas, a condition of the Dallas/Ft. Worth site being selected by the Department. If the line were to be delayed beyond the commissioning date for the facility, the Laboratory would be forced to make do with interim power lines at lower voltage and capacity with all the associated risks and penalties noted in #8.1.2, above provided capacity exists in the existing East grid(s). However, the quality of service to existing customers also connected to these interim lines would be substantially degraded by the added load requirements of SSC facility operation. The environmental, cost and schedule implications of bringing in a lower voltage line are similar to those for the 345 kV line. The available capacity on the East 138 kV line is 40 MVA, which would have to be increased to 100 MVA, if it were desirable to use 138 kV on this side.

8.1.5 Why is There a Need for Make–Before–Break Between East and West Sides?

Shutting down and restarting major systems like the refrigerators can result in loss of operating time and of cryogenic fluids. When voltage drops to less than 80% of nameplate ratings even temporarily, most devices drop out, shedding load and operation, with restart available only after a predetermined time lapse and a set sequence of operations. Just such a short outage at the Tevatron recently resulted in serious loss of the helium inventory and contamination of the system, a serious financial and operational loss. The dual feed for the distribution system is designed to minimize the probability of such a loss by providing alternate feeds, and thus maintaining continuity of operation. Having two unphased systems at contiguous locations in the tunnel also poses the risk of discontinous grounding of equipment, and subsequent personnel safety. See "Invitation for Site Proposals, Questions, and Answers," Questions 94 and 590.

8.2 Is It Possible for One Utility to Supply the East Substation and a Different Utility to Supply the West Substation?

See 8.1.5, above. The two supply grids must be phased, as noted. In the distribution scheme for normal operation, half of the Collider power supplies are connected to each of the two Main Substations. One of the primary technical concerns when the Collider was first proposed was the arrangement of separately powered ring sectors.

> "The operation of 12 individual power supplies, regulated relative to each other to an accuracy of 100 parts per million (ppm), may prove to be a major technical challenge. It is difficult enough to regulate a single supply to 100 ppm, but to interregulate 12 supplies to such accuracy and at the same time to maintain linearity of the current ramp to 10 ppm may prove to be a major technical challenge. Considerable engineering will need to be done to ensure this type of operation." (DOE RDS Review)

The impact on this problem of dynamic phase differences on the AC side between supplies would have to be studied before such a solution could be accepted.

8.3 What Part of the Load can be Supplied by Interruptible Power? What are the Trade–Offs?

The candidates for interruptible power are the administration and general support buildings, but these are a very minor fraction of the load and interruption and would not have significant load or cost impact. The main component of the load is the cryogenic systems. For extended, planned shutdowns, these can be scaled back by allowing the magnet temperatures to drift up, but it is not practicable to shut them down on short notice for brief periods, putting the system at risk.

8.4 Does the Laboratory Consider it Advisable from a Technical, Cost, and Schedule Perspective for Utilities to be Given the Opportunity to Design and/or Construct the SSC Distribution System and/or Substation?

The answer to this question requires some clarification. If a utility has the engineering staff to design and build for its own system substations of the same capacity and complexity as the SSC substations, it could be cost effective and improve schedule to have them design and build the SSC substations. This could include the Main and Ring Substations and the 69 kV distribution. Below this voltage level, the distribution system is integral to the technical systems, so it would not be advisable for a utility to design and/or build this part of the system.

8.5 Identify the Baseline Cost Estimate Allocation Solely for Design and Construction of the Power Transmission System Extension, Switching Station and Distribution System by Work Breakdown Structure.

Extension of the power transmission systems to the site and construction of the connecting utility switching stations are to be provided at no cost to DOE, and, therefore are not included in the Baseline Cost Estimate. See SSC Invitation for Site Proposals, Questions and Answers, Question 501. The BCE for the distribution system is distributed among various facilities and the Infrastructure.

8.6 Is it Possible to Meter Power Consumption at SSC Service Areas above Ground and at Utility Singly Certificated Area Borders under Ground?

It is not possible to meter the 69 kV underground since the distribution is continuous between service areas. Introduction of 69 kV switchgear and metering below ground would be a serious safety hazard and involve extra vaults. At the Service Area the redundant feeder connections rule out metering at the 69 kV level. Metering would have to be accomplished on the secondary of all "5" site transformers. It would require three kWHour meters at each "5" site, which would then have to be summed to determine the Service Area Load.

APPENDIX

SSC ELECTRICAL SERVICE REQUIREMENTS AND OPTION STUDIES

1.0 BACKGROUND

The policies and procedures for the acquisition and management of utility services is contained in DOE Order 4540.1B "UTILITY ACQUISITION AND MANAGEMENT." Additional how–to–do information is contained in the "Utilities Planning and Management For Department of Energy Facilities" Manual. These documents provide a logical sequence of actions starting with a "Utility Service Requirements and Option Study." It is desired that the "Utility Service Requirements and Option Study" be accomplished 2 years prior to the need for the utility. This study is to identify all available energy supply sources and options that can meet present and planned utility requirements of the site in order to acquire the most economical and reliable service. A summary of the completed option study and recommendations must be provided to DOE Headquarters Public Utilities Branch for review and concurrence.

2.0 STUDY REQUIREMENTS

At a minimum, a study should identify and, where appropriate, thoroughly analyze the following:

2.1 Service Requirements

2.1.2 Future Service Requirements. New loads or revised load pattern; and changes from baseline,levels.

2.2 All Available Sources of Supply.

2.2.1 Utility Capacity Status. Reserve margin adequacy; and major new plant additions.

2.2.2 Utility Financial Status. Planned/anticipated major plant closures; service area's economic development pattern; and ability to switch to alternate fuels.

2.2.3 Available Opportunities for Changes in Service. Cogeneration capabilities; transmission services; interties; third–party financing; types of services; and rate provisions.

2.2.4 On Site Utility Distribution System. Adequacy and capacity to meet projected loads.

2.2.5 Allocations from Power Administrations. Electric power allocations available to Federal agencies.

2.2.6 Regulatory climate. Federal, State and local regulatory bodies.

3.0 STUDY BENEFITS

A properly conducted study will explore all feasible options and provide a best solution to insure adequate and economical electrical service initially and not preclude taking advantage of desired system improvement and cheaper/better utility supplies in the future.

4.0 SSC SITUATION

Utility acquisition under normal conditions is a complex process. It is even more complicated here at SSC because we operate in singly certified areas of three utilities, all utilities are interested in providing all/some of the permanent power, each utility can provide an advantage, we have a large unique load, there is more than one way to satisfy internal electrical load (distribution system), some of the system requirements and operational schedules have not been finalized, transmission lines to our desired points of delivery do not exist, funding is limited, *etc...*

5.0 NEED FOR STUDY

Much has been done to investigate the SSC utility environment, requirements and to provide solutions, however, a formal study has not been accomplished and there are some very significant concerns that have not been resolved. An RFP to acquire adequate, reliable and economical permanent electrical power for the SSC cannot be developed until those items normally contained in a study and those items peculiar to the SSC are investigated. In addition the requirement still exists to submit a summary of the option study and recommendations to Headquarters. For the above reasons it is important that an effective option study be accomplished soon.

6.0 SCHEDULE

Because of the process of environmental impact statements, obtaining a Certificate of Convenience and Necessity and long lead time for materials, it is estimated that it will take 33 months after award to complete a transmission line extension of 2 to 4 miles. The initial requirement for permanent power to support system testing is Jan 1995. To meet this timetable a contract should have been awarded by now. It is important not only that an adequate study be completed but also that it is completed as soon as possible.

7.0 OPTION STUDY EXECUTION

DOE Headquarters Organization, Resources and Facilities Management has agreed to use their contractor to complete the option study. The estimated completion date is September 1992. For them to accomplish the study the following information must be provided.

8.0 BY SSCL: 1 JULY 1992

8.1 *How Did You Arrive at the Distribution System Configuration Selected?*

Why do we need East & West substations?

Why 345 kV at East and West Substations?

Is 345 kV on the West and 138 kV on the East feasible? Should this be reconsidered if the E3345 kV line is not provided when needed? Are contingency plans identified?

Why is there a need for make before break between the East & West sides?

8.2 Is it Possible for One Utility to Supply the East Substation & a Different Utility Supply the West Substation? Explain.

8.3 What Part of the Load Can be Supplied by Interruptible Power? What are the Trade–offs?

8.4 Does the Laboratory Consider it Advisable from a Technical, Cost, and Schedule Perspective for Utilities to be Given the Opportunity to Design an/or Construct the SSC Distribution System and/or Substation?

8.5 Identify the Baseline Cost Estimate Allocation Solely for Design and Construction of the Power Transmission System Extension, Switching Station and Distribution System by Work Breakdown Structure.

8.6 Is it Possible to Meter Power Consumption at SSC Service Areas above Ground and at Utility Singly Certificated Area Borders under Ground?