MASTER

AN ASSESSMENT OF RESEARCH DIRECTIONS
FOR HIGH VOLTAGE DIRECT CURRENT
POWER SYSTEMS

Quarterly Technical Progress Report
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ABSTRACT

The activities reported herein cover a variety of topics which were investigated over the previous quarterly reporting period.

QUARTERLY REPORT

This is the ninth quarterly report under Contract No. DE-AC02-78ET29185 "An Assessment of Research Directions for High Voltage Direct Current Power Systems." The objective of the study, as quoted from the statement of work in the original proposal, is "to identify hardware developments and, where appropriate, system applications which can exemplify cost and operational advantages of integrated ac/dc power systems."

MICROPROCESSOR CONTROLLED CURRENT INJECTION TECHNIQUES

A graduate student, Gary Dreifuerst, has been working on a laboratory prototype of a new technique for the cancellation of harmonic currents as produced by HVDC converters. It employs a microprocessor controlled current injection technique, with phase locked loops serving as the harmonic current detection means. Magnitude and phase information is used to control an ac-dc-ac converter which acts as the harmonic current source.

The circuitry operates with low losses and fast response times, and could be applicable for 11th and 13th harmonic filtering applications. It appears to be somewhat vulnerable to transient overvoltages accompanying current change orders. This may diminish some of the advantage of low losses by requiring a higher transient overvoltage rating than originally envisioned.

Experimental work on this system has been undertaken. The rectifier current magnitude control loop has been tested and found to perform as designed. The protection system has likewise been tested, and the microprocessor-based controller appears to properly shut the system down in response to a variety of simulated failure modes. The inverter phase controller has been partially tested; full power testing is yet to be done.

Dr. Long and graduate student, G.R. Dreifuerst, visited Bonneville Power Administration to discuss this project with them. There has been long-standing interest within BPA in alternate filtering techniques, especially in view of the losses associated with existing passive filters. It was explained that while the concept is experimentally credible, there remains a transient overvoltage problem associated with current change orders. Further work in this area will be undertaken before abandoning the concept.

DIGITAL COMPUTER MODELING OF HVDC SYSTEMS

Studies are underway examining more efficient ways to utilize the Electro-magnetic Transients Program (EMTP) for the modeling of HVDC converters, control systems, and complete transmission systems. At the present time the program is available on the Harris machine in the Engineering Computing Laboratory. This is not effective for research activities, as the machine receives

heavy student use during the academic year. Dr. Lasseter is investigating the establishment of a link to the DEC VAX/780 computer in the Physical Sciences Laboratory. This machine could then become our primary research tool, affording greatly increased accessibility.

LITERATURE SURVEY

Papers from CIGRE Study Committee 14 has been reviewed for technical content. Of special interest is Paper 14-09 entitled "The New 2000 MW Interconnection Between France and the United Kingdom" by S.C. Goddard, et.al. They refer to severe voltage regulation problems on the English side requiring very large amounts of variable reactive compensation. This emphasizes the kinds of problems that occur at the interface of ac-dc systems, reinforcing the need for additional studies of this topic.

AMERICAN ELECTRIC POWER SYSTEM STUDY

A meeting was held at AEP headquarters to discuss the status of the proposed DOE-sponsored system study. Interest appears to be increasing as the system planning group nears completion of its relocation and reorganization in Columbus, Ohio. Other groups within AEP also appear to be supportive of the study. A decision is expected to be forthcoming from AEP within the next two months.

HIGH VOLTAGE DIRECT CURRENT CIRCUIT BREAKER PROTOTYPE

An extensive amount of time was devoted to reviewing proposals for the laboratory investigation and field testing of a dc circuit breaker. It is inappropriate to review any of the details of the proposals herein other than to comment that it appears evident that further research into the fundamentals of high voltage direct current interruption techniques is obligatory.

This brief paragraph does not do justice to the time spent reviewing the proposals.

LONG RANGE-PLANNING ACTIVITY

A meeting was held between Dr. Long and Dr. Lasseter and DOE personnel to examine alternatives and priorities for further DOE/EES HVDC projects. Briefly, three major components were identified:

1. Newly initiated system studies--these include dc circuit breaker studies, a long-distance underground system study (Philadelphia Electric Study), and a tightly interconnected system study (American Electric Power Study).

2. Digital computer modeling studies--these are advancements in modeling techniques principally using the BPA EMTP computer program. In addition, benchmark studies will be undertaken relating to high impedance ac systems, insulation coordination, smoothing reactor design, static VAR systems, and dc circuit breaker-system transient interactions.

3. A symposium for system planners--this would build on the successful conference held in Phoenix, Arizona in March, 1980, excepting that emphasis would be placed on obtaining many more papers relating to ongoing HVDC-related system studies being conducted by utilities.

Further documentation expanding on the above topics will be forthcoming.

WORK STATEMENT FOR THIS QUARTER

All requirements of this contract have been compiled with to date. Dr. Long has been devoting about 30 percent of his time to this contract, and is continuing the services of a graduate student. Dr. Lasseter is now devoting 25 percent of his time to this contract. Travel expenditures are above projections in the contract, but this is counterbalanced by computer costs being below the projections. Some computer costs are being incurred in connection with Dr. Lasseter's research.