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 eighth 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."

IEEE CONFERENCE ON OVERVOLTAGES AND COMPENSATION ON INTEGRATED AC-DC SYSTEMS

The above mentioned conference was held in Winnipeg Manitoba July 8-12, 1980. The program is attached. As with all such conferences, the papers varied in quality and in content. Papers dealing with problems of actual operating systems tended to be the most interesting, especially as they included field data rather than just computer results. Probably the best paper was presented by John Bowles of Rousseau, Sauve, and Warren Consultants. It dealt in depth with the need for an understanding of the ac system, especially relating to high impedance systems (low short circuit ratio). CIGRE has established a working group on this topic, and it is expected to have increasing impact on future HVDC systems.

In addition, the DC Subcommittee of the IEEE T & D Committee has established a new working group to look at this problem. The chairman is Dr. P.C.S. Krishnayya of IREQ. It is believed by this investigator that discussions with Dr. Krishnayya are necessary in order to ascertain whether this topic is appropriate for detailed studies supported by EES. There seems no doubt that major attention is beginning to focus on this topic and that timely research support might prove extremely fruitful.

IEEE SUMMER POWER MEETING

This meeting was held in Minneapolis on July 13-18, 1980. In addition to two technical paper sessions there were a number of committee meetings relating to HVDC power transmission. Of special note is the reorganization of the DC Subcommittee into eight working groups. This investigator is chairman of the working group on multiterminal systems, which meshes well with the ongoing activity (previously reported) in developing a HVDC System Study RFP.

It appears that the IEEE is going to sponsor a new award--the Uno Lamm Award for contributions to the advancement of HVDC technology. It is named for the ASEA engineer who pioneered the modern-day mercury arc valve that brought dc to acceptability in the 1950s. ASEA is providing the funding support for this award, and this investigator has been asked to sit on the award committee.

COMPRESSED GAS INSULATED TRANSMISSION SYSTEMS

A review meeting for the Westinghouse-IREQ system study was held in Montreal. The objective of this study is to examine the effects of normal and abnormal dc system operation on the CGIT cable. Particular emphasis is placed on determining proper BIL levels.

The studies have not progressed at the expected rate. This has been documented in other correspondence and will not be elaborated on here. A supplemental proposal has been received from the team which would complete the originally envisioned study and add a useful digital computer study. This investigator has briefly reviewed the proposal and expects upon closer scrutiny to recommend that it not be funded.

A second set of meetings was held at DOE to make a comparative judgment between the Westinghouse-IREQ and Alcoa-GE project teams. It was evident that the latter is much further along in research leading to a practical CGIT system, although the system study and voltage breakdown work of the former is quite valuable.

EPRI PROPOSAL EVALUATION

An extensive amount of time was spent reviewing proposals relating to HVDC research which had been submitted to EPRI. Recommendations were forwarded to EPRI and a contract award has been made. There has been no indication that further involvement in this particular study is being considered.

DIGITAL COMPUTER STUDIES

As previously reported, Dr. R.H. Lasseter has begun digital computer studies of HVDC systems under 25 percent support from this contract. The following abstract indicates his analysis of his proposed research activity.

Power system simulation has been an important tool for power systems planning and analysis since the early 1920s. With the advent of modern high power AC/DC converters and DC transmission there was a need for AC/DC simulators (1). These simulators required the addition of AC/DC converters and controls systems to the basic power system simulators. Rather than model the control system most AC/DC simulators use the actual control system. The resulting simulators have been effective tools but limited to the controls available to the simulator. Of the major AC/DC simulators in North America the Wisconsin simulator has ASEA's control built in 1960; General Electric's simulator has the same ASEA controls plus their own; while IREQ has a more current ASEA control and an older General Electric control built in the early 1970s. There are no facilities where AC/DC systems from different manufacturing can be studied with the most current controls. Basically, this is due to the cost of controls and the fact the designs are being refined yearly. The going price for a state-of-the-art AC/DC simulator with General Electric controls is 2 million dollars with the problem of obsolete controls within a few years.

With the availability of high speed digital computers digital simulation of electrical power systems became a practical alternative to model type simulators. One of the most sophisticated and widely used programs is the Electromagnetic Transients Program (EMTP), which was developed by Bonneville Power Administration (BPA), over the last 15 years. A major breakthrough in 1976 was the addition of control models to the EMTP. This allowed power system transients, control systems, and AC/DC converters to be modelled simultaneously resulting in an all digital modeling capability to simulate AC/DC systems. To date there have been AC/DC system studies on special problems using the EMTP. (2-4) These runs have used main-frame computers to simulate dynamics of 10-1000 milliseconds.

It should now be possible to replace AC/DC model simulators with a digital simulator using the EMTP. This can be achieved by using the DEC VAX/780 computer for short time simulation studies. These studies would be chosen to simulate actual system data where available or data from the Wisconsin AC/DC simulator if the actual data was not available.

- 1) J.E. Hudson, E.M. Hunter, D.D. Wilson, "EHV-DC Simulator," IEEE PAS, Vol-85, Nov. 1976.
- 2) R.H. Lasseter, "Transient Overvoltages on the Neutral Bus of HVDC Transmission Systems," IEEE PAS, 1978.
- 3) R.H. Lasseter, "Electrical Characteristics of Long, Overhead HVDC Transmission Lines," IEEE, PAS, 1979.
- 4) H.W. Dommel, "Analyzing Transients in AC/DC Systems with the BPA Electromagnetic Transients Program," Proc. IEEE, 1980.

WORK STATEMENT FOR THIS QUARTER

All requirements of this contract have been complied 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 projections. Some moderate computer costs are anticipated over the next quarter in connection with Dr. Lasseter's research.