



*Proceedings of the*

# **AMERICAN POWER CONFERENCE**

## **Volume 39**

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## FOREWORD

This volume contains the papers and addresses presented at the thirty-ninth annual meeting of the American Power Conference held in Chicago on April 18-20, 1977. The Conference is an independent forum open to all persons interested in the generation, transmission, distribution or utilization of power, irrespective of society affiliations. It is sponsored by Illinois Institute of Technology with the cooperation of the universities and societies listed on the opposite page.

In these days of dwindling oil and natural gas supplies, increased attention is being directed toward the use of coal and uranium as primary sources of energy. Extraction and utilization of these fuels in an efficient and environmentally acceptable manner is a high-priority national goal. So, also, is conservation and the development of alternative energy sources. The Conference seeks to play a role in achieving these goals by providing an open forum where all segments of the power industry can meet for full and frank discussion. Academic sponsorship encourages this and permits the freest possible exchange of ideas, ranging from the technical through the economic and into the social aspects of the subject.

Papers presented at the Conference are by invitation. They are selected by committees representing the various fields of activity, chosen from the cooperating universities and societies, industry, and government. Suggestions for papers are always welcome and will be given careful consideration if received by September 15 of the year immediately preceding the Conference.

The sponsors of the Conference wish to thank all those companies and individuals who have contributed toward the success of the meeting. The help of the Division Chairmen, the Session Chairmen and Cochairmen, the University and Society Representatives, the Industry Committee, the Program Committee, the Editorial Committee, and all other committees is gratefully acknowledged. A special debt of gratitude also goes to the Editor and to the many Authors whose contributions appear in the Proceedings. Without their cooperation, the Proceedings could not be published.

R. A. BUDENHOLZER  
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## DANIEL A. SULLIVAN

### 1897-1977

It is with deep regret that we announce the death of Dan Sullivan, who served as Chairman of the Industry Committee of the American Power Conference for many years. He was one of the earliest supporters of the Midwest Power Conference, from which the American Power Conference evolved, and his efforts contributed greatly to the success of the Conference as you know it today.

In addition, he was a Service Annuitant of Commonwealth Edison Company of Chicago; Vice President, Society of American Military Engineers; Founder and former Executive Director of the Institute for American Strategy; Founder and Past President of the Midwestern Air Pollution Prevention Association; National Coordinator of the Electric Industry's Wartime Aid Program; Former Secretary, Chicago Civil Defense Corps; and Director, National Military Industrial Conferences.

Among the many honors bestowed upon him are: Presidential Medal of Merit, awarded by President Truman for "Outstanding Fidelity and Meritorious Conduct in Aid of the War Effort Against the Common Enemies of the United States and its Allies in World War II;" Honorary Life Member, Society of American Military Engineers; Gold Medal Award, Society of American Military Engineers for Distinguished Service to the Engineering Profession; Meritorious Service Citation, Secretary of the Navy, 1961; Meritorious Service Citation for Outstanding Service to the Army, Secretary of the Army; Commendation for Outstanding Service, U. S. Navy, Bureau of Yards and Docks, June 1947; and a Citation for Directing the Electric Power Wartime Aid Program from Edison Electric Institute.

Through the many contacts he had made over the years, Dan was able to enlist many of the important and interesting speakers who have appeared at our Opening Meetings, Luncheons, and All Engineers Dinners.

He was a longtime personal friend of many who have attended the Conference, as well as to its Officers and Committee members. He will be sorely missed.

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Thirty-Ninth Annual Meeting

The Palmer House

April 18, 19, 20, 1977

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## **HYDROELECTRIC SESSION**

### **HYDROELECTRIC POWER—THE GRAND COULEE THIRD POWER PLANT**

Chairman: Adolph J. Ackerman, Consulting Engineer, Madison, Wisconsin

Cochairman: John W. Forster, Assistant Manager, Hydroelectric Design Division, British Columbia Hydro & Power Authority, Vancouver, BC, Canada

## **ELECTRICAL SESSIONS**

### **ELECTRICAL I—SYSTEM PLANNING**

Chairman: Warren W. Walkley, Manager, Technical Analysis & Marketing Support, General Electric Company, Washington, D. C.

Cochairman: James E. Van Ness, Professor of Electrical Engineering, Northwestern University, Evanston, Illinois

### **ELECTRICAL II—PCB REPLACEMENT**

Chairman: Robert D. Camburn, Senior Projects Engineer, Gilbert/Commonwealth, Jackson, Michigan

Cochairman: James J. Skiles, Professor of Electrical and Computer Engineering, University of Wisconsin, Madison

### **ELECTRICAL III—OPERATION AND RELIABILITY**

Chairman: W. A. Lewis, Consulting Electrical Engineer, Systems Control, Inc., Sunnyvale, California

Cochairman: E. Keith Stanek, Associate Professor, Department of Electrical Engineering, West Virginia University, Morgantown

### **ELECTRICAL IV—TRANSMISSION I**

Chairman: R. X. French, Assistant Manager, Electrical Department, Sargent & Lundy, Chicago

Cochairman: Sidney Bass, Director, Electronics Research, IIT Research Institute, Chicago

### **ELECTRICAL V—DISTRIBUTION**

Chairman: William E. Keefe, Senior Application Engineer, General Electric Company, Oak Brook, Illinois

Cochairman: M. S. A. A. Hammam, Professor of Electrical and Computer Engineering, Clarkson College of Technology, Potsdam, New York

### **ELECTRICAL VI—TRANSMISSION II**

Chairman: John H. Cronin, Advisory Engineer, Westinghouse Electric Corporation, East Pittsburgh

Cochairman: Clifford C. Mosher, Professor of Electrical Engineering, Washington State University, Pullman