



Electrical System Studies

INTRODUCTION

Burns & McDonnell's experienced professionals provide electrical systems planning and design services to improve the safety and the reliability of electric power systems. The planning, design and operation of each power system requires comprehensive analyses, which assess current performance as well as examine the effectiveness of alternatives for system improvement and expansion. The Electrical System Studies Department offers systems modeling, short circuit analysis, power flow analysis, harmonic analysis, reliability analysis, dynamic and transient analysis, motor starting/acceleration studies, protective device coordination, and power factor correction. Our approach and experience provides value-added engineering services for your company beyond traditional power systems analysis and design.

RECENT PROJECTS

GENERAL MOTORS SHORT CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDY

Burns & McDonnell conducted a Short Circuit and Protective Device Coordination Study for General Motors' Worldwide Facilities Group. The primary purpose for this study was to be able to coordinate plant system operations based upon the available electric supply arrangement and identify all electrical system deficiencies that require correction. A secondary purpose for this study is to update and standardize the available site documentation for protective device coordination and equipment fault duties.

Burns & McDonnell has performed this study at the following four sites: Fairfax Assembly Center in Kansas City, Allison Transmission plant in Indianapolis, Arlington Assembly Center in Texas, and Mansfield Metal Fabrication Plant in Ohio.

Burns & McDonnell performed electrical system data gathering of the electrical system at the sites. A model was then developed from utility interconnect voltage to the 480V distribution to facilitate the execution of the short circuit and protective device coordination studies.

We have the practical experience and expertise to optimize performance of your power system

An Equipment Evaluation Report was prepared that indicates which equipment “Failed” or was “Marginal” with respect to being rated for the worst-case fault currents.

For each substation room, a layout drawing was prepared that shows the general arrangement of equipment within the room with an equipment elevation drawing showing the layout of the transformers, breakers and protective devices. A one-line diagram of the electrical equipment connectivity was also prepared which shows all relevant electrical devices. Time-current curves (TCC’s) were provided for each substation, showing the coordination of the protective devices. Equipment ratings and additional system information were provided for each substation room.

CITY OF ANAHEIM, CALIFORNIA

Burns & McDonnell conducted a comparative analysis of the utility industry, comparing the engineering and operations policies and procedures among a broad cross-section of municipal utilities, investor-owned utilities, and electric cooperatives. Comprehensive surveys were prepared and issued to forty utilities. Twenty-three utilities agreed to participate and subsequently provided a response.

The following engineering and operations topics were addressed in the survey:

Construction and Material Standards Electric Power System Data:

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|--------------------------|----------------------------|
| System Planning | System Communications |
| System Operation | System Maintenance |
| System Inventory | Emergency Restoration Plan |
| Power Quality Assessment | Work Order Process |
| Organizational Structure | Capital Budgeting |

ORANGE COUNTY SANITATION DISTRICT

Burns & McDonnell was contracted by Carollo Engineers to provide assistance in a comprehensive system study for two wastewater treatment plants for Orange County. Burns & McDonnell’s scope included development of a database for maintaining equipment ratings and maintenance information. This database was designed to transfer equipment information into the ETAP load flow and short circuit analysis programs. Information shared between ETAP and this custom-designed database allowed reports to be generated that compared equipment ratings with system parameters. Burns & McDonnell’s scope also included a reliability study using the Fault



Our approach and experience provides value-added engineering services



Tree reliability analysis software, evaluation of the protective device coordination throughout both plants and a neutral grounding study. Burns & McDonnell also was contracted to review Carollo's short circuit, load flow, motor starting, and harmonics studies. These studies included analysis of the existing electrical systems, recommendations for improvements, analysis of the improved scenarios, and recommendations for future planning through the year 2020.

CORN BELT POWER COOPERATIVE

Burns & McDonnell developed a short-circuit study database in Aspen, performed a short circuit study and calculated relay settings for Corn Belt's 161-kV and 69-kV transmission systems. Following the initial study, Burns & McDonnell was contracted to provide additional relay settings for several new substations.

Burns & McDonnell also prepared a Facilities Rating Document for Corn Belt to comply with NERC standards requirements. This document described the ratings for major transmission system components and the methodology used to determine equipment ratings.

Corn Belt has continued to use Burns & McDonnell to trouble-shoot relay coordination problems and to provide miscellaneous system studies as required.

SOUTHERN ILLINOIS POWER COOPERATIVE (SIPC)

Burns & McDonnell provided a review of SIPC's 161-kV, 138-kV and 69-kV system relay settings as a total project for interface with the neighboring utilities, three distribution cooperatives and two municipals. The review included relays for the transmission lines, transmission substation buses, transmission substation transformers, and transmission substation capacitor banks. High side fusing of transformers at the distribution substations was reviewed for proper coordination with upstream relaying. Recommendations for improved coordination were provided with Burns & McDonnell's final report.

SIPC continues to use Burns & McDonnell to provide further protective coordination of new facilities as appropriate.



CITY OF WAMEGO, KANSAS

Burns & McDonnell prepared a long-range plan of the City's electrical distribution system needs. A condition assessment of the existing distribution system was performed as part of the work. The final plan included development of practical and economical means of serving anticipated future load, recommendation of system improvements and preparation of construction cost estimates for the recommended work.

LAWRENCE LIVERMORE NATIONAL LABORATORIES (LLNL)

Burns & McDonnell prepared an Electrical Utilities Master Plan for LLNL. This work included a condition assessment of the electrical system, a load forecast, power flow analysis of the existing system and review of the SCADA and metering systems. Expansion plans for the next five years and long-term plans for the next 20 years were evaluated. Recommended modifications and improvements were identified for LLNL's consideration.

TEXAS-NEW MEXICO POWER COMPANY (TNMP)

Burns & McDonnell was retained by TNMP to perform a reliability study regarding the quality of service to the City of Sanderson, Texas. The 69-kV transmission line from Fort Stockton to Sanderson, the distribution substation in Sanderson, the 4-kV distribution system in Sanderson, were compared with industry standard values. Recommendations were proposed to improve the system reliability, and construction cost estimates for implementation of the recommendations were prepared.

FLORIDA KEYS ELECTRIC COOPERATIVE (FKEC)

Burns & McDonnell prepared a long range planning study for FKEC to analyze the performance of the existing transmission and distribution systems, and to make recommendations for system modifications through a 20-year planning period. A system aging study was performed to aid FKEC in determining an economical replacement program for system components over the 20-year planning horizon. The 138-kV transmission system and the 24.9-kV distribution system were reviewed, load flow cases were prepared and system improvements were recommended. Construction cost estimates were prepared for the recommended alternatives.

DEPARTMENT OF DEFENSE JOINT PROGRAM OFFICE FOR INFRASTRUCTURE ASSURANCE

Burns & McDonnell was contracted to provide a site assessment of McConnell Air Force Base in Wichita, Kansas. Burns & McDonnell evaluated the regional and local area electrical systems and the on-base distribution system. Power flow analysis of the regional transmission system was reviewed and an assessment of the reliability of the system was provided. A condition assessment of the on-base distribution system was performed. An assessment of the reliability of the local area and on-base distribution system was provided. Failure mode and effect analysis was used to document reliability recommendations. Cost estimates were provided for the various improvement alternatives.

CITY OF ANAHEIM, CALIFORNIA

Burns & McDonnell was contracted to provide a comprehensive Electrical System Planning Study. The scope included establishment of planning criteria and reliability guidelines; a condition assessment of the City's 66-kV transmission system and 12-kV distribution system; a load growth forecast; a land use forecast; power flow and short circuit studies projected out 20 years in 5-year increments; reliability studies utilizing failure mode and effect analysis; a departmental organizational structure review; a communications network review; an operations and maintenance review; and a construction standards and material management review. The findings and recommendations were required to be presented to the City Council and the Anaheim Public Utilities Board.

MUSCATINE POWER & WATER

Burns & McDonnell provided transmission-planning services to develop a ten-year plan for Muscatine Power & Water's electric power system. As part of this project, Burns & McDonnell developed power system models, completed power flow analyses to identify transmission system limitations, developed and evaluated improvement and expansion alternatives and analyzed through-flow and import and export capability.

SOUTHERN MARYLAND ELECTRIC COOPERATIVE

Burns & McDonnell was contracted by Southern Maryland Electric Cooperative to engineer, procure and construct electric facilities to utilize two existing diesel engine-generators owned by the Charlotte Hall Veterans Home for peak sharing. As part of this project, Burns & McDonnell completed engineering analyses to examine each application's compliance with minimum transfer times established by



the National Electric Code and National Fire Protection Association. Each application was examined to confirm that the design of electric facilities would provide transfer capability from normal to emergency power for essential electrical systems within ten seconds after loss of normal power with local generation initially paralleled with commercial power.

MANFIELD DEVELOPMENT, MALAYSIA

Retained as Banker's Engineer for the Kulim Hi-Tech Industrial Park, Malaysia. Burns & McDonnell completed an independent technical assessment of the developer's design criteria, conceptual design, technical specifications and contract documents for the Kulim Hi-Tech Industrial Park, Malaysia.

CITY OF GARDNER, KANSAS

Burns & McDonnell provided planning services to develop long range plans for the City of Gardner's electric distribution system. Burns & McDonnell reviewed the utility's planning criteria, developed area load forecasts, developed comprehensive computer models of the existing system, analyzed the system's short and long range requirements, and developed a recommended improvement and expansion plan. An important part of this project was the completion of a "fast-track" study to identify the immediate system needs to accommodate the addition of a new high school. Burns & McDonnell developed electric load profiles for the new high school based on computer modeling of the building's heating, air-conditioning, lighting and auxiliary loads, design and construction, and occupancy. Power flow analyses were completed in order to examine the effectiveness of system improvements. Burns & McDonnell also developed computer maps, reviewed sectionalizing practices, and developed construction and material specifications for underground electric service extensions.

LEE COUNTY ELECTRIC COOPERATIVE, NORTH FORT MYERS, FLORIDA

Burns & McDonnell completed an independent technical assessment of the utility's transmission and distribution systems and related engineering and operation procedures. The purpose of each assessment was to determine the present condition and operations of each system, make comparisons of engineering and operations policies to current industry standards and utilities of similar size in the areas of system planning, design, construction, operation, and

maintenance of transmission, distribution and substation facilities. Recommendations consistent with improving the overall reliability of the utility's electric power system were provided.

**KNOXVILLE UTILITIES BOARD,
KNOXVILLE, TENNESSEE**

Knoxville Utilities Board retained Burns & McDonnell to develop an electrical transmission and distribution master plan to provide a guide for orderly development of their electric power system. The development of the master plan involved areas of system planning. Burns & McDonnell reviewed the utility's planning criteria, developed area load forecasts, developed comprehensive computer models for the existing power system, analyzed the system's short and long-range requirements, and developed a recommended plan for system improvement and expansion. Since the present and future design of this power system greatly affects this electric system's overall reliability. Burns & McDonnell completed technical reviews of the existing system to provide reliability improvements. Additionally, the utility's existing design practices and standards related to sectionalizing, lightning protection and the application of voltage regulation equipment were reviewed.

**KOCH REFINING COMPANY,
CORPUS CHRISTI, TEXAS**

Burns & McDonnell performed comprehensive power system analyses to support development of a long-range electric utility plan for Koch Refining Company's East and West Refineries located in Corpus Christi, Texas. Power flow and short circuit analyses were completed to assess the performance of the existing electric power system and examine the effectiveness of alternatives for system expansion. Additional technical studies were completed to further examine specific improvements including harmonic analysis, reliability analysis and protective device coordination. Comprehensive reliability analyses based on probability techniques were completed for both refineries. Value-based system planning was used to justify reliability improvements. Opportunity costs were assigned to various levels of reliability based on the dollar value associated with an electrical outage. The investment cost required to eliminate the outage was compared to the cost of the lost opportunity to allow justification of the reliability-based improvement.



Koch Refining Company continues to use Burns & McDonnell for updates to the system models and for miscellaneous system studies and protective device coordination reviews.

TOP O'MICHIGAN ELECTRIC COMPANY

Burns & McDonnell developed an electric system long-range plan which included development of planning criteria, documentation of our study methodology; development of area load forecasts; computer modeling of the existing transmission and distribution systems; technical evaluation of the existing transmission and distribution system; development of exploratory plans; and technical and economic evaluation of exploratory plans. Burns & McDonnell's compared exploratory plans to provide the recommended long-range plan. Top O'Michigan's short, intermediate and long-range demand levels were estimated to be 80, 125 and 168 MW, respectively. This provides an indication of the relative size of the electric power system.

CITY OF OTTAWA, KANSAS

Burns & McDonnell developed an electric system master plan which included development of planning criteria, documentation of our study methodology; development of area load forecasts; computer modeling of the existing distribution system; technical evaluation of the existing distribution system; development of exploratory plans; and technical and economic evaluation of exploratory plans. Burns & McDonnell's compared exploratory plans to provide the recommended long-range plan. Economic analyses of power supply options were also completed. The City's short, intermediate and long-range demand levels were estimated to be 32.9, 36.4 and 39.4 MW, respectively. This provides an indication of the relative size of the electric power system.

NAVY BASE ELECTRIC UTILITY PRIVATIZATION STUDIES

Burns & McDonnell conducted a very large utility privatization study for the US Navy. The purpose of the study was to determine and document general utility system condition, system replacement cost, depreciated value, upgrade cost requirements, and equipment needs for the purpose of privatizing the government assets. Work included site inspections, employee interviews, map and document reviews, electrical equipment inventory, and a condition assessment. Reports included site condition assessment, equipment inventory, operating performance, maintenance program, system reliability, capacities, noted deficiencies and code violations, safety violations,

recommended improvements, and a list of documents/electrical maps reviewed.

LIGHT RAIL TRAIN SPECIAL CONCERNS STUDY

The Minnesota Department of Transportation proposed a Light Rail Train System that required the relocation, replacement and/or modification of major downtown 15-kV feeders owned by Northern States Power (now part of Xcel Energy). Burns & McDonnell was retained to mediate technical and cost issues between the parties. Work performed included an analysis of potential vibration effects resulting from light rail train operation on the existing under street utility structures, a review with comments on the need for cathodic protection of the utility plant, review of applicable codes, past practice and any other items deemed pertinent to recommend safe working clearances, and development of an estimate of costs necessary to relocate and accommodate NSP's facilities in the downtown area.