



# Design/Build Services

## INTRODUCTION

Design/Build, Turnkey, Engineer/Procure/Construct (EPC), Engineer/Furnish/Install (EFI) . . . no matter what you call it, it has become a popular method to perform work. Burns & McDonnell has an excellent record of performance using the Design/Build method. By employing a comprehensive delivery structure, Design/Build leverages owner resources; reduces risk and coordination issues; shortens project cycle times; provides a convenient and efficient single point of contact; increases cooperation among engineers, equipment suppliers and construction resources; and provides an opportunity to introduce new design and construction concepts.

Typical reasons the Design/Build delivery method is chosen include:

- Owner resources are limited
- Schedule constraints do not allow time for Design-Bid-Build
- Owner is unfamiliar with required technology
- Financing structure requires strong indicative or firm price
- Third party, such as a customer or interconnector, is driving the project need
- Owner desires to lock-in equipment and construction resources and pricing early in the project cycle
- Desire for engineering and construction teams to participate in early commitment with regard to permitting, land requirements, and strategic procurement
- Complicated construction sequences due to weather and outage restrictions require strong scheduling and outage planning commitment



Burns & McDonnell offers clients a long and impressive history of delivering responsive, high-quality substation and transmission line design; and construction services around the world. For more than 112 years, the mission of the employee-owners at Burns & McDonnell has been to “make our clients successful”. These qualifications demonstrate that success.

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## COMPREHENSIVE SERVICES

As a full-service provider Burns & McDonnell self-performs the bulk of the tasks required to comprehensively deliver its projects. With our extensive network of construction partners, our Team is capable of delivering the following:

- Routing and Permitting
  - Public Involvement
  - Expert Testimony
- Real Estate Acquisition
- Engineering and Design
- Procurement Services
  - Purchasing
  - Expedition
  - Inspection
  - Materials
- Quality Control/Assurance
- Schedule Control
- Cost Control
- Constructibility
- Risk Management
- Document Control and Management
- Construction Services
  - Safety
  - Construction Management
  - Field Engineering
  - Outage Planning and Coordination
  - Permitting & Environmental Compliance
- Community Relations
- Testing and Commissioning



*These activities are extensively linked and their success is dependent upon each other.*

Burns & McDonnell's execution philosophy entails developing and maintaining an integrated approach focused on meeting stakeholder requirements as well as the needs, goals, objectives and expectations of the Project. We coordinate and complement the activities of the Project Team while remaining focused on the need to identify, mitigate and resolve issues as early as possible. The Burns & McDonnell Team applies the knowledge, skills and processes that will guide the Project Team through project completion.

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## RECENT PROJECTS

### **XCEL ENERGY**

Burns & McDonnell was selected by Xcel Energy as EPC Contractor for their Buffalo Ridge Incremental Generation Outlet (BRIGO) Nobles – Fenton Transmission Line. The project consists of 23 miles of 115-kV transmission line design, procurement, and construction.

Included in the EPC scope was coordination of ROW acquisition; procurement of all structures, assemblies, conductor, detailed transmission design, construction management, construction, permitting; and overall project management.

Burns & McDonnell subcontracted construction, aerial and ground surveying, and geotechnical investigations. Right-of-way acquisition was coordinated by Burns & McDonnell and performed by Xcel Energy. All other services were self-performed including transmission design, permitting, construction management, procurement, scheduling, and cost control.



### **XCEL ENERGY**

To provide for wind generation outlet in southwest Minnesota, Xcel Energy committed to provide transmission and substation facilities for 825MW. Burns & McDonnell acted as the Prime EPC Contractor to provide the majority of these facilities. The Project included two green-field substations (Nobles County and Fenton), three substation expansions (Chanarambie, Lakefield Junction, and Split Rock), 66 miles of 345-kV transmission line, 20 miles of double circuit 345/161-kV transmission line, 28 miles of 115-kV transmission line, and 11 miles of double circuit 115/69-kV transmission line.

Burns & McDonnell's scope of services included right-of-way acquisition, environmental permitting, design, equipment and material procurement, and construction of transmission lines and substations. Xcel Energy self-performed the site work and foundation construction in support of the project. The construction lasted nearly two years and required substantial outage coordination for the substation modifications and double-circuiting with existing transmission lines.



### **ALABAMA POWER**

As part of a plan to improve reliability to electric power customers in Birmingham, AL, Alabama Power Company planned a new substation located in an urban neighborhood to provide an additional

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distribution source to the area. Burns & McDonnell partnered with E.P. Breaux to design and build the Alabama Power 18<sup>th</sup> Street Substation. In addition to the substation itself the project also included the installation of two 115-kV underground high pressure fluid filled (HPFF) line segments to tie into an existing underground line located about two blocks from the new station, the installation of 15-kV ductbanks between the new station and existing overhead lines, and the installation of two overhead fiber-optic circuits to connect into the existing utility communications system. Major equipment furnished and installed inside the substation included one 115-13.8-kV power transformer, two 115-kV circuit breakers, one control house, protective relay panels, 15-kV switchgear, and a pumping plant for the HPFF lines. Two existing office buildings were demolished to make way for the substation and a decorative concrete wall was approved by the neighborhood association and built to enclose the substation equipment.

Burns & McDonnell's scope of services included permitting, design, equipment and material procurement, construction management and partial electrical testing services. Alabama Power furnished the 115-kV circuit breakers and furnished and installed communications equipment and the 115-13.8-kV power transformer. Alabama Power also performed electrical testing of control and protective relay systems and was responsible for commissioning and energization of the new facility. The Burns & McDonnell/E.P. Breaux Team utilized local contractors to build the decorative wall, install landscaping, and perform excavation activities associated with the installation of the underground 115-kV lines and the 15-kV ducbanks. Prysmian was subcontracted to design and install the 115-kV HPFF lines and the pumping plant. Construction lasted approximately 10 months.

### **AMERICAN ELECTRIC POWER**

Since 2004, Burns & McDonnell has allocated an experienced team to service American Electric Power (AEP) in Texas, Oklahoma, Arkansas and Louisiana.

Burns & McDonnell provided engineering, procurement services using AEP's INDUS system, construction support, and project management support services related to over 200 substation and transmission projects which includes:

- 345-kV/138-kV substations for wind farm inter-connection
- 138-kV and 345-kV new substations
- 15-kV, 69-kV, 138-kV and 345-kV breaker replacements
- 69-kV, 138-kV and 345-kV line panel replacements



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- Replace legacy RTU with new D20 RTU systems
  - Added new RTU systems to rural substations
  - Cap bank additions on 69-kV and 138-kV systems
  - Static Var Compensation equipment additions on 138-kV and 345-kV systems
  - Reactive Bank additions on 138-kV and 345-kV systems
  - Added a 35-kV distribution bay and its associated transformer and breakers
  - Added 35-kV distribution feeders to existing bays
  - Replaced transformers and upgraded associated bus, switches and control houses
  - Replaced power line carrier equipment and panels for line protection
  - Designed new substation control houses to separate transmission assets from existing generation assets

Burns & McDonnell provided engineering, procurement, construction, testing and commissioning services related to following projects for American Electric Power (AEP):

- Lane City 138-kV Substation modification
- Chocolate Bayou 69-kV green field substation
- Tontitown 138-kV substation modification and Madison Power Plant green field station
- Power Plant Separation at Nueces Bay 138-kV/69-kV substation
- Power Plant Separation at Lone Hill 138-kV/69-kV substation
- Power Plant Separation at Lake Pauline 138-kV/69-kV substation
- Power Plant Separation at San Angelo 138-kV/69-kV substation
- Power Plant Separation at Ft Phantom 138-kV/69-kV substation
- Power Plant Separation at Bates 138-kV/69-kV substation
- Power Plant Separation at La Palma 138-kV/69-kV substation
- Power Plant Separation at Paint Creek 138-kV/69-kV substation
- Repowering project at Nueces Bay substation
- Repowering project at Barnes Davis substation

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## **EL PASO ELECTRIC COMPANY**

Burns & McDonnell provided engineering, procurement, construction, testing and commissioning services related to the new Pipeline Substation, new Jornada Substation, retrofit Diablo Substation and new Pipeline to Newman Transmission Line for El Paso Electric Company.

The Pipeline Substation Project consisted of one 115-kV four position ring bus (three breakers for this project and one future breaker position), one 28MVA 115-kV/15-kV transformer, and one 115-kV metering set to connect to Kinder Morgan Company.

The Jornada Substation Project consisted of one 115-kV four position ring bus (three breakers for this project and one future breaker position), one 28MVA 115kV/25-kV transformer, one lineup of 25kV distribution metal-clad switchgear, and voltage regulators for the distribution feeders’.

The Diablo Substation Project consisted of adding one 345kV breaker position (one breaker and three motor operated switches) to an existing four position ring bus, one 200MVA 345kV/115-kV auto transformer, and one 115-kV bay to an existing breaker-and-half bus (two 115-kV breakers).

The new Pipeline to Newman 115-kV Transmission Line consists of 4 miles of single 954ACSR conductors with a monopole structure configuration.

Burns & McDonnell was responsible for site development, city permits, civil/structural/electrical design, procurement (panels, substation materials, steel / concrete poles), construction, construction sequencing associated with outage planning, testing and commissioning. Burns & McDonnell was also responsible for coordinating with geotechnical firm, surveyor, site development, erection, and testing contractors.

## **PUBLIC SERVICE ELECTRIC & GAS COMPANY**

Construction of new 69/13-kV Franklin Substation consisting of a 69-kV bus, two 69-kV line positions, a 69-kV bus section breaker, two 27MVA 69/13-kV transformers, 13-kV sheltered aisle switchgear, and two 9MVAR 69-kV capacitor banks. Franklin Substation is configured for future expansion to include a second 69kV bus, a third 69-kV line position, a second 13-kV sheltered aisle switchgear and two additional 9MVAR 69-kV capacitor banks. Burns &



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McDonnell's design, procurement and construction responsibilities included site grading, substation electrical, and protection and controls systems. Burns & McDonnell provided support for licensing and permitting by Owner. Construction was completed on a fast track schedule. The station was successfully energized five months after mobilization, with site grading and foundation work performed in winter conditions.

### **PUBLIC SERVICE ELECTRIC & GAS COMPANY**

For PSE&G, Burns & McDonnell is engaged in a number of EPC projects as Prime EPC Contractor. To facilitate aggressive project schedules, PSE&G has selected Burns & McDonnell to provide an EPC approach to allow parallel scoping, preliminary design, detailed engineering, procurement, and construction activities cutting months from the typical project cycle. This has resulted in continual on-time energization schedules working under critical outage windows. Burns & McDonnell works closely with PSE&G to pre-qualify and select subcontractors and suppliers which include a combination of vendors familiar to either or both firms. Projects include the following:



At the Bayway Substation the existing 138kV W-1323 transmission line that ran from Federal Square to Linden Generation was now to be split and terminated at Bayway Substation. With the new line added to the Station the existing Ring Bus was upgraded to 3000 amps. This required the replacement/upgrades of twelve (12) 138-kV disconnect switches and four (4) 138-kV breakers.

The Branchburg was a 230-kV ring bus expansion project. To prepare for a new 230-kV line, Burns & McDonnell designed, procured, and installed all adjacent and new facilities to support the addition of a line position into the existing 230-kV ring bus. One new breaker was added to the ring bus along with the bus, switches, CCVTs, and surge arresters to support the new line. To increase the reliability of the station, another breaker was added to the ring bus to split the existing capacitor bank from an existing line position, along with associated switches, and upgraded relaying for the capacitor bank. To support the new line, and reconfiguration of existing lines, Burns & McDonnell designed, procured, and installed relaying and disconnect switch upgrades at three other substations. Working with PSE&G, Burns & McDonnell coordinated with complicated outage schedules to meet the on-time line energization.

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A 138-kV reactor bypass project to increase system transfer capability. Due to space constraints, single-phase candlestick power circuit breakers were installed immediately adjacent to 138-kV series reactors. Due to poor soils, clearance issues, and limited outage times; a helical pile system with spread footer foundations were utilized. Each new breaker was installed, wired, high-voltage connections made, and commissioned within a one-week period.

A substation controls upgrade/retrofit project. Due to a coming generating facility demolition project containing substation controls, an existing 26-kV substation protection and controls system servicing 18 feeder, transformer, and tie breakers required replacement. Burns & McDonnell provided a single-piece 16' x 50' control enclosure complete with relay panels, and AC/DC systems. Abandoned transformer pads were used which required close coordination with the enclosure manufacturer. New cable trench was installed throughout the substation serving as the backbone of the raceway system from the enclosure to existing breakers, instrument transformers, and station service equipment.

Three 500/230-kV autotransformer projects. With existing derated transformer banks and increasing transfer capacity demands, two banks of 500/230-kV autotransformers were scheduled for replacement and a third was added. Working with PSE&G and their transformer vendors, Burns & McDonnell designed, procured, and installed all adjacent and new facilities to support the replacement projects. Each replacement bank was allowed a five week outage. Within that timeframe and working nights, weekends and holidays; the following work was performed: existing transformers removed from the pads, existing rock removed, containment liners added, new conduit and grounding added, jacking pads modified, new units set and assembled, new rock installed, high voltage connections made, low voltage cables terminated, protection system upgraded, and all components tested and commissioned.

Other miscellaneous projects include breaker, switch, and circuit switcher replacements; line terminal additions and upgrades; and other retrofit and new construction.

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## **FIRSTENERGY CORPORATION**

Keystone power plant, owned by Reliant, installed two FGD scrubber units. This required the addition of two 230-kV underground lines into Keystone Substation. The substation consisted of two 500-230-kV transformer banks feeding one 230-kV line. In order to accommodate the new lines, low-side breakers were installed on each of the two transformer banks, creating two independent 230-kV busses, and new line breakers were installed for each of the new underground lines.



Burns & McDonnell was responsible for all phases of design including foundations, raceway, grounding, control building, one-lines, schematics, and wiring diagrams. The project involved the complete design, procurement and construction of the substation. The schedule for this project was very aggressive. Burns & McDonnell worked closely with material suppliers and its electrical subcontractor to deliver the project on time. Construction, testing and commissioning activities were the responsibility of Burns & McDonnell, with input from First Energy crews.

## **SANTA CLARA, CALIFORNIA**

The Silicon Valley Power Northern Receiving Station 230-kV transmission project is located in the cities of Santa Clara and San Jose, California. The project consists of a new 230-kV switching station, 1.75 miles of overhead and 2.5 miles of underground 230-kV transmission line and additions to an existing 230/115-kV substation. Upgrades to two other substations are also included in the EPC project. The project increases capacity in San Jose and Santa Clara, California.



Burns & McDonnell teamed with a construction partner as a joint venture partner for this project. The contractor performed all construction to the substations plus overhead and underground transmission line installation. The project was managed from Burns & McDonnell's Kansas City office with environmental and permitting support from our San Francisco project office. Construction began late 2003 and was completed in April 2005.

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## ORLANDO UTILITIES COMMISSION

Burns & McDonnell with a joint venture partner designed and constructed three substations and two transmission lines for Orlando Utilities Commission in Orlando and neighboring St. Cloud, Florida. Kaley and Lake Nona Substations, located in Orlando, were built in 2004. St. Cloud South Substation and two transmission lines will be completed in late 2005.



The 115-kV Kaley Substation site was used as a termination site for the termination of a 115-kV underground High Pressure Liquid Filled (HPLF) transmission line. The station was converted to 115-kV 8-position ring bus substation. The substation is a low profile design with a decorative wall and landscaping to shield the view of the substation by neighboring residents and commercial businesses. 12.47-kV and 27-kV distribution circuits were installed from the substation in underground ductbanks beneath Orange Avenue.

The new 230-kV Lake Nona Substation was constructed near the Orlando International Airport on property owned by the Greater Orlando Aviation Authority. The new substation connects OUC's Airport Substation and OUC's Industrial Park and Airport Substations. The substation is low profile and is designed to accommodate an ultimate 10-position ring bus configuration with three 230-kV transmission lines, five 230/12.47-kV transformers, and two 230/24.94-kV transformers.

A new 230/69-kV St. Cloud South Substation will be placed in service in December of 2005. The 230/69-kV substation includes a 150MVA, 230/69kV autotransformer, a four-position 230kV ring bus, and a six-position 69kV ring bus. New 230-kV and 69-kV transmission lines totaling approximately 15 miles will be constructed in Osceola County, Florida, to tie the new St. Cloud South Substation to the grid.

Burns & McDonnell performed the transmission line routing study, and assisted OUC with public involvement in the route selection process. Public open houses were held to present and discuss routing options with the community. The selected routes include both overhead and underground transmission segments.

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## **ALLIANT ENERGY**

As part of a power plant contract Burns & McDonnell provided EPC services for a 345-kV collector bus at Sheboygan Energy Center in Wisconsin. The collector bus connected to an adjacent ATC switchyard. The project was completed in early February 2005. Engineering and procurement functions were performed by Burns & McDonnell and 345-kV construction was subcontracted.

## **PACIFIC GAS & ELECTRIC**

In conjunction with the Tri-Valley Expansion Project, Pacific Gas and Electric selected Burns & McDonnell to Engineer, Procure, and Construct the 230/23-kV Cayetano substation.

The project required the installation of a three position, 230-kV ring bus substation. The substation consists of three 230-kV circuit breakers with two underground 230-kV transmission lines and a 50MVA 230/23-kV transformer. The substation layout and protection scheme allows for the future conversion to a six-position ring bus on the same property. Landscaping and a decorative wall minimizes the visual impact to the residential community.



Burns & McDonnell was responsible for design of the substation including electrical and civil/structural design. Design responsibilities included field trips to substation site, preparation of equipment specifications, and preparation of construction specifications. It was also important to coordinate with other contractors and consultants responsible for other phases of this complex project. Electrical drawings, civil/structural drawings, protective relaying drawings, data systems interface, material requests, drawing lists, and bills of material were provided by Burns & McDonnell.

Burns & McDonnell directly procured all engineered equipment including circuit breakers, disconnect switches, structural steel, and relay panels. Through its subcontractor, Burns & McDonnell procured the balance of the equipment and materials.

Burns & McDonnell was responsible for all substation construction including site work, installation, testing, and commissioning. Burns & McDonnell administered the site's safety program and coordinated all subcontractors.

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## AQUILA ENERGY

Aquila Energy planned and financed the construction of a simple cycle 388MW nominal output gas-fired peaking power plant named the Crossroads Energy Center located in Clarksdale, Mississippi. The new plant is an independent power producer (IPP) plant owned and operated by Clarksdale Public Utilities (CPU) and is physically adjacent to the CPU Wilkins Power Plant. The plant is electrically connected to the City of Clarksdale and to Entergy's transmission system via one 115-kV transmission line and one 230-kV transmission line. The transmission upgrades associated with the project included construction of a new 230/115-kV plant substation, construction of the Entergy Moon Lake 230-kV switching station, construction of a 23-mile 230-kV transmission line, and the upgrade of a ¾-mile 115-kV transmission line.



Burns & McDonnell was responsible for design of the 230/115-kV plant substation and the 230-kV switching station projects as well as design of the new 230-kV transmission line and the upgrade of the 115-kV transmission line. Design responsibilities included determination of equipment ratings, line conductor selection, conceptual design and planning, protective relay selection, field trips to the project sites, preparation of the scope of work, and coordination with equipment vendors and construction contractors. It was also important to coordinate with Aquila, CPU and Entergy. Electrical drawings, civil/structural drawings, plan and profile drawings, structure loading diagrams, protective relaying drawings, equipment purchase specifications, construction specifications, protective relay settings and energization procedures were provided by Burns & McDonnell.

Burns & McDonnell furnished Owner's Engineer construction inspection services for the Moon Lake Switching Station and transmission line projects. A full-time Engineer Project Representative was on-site to observe construction activity for the duration of these projects. The Crossroads Energy Center plant and substation project was a design-build project where Burns & McDonnell had responsibility for all Engineering, Procurement and Construction activities. Burns & McDonnell provided construction project management from the home office in Kansas City and on-site project management to manage construction sub-contractors, manage testing sub-contractors and to coordinate with equipment and materials suppliers.

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## FIRST ENERGY

Burns & McDonnell delivered a substation engineering, procurement, and construction project for the design and construction of the new West Fremont 138-kV substation. This substation is a 15-breaker, 10-position breaker-and-a-half scheme.

Burns & McDonnell was responsible for all phases of design including foundations, raceway, grounding, control building, one lines, schematics and wiring diagrams. The project involved the complete design, procurement and construction of the substation. Burns & McDonnell was involved with reviewing vendor drawings and incorporating final vendor drawings into the construction packages. The line and bus protection included SEL-321, SEL-311B, SEL-311C, SEL-501, SEL-387, PVD, and KAB relays. Burns & McDonnell developed detailed schematics and wiring diagrams for the entire project.



## ALABAMA POWER

To improve reliability and operability of their 115-kV system, Alabama Power required an upgrade of their Fulton Springs Substation, located north of Birmingham, Alabama. Prior to the upgrade, the Fulton Springs arrangement consisted of manually-operated disconnect switches mounted on a lattice structure. The 115-kV portion of the station allowed pass-through of transmission lines that could be connected in a limited number of arrangements.



Due to limited flexibility of the existing system and ongoing transmission upgrade projects, the substation was required to maintain service throughout the construction period. Therefore, the new arrangement was constructed under energized transmission lines with no outages.

Burns & McDonnell and their joint venture partner provided turnkey services to complete the project on time with an aggressive schedule. Burns & McDonnell procured all engineered equipment and the construction partner provided commodity materials.

The new 115-kV equipment is in a breaker-and-a-half configuration with a 3000A main bus and four 2000A bays. The power circuit breakers have an interrupting rating of 63-kA and the bus and grounding systems are designed for 50-kA available fault current.

Spread footings were used and locations of piers for dead-end structures were located to allow excavation under energized lines.

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During the geotechnical investigation portion of design phase, solid sandstone was encountered within seven feet of the surface requiring five six-foot diameter 11-ft deep rock sockets. Burns & McDonnell's partner subcontracted the rock drilling to an industry specialist.

Each of the seven existing transmission lines was modified for connection to the new switchyard. This work included the addition of new concrete poles and modification of existing concrete, wood and steel structures. Burns & McDonnell worked closely with Alabama Power staff to coordinate outages for the transmission conversion from the existing structures to the new arrangement.

### **ALABAMA POWER**

Alabama Power's West Vernon Switching Station was a joint venture EPC project between Burns & McDonnell and its construction partner. The project consisted of adding a new 500-kV, 4-bay, breaker-and-half switchyard to handle the capacity from new generating facilities on a site that fell 60 feet west to east. This grade was not conducive to developing a switching station in an area already populated with existing transmission line structures. Before crewmembers leveled the grade, they removed a tower that connected to an active transmission line, so more room was made for new structures. To ensure that electrical service to customers remained uninterrupted, Burns & McDonnell designed a dead-end structure for this line. Once the line was terminated on the structure, the tower was removed and the grade was leveled. The station was energized one month ahead of schedule.



### **SEI (MIRANT)**

In conjunction with a merchant plant, Mirant Corporation selected Burns & McDonnell to Engineer, Procure and Construct a 345-kV Substation in Zeeland Michigan.

Phase I required the installation of two 170 MW simple cycle combustion turbines and a 345-kV substation. The substation consisted of three 345-kV circuit breakers with one transmission line in a collector bus arrangement. The substation layout and protection scheme allowed for the future conversion of Phase I to a combined cycle plant as well as the addition of a two-on-one combined cycle plant on the same property. During construction, the transmission line entrance was relocated from the south to the north due to right-of-way issues. Burns & McDonnell redesigned the substation layout without impacting the energization schedule.



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Phase II required expanding the existing site and installing a two-on-one combined cycle plant and associated substation. The substation consisted of four 345-kV circuit breakers with one transmission line in a collector bus arrangement and a 345-kV Phase I-Phase II bus tie circuit breaker. The protection scheme was modified for the additional bus and equipment.

### **RELIANT ENERGY**

Burns & McDonnell was the design-build firm for Reliant's Channel Energy Center 345-kV Plant Tie Circuit. The circuit included interconnecting the generation side, located within the LC refinery, and the Reliant substation.

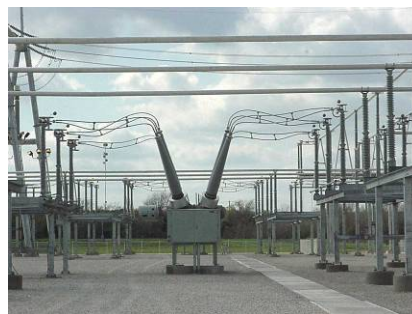
The tie circuit had to cross through a very congested industrial area, which set the stage for a complex and highly schedule-sensitive project. Burns & McDonnell chose to use self-supporting steel poles throughout the transmission line due to the relatively small footprint areas required inside the refinery. The poles ranged from 186 feet to 214 feet in height with the largest pole requiring an FAA approved aircraft warning light. These giant structures allowed the line to span over petroleum tanks, refinery equipment, multiple elevated pipe racks, and an existing 138-kV transmission line among other obstacles.



Burns & McDonnell's services included specification/bid document preparation, structure conceptual design, equipment and material procurement, on-site construction management, construction activity sequencing, and evaluation and awarding of all construction subcontracts.

### **BRAZOS ELECTRIC COOPERATIVE/MIRANT**

The Bosque Switch project was constructed to provide an interconnection point for a new generating facility. The project consisted of new 345-kV and 138-kV switchyards constructed in the vicinity of an existing 345/138-kV substation. An adjacent 345-kV transmission line was modified to loop through the new 345-kV switchyard. A new 138-kV transmission line was constructed to connect the new switchyard to the existing substation.



Unique design aspects included the following:

Provided for a "fast-track" construction schedule from preliminary design to energization in eight months.

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Tapped a 345-kV transmission structure by converting it to a double deadend using isolating suspension insulators to electrically divide the existing line into two circuits.

Provided EPC services for the portions of the switchyards owned by the generation interconnecting company, including deadend structures, circuit breakers, and switches.

Coordinated phasing, grounding, raceway, backup station service, and relaying interfaces with the generating facility.

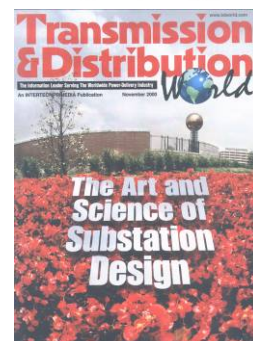
Burns & McDonnell was responsible for the design of a 138-kV transmission line. In its short half-mile, the line crosses another 138-kV line, a 69-kV line and a distribution line. Burns & McDonnell assisted the owner with right-of-way procurement, developed the plan and profile drawings, and provided guying and other miscellaneous details.

### **KNOXVILLE UTILITIES BOARD**

The Knoxville Utility Board (KUB) required relocation of their Network Substation to accommodate redevelopment of downtown Knoxville, TN, including the construction of a new convention center. Burns & McDonnell and a construction contractor operated as a joint venture to complete this design build project. Local Knoxville engineers, architects and landscape architects participated on the design team to provide local expertise and to help blend the substation into the overall downtown redevelopment plan. The project was featured as the cover story in the November, 2000 issue of T&D World Magazine.

The Network Substation is a 66/13.8-kV distribution substation. Fourteen 13.8-kV feeders exit an outdoor metalclad switchgear building and tie into the existing downtown network, overhead lines and the new convention center.

The substation includes a loop-thru configuration on the primary side and is fed by an existing 66-kV line. Due to aesthetic considerations and limited physical space, 69-kV gas insulated switchgear was installed and underground 69-kV cable connects the substation to the existing overhead line. Except for three 30MVA transformers, provided by KUB, Burns & McDonnell specified and procured the 15-kV outdoor metalclad switchgear, 69-kV gas insulated switchgear and building, a 15-kV capacitor, and all other equipment and materials.



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## **TENNESSEE VALLEY AUTHORITY**

The Alpha 230/115-kV Substation project involved design and construction with Burns & McDonnell as the lead partner in a joint venture. The substation design was based on TVA standards. Drawings were prepared according to TVA detailing standards and drawing set requirements. The Alpha 230/115-kV substation consists of an 8-bay 115-kV main and transfer bus, two 115-kV, 36 MVAR capacitor banks, one 230/115-26-kV, 200 MVA autotransformer and a three-position 230-kV ring bus. Also included as part of this substation was a prefabricated substation control building complete with all relaying, control, supervisory and communication equipment, a warehouse/maintenance building, an oil containment system and potable water/sanitary systems. With the exception of the power circuit breakers and the power transformer, which were furnished by TVA, all equipment, structures and materials were furnished and installed by the joint venture.



## **IMPERIAL IRRIGATION DISTRICT**

The initial project consisted of 43 miles of lattice steel tower double-circuit 230-kV, 44 miles of tubular pole double circuit 230-kV and 12 miles of wood pole double circuit 92-kV transmission lines. Additional transmission projects consist of 11 miles of double-circuit 161-kV tubular steel structures, 7.5 miles of double-circuit 92-kV wood poles. The initial substation projects were two new 230/92-kV substations and one 230-kV substation addition, then three 92/13.2-kV substations, one new 92-kV switching station, one 92-kV switching station rebuild and additions to a major 230/92-kV substation. Two new 2GHZ microwave stations and additions to four existing microwave stations were made also. This project was required to enable the Imperial Irrigation District to wheel up to 600 MW of power from geothermal plants located in southern and mid-Imperial County to their interconnection with Southern California Edison Company in Riverside County. The projects were design-build contracts with Irby Construction Company as the prime contractor and Burns & McDonnell providing all design services.



## **OHIO-EDISON**

Burns & McDonnell Engineering Company, Inc. and its construction partner provided the project management, engineering, material procurement, construction and testing of the Crissinger-Tangy 138-kV Transmission Line Underground Relocation for the Delaware Airport. As the prime partner, Burns & McDonnell had overall responsibility for the project from initial design to procurement, construction and testing. Burns & McDonnell performed all detailed



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design, as well as procured: the 138-kV XLPE cable, terminators, and clamps; surge arresters, fiber optic cable splice boxes, fiber optic cable and tubular steel structures. The construction partner supplied all on-site construction management, construction supervision, construction labor, testing supervision/labor equipment, construction equipment, construction materials (including conduits and innerduct, grounding rods and conductor, guy wires, anchors and rock surfacing), and fencing.

### **HAMAKUA-COGEN FACILITY**

The Hamakua Cogen Facility project is located on the Big Island of Hawaii. This was a joint venture EPC merchant power plant project with an extremely short, aggressive schedule. The T&D portion of the project consists of a new, four position, breaker and a half, 69-kV substation and two new wood and steel pole, 69-kV transmission lines with OPGW that intercept an existing Hawaii Electric Light Company (HELCO) transmission line. Design of the substation and transmission lines is based on HELCO standards and drawing set requirements. With the exception of the fiber optic termination/multiplexing equipment and the RTU, which were Hamakua Cogen Facility furnished and installed by HELCO, all equipment, structures and materials were furnished and installed by the joint venture. Ownership of the substation and transmission lined were transferred to HELCO at energization.



### **CITY OF BENTONVILLE, ARK**

This EPC project was completed for the City of Bentonville Electric Department. The project involved upgrading an existing 69/12.47-kV substation to provide better reliability for the entire electrical system. Existing 69-kV fuses on the high sides of two transformers were replaced with circuit breakers and transformer differential relaying. Also, all electromechanical relays on five 12.47-kV distribution feeders were replaced with new microprocessor type relays. Burns & McDonnell purchased all equipment, provided engineering, produced updated drawings, hired a construction contractor, and provided field support throughout the entire project.



### **AK STEEL CORPORATION**

A new substation and transmission lines were needed to provide power for AK Steel's new oxygen plant at their steel works in Middletown, Ohio. This was a Burns & McDonnell design-build (turnkey) project. Equipment procurement, design, construction, and testing of this project was completed within nine months. The design included a new 132/13.2-kV substation, with a 132-kV SF6 circuit



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breaker and a 132/13.2-kV 25 MVA transformer feeding a line-up of 15-kV 750 MVA outdoor metaclad switchgear. This project included equipment removal and structure modification of three existing 13.2-kV substations. The transmission line design consisted of single-circuit 132-kV steel poles from an existing AKS substation to the new substation. The project also included relocation and tapping of existing 7.2 and 13.2 -kV distribution lines.