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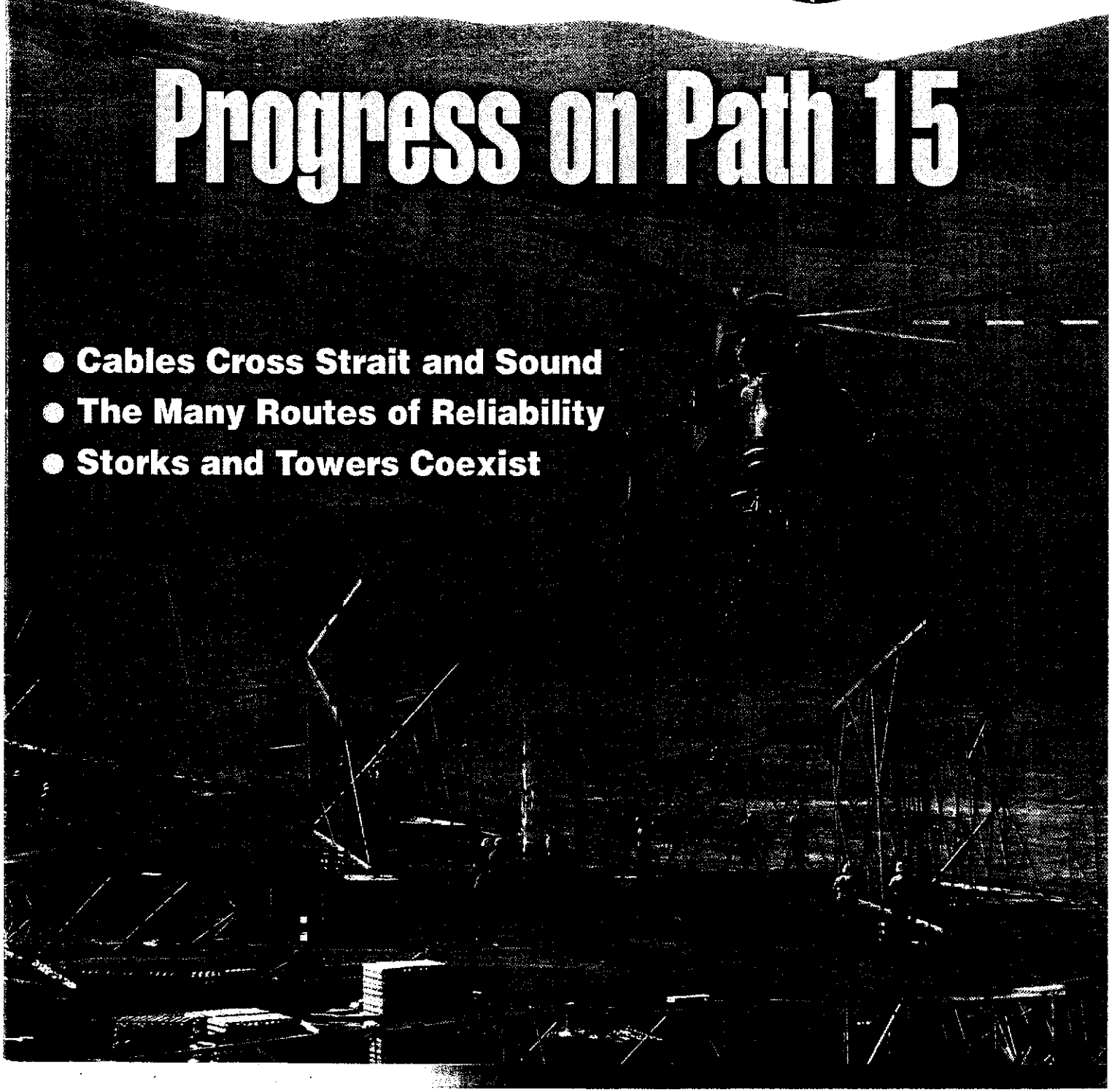
Progress on Path 15

- Cables Cross Strait and Sound
- The Many Routes of Reliability
- Storks and Towers Coexist



More Transmission Capacity

The long-awaited upgrade to California's Path 15 will relieve constraints on power flow.

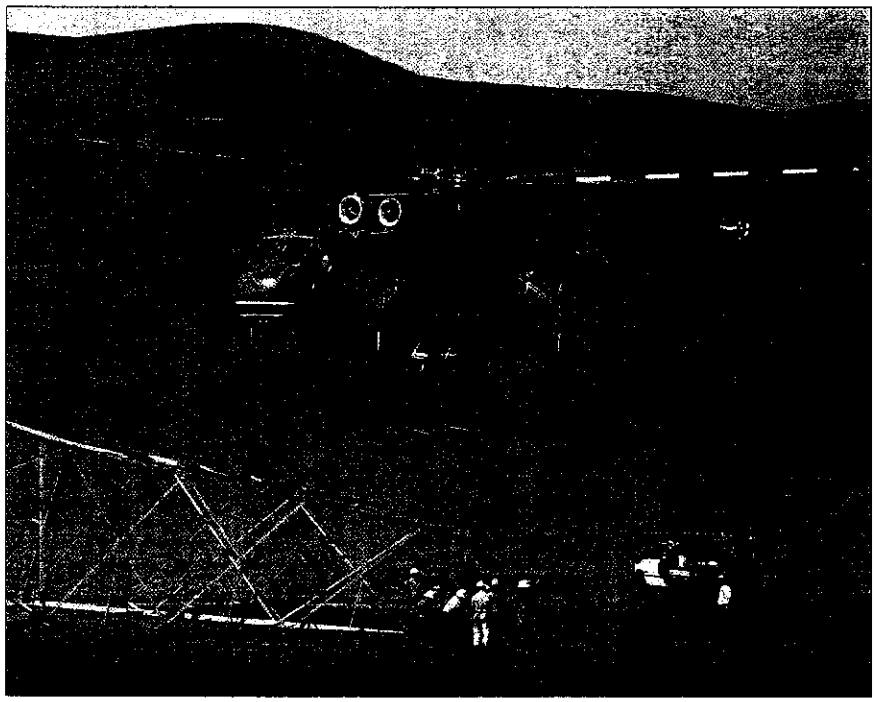
By Tom Boyko, Western Area Power Administration

The Path 15 upgrade in California represents the first public-private partnership organized to improve a transmission system that has become seriously congested. Pointing out that Path 15 is not the only circuit that has suffered from congestion problems, the Electric Power Research Institute (EPRI; Palo Alto, California, U.S.), estimates that US$100 billion must be spent to upgrade the U.S. electricity grid. At the same time, the Edison Electric Institute (EEI) estimates that $56 billion is required for upgrades over the next nine years. No wonder both the investment community and the electric utility industry are closely watching the project, undertaken by the Western Area Power Administration (Western; Lakewood, Colorado, U.S.). Western has acquired land rights, is managing the construction of the line, will own the line and will retain a 10% share of the new line's capacity. Meanwhile, Pacific Gas & Electric (PG&E; San Francisco, California) is financing and building expansions at Los Banos and Gates substations to connect the new line to its system, along with other 230-kV and 115-kV reinforcements north of Midway. Initially, PG&E will receive 18% of the new transmission capacity. Trans-Elect (Reston, Virginia, U.S.) also will invest in the project by providing the remaining financing for the line, entitling it to an initial share of 72% of the new capacity. Final capacity ownership for the two companies will be based on their percentage of project costs, with capacity available to all transmission system users.

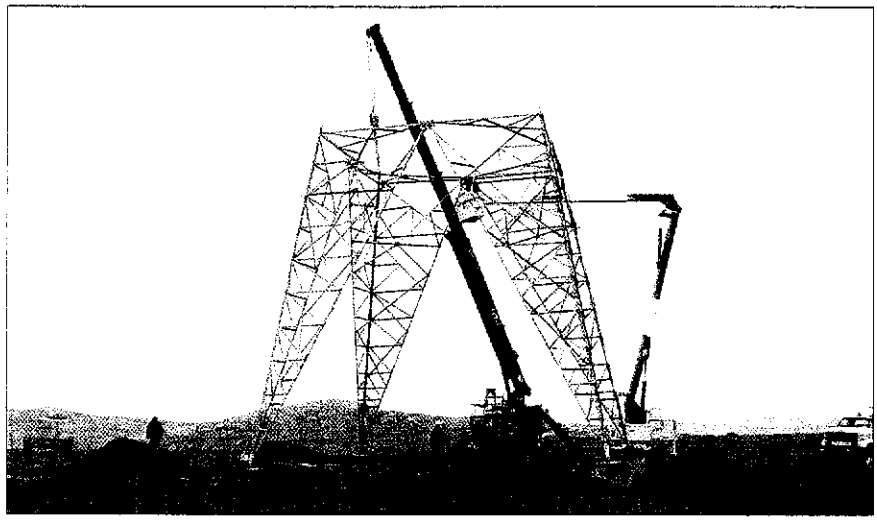
The new line will be in the middle of the California ISO's Control Area, with all investing parties turning over operational control to the ISO. The organization of this partnership among private and public entities may serve as a model for future projects as power providers begin their own projects for upgrading aging transmission infrastructure to avoid repeats of the Northeast blackouts that affected more than 50 million people.

Recapping the California Problem

When the lights went out in Northern California in 2000-2001, a long-standing transmission bottleneck received national attention. A contributing factor to the crisis was a transmission constraint in Central California known as Path 15, where three 500-kV lines linking northern and southern California narrowed to two lines for 84 miles (135 km) through the Central Valley. The corridor's lack of transfer capacity hampered efforts to move available generation north from southern California and the desert southwest. To alleviate this constraint, the Department of Energy (DOE) directed Western in May 2001 to explore a Path 15 upgrade. The result was a public-private partnership among Western, Trans-Elect Inc. (the first independent transmission company in the United States) and PG&E, one of three California-based investor-owned utilities. The partnership was charged with the responsibility of constructing a new 84-mile 500-kV line and for modifying substations at both ends of the new segment. Estimated cost for the project was $306 million.



The Sky-Crane helicopter prepares to lift the lattice tower body to be set on the tower legs that were placed by the mobile crane earlier.



Lattice tower legs are erected on the right-of-way using a mobile crane and man lift.

On Sept. 15, 2003, Trans-Elect's New Transmission Development Company provided Western with the necessary funds to start construction, using Maslonka & Associates (M&A; Mesa, Arizona, U.S.) as the line construction contractor.

The upgrade will increase Path 15's south-to-north capacity from 3900 MW to 5400 MW, significantly reducing electricity costs with savings estimated at $100 million annually under normal conditions and more than $300 million during a dry year when Path 15 helps to mitigate lack of hydro in Northern California. The ISO calculates these savings can result in a payoff of the project in four years.

In the 1980s, a Path 15 upgrade was considered for a 500-kV line linking California with the Northwest, as part of the California-Oregon Transmission Project. Due to varicus regulatory issues, the line was never built. A decade later, increased demand and supply constraints pointed to the need to revisit the upgrade.

By late 1998, load growth had become a significant factor for grid operators, who were prevented from moving power across the congested Path 15. The congestion hit hard in 2000 and 2001 when scarce generation forced the ISO to declare stage-three emergencies, indicating reserves were so low that rolling blackouts were imminent and resulting in several days of rotating outages of firm customer load. The emergencies extended into the winter with threats of outages continuing. Between Sept. 1, 1999, and Dec. 31, 2000, consumers spent an additional $221.7 million in energy costs due to constraints on Path 15.

To address the project mandated by DOE, Western advertised in the Federal Register to determine if investors were interested in financing the upgrades. In June 2002, the Federal Energy Regulatory Commission (FERC) accepted the terms of a letter agreement among Western, Trans-Elect and PG&E, which provided $1.5 million in initial funding from Trans-Elect and outlined the overall project terms and conditions. In December, the project participants signed a Construction and Coordination Agreement, which spelled out project terms and conditions in more detail. Trans-Elect provided an additional $8.5 million to Western in initial funding, followed by construction funding in September 2003.

PG&E performed the Path 15 rating studies using the rating process of the Western Electric Coordinating Council (WECC), which coordinates and promotes system reliability in 14 Western states, two Canadian provinces and portions of one Mexican state. Under the WECC process, PG&E established a group to review and comment on its studies to ensure that any impacts of the proposed upgrade were adequately addressed. Based on the studies, Path 15 received an accepted rating of 5400 MW, south to north, and 3400 MW, north to south. The studies showed the upgrade also will increase the simultaneous import capabilities into the Pacific Northwest during winter and will not affect the operation of other WECC paths at their respective ratings.

Environmental Issues

The Path 15 Upgrade Project is in the foothills on the west side of the San Joaquin Valley in California's Central Valley. The new 500-kV line between Los Banos and Gates substations is being constructed west of the existing Los Banos-Gates and Los Banos-Midway 500-kV lines, which occupy a common corridor near Interstate 5,

selected to minimize environmental impact. The separation of the two rights-of-way is about 2000 ft (610 m). Western acquired the necessary rights-of-way for the transmission line easement and an additional 149 miles (240 km) of access road easements, which were required for project construction. The right-of-way is 200 ft (61 m) wide and vertical ground clearance is 35 ft (10.6 m).

Much of the corridor is dry rangeland used for stock grazing. Because the area also is home to diverse wildlife, plant life and historical and cultural resources, measures were taken to lessen environmental impacts. Environmental analyses in compliance with the National Environmental Policy Act concluded the upgrade would pose no significant, adverse environmental problems. The California Public Utilities Commission (PUC) adopted a Final Environmental Impact Review, which found the proposed corridor west of Interstate 5 as the environmentally superior alternative. In addition, Western's administrator signed a Mitigation Action Plan, which outlines measures designed to reduce adverse environmental impacts. The U.S. Fish and Wildlife Service issued a biological opinion, and Western obtained other necessary permits. Western and other state and federal agencies also signed a programmatic agreement that covers treatment of historical and cultural resources and Native American cultural sites, including burial sites.

As a result of pre-construction environmental surveying, engineers modified the project design to minimize the impact on endangered species and existing farmland. For example, they chose to use steel poles in some areas because they could accommodate anti-perch devices so that raptors would not land on crossarms and contaminate insulators, or hunt down other protected species. Anti-perch devices, made of black polyethylene with UV stabilizer and cone-shaped to prevent raptors from roosting, are designed for installation on crossarms using stainless-steel straps.

Other design modifications could be made to address any significant findings during ongoing paleontological, biological, archaeological and Native American cultural monitoring, which continues throughout the construction of the line. Modifications could include moving roads, shifting structures or re-clearing areas for biological or cultural resources. For instance, before construction started, an access road was moved to avoid sensitive plant areas. A significant effort was expended on tracking and protecting endangered species, such as kit foxes and burrowing owls.

Design and Construction

To design the project, Western's engineers used some of the most technologically advanced tools available, including topographic data of the corridor provided by the Light Detection and Ranging system (LIDAR), which uses a laser beam onboard an aircraft to measure elevation and ground coordinates. This information can be downloaded and used with the Power Line Systems' Computer-Aided Design and Drawings software (PLS-CADD). Using this software, engineers selected the best route and structure locations, generating detailed plan and profile drawings in AutoCad. Maslonka and Associates, the contractor, had access to these drawings over the Internet via a satellite link.

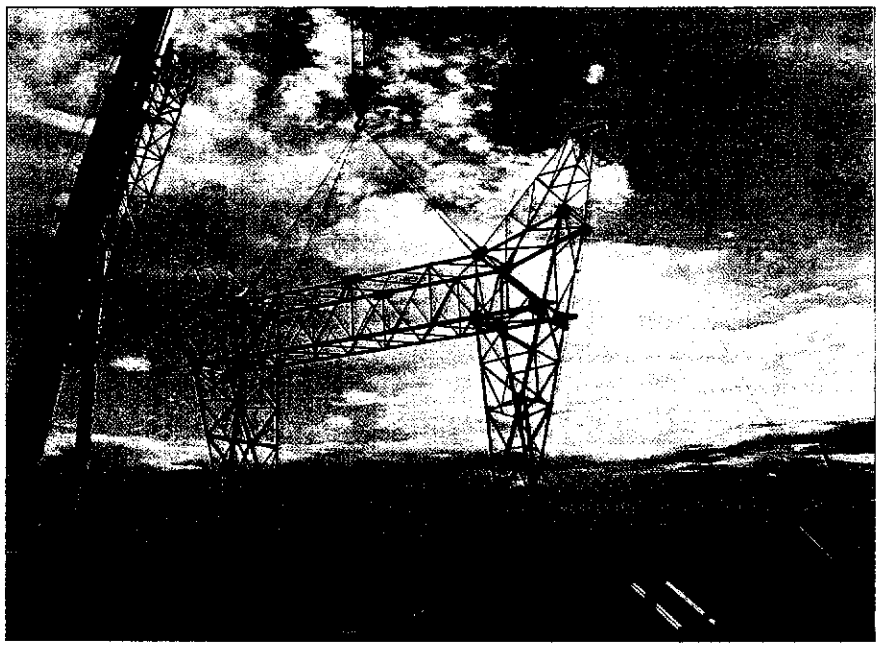
The new line will consist of a single 500-kV circuit, with triple-bundled 1590 kcmil, 45/7 Lapwing ACSR arranged in triangular configuration with 18-inch (45.7-cm) spacing between subconductors. The largest conductor that could be accommodated by the lattice tower structures was selected.

The design also includes spacer dampeners attached to the conductors and vibration dampeners for OHGW. Orange marker balls 36 inches (91.4 mm) in diameter are used at line crossings. In order to make the line more visible to federally protected California Condors, UV-stabilized and phosphorescent flapper-type line markers are used on the OHGW. Three V-shaped insulator strings support the conductors and maintain electrical design clearance between conductors and towers. Each leg of the insulator string contains 32 ball-and-socket fog-type porcelain insulators, 18 ft (5.5 m) long. Deadend towers have fog-type porcelain, double-horizontal insulator strings about 25 ft (7.6 m) long. Insulator assemblies are similar to those used on the California-Oregon Transmission Project, enabling maintenance crews to use the same equipment and tools for barehand and hot line work.

The groundwire assembly, which includes two 0.5-inch-diameter, high-strength steel, seven-strand ground wires, will protect the conductors from direct lightning strikes. The line will use 246 self-supporting, galvanized lattice steel towers and 98 steel pole structures, averaging four structures per mile. Lattice structures, weighing from 10 to 70 tons, vary in height from 100 to 160 ft (30.5 to 48.8 m). The steel poles, weighing from 20 to 75 tons, vary in height from 127 to 207 ft (36.6 to 63 m).

Crews jack together segments of steel poles from Thomas & Betts with hydraulic jacks.

Almost half of the towers will be installed by Erickson Air-Crane to provide an efficient and economical way to construct the lattice towers, which are assembled in three pieces. The base section, or tower legs, is constructed in a conventional manner by ground crews and set onto the concrete footings. Guide brackets on each top corner of the leg section help guide the bottom of the body into place when flown in and, later, bolted by linemen. The remaining top, or bridge piece, is set by helicopter and bolted. Although the Air-Crane has a high per-hour cost, the expense is offset by the fact that each section can be set in about a minute, plus ferry time to and from the assembly area or fly yard. Because fly yards are on the structure right-of-way, the average time from fly yard to structure location is about five minutes. The Air-Crane helicopter, developed initially for the military, is now in use worldwide after having been remanufactured from military surplus status to civilian specs and modified



A lattice deadend tower bridge section is lifted by a mobile crane to be placed on the body section.

for heavy-lift construction, logging and fire-tanker operations.

PG&E's Substation Modifications

PG&E, which is responsible for the project's substation and 230-kV transmission line work, awarded two contracts to Burns & McDonnell (Kansas City, Missouri, U.S.) for substation modifications and 230-kV shunt capacitor work. Substation modifications include: installing two new 500-kV circuit breakers at Gates Substation and modifying Gates' 500-kV bus from a ring bus to a breaker-and-a-half arrangement; installing 250 MVARs of 230-kV shunt capacitors at Los Banos Substation; installing 250 MVARs of 230-kV shunt capacitors at Gates Substation; reinforcing sections of 230-kV and 115-kV lines north of Midway.

The breaker-and-a-half design is considered to be the industry-standard design for the number of lines and transformer banks terminating in a 500-kV bus. Its design is consistent with ISO operating practices and is more reliable because it allows for easier maintenance and more operating flexibility. The reinforcement work of the 230-kV and 115-kV lines north of Midway includes raising some of the 230-kV towers to accommodate an increase in conductor sag. PG&E also will install current-limiting reactors to limit the flow on the parallel system.

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