

# The Pacific DC Intertie Sylmar Replacement Project



The replacement project will enhance reliability and reduce operation and maintenance costs.

**Overhead  
Lines**

**Cable**

**Back-to-back**



# Background



## Background

The Pacific DC Intertie provides a vital power link between the Pacific Northwest’s hydro-power and Southern California’s predominantly thermal sources. The use of direct current (DC) offers levels of transmission efficiency, reliability, and stability that are not available using traditional alternating current (AC) transmission.

Spanning over 800 miles, the transmission’s northern end is located along the Columbia River on the Oregon/Washington border while the southern terminus is in California’s seismically active San Fernando Valley. The Intertie was originally commissioned in 1970, transmitting 1,440 MW of power. Through the years, it has undergone several upgrades, each time updating the technology and increasing its power transmission capability until it reached 3,100 MW, or the rough equivalent of 3 large power plants.

## The Sylmar station

The southern terminal is located at Sylmar, at the northern tip of the San Fernando Valley basin. Sylmar is jointly owned by the Los Angeles Department of Water and Power (LADWP),

Southern California Edison and the cities of Burbank, Glendale and Pasadena, and is operated by LADWP.

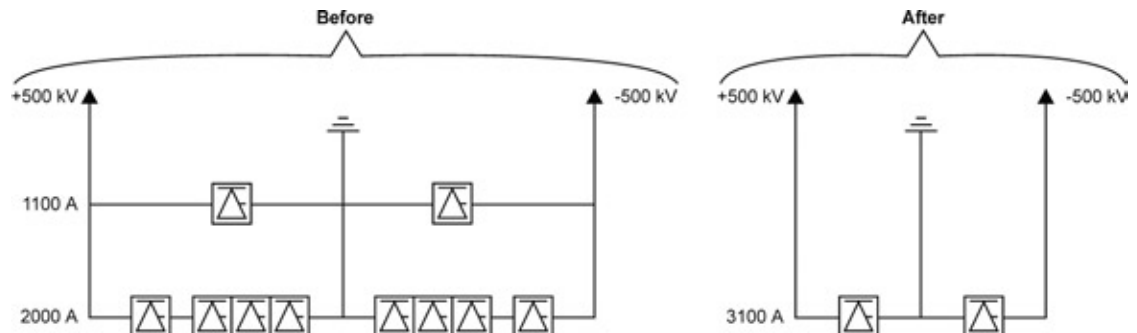
The station was damaged during the 1971 Sylmar earthquake shortly after commissioning and the facility was seismically strengthened with each subsequent modification. However, the North-ridge earthquake in 1994 demonstrated that a facility made up of varying designs over almost a quarter of a century was subject to damage. Sylmar’s owners realized that a large earthquake could make a major source of power unavailable for an extended period of time. As a result, in 2004, the Sylmar Converter Terminal underwent perhaps its most significant modernization project ever.

The station’s owners determined that due to the age of the existing equipment, the findings of reliability studies, and the damage sustained from the North-ridge earthquake, the time had come to create a “new” Sylmar Converter Terminal. Having a long history with the station, a strong back-ground in designing in seismically active areas, and the technology and organization necessary to accomplish the task, ABB was chosen as the supplier to accomplish what became known as the “Sylmar Replacement Project” (SRP).

## History of Sylmar

- **1970** Pacific HVDC Intertie construction complete – Capacity 1,440 MW, +/-400kV with mercury arc valves in the converters
- **1985** Pacific HVDC Intertie Upgrade increases capacity to 2,000MW, +/-500kV, by series connected thyristor valve converters
- **1989** Pacific HVDC Intertie Expansion brings Sylmar capacity to 3,100MW, +/-500kV, by adding one parallel converter in each pole
- **2004** Sylmar Replacement Project is available for commercial operation, with the same capacity in one modern, state of the art, compact, seismically designed facility

Schematic of the Sylmar replacement project before and after.





Valve hall at Sylmar East.



The 621 MVA converter transformer, 355 tons transport weight each.

## The Sylmar Replacement Project

The owners decided to consolidate the geographically sprawling substation into one. This would allow for complete removal of the older technology, including the earliest equipment that had used large quantities of mercury as a component. Advances in technology allowed ABB to house the AC/DC conversion equipment rated 3,100 MW in one of the existing buildings that had previously provided 1,100 MW of the transmission. This building had been built by ABB, was unhurt by the Northridge quake, and was determined to be seismically qualified to newer standards. In addition, as much of the existing equipment as possible was used in order to save money. This equipment had also successfully been “tested” by Mother Nature.

In order to get the latest technology, not only the converter valves but also the valve cooling and the HVDC control equipment were replaced. In the main circuit, all series connected equipment, such as the converter transformers and smoothing reactors. However, almost all shunt connected equipment, typically filters, have been reused. Many challenges had to be faced, in the form of interfaces between old and new equipment as well as between the existing controls of Celilo station (the northern terminus) and the modern MACH 2™ control equipment supplied for Sylmar.

The total project execution time was 30 months. However, in order to minimize power outage the maximum time allowed for all site activities was nine months. The critical path was to remove the old transformers, modify and expand foundations, remove the old valves, modify the converter building, install new thyristor valves, and install new converter

transformers. All of these steps had to be completed before any testing could start. At the heart of the facility were the HVDC converter transformers (the largest of their type at over 500 tons), the updated electrical control and protection systems using ABB’s state-of-art MACH 2™ system, and the giant thyristor valves that provide the AC/DC conversion. In order to minimize the impact on one of the major avenues of north/south power flow in the US, the challenging implementation was worked around a schedule roughly matching the “normal” maintenance schedule and cyclical reductions in power flow. This, in effect, accelerated design and delivery schedules and compressed the time allowed on site for the construction, installation and commissioning of the highly complex equipment.

During the first six months, Sylmar West remained in service with a capacity of 2,000 MW. The last three months were used for integration of the existing Sylmar West AC- and DC-filters as well as for terminal and transmission testing.

### Main data

Rated power	3,100 MW
DC voltage	±500 kV
AC system voltage	230 kV

### Thyristor Valves

Valve type	Quadruple, suspended
Cooling system	Water (single circuit)
Thyristor size	YST 90 (5 inch)
No. of thyristors per single valve	84
Total number of thyristors	2016
Max. voltage per thyristor	7.2 kV

### Converter transformers

Type	Single-phase, 3-winding (6+1 units)
Rated power	621 MVA each
Transport weight	355 tons

### AC filters

East	2x370 Mvar
West	2x293 Mvar

### **Successful cooperation**

The successful accomplishment of this project required close cooperation between ABB's personnel and those of the station owners, primarily the Los Angeles Department of Water and Power (LADWP) who operate the station. While ABB provided the overall design, it made sense for LADWP to handle the outdoor portion of the construction and installation using its own resources. This "marriage" worked extremely well and the project was delivered ahead of schedule at a fraction of the cost of building a new converter station from scratch.

Sylmar was back in commercial operation in December of 2004. A formal rededication was held in March, 2005.



The Sylmar East facility.



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