All the angles covered with Geometrica domes: storing coal for Tai Power


Domes during construction.

Tai Power, Taiwan's state-owned Energy Company, needed a storage solution for fuel at its Hsin-Ta Fossil Power Station in Kaohsiung Hsien, Taiwan. Gibsin Engineers, a specialist company hired by TaiPower, determined that four 126-metre-diameter concrete silos with an aluminium dome cover would fend off saltwater spray and typhoon winds.

In 2005, Geometrica Inc. from Houston, Texas, along with Triumstar International Co. Ltd. and Chien Yang Construction and Engineering Co. Ltd. (both from Taipei), won the bid to provide cost-efficient structures that met with TaiPower requirements. From the start and throughout the whole project, the companies supported each other to deliver a seamless experience to Tai Power. Triumstar and Geometrica had over ten years' experience co-operating in the construction of domes. Geometrica handled engineering, manufacturing and technical assistance during installation.

Project backgrounds

As part of its expansion plans, Tai Power needed to store fuel under cover at their Hsin-Ta Fossil Power Station in Kaohsiung Hsien, Taiwan. The state-owned company retained the specialist company Gibson Engineers to draw up the plans and specifications that would encompass all emerging necessities for the coal storage. Gibsin's advocated four 26m diameter concrete silos with internal automated stacker/reclaimer system, and metal dome covers. Each unit would store 180,000 tonnes of coal in a live pile, providing a total capacity of 720,000 tonnes.


Completed domes.

The metal dome covers presented several challenges that raised the bar for all possible manufacturers. First, the buildings would be located immediately adjacent to the ocean, and therefore would be subject to corrosive conditions from saltwater spray. Second, the area is exposed to recurring typhoon winds, and recent history had shown that these winds reached speeds higher than Taiwan's building code requirements. Third, due to scheduling constraints, the domes would have to be built after the coal stacking/reclaiming equipment was installed. Fourth, the domes would have to be designed to minimize accumulation of coal dust on the structural members, to prevent fire and explosion hazards. Fifth the selected domes should meet these various challenges in the most cost-efficient manner. The project schedule was very ambitious, and also specified a very critical design wind speed of 65m/s 10 minute mean measurement at 10m above ground (equivalent to 94m/s gust).

Gibsin specified domes clad with aluminium sheeting and galvanized steel for the structure, as it would provide superior strength, flexibility in schedule, and because it used round tubular members (which preclude dust accumulation on the members), all for a more competitive price.

In mid-2005, the team consisting of Triumstar International Co. Ltd. of Taipei, Geometrica, Inc. of Houston, Texas, and Chien Yang Construction and Engineering Co. Ltd. of Taipei, was chosen for the project.

Planning and Design

Triumstar and Geometrica retained BMT Fluid Mechanics of London to determine the structural loading to be applied to the domes using a wind tunnel test. BMT's testing confirmed the safety of the specification and provided four critical load cases for each of the four domes, in each of 36 possible wind directions.

Under an Extraordinary Event with 94m/s gusts, the testing showed localized pressures above 5kPa in large regions, and exceeded 12kPa at locations on the units' cupola. Maximum uplift reached 61MN, quite possibly the largest load for which a dome of these characteristics has ever been designed.

Geometrica engineers modeled the effects of dead and live loads, support displacements, as well as earthquake, temperature and wind, in nearly 50 basic load cases and 100 load combinations, and analyzed the structure linearly. Gibsin engineers verified the reports and gave the go-ahead for manufacturing.

Manufacturing and construction

Triumstar procured most materials in Taiwan and Geometrica fabricated the structure at a facility in Kaohsiung. The structure in each dome consisted of 37,000 nodes and 120,000 galvanized steel tubes, plus assorted purlins, hardware and accessories.

Construction on site started in July 2006. The dome was assembled using the 'perimeter-in' method of construction: the first nodes and tubes are settled on the supporting concrete wall. Each three to five tubes were joined to one node forming a 'spider'. Each spider was then raised to the work front and tapped into place, creating rings around the base that grew one on top of the other until the whole skeleton was formed.

Coordination with other trades was easy, as the area under the dome was free of obstacles. Neither scaffolding nor other special equipment were required, and the project was completed with a perfect safety record.

Project Completion

Turnover of the domes and testing of the first silo started in October 2007, approximately 16 months after start of construction. The completed domes are beautiful evidence of the careful planning, execution and cooperation between the companies involved in the project, and attest to Taiwan Power's commitment to a clean and safe environment.