The Pacific International Center for High Technology Research (PICHTR) was awarded a contract to build an Offshore Thermal Energy Conversion (OTEC) demonstration plant for generating electricity using the water temperature difference stored in tropical oceans. The process uses warm surface seawater that is flash-evaporated under vacuum pressure and cold seawater to condense the water vapor after it passes through a turbine generator. PICHTR believed that the most cost-effective and corrosion-resistant material for this application would be concrete, and consequently, turned to BergerABAM to design this very specialized structure.

The structure, a 16-sided polygon, measures approximately 25 feet across the flats and stands 30 feet tall. The top of the structure is open, featuring a ring corbel to support the plant’s turbine. The walls of the tank contain numerous penetrations, including 2- and 3-foot-diameter waterlines, a 4.5-foot-diameter personnel access door, and other small penetrations for instrumentation leads and viewports.

The challenge to engineers at BergerABAM was to develop a structure that could be constructed to be completely airtight, a condition essential to the operation of the plant. BergerABAM’s design needed to eliminate the possibility of air leaking around the numerous embedments, at construction joints, or through any cracks caused by flexural action of the structure under vacuum load. A detailed finite element analysis was performed by BergerABAM to assess the effects of vacuum and hydrostatic pressure loads and effects of the various wall penetrations. Based on this analysis, prestressing was provided to counteract the inward dishing caused by vacuum pressure. The top ring was prestressed to compensate for the effects of the turbine load and vacuum.

Construction details were designed with an eye toward eliminating air leaks. The foundation slab was of special concern because it would be inaccessible after the tank was completed. As insurance, a continuously welded steel membrane was installed under the base as a part of the tank construction. Construction joints and penetrations were also given needed special attention in the design. Concrete mix designs and curing practices were specified to minimize potential shrinkage and other cracking. Methods for testing the structure for air leaks and special leak repair methods were identified by BergerABAM and incorporated into the final design specification.

Because concern was raised that local contractors working in Kona would be reluctant to bid on such a highly specialized structure, BergerABAM also developed methods of sharing the construction cost risk between PICHTR and the contractor.

BergerABAM’s long history of experience in the design of concrete structures assures clients that highly specialized, unique structures will be constructed to close tolerances necessary to achieve expected operational goods.