

## BHP BILLITON (AMERICAS INC) ANGOSTURA LNG PROJECT

### Wellhead Platform Front End Engineering Design (FEED) study

ICON Engineering was commissioned by BHP Billiton Petroleum (Americas) Inc to perform a Front End Engineering Design (FEED) study and cost estimates for three wellhead platform topsides.

ICON's work in Perth commenced with a conceptual proposal to meet client requirements that the wellhead platforms be unmanned, remotely controlled, with restricted personnel visits. Work then proceeded to multi-discipline detailed design.

The Angostura Development Project is an oil and gas development in 85 to 190 feet of water located some 22 miles offshore from the northeast coast of Trinidad.

The platforms are expected to produce one hundred thousand barrels of oil per day and two hundred and eighty million standard cubic feet of gas per day.

Production will be fed from the wellhead platforms via subsea lines to a central processing platform, from where the oil will be piped to an onshore tank farm. The gas will initially be reinjected via the wellhead platforms.

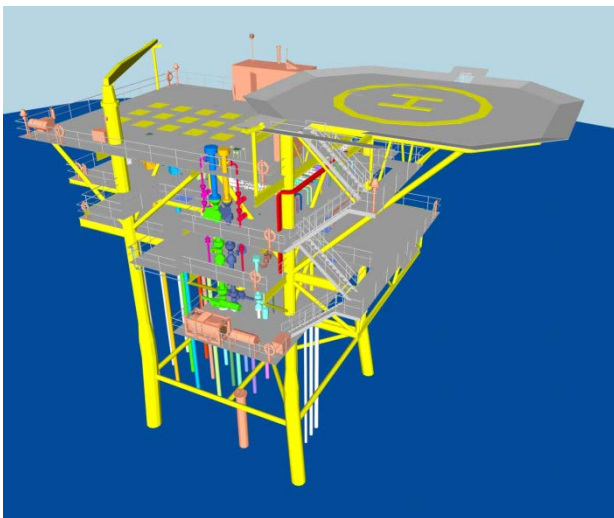


**Hydraulic actuators controlled from the central processing platform will adjust well flows by activating choke valves or by diverting the product streams between manifolds. Injection of chemicals is achieved by the same method**

Christmas trees to any of 4 manifolds – test, high pressure oil, high gas oil ratio, or gas.

Full remote operation is accomplished by an Integrated Control & Safety System (ICSS) and high speed communication links through an umbilical. These ensure complete autonomy and safe operation, even in the event of power failure or loss of communications.

3D CAD models incorporating all disciplines were built using the relational database software AutoPlant, from which material lists, weight reports and AutoCad format drawings were generated. Communications with the client in Houston were via email, including electronic transfer of all documents and drawings. ICON's FEED project was successfully completed on schedule.

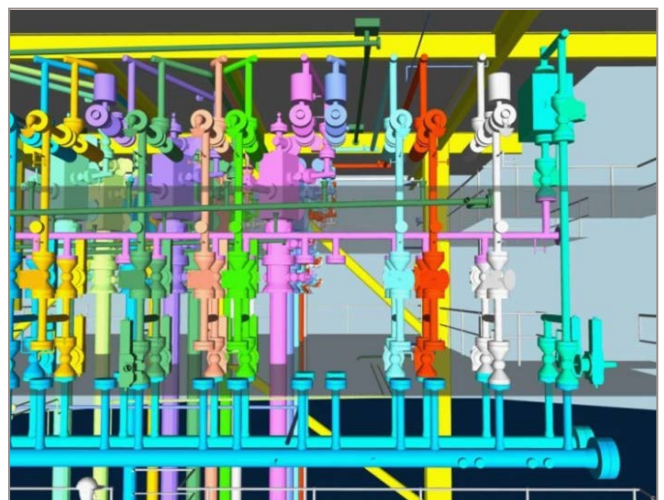


**Topsides on the wellhead platforms were designed to comply with API RP 14C. Personnel access is via helicopter**

Several options were investigated for technical merit and cost effectiveness. These included alternative energy sources such as wind / solar or micro gas turbines, several delivery methods for services such as injection of chemicals, and various combinations of production piping and test manifolding. The multi discipline team continued through process design and basic layout to piping, electrical, instrumentation and communications design.

Cost estimates for the technically viable options were assessed and cost reduction techniques applied to ensure minimum overall cost of the project.

Production flexibility is assured during the 25 year design life of the field. The piping configuration will facilitate diversion of varying product streams from any of 15



**Product composition and flow rates will be analysed by the latest technology multiphase flow meters**