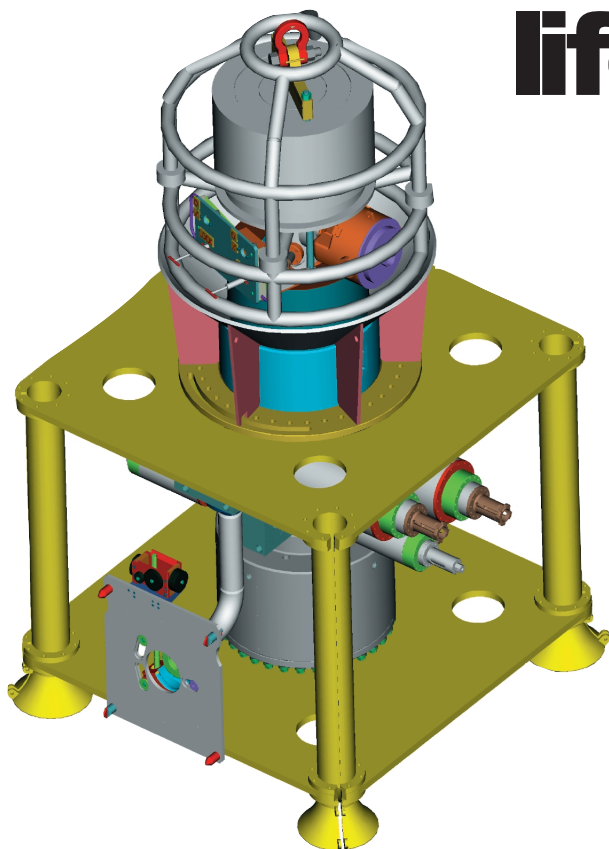


LIFT

a vehicle for low life cycle costs

Steve Fenton



Pressure on costs continues to exert influence on subsea production systems markets, requiring consideration of life cycle costs (LCC) to be given greater prominence in the system selection process. ABB recognizes this and is active in the promotion of system concepts which can best contribute to clients' objectives, the LIFT concept being one such example. The appeal of LIFT is based on the results of systems analysis techniques, such as RAM (Reliability, Availability and Maintainability), which considers the interaction between component reliability, its impact on production availability, and how this can be optimized by considering the cost and impact of system maintenance in the overall assessment of LCC.

The LIFT concept (LIFT stands for Light Intervention Friendly Tree) arose from a design study aimed at establishing a simpler and more 'integrated' subsea tree system that could make a significant contribution to lower life cycle costs. ABB Vetco Gray, ABB Offshore Systems, ABB Corporate Research and ABB Control Valves all participated in the program.

Of several concepts identified, LIFT was selected as best meeting the study criteria, ie to provide a more cost-effective product and require only minimal product development at the component level. The

concept was subsequently taken to the detailed layout stage to facilitate LCC (life cycle cost) and RAM (reliability, availability and maintainability) analysis, using as reference a base case system architecture of 2x4 well mini-templates at moderate water depth and comparing with a conventional dual parallel bore tree system.

Design attributes

The system comprises an upper and a lower module **1**. The upper module contains the active 'wear-sensitive' components of the tree system, namely:

- Subsea control module (SCM)
- Choke
- Sensors (pressure, temperature, sand)
- An optional multi-phase flow meter (MPM)

All of these parts are integrated into the main body forging. Such an approach has the advantage that it eliminates the need for individual ROV retrieval interfaces on these components, thereby reducing the overall system complexity.

Additionally, integrating the parts into a single assembly which effectively takes the place of a traditional tree cap,

means that they can be recovered by a mono-hull vessel on wire, with ROV assistance.

Since reliable and testable well barriers (gate valves) are maintained in the lower module, the MTBF¹ of which is significantly better than that of the upper module and which will not normally need to be recovered unless heavy workover is required, maintenance/repairs can be carried out without having to run and set plugs in the tubing hanger.

Additionally, there are fewer valves (eg, no swab valves and no separate crossover valve) and the associated

hardware is less complex than for a conventional system. As a result, the MTBF of the lower module is higher than that of the equivalent component in a conventional tree system (irrespective of the MTBF of the SCM and choke).

Whilst the original concept was constrained around the premise of a conventional dual bore 5 1/8" x 2 1/16" parallel bore system (base case), the concept has been extended further.

Accordingly, the system can be configured with a concentric (non-HT²) hanger system, enabling final installation on a simple mono-bore riser.

Further, and recognizing the growth in acceptance of horizontal tree systems, the 'LIFT' package can be adapted to be compatible with such systems, affording further potential benefits when considering close proximity cluster or mini-template field architectures. This is due to the fact that the impact of incremental additional hardware (which would be required in, eg, the case of a single/satellite HT well to accommodate the LIFT module) is offset by system integration within the associated structures.

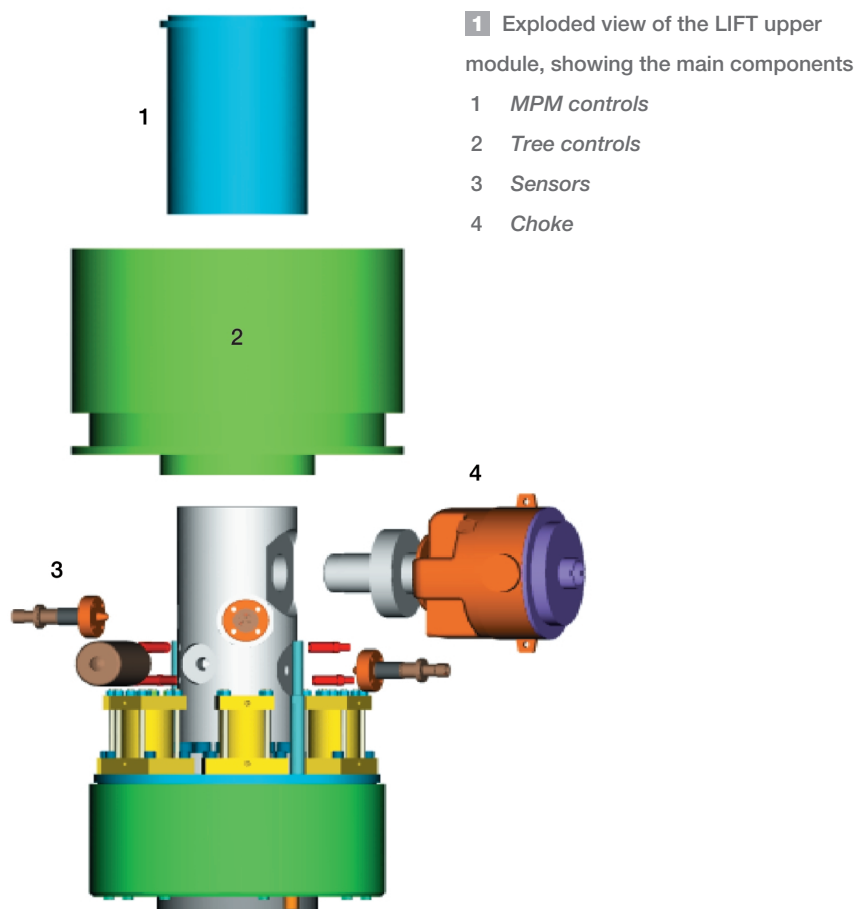
In any case, the advantage of incorporating LIFT into an HT configuration is that it can significantly reduce the likelihood of having to recover the tree-head, with the attendant drawback that this would necessitate recovery of the downhole completion. Thus, the potential LCC advantage in this scenario is considerable, although this has not been quantified by RAM analysis at this stage, which only looked at the base case.

Marketability

The primary factors contributing to the market potential of LIFT result from its ability to maintain a level of safety and functionality comparable with that of competing tree systems even as it offers lower life cycle costs, due principally to improved reliability and maintainability.

LCC savings as high as 40% are indicated over the 15-year field life studied for the base case system.

This lower systems cost is actually due to projected benefits in the three elements

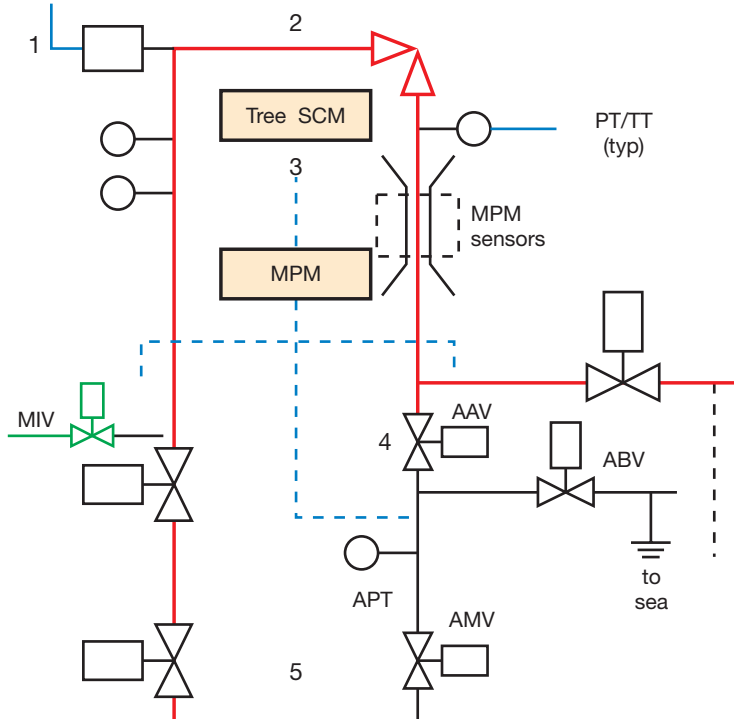


¹ Mean Time Between Failures

² Horizontal Tree

2 Schematic representation of the LIFT tree system (base case). Features include a simpler, non-insert choke (1), elimination of swab valves (2), significantly fewer hydraulic couplers (3), a combined annulus access and crossover valve (4), and a smaller block forging (5)

- AAV *Annulus access valve*
- ABV *Annulus bleed valve*
- AMV *Annulus master valve*
- APT *Annulus pressure transducer*
- MIV *Methanol injection valve*
- SCM *Subsea control module*
- MPM *Multi-phase flow meter*
- PT/TT *Pressure/temperature transducer*



of capital expenditure (CAPEX), operating (OPEX) and regularity (REGEX).

Lower CAPEX results from, eg, a combination of reduced hardware and simpler hardware interfaces, as well as (see **2**):

- Use of a simpler, non-insert choke
- No swab valves
- Combined annulus access and crossover valve
- Significantly fewer hydraulic couplers
- Simpler construction / integral subsea control module (including optional MPM controls)
- Smaller block forging

However, in the base case analyzed the CAPEX contribution (CAPEX being nominally 15–20% less than that for the conventional tree hardware) was only nominally 10% of the total LCC savings,

the more significant amount being attributable to lower OPEX and REGEX.

The lower OPEX is principally due to:

- Improved MTBF. This is a direct consequence of the described reduction in hardware and interfaces.
- A lower-cost intervention vessel can be used for component change-out. This is because of the compactness of the upper module that is made possible by component integration, resulting in a nominal weight in air of only 6 to 7 tonnes; hence, it can be deployed, via crane wire, from a wide range of service vessels, with ROV assistance.

The lower REGEX results mainly from:

- Improved tree sensor availability. This assumes that reservoir and well-management philosophy is dependent

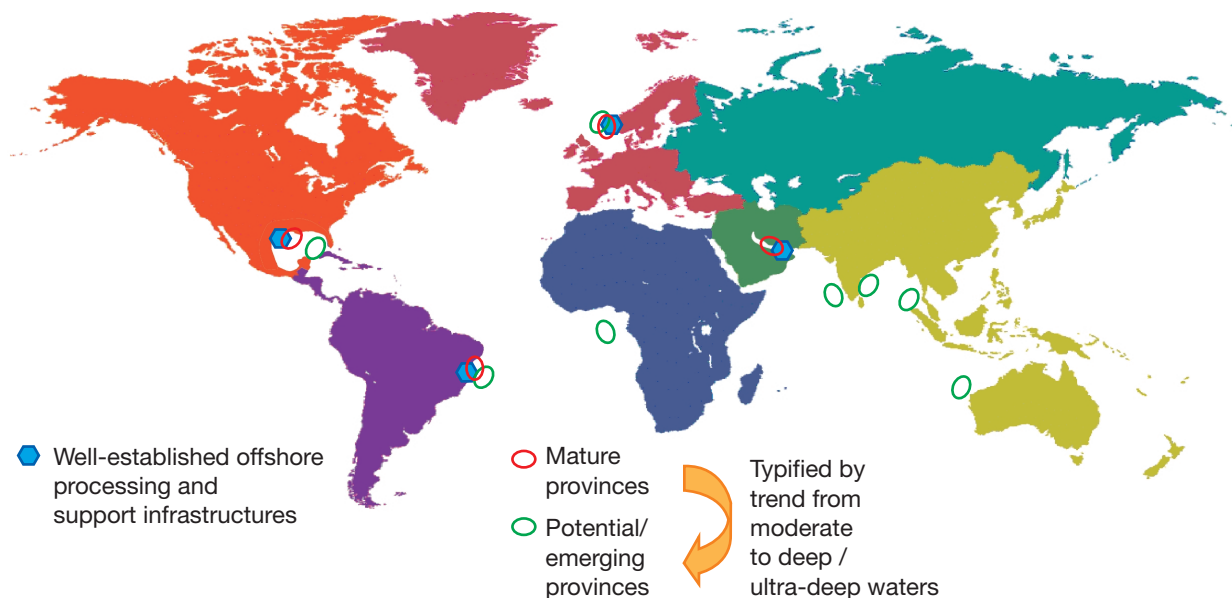
upon sensor availability, and that the higher sensor availability resulting from the RAM analysis (based on ease of access for change-out) translates into reduced production downtime in practice.

- Higher ‘opportunity’ maintenance. This is linked to the above, but is the result of retrieval of the upper module in response to SCM or choke malfunction (since these are predicted to have a lower MTBF than the sensors themselves) enabling sensor replacement before failure. Thus, taking advantage of the opportunity maintenance can contribute to sensor availability.

Multi-phase flow meter option

A byproduct of the design configuration of the upper module is that it readily lends itself to cost-effective integration of a multi-phase flow meter. This has the

3 Typical global offshore market segregation. A Customer Forum is currently exploring the possibility of LIFT applications in mature as well as deepwater frontier regions.



potential to contribute further to field LCC economies, given the attendant advantages that come from the reduced need for process hardware (ie, test lines and separators).

While this has not been factored into the LCC analysis, on which the savings have been formally evaluated to date, the necessary design work has been undertaken with one manufacturer to establish the technical solution and interfacing. This was accomplished within the envelope of the main body forging of the upper module.

Accordingly, it is considered that this provides a very cost-effective means of adding an MPM. In addition, given the ease of upper module recovery on which LIFT is founded, users can opt to 'upgrade' by means of a simple retrofit onto any LIFT tree (ie, by replacing the

upper module only, since it is interchangeable). This may be beneficial later in field life, for example as water cut becomes more predominant. LIFT therefore provides more flexible tree system architecture, with minimum cost and disruption.

Customer Forum

A Customer Forum is presently being organized to further challenge and validate the LIFT concept and its potential for LCC savings.

The Forum will explore the relevance of the LIFT concept attributes from the customers' perspective, and consider applications in both mature provinces as well as deepwater frontier regions **3**.

It is anticipated that the perspective of what constitutes 'added value' with regard to the emphasis placed on the balance

between CAPEX savings and factors contributing to OPEX/REGEX savings (eg, intervention frequency, reservoir management/shutdown philosophy) will vary quite significantly between applications and operators. Therefore, this needs to be comprehensively understood, and the Forum will provide valuable feedback to test breadth of market application in that context, in advance of product commercialization.

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