Light Well Intervention Vessel (LWIV) Well Abandonment

(Output from ITF Theme Day, Aberdeen)

Collaborative Approach to Technology Investment

The Industry Technology Facilitator (ITF) is a not for profit organisation owned by, and with access to funds from major oil and gas operating and service companies that comprise its membership. ITF has an impressive track record in delivering finance to help develop new initiatives for oil and gas technologies from early stage joint industry projects (JIPs) through to field trials and commercialisation. Since 1999, ITF has supported over **140** projects worth in excess of **£40 million** in funding. ITF's key objectives are to identify technology needs, foster innovation and facilitate the development and implementation of new technologies.

A fundamental element of ITF's role as an internationally recognised champion for facilitating research, development and deployment of technology innovation within the upstream oil and gas industry is to engage with key industry sources. ITF uses a proven process, working in collaborative participation with both its Members and industry to identify technology needs and potential solutions.

The ITF process, illustrated below as a step-by-step course of actions, endeavours to bridge the gap between the industry's large global players and development community with the ultimate aim of implementing new technology solutions:

STEP 1 - Understand and Identify Technology Needs
STEP 2 - Engage the Development Community / Invite Proposals
STEP 3 - Evaluate Proposal Submissions
STEP 4 - Secure Funding
STEP 5 - Assist the Launch of JIPs
STEP 6 - Facilitate the Implementation of Technologies

ITF has contractual confidentiality arrangements with all its Members and will enter into a parallel agreement with all developers submitting proposal applications. Proposals will be submitted to our Members only for the purpose for which they are provided, i.e. assessment for funding support and implementation.

Proposals submitted under this Theme will be reviewed for financial sponsorship by **all ITF Members** therefore this is an excellent opportunity to gain access to a global audience in seeking support for your technology. The focus of all ITF themes is to identify technologies which bring clear benefits to sponsors but which require assistance in **research, development, and / or field trial.**

For details of ITF's full Portfolio of Members, please visit our Website - www.oil-itf.com

Background to the Theme

In line with the industry's focus on Well Abandonment, this Call for Proposals is the collective output of an ITF 'LWIV Well Abandonment' Theme Day was held in Aberdeen on 1st July 2009 aimed at tackling the technology issues surrounding the use of Light Well Intervention Vessels (LWIV) for well abandonment.

By bringing together a number of the industry's major operator and service companies, this theme day discussed a number of the challenges facing the industry with a view to stimulating innovative technology solutions to have a significant impact in the area of utilising LWIV for well abandonment.

A recent UK North Sea Well Abandonment Study (Issue 3 Nov 2008) commissioned by UK Oil and Gas concluded that in the subsea well abandonment sector existing technology is capable of performing a rigless abandonment approach using Well Intervention Vessels, for approximately 554 wells (61% of UK North Sea subsea wells). An additional 220 wells (24% of subsea wells) could potentially be undertaken in a rigless manner, if new technology is developed.

The requirements for Well Abandonment are governed by the "Guidelines for Suspension and Abandoned of Wells", Version 3, March 2009, issued by Oil & Gas UK.

Challenges such as removal of gauge cables, well head removal, verification of permanent barriers and annulus cementation are some of the key issues identified facing the industry in this sector. The aspiration is to reduce the use of Rigs for Plug & Abandonment (P&A) through increased use of LWIV which could result in significant cost savings in the permanent abandonment of wells.

The Theme Day included an intensive, facilitated workshop which brought together over 100 professionals and experts from ITF membership, operators, service companies, small and medium-sized enterprises, and research and academia. This wide variety of attendees discussed the challenges faced within the area of 'LWIV Well Abandonment'; the output of these discussions has formed the basis of this Call for Proposals.

Theme Timeline

Each ITF Theme follows a nine month timeline from Theme Day to Theme Completion. The following list of tasks describes the key milestones and their associated date:

Theme Start / Theme Day	1 Jul 2009
Call for Proposals Issued	September 2009
Deadline for Receipt of Proposals	***late Oct 2009***
Publish to Members for Review	November 2009
Member Review and Voting	December 2009
Technical Clarification Meeting	January 2010
Members finalise commitment to sponsor	Feb/March 2010

Open Invitation to Global Technology Developers

This document aims to stimulate proposals from global development expertise to meet the specific challenges identified to enable a Light Well Intervention Vessel (LWIV) to carry out subsea Well Abandonment. The main driver for using a LWIV is that cost savings of up to 50% could potentially be achieved compared to a conventional rig or MODU (mobile offshore drilling unit).

The use of a LWIV for well abandonment does however, impose a number of operating limitations when compared to a conventional rig:

- There is currently no capability to deploy a marine riser and hence no circulation path (i.e. no returns to surface other than via a small diameter hose)
- Cannot pull the completion tubing or casing strings due to the inability to deploy a BOP and large diameter marine riser
- The LWIV is currently limited to wireline operations only, enabled by subsea well intervention systems e.g. subsea lubricator.
- No coiled tubing capability currently exists and is several years from being commercially available.

Accordingly, these limitations severely restrict the ability to run and rotate strings of jointed pipe as normally carried out in a rig based abandonment operation.
It is against this background that an open invitation is extended to any organisation (or consortia of organisations) to submit proposals seeking sponsorship for research, development, and / or field trials of innovative technologies or technical solutions related to the six challenges (A-F) which have been identified by the ITF Members in relation to using LWIV for well abandonment (refer also to appendix):

Challenge	Title	Summary
Challenge A	Solving the Cable Issue	Ability to remove the gauge cable secured to the outside of Completion tubing in order to meet Oil and Gas UK Guidelines
Challenge B	Logging Through Tubing	Ability to identify / Confirm what fluids or other materials (cement) are in each annulus, the condition of the tubing and casing strings, and where the top of good cement is in each annulus
Challenge C	New Materials Challenge	Development and qualification of a reduced cost alternative material (to cement) with suitable properties for the plugging and abandonment of oil and gas wells
Challenge D	Tagging And Verification Of Cement Plugs With Wireline	Ability to verify the location of the permanent barrier where coiled tubing or jointed pipe is not available
Challenge E	Cementing Multiple Annuli	Ability to place cement in the B & C annuli with the completion tubing still in place
Challenge F	Wellhead Removal	Ability to remove the wellhead with the completion tubing still in place (i.e. cut through production tubing as well as the 9 5/8", 13 3/8", 20" & 30"/36" casing strings a minimum of 10ft below the seabed)

The six challenges are discussed in more detail within the next section "Specific Technology Requirements" of this document.

This is an open invitation to any organisation with innovative solutions in the oil and gas industry to submit proposals for research, development, and / or field trial in the following areas, associated with the identified needs.

This invitation also welcomes proposals from consortia of organisations where the relevant expertise of each organisation has a valuable input into providing the overall most innovative and best practical solution.

The method for submitting a proposal is described later in this document but you can also learn how to submit a proposal by going to our website www.oil-itf.com

Note:
For clarification purposes BP have agreed to the distribution of the presentation delivered at the Theme Day on 1st July 2009.

This can be found on the ITF Website by accessing the following link:-

http://www.oil-itf.com/index/cms-filesystem-action/calls/lwiv-wa-call-presentation.pdf

Specific Technology Requirements

(Any submitted proposal ***must*** address one or more of the following identified requirements)

Challenge A: SOLVING THE CABLE ISSUES

Background:

The Oil & Gas UK guidelines stipulate that a permanent abandonment plug is to be set in a well for isolation purposes. However, it further states that 'cables and control lines should not form part of permanent barriers, since they may be a potential leak path. This includes electrical cables, pressure gauge cables, control lines, fibre optic cables or any such device that runs parallel to the tubing. Any of these could be bare or encapsulated either as a single item or as a collection of cables. These cables or control lines could be deep in the well or higher up, but what is relevant is that they are within the boundaries of the permanent barrier.

The challenge lies in how to install a qualified, permanent, abandonment barrier in a well that has cables or control lines in the annulus without using a rig to remove the completion tubing (and so remove the cable simultaneously).

Requirements:

- Means to remove at least 200ft, preferably 800 ft, of the gauge cable on the OD of the completion tubing across the plug setting depths without removing the tubing

Or

- Development of a material that can 'self heal' as the cable/control line degrades over time maintaining a seal

Or

- Method for removing the required amount of tubing (and cable / control line) across the area in which a permanent barrier is required to be set

Considerations:

- Can cable breaks be created?
- Can the cable be cut or destroyed in sections?
- Can cable movement / rotation be managed?
- Confirmation of the cable leak path - either within it or outside it?
- Can cable manufacturers assist with knowledge of leakage issues and on methods of cable destruction?
- Development and qualification of a barrier plug that can contain the cable/control line that can be accepted by the industry?
- Removal of the tubing will require a pipe handling system which is generally not available on LWIVs.

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Challenge B: LOGGING THROUGH TUBING

Background:

The optimal strategy is to abandon wells through tubing using LWIVs as this will result in time and cost savings. In order to do this, confirmation of what fluids or other materials (cement) are in each annulus, the condition of the tubing and casing strings, and where the top of good cement is in each annulus is required.

Note: This issue is applicable to subsea, platform and land wells.

Requirements:

- Development of a logging tool that when run through the tubing would sense and confirm:
  - Fluid in tubing (gas, water, brine, oil)
  - Tubing condition (steel, may be stainless, or be corroded, connections)
  - A-annulus fluid (water, brine, oil, residue)
  - Casing condition (steel, may be corroded, connections)
  - B-annulus fluid (cement, drilling mud and spacers, brine, gas, oil, channels, cracked cement, micro annulus on casings or formation)
  - Formation (e.g. shale, sand, limestone, salt), or further casing, cemented or not.

Considerations:

- Tool would need to be sized to run through tubing and jewellery restrictions (Tubing outside diameter 2.7/8" - 7")
- Ability to sense tubing and casing condition (outside diameters range from 2 7/8" to 13.3/8" - If possible reading out to 30" and beyond would be desirable)
- Ability to sense 6" - 18"+ into the formation (including possible washouts)
- Pressure range 5ksi -10ksi (<15ksi optional)
- Temperature range <121degC (<150degC or higher temperature rating also desirable)
- Compatibility with fluids (oil, brine, seawater, gas, possibly H2S, N2, CO2)
- Conveyance (electric line or slick line), memory recording acceptable
- Consideration will need to be given to the method of telemetry and/or memory capacity
- Safe handling of the tool on surface
- Calibration and proof of concept against current cement bond logs
- No HSE hazards e.g. radioactive sources, hazardous chemicals, explosives
- Combine with other tools, e.g. CCL & Gamma Ray for depth correlation
- Alternative ideas are invited such as acoustic, EM and ideas from other sectors such as medical, which could be adapted to the downhole environment

Challenge C: NEW MATERIALS CHALLENGE

Background:

It is argued that there are currently alternative materials with better properties to conventional cement for plugging and abandonment of oil and gas wells.

The Oil & Gas UK guidelines require materials that are non-brittle, have long term integrity, are resistant to downhole fluids and gases, ductile, flexible, non-shrinking, bonding and has low permeablity.

Conventional cement does not completely fulfil these requirements, but is still used because of convention and precedent. As a result, large volumes of cement are pumped to provide sufficient redundancy.

Materials that provide better sealing properties and are placed more reliably, could allow for less excess being pumped, hence shorter plugs. Shorter plugs may then be an enabler for solving Challenges A and E.

Some alternative materials are already available, but there is a difficulty in acceptance by the market because of inherent problems of qualification.

Requirements:

- Development and qualification of a reduced cost alternative material (to cement) with suitable properties for the plugging and abandonment of an oil and gas wells.

Considerations:

- Drivers for change that should be taken into account include reduced cost, material properties (physical and chemical), integrity, controlled setting time, permeability, degradation, ISO standards, strength, well conditions and ease of placement
- Potential suitable materials include:
  - Amber / Polymer (Thermosetting)
  - Silicone Elastomer (Free of solid matter, swells, elasticity)
  - Grouts and setting Muds (Catalyst to set drilling fluids)
  - Resins (epoxy, phenolic, polyacrylate, polyester, silicon)
  - Clay gels (bentonite, synthetic)
  - Berylium/Tin alloy
  - Phosphate ceramics
- Establish a set of defined criteria to allow proper comparison of materials
- Establish accelerated ageing tests to prove “permanence” of sealing for cement Vs alternative materials
- Verifiable weight tests - that can be easily achieved downhole from a LWIV?
- Interaction of “new” materials with residual material in the wellbore (e.g. old cement, and bonding issues if the cleaning process has not been fully successful (e.g. reaction to “sludge”)
- Non-particle materials are promising for injection to repair failed cements, as identified by logging tools as described in Challenge B

Challenge D: TAGGING AND VERIFICATION OF CEMENT PLUGS WITH WIRELINE

Background:

The Oil & Gas UK guidelines stipulate that 'Any Permanent Barrier should be verified to ensure the barrier is placed at the required depth and will have the required sealing capability'.

The permanent barrier can be verified to confirm its strength (with a surface sample) and to confirm its sealing capability (through pressure / inflow test). However, as a LWIV is typically limited to wireline, the position of the cement is more difficult to confirm due to the potential for cement stringers holding up the tool string above the actual top of cement.

Requirements:

- Means to verify the position of the permanent abandonment plug should coiled tubing / jointed pipe not be available on the LWIV.

Considerations:

- Avoidance of cement stringer formation through the use of alternative barrier fluid
- Avoidance of cement stringer formation through new wiper darts / non-wearing foam balls. ***Note:*** These would need to pass through a 1" umbilical and potentially expand up to 5"
- Development of a slickline or e-line logging tool with a downwards looking sensor, which would help to recognise the top of the cement plug in the tubing and potentially in the annulus
- A reliable mechanical means to tag the top of cement using wireline
- Use of flow monitoring to assess total volumes in/out, and potential losses, taking into account the uncertainty of downhole geometry

Challenge E: CEMENTING MULTIPLE ANNULI

Background:

In accordance with Oil & Gas UK well suspension and abandonment guidelines, all distinct permeable formations penetrated by the well must be isolated from each other and from the surface. In order to isolate a shallow permeable sand formation from surface it is often necessary for the abandonment cement plug to extend laterally across the entire well bore (into the A, B and C annuli).

Unlike platform wells, typical subsea wellhead / casing hanger arrangements do not allow for circulation into the B and C annuli as these are sealed at the casing hanger with no annulus outlet at the wellhead. Therefore, circulation is only possible via the production tubing and the A annulus.

Circulation into the B and C annuli can only be achieved via penetration / severance of the casing strings and the use of downhole packer / straddle arrangements.

There is recognition that this challenge will require a combination of existing and/or new technologies and methodologies.

Requirements

- Means to selectively place and verify a minimum of 100ft MD (typically 500ft) of good cement into the A, B & C annuli of a well.

Considerations:

- Consider explosive or alternative method to create a circulation path into the B and C annuli, i.e. mechanical punch, plasma cutter, etc.
- Develop a reliable verification method:
  - circulation path via either B or C annulus following perforation
  - thickness of tubing
  - height of plug
  - what has been achieved versus what was planned
- Develop logging technology to assess condition of outer casing strings (corrosion) and proximity of casing strings, i.e. eccentricity
- Typically limited to wireline deployed solution on a LWIV although Coiled Tubing deployed methods should also be considered

Challenge F: WELLHEAD REMOVAL

Background:

The Oil & Gas UK guidelines stipulate that 'Redundant subsea equipment must not present a hazard to other users of the sea. It is an OSPAR requirement to retrieve all casing strings to a minimum of 10ft below seabed'. The removal of subsea wellhead with 4 ½" tubing requires severance of typically 4.5" - 7" tubing and the 9 5/8", 13 3/8", 20" and 30 or 36" casing strings at a minimum of 10ft below seabed to be in-line with industry guidance.

Requirements:

- Means to cut through the completion tubing as well as the 9 5/8", 13 3/8", 20" & 30"/36" casing strings a minimum of 10ft below seabed in order to allow the wellhead to be retrieved to surface using an LWIV

Considerations:

- Method of tubing hanger removal using LWIV
- Technology that can be executed through the completion tubing at any depth.
- Review potential to miniaturise current tools
- Develop smart explosives
- Evaluation of potential cutting techniques:
  - Mechanical Cutters, Hot Cut, Plasma, Chemical Cutters, Anode Acceleration, Rotating Electrode, etc
- Proving wellhead is cut - Verification of explosive cutting is currently only possible once cut is complete
- Removal of Cement Pancake around Wellhead - After cutting wellhead recovery may be impacted by the adhesion of soil or cement located outside the casing at the seabed level. Ideas to address this either as part of the wellhead cut or using a separate tool
- Equipment to handle severed wellhead and stump assembly at surface on the vessel

Process for Submitting a Proposal

1. **Register Interest with ITF**
   Register your interest as early as possible by sending an email to Ryan McPherson at r.mcpherson@oil-itf.com

2. **Visit the ITF Website -** www.oil-itf.com
   On the ITF Home page, click on the "How to Submit a Proposal" button or follow this link to access all the information required to submit a proposal.

3. **Read the 'Project Application Guidance' Document**
   This document is available to view or download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website. Reading this document prior to submitting a proposal is essential. If you require further clarification or are unsure if your proposal is suitable for submission, please call ITF (ITF Contact Information appears later).

4. **Download and Complete the 'Project Application Form'**
   This form is available to download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website.

5. **Download and Complete the 'Project Presentation Template'**
   This template is available to download from the 'ITF Downloads' / 'Proposal Submission' section of the ITF Website.

6. **Email the Completed 'Project Application Form' and 'Project Presentation Template' to ITF**
   Email the Completed 'Project Application Form' in Microsoft Word format (not PDF) and the 'Project Presentation Template' in Microsoft PowerPoint format (not PDF) to Ryan McPherson at r.mcpherson@oil-itf.com by **no later than 30th October 2009**. Proposals received after this date may not be processed.

Qualifying Technologies

In order to qualify for potential sponsorship, technologies submitted in response to this Call for Proposals must:

- be applicable to at least one of the identified requirements
- be novel or innovative
- demonstrate a clear business case for support
- have a clear and demonstrable path to commercialisation and implementation
- be capable of being developed by the proposer(s)

Note: Proposals submitted to any other ITF Call in the past nine months or any previously unsuccessful applications should not be resubmitted without first consulting ITF (contact information provided later in this document).

Qualifying Organisations

Proposals are invited from any organisation including SME's, academia, research institutions, large organisations, consortiums or alliances. Proposals may be submitted by a national or international organisation, and equal opportunities will be extended to all proposers. Please keep in mind however that should your proposal be taken forward, you will be required to participate in meetings and make presentations to interested parties in the UK and in the English language (teleconference and video conference are acceptable).

ITF Contact Information

If you would like to discuss any matters related to this call or any other issue related to ITF, please contact any of the following people:

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