EuoAG Workshop

Workshop on decommissioning of offshore installations
Challenges, options and lessons learned – PP&A

Johnny Gundersen Principal Engineer, PSA Norway
Content

• Requirements for PP&A in Norway
• Main challenges (both industry and authorities)
• Available options (existing technologies and implemented new methods)
• New techniques for PP&A
• Lessons learned
Regulation
Principal features of the regulations

• The regulations are based on performance (functional) requirements, which:
  • give the industry the freedom to choose its own good solutions
  • underpin the allocation of responsibility
  • refer to norms and industry standards, providing predictability for users and indicating the standard which solutions are expected to meet.

• The regulations require the companies to set risk targets and to manage their operations in relation to these.
Framework for Drilling & Well

- **Legal level requirement:**
  - Framework Regulations
  - Management Regulations
  - Facility Regulations
  - Activity Regulations

- **Guidance level**
  - Guidance for Framework Regulations
  - Guidance for Management Regulations
  - Guidance for Facility Regulations
  - Guidance for Activity Regulations

- **Some references to Standards in guidance to regulations:**
  - NORSOK D-001 Drilling facilities, revision 3
  - NORSOK D-002 System requirements well intervention equipment, revision 2
  - NORSOK D-007 Well testing system, revision 2
  - NORSOK D-010 Well integrity in drilling and well operations, revision 4
  - DNV-OS-E101, Drilling Plant, October 2013
  - NORSOK U-001 Subsea production systems, revision 3
  - Norwegian Oil and Gas’ guideline No. 081

- **Informative and normative references in standards:**
Plug and abandonment-requirements

- **General requirements:**
  - All wells shall be secured before they are abandoned so that well integrity is safeguarded during the time they are abandoned.
  - Well barriers shall be designed such that unintended well influx and outflow to the external environment is prevented, and such that they do not hinder well activities.
  - When plugging wells, it shall be possible to cut the casings without harming the surroundings.
  - The well barriers shall be designed such that their performance can be verified.
Challenges
General Industry Challenges related to PP&A:

• Old and poorly maintained equipment on some of the platforms
• Technical **challenging, complicated and time consuming**
  - **high cost** operations
• Establish robust solutions that **will last** «for ever»
• **Suitable** equipment and methods
• **Timing** (not postpone all the wells)
• **Cost** of PP&A
• Credible verification of necessary quality, suitability and durability of the barriers
A) Isolation of permeable Zones

- Well barriers shall be designed such that well integrity is ensured and the barrier functions are safeguarded during the well's lifetime (Facilities regulation § 48).
  - Well barriers shall be designed such that unintended well influx and outflow to the external environment is prevented

- Discussion:
  - Which zones has to be sealed of by barriers?
    - Thickness/height of zone, permeability, type of fluid, flow potential?
  - What about leakages outside the wellhead?
    - Shallow gas/water?
    - Other?
B) Temporary abandoned wells

• How long could wells be temporary abandoned?
  - We feel it is necessary to control the number of temporary abandoned wells on the NCS and survey this regularly
  - Change in the 2014 regulation:
    - Appraisal wells shall not be temporary abandoned for longer than 2 years. If production wells are to be temporary abandoned for more than 3 years, hydrocarbon filled zones shall be permanently plugged and abandoned within 2 years (Activity regulation § 88)
    - Requirement is not retroactive ): not valid for wells temporarily abandoned before 2014
  - Norsok D-010 has changed the definition of temporary abandoned wells - Wells with monitoring and wells without monitoring
    - For Wells with monitoring there is no maximum temporary abandonment period
C) Final pressure in the well

- Discussion of what is the maximum final pressure to be expected in the well after P&A (used for designing the plug depth)?
  - Driven by the discussion of how many plugs/barriers to be set in the well and how deep to set the plugs
  - Could imply milling/pulling casing to get down to the required depth to place the necessary plugs to control pressure
  - In some wells the barrier could not be established deep enough
- Different practice among the operators:
  - Use virgin reservoir pressure
  - Pressure calculated by a model
D) P&A by vessels

• **What could** be done by a vessel:
  - In Norway we have seen a lot of talk about such solutions
  - So far only cutting and removing well heads by vessels
  - New equipment being developed to do deeper and more challenging P&A operations
  - Challenges with regard to pressure control
  - Challenges pulling tubing/casing
  - Vessel/installation?
  - Verification of barriers
  - New installation being built to perform P&A (SUT)
E) Verification of barriers

- Todays verification methods are **not** good enough
  - Experiences with existing logging tools are inconclusive/variable/poor (CET, CBL/VDL etc)
  - Old cement logs are poor, impossible to evaluate or non existing
  - Today it is not possible to verify good cement for the second and third annulus when P&A'ing the well
  - No logging tools that can see through several casing available today
  - PWC with large perforations/many perforations – reduced quality of logging

- Requirement for better interpretation of logs in the standards or new ways of verification?
  - Alternative verification methods and qualifying such
  - Need for continuous monitoring of pressure below barriers?
F) Formation as barrier

- Establish decision criteria for formation as a barrier
- Document the ability of the formation to be a good barrier element
- Document the necessary height and horizontal reach of the formation to act as a barrier
- Understand and document the mechanism that lead to formation swelling/formation collapse around the casing
- Document that the formation will be a fully acceptable and ever lasting barrier
- Develop acceptable verification criteria, e.g. pressure testing/logging
G) Industry co-operation

- Each operating company working individually with solutions
- Patents instead of sharing experiences
- Increased costs
- Longer development time

Stop unnecessary discussions about the problems

Focus on the solutions
- Act jointly to develop better solutions
- Jointly qualification and testing
- More JIP
Options
Available Options

- Traditional PP&A
- Alternative Methods
- New Techniques
Alternative methods

- Expandable cement
- Sandaband
- Development in Milling
- PWC (https://www.hydrawell.no/product/hydrahemera/)
  - Swab cups
  - Jet flow
- Formation as barrier
Perf, Wash and Cement (PWC)

- Establish a Qualification Matrix
  - Set specific requirements for the job:
    - Casing, TCP, PWC details, mud, spacer, cement
- Verification
  - Verification based on established criteria:
    - First 2-3 PWC jobs to be drilled out and logged in a P&A campaign
    - Logs to be qualified by competent personnel
    - If logs confirm necessary barriers, logging could be omitted for the next wells as long as the job is done according to the Qualification Matrix
    - If deviation from the Qualification Matrix, the section should be drilled out and logged.
    - If poor cement/poor bonding, perform new job
New Techniques

- Industry main focus now is “reducing time and cost”
- Well Set (http://www.wellset.no/home)
  - Down hole pump below the P&A plug creating differential pressure
  - Magnetic related fluid for annulus barrier
  - New logging methods
- WellCem (http://www.wellcem.no/videos)
  - Resin (depleted reservoirs, annulus seal off)
- Use of tracers to test leakages over barriers inside casing/tubing (N₂, Helium, etc)
- Use of Bismuth plugs (http://www.bisn.com/bisn-video-portfolio/)
- PP&A with pumping cement through tubing
- PWC through several casings
- Thermite
Identified Technology needs

Roadmap for New P&A Technologies

- Optimize Perf Wash & Cement
- Optimize Milling
- Tubing left in hole
- LIV CT Pilot hole drilling/cementing
- Rig/Process optimization
- Ctrl line left in hole

- Alternatives to cement
  - Creeping shale / Formation effects
  - Sand/Rock/Natural materials
  - Chemical materials
  - Steel

- Well Intervention technology for P&A

- Improved Verification / Logging methods
  - Dual string: Cement bond logging Perf, Wash & Cement, Milling

- Rigless P&A
  - High Capacity CT System
  - High Energy Solutions (Melt/Burn)/Extreme Concept

- Wireless technology (subsea wellheads)

- Tender Support P&A rigs/Modular Rigs
Interwell – “Thermite solution”

- Mixture of iron oxide and aluminum set off at plug depth
- Burns with high temperature and melts formation, cement, mud, casing etc
- Forming some kind of “magma plug”
- Rig less approach
- No recovery of tubing
- No need for drill pipe while placing the barriers
- P&A performed on E-line

https://www.youtube.com/watch?v=LXeLWvhDhKI
Lessons learned
Lessons Learned

- Plans for P&A to be established earlier in the well design
- Establish “a good toolbox for PP&A”
- Establish background information for P&A
  - Regulatory Requirements
- Availability of Well- and Underground data
  - Future pressures build up in the reservoir
  - Experience transfer
- Establish strategy for permanent P&A
  - Status existing barriers (type of, height, condition, etc)
  - Depth and number of new barriers
- Methods for PP&A
- Verification of barriers
- Establish plans for operation
  - WL/CT/Existing Drilling Rig/Modul Rig/Jack-Up/boat
Lessons learned for PSA

• PSA:
  - Follow up of PP&A operations
  - Early involvement in PP&A techniques/methods/equipment
  - Early communication with the operators
  - follow up development of new methods/new equipment
  - Involvement in development of standards
  - Focus on qualification/verification/documentation of methods and barriers!
Incidents related to PP&A

- Increased number of incidents related to PP&A with increased number of wells PP&A
  - Before 2014 - none
  - 2014 – 5 incidents
  - 2015 – 6 incidents
  - 2016 – 1 incident
  - 2017 - 1 incident

- Incidents mainly minor and handled according to well control procedures
  - Kick after perforation of casing/tubing
  - Milling of packers
  - Pulling seal assembly
  - Perf, Wash and cement

- Serious well control incident during PP&A with S. Endurance on the Troll field

http://www.ptil.no//Tilsyn/Granskinger/2016Granskingsrapport
Thank you questions?

http://www.psa.no