International Association of Oil & Gas Producers

IOGP's PPFG and Report 476 Update

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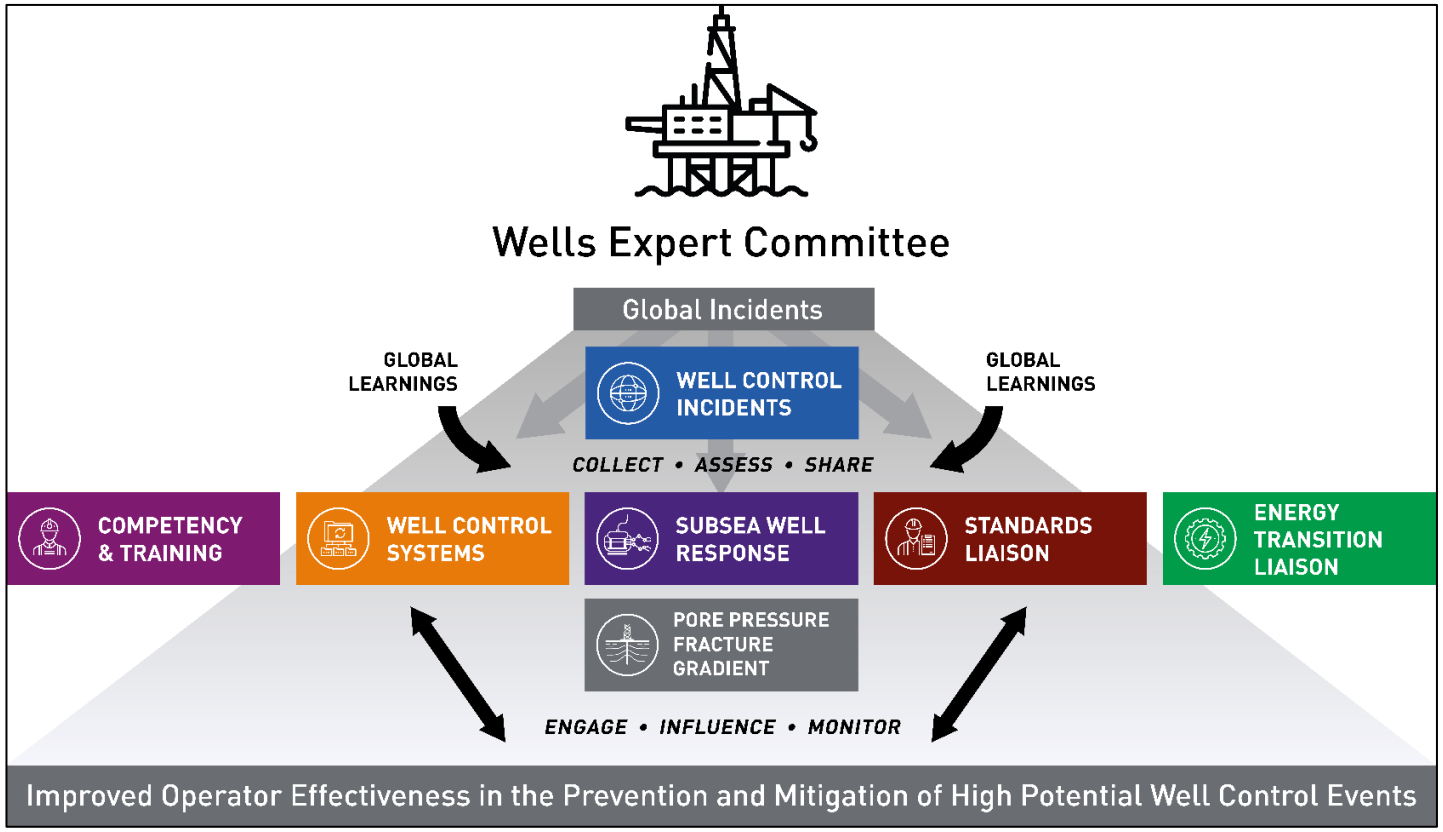
PSA Industry Day

18th January 2024

Wells Expert Committee (WEC)

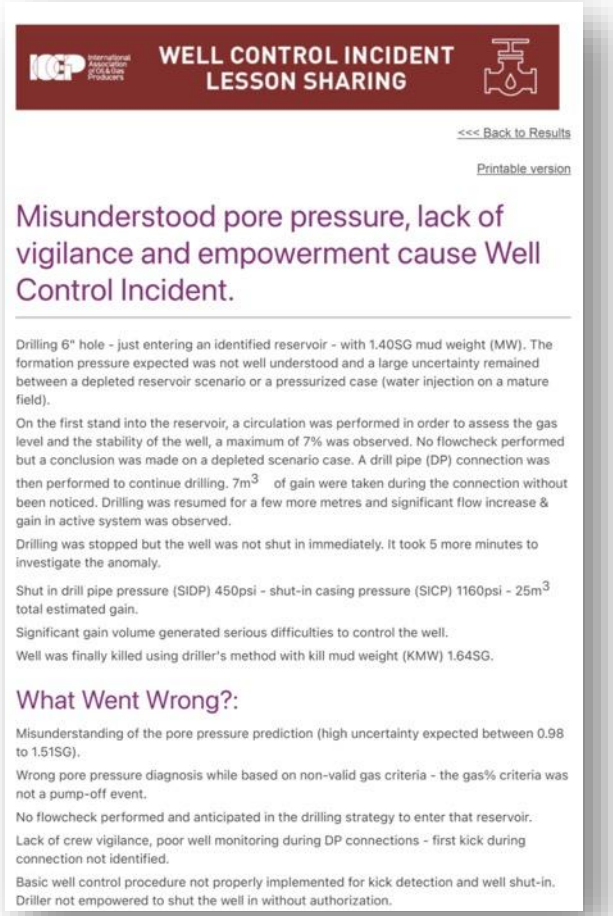
The purpose of the Wells Expert Committee (WEC) is to improve well Operators' effectiveness in the prevention and mitigation of high consequence well control events throughout the well life cycle, but particularly during well construction and well work, recognizing that such events pose the highest global risk to safety, to the environment, and to the industry's license to operate



Pore Pressure Fracture Gradient Expert Group

The purpose of the Pore Pressure Fracture Gradient is to develop an industry guidance document to describe the Well Control Hazard (Hydrocarbons Under Pressure) and through that help harmonize approaches to this critical task in the Well Control bow tie.

PPFG related WCIs



WELL CONTROL INCIDENT LESSON SHARING

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Printable version

Misunderstood pore pressure, lack of vigilance and empowerment cause Well Control Incident.

Drilling 6" hole - just entering an identified reservoir - with 1.40SG mud weight (MW). The formation pressure expected was not well understood and a large uncertainty remained between a depleted reservoir scenario or a pressurized case (water injection on a mature field).

On the first stand into the reservoir, a circulation was performed in order to assess the gas level and the stability of the well, a maximum of 7% was observed. No flowcheck performed but a conclusion was made on a depleted scenario case. A drill pipe (DP) connection was then performed to continue drilling. $7m^3$ of gain were taken during the connection without been noticed. Drilling was resumed for a few more metres and significant flow increase & gain in active system was observed.

Drilling was stopped but the well was not shut in immediately. It took 5 more minutes to investigate the anomaly.

Shut in drill pipe pressure (SIDP) 450psi - shut-in casing pressure (SICP) 1160psi - $25m^3$ total estimated gain.

Significant gain volume generated serious difficulties to control the well.

Well was finally killed using driller's method with kill mud weight (KMW) 1.64SG.

What Went Wrong?:

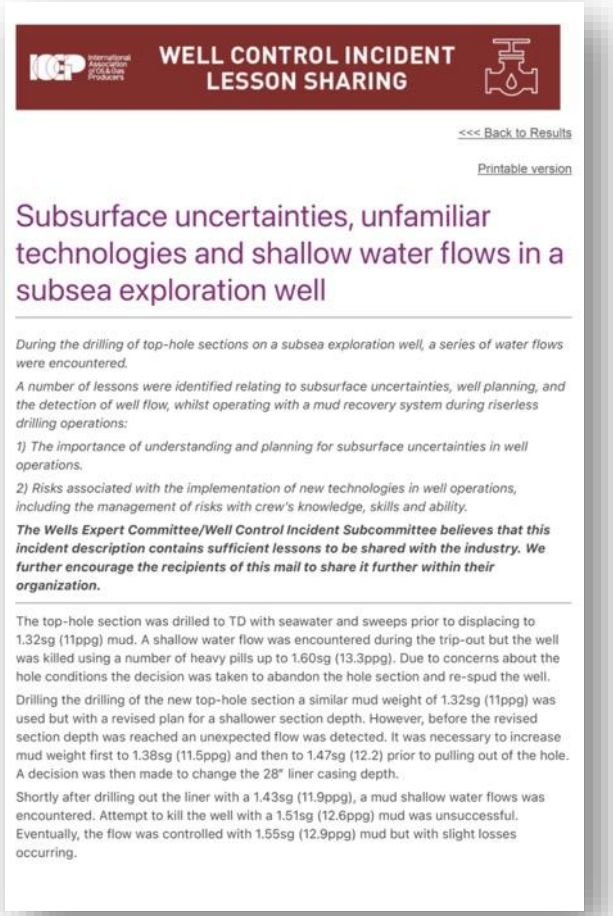
Misunderstanding of the pore pressure prediction (high uncertainty expected between 0.98 to 1.51SG).

Wrong pore pressure diagnosis while based on non-valid gas criteria - the gas% criteria was not a pump-off event.

No flowcheck performed and anticipated in the drilling strategy to enter that reservoir.

Lack of crew vigilance, poor well monitoring during DP connections - first kick during connection not identified.

Basic well control procedure not properly implemented for kick detection and well shut-in. Driller not empowered to shut the well in without authorization.



WELL CONTROL INCIDENT LESSON SHARING

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Subsurface uncertainties, unfamiliar technologies and shallow water flows in a subsea exploration well

During the drilling of top-hole sections on a subsea exploration well, a series of water flows were encountered.

A number of lessons were identified relating to subsurface uncertainties, well planning, and the detection of well flow, whilst operating with a mud recovery system during riserless drilling operations:

1) The importance of understanding and planning for subsurface uncertainties in well operations.

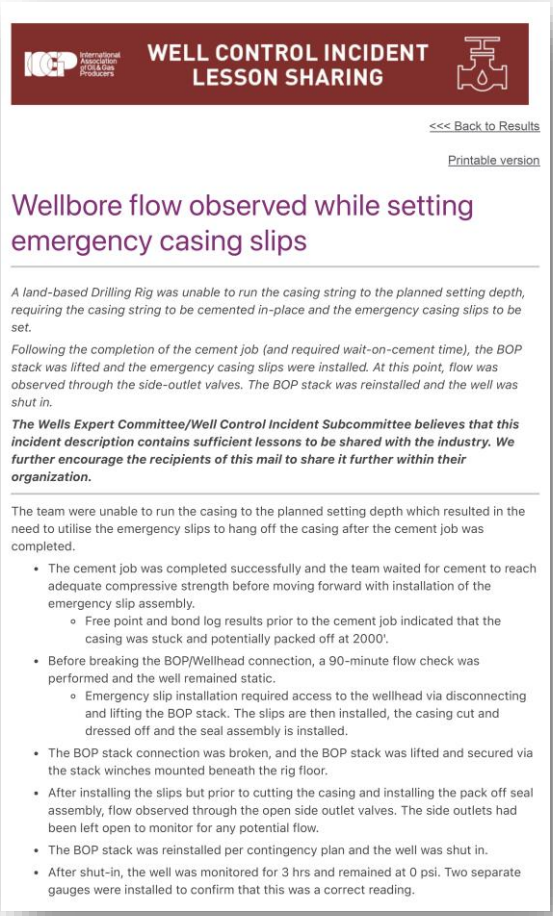
2) Risks associated with the implementation of new technologies in well operations, including the management of risks with crew's knowledge, skills and ability.

The Wells Expert Committee/Well Control Incident Subcommittee believes that this incident description contains sufficient lessons to be shared with the industry. We further encourage the recipients of this mail to share it further within their organization.

The top-hole section was drilled to TD with seawater and sweeps prior to displacing to 1.32sg (11ppg) mud. A shallow water flow was encountered during the trip-out but the well was killed using a number of heavy pills up to 1.60sg (13.3ppg). Due to concerns about the hole conditions the decision was taken to abandon the hole section and re-spud the well.

Drilling the drilling of the new top-hole section a similar mud weight of 1.32sg (11ppg) was used but with a revised plan for a shallower section depth. However, before the revised section depth was reached an unexpected flow was detected. It was necessary to increase mud weight first to 1.38sg (11.5ppg) and then to 1.47sg (12.2) prior to pulling out of the hole. A decision was then made to change the 28" liner casing depth.

Shortly after drilling out the liner with a 1.43sg (11.9ppg), a mud shallow water flows was encountered. Attempt to kill the well with a 1.51sg (12.6ppg) mud was unsuccessful. Eventually, the flow was controlled with 1.55sg (12.9ppg) mud but with slight losses occurring.



WELL CONTROL INCIDENT LESSON SHARING

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Wellbore flow observed while setting emergency casing slips

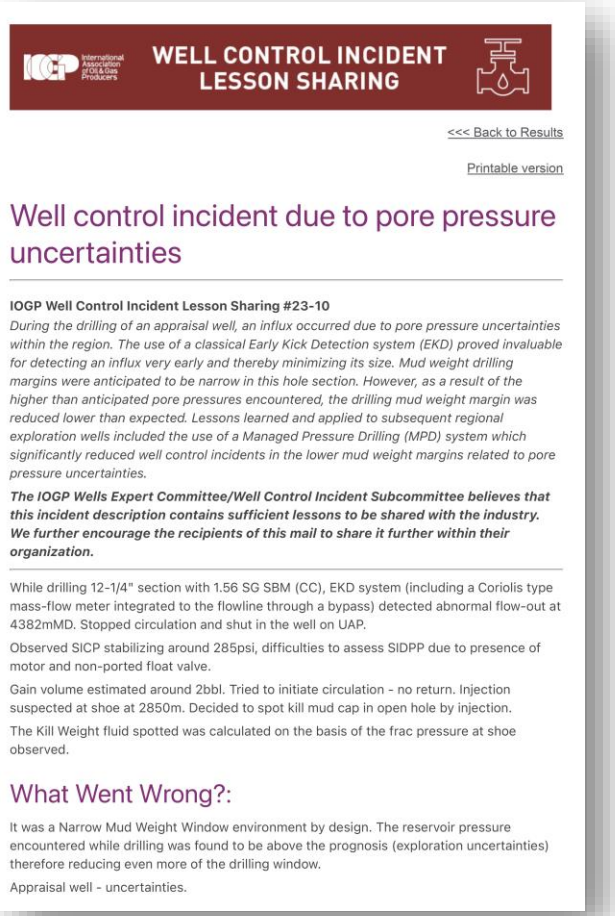
A land-based Drilling Rig was unable to run the casing string to the planned setting depth, requiring the casing string to be cemented in-place and the emergency casing slips to be set.

Following the completion of the cement job (and required wait-on-cement time), the BOP stack was lifted and the emergency casing slips were installed. At this point, flow was observed through the side-outlet valves. The BOP stack was reinstalled and the well was shut in.

The Wells Expert Committee/Well Control Incident Subcommittee believes that this incident description contains sufficient lessons to be shared with the industry. We further encourage the recipients of this mail to share it further within their organization.

The team were unable to run the casing to the planned setting depth which resulted in the need to utilise the emergency slips to hang off the casing after the cement job was completed.

- The cement job was completed successfully and the team waited for cement to reach adequate compressive strength before moving forward with installation of the emergency slip assembly.
  - Free point and bond log results prior to the cement job indicated that the casing was stuck and potentially packed off at 2000'.
- Before breaking the BOP/Wellhead connection, a 90-minute flow check was performed and the well remained static.
  - Emergency slip installation required access to the wellhead via disconnecting and lifting the BOP stack. The slips are then installed, the casing cut and dressed off and the seal assembly is installed.
- The BOP stack connection was broken, and the BOP stack was lifted and secured via the stack winches mounted beneath the rig floor.
- After installing the slips but prior to cutting the casing and installing the pack off seal assembly, flow observed through the open side outlet valves. The side outlets had been left open to monitor for any potential flow.
- The BOP stack was reinstalled per contingency plan and the well was shut in.
- After shut-in, the well was monitored for 3 hrs and remained at 0 psi. Two separate gauges were installed to confirm that this was a correct reading.



WELL CONTROL INCIDENT LESSON SHARING

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Well control incident due to pore pressure uncertainties

IOGP Well Control Incident Lesson Sharing #23-10

During the drilling of an appraisal well, an influx occurred due to pore pressure uncertainties within the region. The use of a classical Early Kick Detection system (EKD) proved invaluable for detecting an influx very early and thereby minimizing its size. Mud weight drilling margins were anticipated to be narrow in this hole section. However, as a result of the higher than anticipated pore pressures encountered, the drilling mud weight margin was reduced lower than expected. Lessons learned and applied to subsequent regional exploration wells included the use of a Managed Pressure Drilling (MPD) system which significantly reduced well control incidents in the lower mud weight margins related to pore pressure uncertainties.

The IOGP Wells Expert Committee/Well Control Incident Subcommittee believes that this incident description contains sufficient lessons to be shared with the industry. We further encourage the recipients of this mail to share it further within their organization.

While drilling 12-1/4" section with 1.56 SG SBM (CC), EKD system (including a Coriolis type mass-flow meter integrated to the flowline through a bypass) detected abnormal flow-out at 4382mMD. Stopped circulation and shut in the well on UAP.

Observed SICP stabilizing around 285psi, difficulties to assess SIDPP due to presence of motor and non-ported float valve.

Gain volume estimated around 2bbl. Tried to initiate circulation - no return. Injection suspected at shoe at 2850m. Decided to spot kill mud cap in open hole by injection.

The Kill Weight fluid spotted was calculated on the basis of the frac pressure at shoe observed.

What Went Wrong?:

It was a Narrow Mud Weight Window environment by design. The reservoir pressure encountered while drilling was found to be above the prognosis (exploration uncertainties) therefore reducing even more of the drilling window.

Appraisal well - uncertainties.

IRF Problem Statement: Well Control

Prevention of well control incidents – greater emphasis on the left-hand side of the well control bow-tie (i.e. prevention of incidents), particularly with regards to pore pressure and fracture gradient prediction and monitoring

Expected outcomes:

- Systematic approach to PPFG prediction
- Systematic workflows for translating PPFG data into well design
- Systematic implementation of existing guidance on well operating envelopes

International Regulators' Forum
GLOBAL OFFSHORE SAFETY

Title: Well Integrity: Prevention of Well Control Incidents, the case for industry guidelines

Problem Statement:

Much industry collective effort has gone into defining responses to deal with any loss of well control situation. Recent data and incidents provide a view that a deeper understanding of the underlying hazards and how industry designs for them is worthy of collective action. This will strengthen industry focus towards the Left Hand Side of the "Loss of Well Control" bow tie and thus reduce the likelihood of any loss of well control events taking place. The planned efforts can be split in three broad areas:
1) Well design "inputs" (pore pressure/fracture gradients/geological risks).
2) translation of 1) into efficient and safe well designs
3) definition of safe operating envelopes for Wells activities in the operations and production phases.
It is recognized that -whilst some areas like pore pressure/fracture gradient prediction has no universally accepted industry guidelines- in other areas guidance does exist. As such, this effort will likely need some development of new guidance but also target implementation of existing guidance.

The changes we expect to see:

- Systematic industry approach to pore pressure/fracture gradient prediction, likely through the development and adoption of new industry baseline guidance.
- Systematic work flows and key technical elements required for translating any new pore pressure/fracture gradient guideline into efficient and safe well designs, likely through development and implementation of new industry baseline guidance.
- Systematic implementation of existing relevant guidance on safe well operating envelopes.

Industry Association(s) invited to lead the change / develop the solution:

- International Association of Oil and Gas Producers (IOGP) / International Association of Drilling Contractors (IADC)

Key performance indicators:

- Development of industry wide standards or guidelines.
- IRF/IOGP collaboration on selection of targeted guidance for shared implementation focus.
- Reduced likelihood of well control incidents.

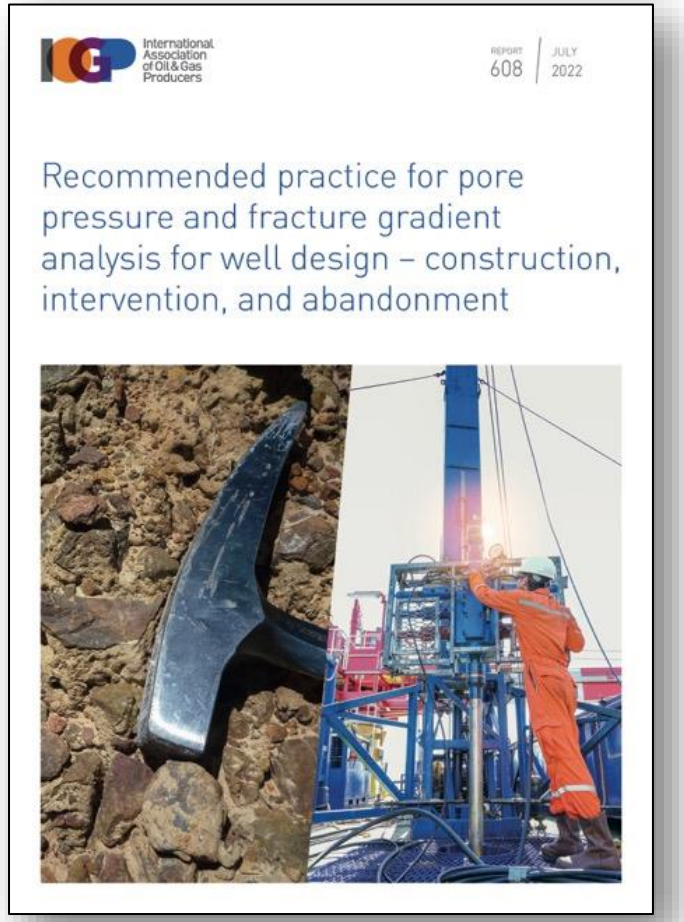
Contact: NOPSEMA (Australia) Date: 05 July 2021
Endorsed by IRF Management Committee

International Association of Oil & Gas Producers

IOGP Report 608

Published July 2022

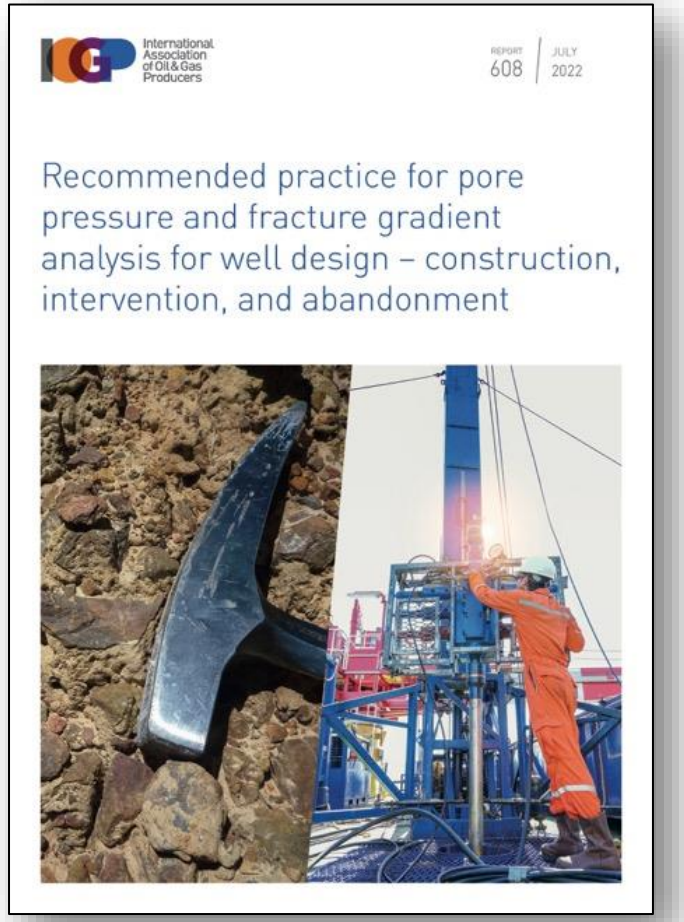
This guidance document aims to define ***shared language*** between subsurface and drilling specialists and provide a globally applicable recommended practice for the preparation of PPFG predictions, the definition and communication of ***associated risks***, and ***uncertainties***, and ***real-time PPFG monitoring*** during well construction, intervention, and abandonment.



International Association of Oil & Gas Producers

IOGP Report 608

Definitions	Pre-Drill PPFG Prediction	Real-time PP Monitoring
• Stress • Pore Pressure • Fracture Pressure • Drilling	• Methods • Components • Uncertainty • Pre-Drill Assurance	• Planning • RP during Drilling • Post-Well Review



Next Steps….

Communication tool to aid on effective communication between pore pressure specialists and drilling personnel

Document covers two components:

- Communication protocols (types of communications, to whom, urgency, etc.
- Hazards identification pre-section (depth section, etc.)

Expected Publication February 2024

Well Competency & Training Subcommittee

The purpose of the Competency and Training Subcommittee is to minimize the impact of global well control events due to operations-related human error.

This involves providing individuals and operations teams in our industry the leadership and guidance to assure development and verification of technical and non-technical competency, including human behaviours.

What is Report 476?

The report provides recommended enhancements to existing industry well control training, examination and certification processes, as well as related philosophies that should be considered for adoption throughout the industry to improve well control preparedness and performance.

Its recommendations are applicable to the personnel who plan, approve or execute well work at any stage of a well's lifecycle. Issues addressed include:

- Key input parameters to well design (pore pressure and fracture gradients)
- Well design
- Design of activities on wells
- Well construction (drilling and completion)
- Well intervention, wellhead maintenance or workover
- Plugging, suspending, and abandoning wells

New Edition - Updates

Emphasis has been placed on:

- Reinforcing wording and awareness around the description of the well control hazard (hydrocarbons under pressure) through pore pressure and fracture gradients.
- Strengthening the understanding of hydrocarbon risk awareness.
- Additional content and detail on how individual continuous well control learning can be combined with team-based learning.
- Introduction of the recommendation for simulators for completions and well intervention personnel.
- New subsea credentialing requirements for subsea engineers and technicians that have been introduced within the industry.

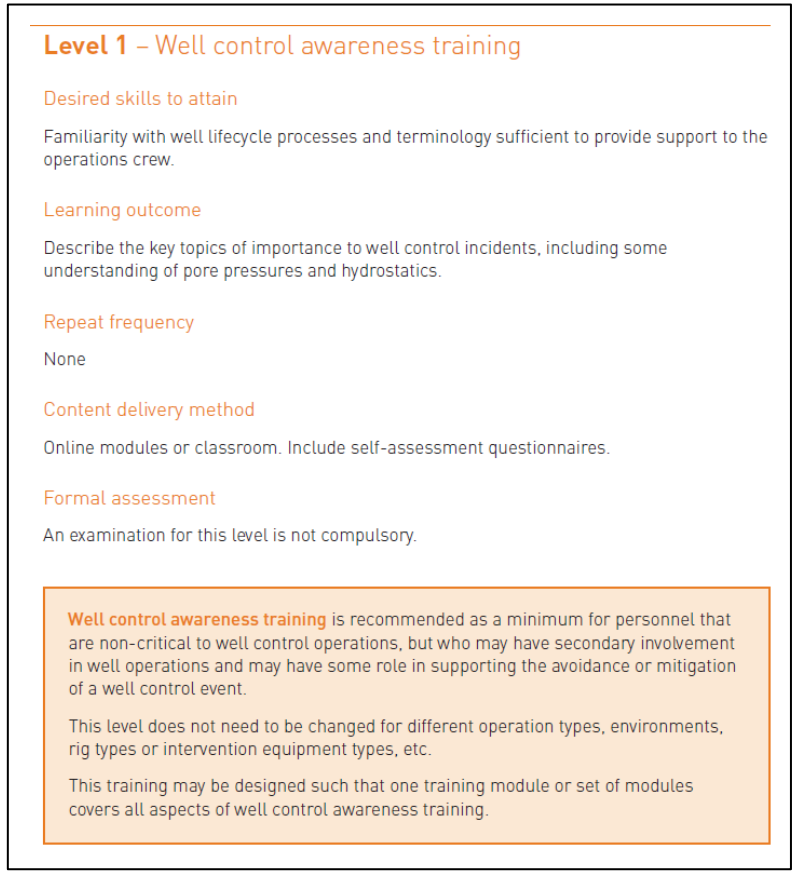
Summary of the role-specific training levels

- Level of training according to responsibilities for Well Control Assurance (WCA) needs.
- Enhanced versions for L3 and L4 include Human Performance factors that impact response to well control incidents.
- ***Note***: Well control in design and lifecycle management training can be completed at any point after an individual has completed the Level 2 training.

Level	Audience	Audience Role	Objective
1	Support personnel contributing to the wells project	For individuals who need an awareness of what wellcontrol is and those who could perform an action that might indirectly impact WCA	Attain ability to understand the key topics that may impact Well Control Assurance and provide effective support.
2	Operations support team personnel	Well-site based position whose action or inaction that could directly influence WCA	Attain ability to effectively act under guidance on items which may affect Well Control Assurance and provide effective advice within own area of expertise.
3	Equipment operator	Analyse wells data and perform actions to prevent or to respond to well control incidents	Attain ability to identify correct actions to take on tasks which may affect well Control Assurance and act accordingly.
4	Supervisor	On-site leadership and oversight to ensure that correct actions are carried out. In many cases, those involved in well control in design and lifecycle management will also attend this level, but it is not a formal requirement.	Attain ability to anticipate, plan, oversee and verify items which may affect Well Control Assurance. Provide oversight during all operations.
	Well control in design and lifecycle management	Staff performing engineering and planning activities to design the well, verifies that it remains within its operating envelope and manages appropriate risks.	Attain ability to design the well and the well activities, and to identify and specify actions to be taken when stepping outside of the normal operating envelope.

Level 1 - Updates

- Formerly known as "*Support Personnel Training*"
- Some understanding of Pore Pressure & Hydrostatics



Level 1 – Well control awareness training

Desired skills to attain

Familiarity with well lifecycle processes and terminology sufficient to provide support to the operations crew.

Learning outcome

Describe the key topics of importance to well control incidents, including some understanding of pore pressures and hydrostatics.

Repeat frequency

None

Content delivery method

Online modules or classroom. Include self-assessment questionnaires.

Formal assessment

An examination for this level is not compulsory.

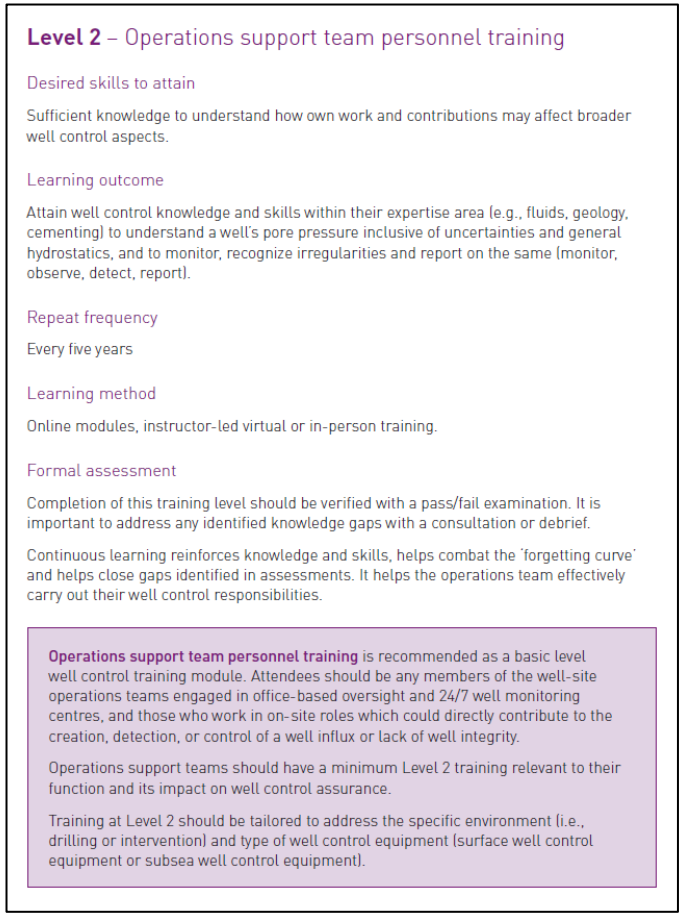
Well control awareness training is recommended as a minimum for personnel that are non-critical to well control operations, but who may have secondary involvement in well operations and may have some role in supporting the avoidance or mitigation of a well control event.

This level does not need to be changed for different operation types, environments, rig types or intervention equipment types, etc.

This training may be designed such that one training module or set of modules covers all aspects of well control awareness training.

Level 2 - Updates

- Formerly known as "*Operations Teams Personnel Training*"
- Understanding of Pore Pressure inclusive of uncertainties and general Hydrostatics
- Learning Method: Online modules, instructor-led virtual or in-person training.



Level 2 – Operations support team personnel training

Desired skills to attain

Sufficient knowledge to understand how own work and contributions may affect broader well control aspects.

Learning outcome

Attain well control knowledge and skills within their expertise area (e.g., fluids, geology, cementing) to understand a well's pore pressure inclusive of uncertainties and general hydrostatics, and to monitor, recognize irregularities and report on the same (monitor, observe, detect, report).

Repeat frequency

Every five years

Learning method

Online modules, instructor-led virtual or in-person training.

Formal assessment

Completion of this training level should be verified with a pass/fail examination. It is important to address any identified knowledge gaps with a consultation or debrief.

Continuous learning reinforces knowledge and skills, helps combat the 'forgetting curve' and helps close gaps identified in assessments. It helps the operations team effectively carry out their well control responsibilities.

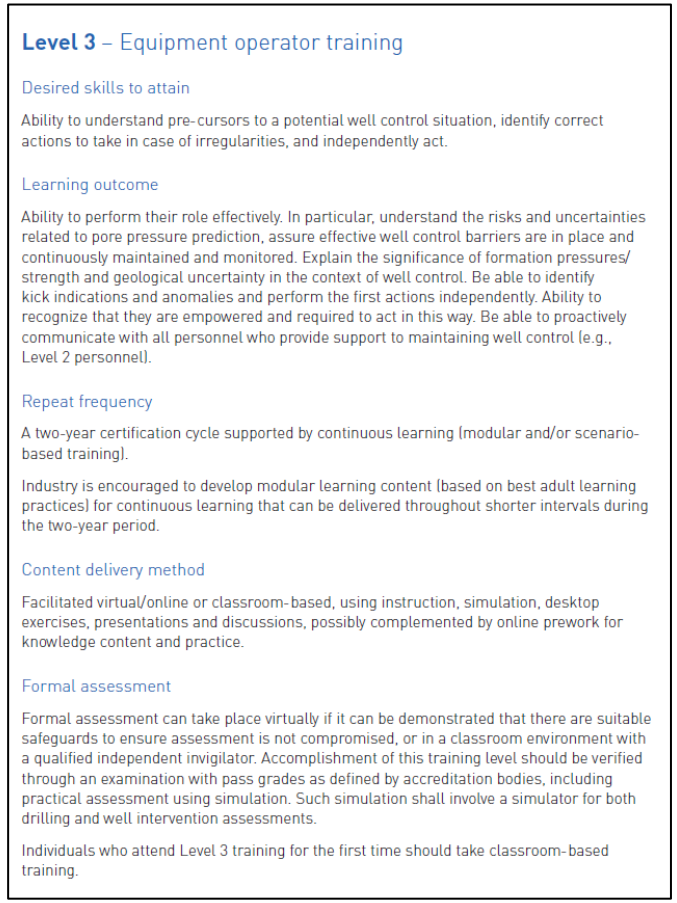
Operations support team personnel training is recommended as a basic level well control training module. Attendees should be any members of the well-site operations teams engaged in office-based oversight and 24/7 well monitoring centres, and those who work in on-site roles which could directly contribute to the creation, detection, or control of a well influx or lack of well integrity.

Operations support teams should have a minimum Level 2 training relevant to their function and its impact on well control assurance.

Training at Level 2 should be tailored to address the specific environment (i.e., drilling or intervention) and type of well control equipment (surface well control equipment or subsea well control equipment).

Level 3 - Updates

- Ability to understand pre-cursors to a potential well control situation.
- Understand the risks and uncertainties related to Pore Pressure prediction
- Frequency: A ***two-year*** certification cycle supported by continuous learning (modular and/or scenario-based training).
- Delivery: Facilitated virtual/online or classroom-based
- Individuals who attend Level 3 training for the first time should take classroom-based training.



Level 3 – Equipment operator training

Desired skills to attain

Ability to understand pre-cursors to a potential well control situation, identify correct actions to take in case of irregularities, and independently act.

Learning outcome

Ability to perform their role effectively. In particular, understand the risks and uncertainties related to pore pressure prediction, assure effective well control barriers are in place and continuously maintained and monitored. Explain the significance of formation pressures/ strength and geological uncertainty in the context of well control. Be able to identify kick indications and anomalies and perform the first actions independently. Ability to recognize that they are empowered and required to act in this way. Be able to proactively communicate with all personnel who provide support to maintaining well control (e.g., Level 2 personnel).

Repeat frequency

A two-year certification cycle supported by continuous learning (modular and/or scenario-based training).

Industry is encouraged to develop modular learning content (based on best adult learning practices) for continuous learning that can be delivered throughout shorter intervals during the two-year period.

Content delivery method

Facilitated virtual/online or classroom-based, using instruction, simulation, desktop exercises, presentations and discussions, possibly complemented by online prework for knowledge content and practice.

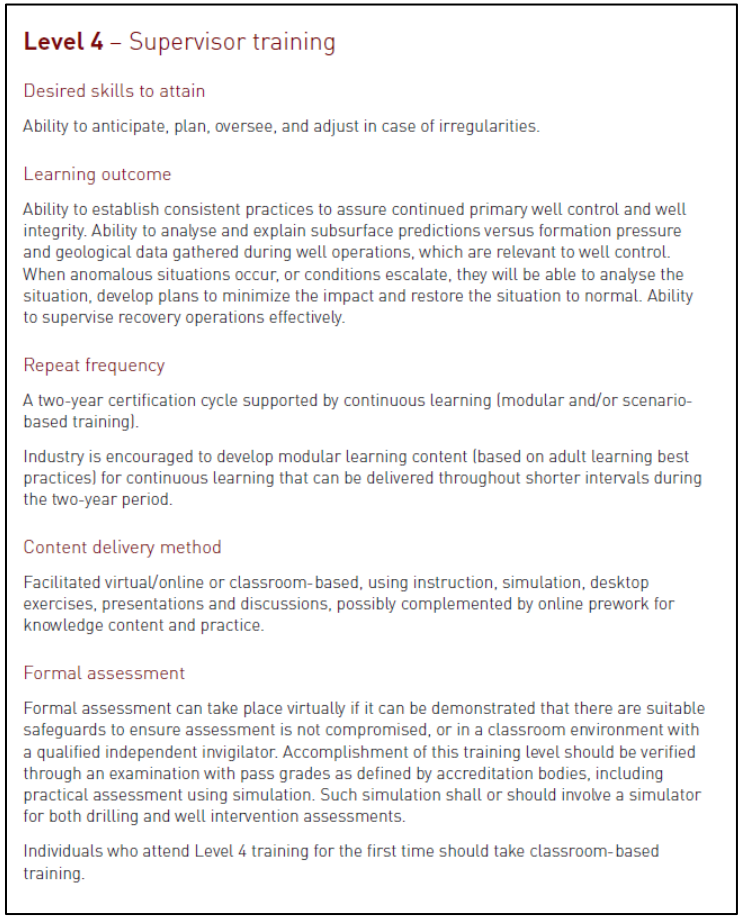
Formal assessment

Formal assessment can take place virtually if it can be demonstrated that there are suitable safeguards to ensure assessment is not compromised, or in a classroom environment with a qualified independent invigilator. Accomplishment of this training level should be verified through an examination with pass grades as defined by accreditation bodies, including practical assessment using simulation. Such simulation shall involve a simulator for both drilling and well intervention assessments.

Individuals who attend Level 3 training for the first time should take classroom-based training.

Level 4 - Updates

- Frequency: A ***two-year*** certification cycle supported by continuous learning (modular and/or scenario-based training).
- Delivery: Facilitated virtual/online or classroom-based
- Individuals who attend Level 4 training for the first time should take classroom-based training.



Level 4 – Supervisor training

Desired skills to attain

Ability to anticipate, plan, oversee, and adjust in case of irregularities.

Learning outcome

Ability to establish consistent practices to assure continued primary well control and well integrity. Ability to analyse and explain subsurface predictions versus formation pressure and geological data gathered during well operations, which are relevant to well control. When anomalous situations occur, or conditions escalate, they will be able to analyse the situation, develop plans to minimize the impact and restore the situation to normal. Ability to supervise recovery operations effectively.

Repeat frequency

A two-year certification cycle supported by continuous learning (modular and/or scenario-based training).

Industry is encouraged to develop modular learning content (based on adult learning best practices) for continuous learning that can be delivered throughout shorter intervals during the two-year period.

Content delivery method

Facilitated virtual/online or classroom-based, using instruction, simulation, desktop exercises, presentations and discussions, possibly complemented by online prework for knowledge content and practice.

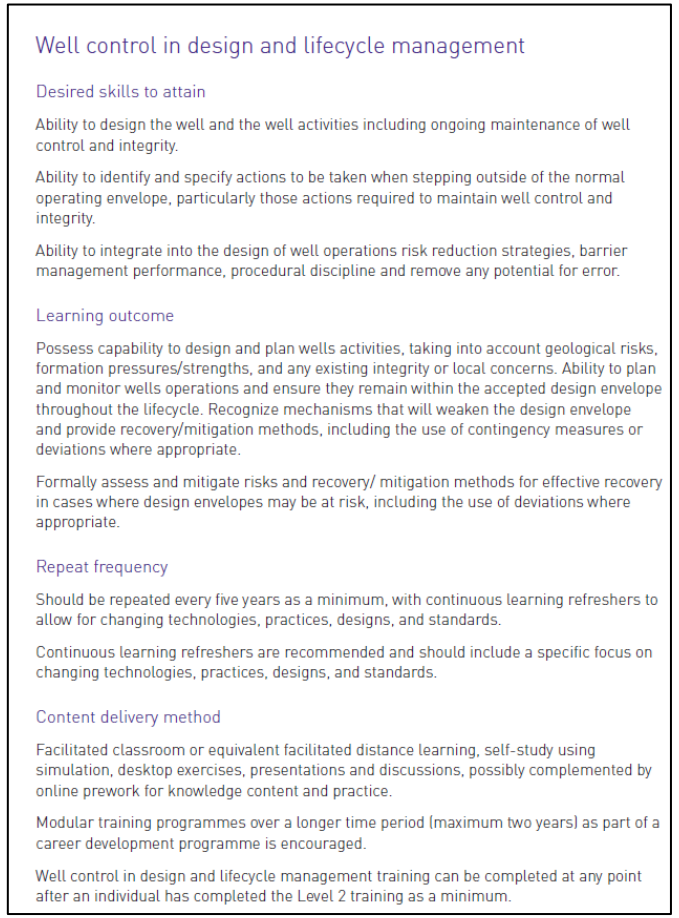
Formal assessment

Formal assessment can take place virtually if it can be demonstrated that there are suitable safeguards to ensure assessment is not compromised, or in a classroom environment with a qualified independent invigilator. Accomplishment of this training level should be verified through an examination with pass grades as defined by accreditation bodies, including practical assessment using simulation. Such simulation shall or should involve a simulator for both drilling and well intervention assessments.

Individuals who attend Level 4 training for the first time should take classroom-based training.

Well control in design and lifecycle management

- Formerly known as "E*ngineer and Approving Authority training*"
- Frequency: Every ***five years as a minimum***, with continuous learning refreshers
- Delivery: Facilitated classroom or equivalent facilitated distance learning
- Modular training programmes over a longer time period (maximum two years) is encouraged.
- Can be completed at any point after an individual has completed the Level 2 training as a minimum.



Well control in design and lifecycle management

Desired skills to attain

Ability to design the well and the well activities including ongoing maintenance of well control and integrity.

Ability to identify and specify actions to be taken when stepping outside of the normal operating envelope, particularly those actions required to maintain well control and integrity.

Ability to integrate into the design of well operations risk reduction strategies, barrier management performance, procedural discipline and remove any potential for error.

Learning outcome

Possess capability to design and plan wells activities, taking into account geological risks, formation pressures/strengths, and any existing integrity or local concerns. Ability to plan and monitor wells operations and ensure they remain within the accepted design envelope throughout the lifecycle. Recognize mechanisms that will weaken the design envelope and provide recovery/mitigation methods, including the use of contingency measures or deviations where appropriate.

Formally assess and mitigate risks and recovery/ mitigation methods for effective recovery in cases where design envelopes may be at risk, including the use of deviations where appropriate.

Repeat frequency

Should be repeated every five years as a minimum, with continuous learning refreshers to allow for changing technologies, practices, designs, and standards.

Continuous learning refreshers are recommended and should include a specific focus on changing technologies, practices, designs, and standards.

Content delivery method

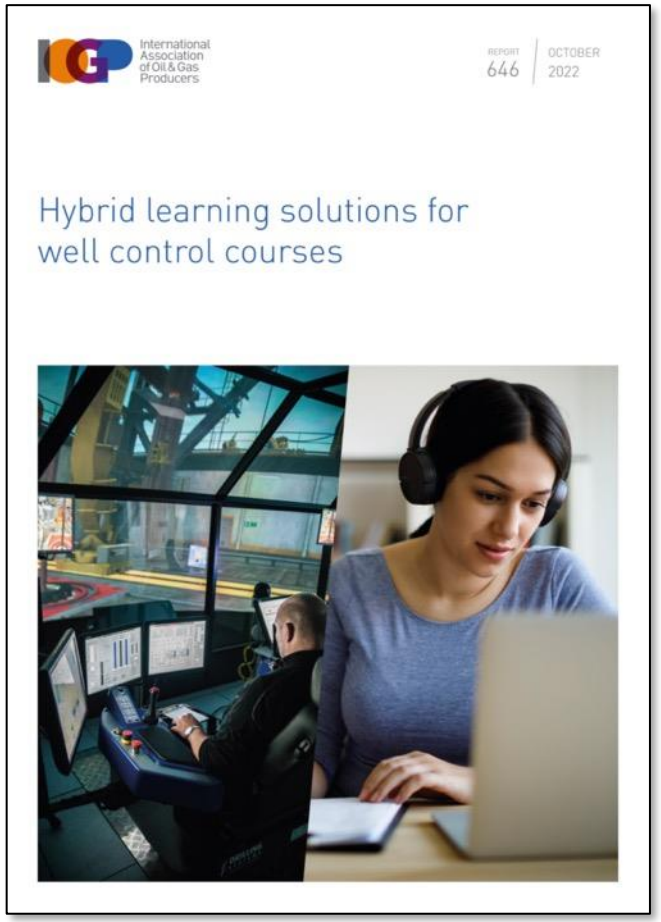
Facilitated classroom or equivalent facilitated distance learning, self-study using simulation, desktop exercises, presentations and discussions, possibly complemented by online prework for knowledge content and practice.

Modular training programmes over a longer time period (maximum two years) as part of a career development programme is encouraged.

Well control in design and lifecycle management training can be completed at any point after an individual has completed the Level 2 training as a minimum.

References


International Association of Oil & Gas Producers
REPORT 628 | DECEMBER 2019
Recommendations for Enhancements to Well Control Drills in the Oil and Gas Industry
exercise
competency


International Association of Oil & Gas Producers
REPORT 646 | OCTOBER 2022
Hybrid learning solutions for well control courses


International Association of Oil & Gas Producers
REPORT 668 | AUGUST 2023
Gamification techniques in well control training and competency

Key Takeaways

Wells Expert Committee (WEC)

The Wells Expert Committee (WEC) will continue to pursue our mission of preventing and mitigating high-impact well control events.

International Association of Oil & Gas Producers

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