International Association of Oil & Gas Producers

REPORT 476 | NOVEMBER 2019

Recommendations for enhancements to well control training, examination and certification

Acknowledgements

Wells Expert Committee

Photography used with permission courtesy of BP p.l.c. and
©iznashih/iStockphoto (Front cover) ©Rumo/iStockphoto (Back cover)

Feedback

IOGP welcomes feedback on our reports: publications@iogp.org

REPORT 476 | NOVEMBER 2019

Recommendations for enhancements to well control training, examination and certification

Revision history

VERSION	DATE	AMENDMENTS
1.0	October 2012	First release
1.1	August 2014	Minor correction (typo)
2.0	August 2016	Full revision
3.0	November 2019	Full revision

Contents

Scope

This 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.

The content of this report applies to all types of onshore and offshore well control operations worldwide. Its recommendations are applicable to the personnel who plan, approve and execute well work at any stage of a well's life cycle.

Issues specifically addressed include:

- well design
- design of activities on wells
- well construction (drilling and completion)
- well intervention, wellhead maintenance or work-over
- plugging, suspending and abandoning wells.

The focus of this effort excludes production-related work.

Foreword

The exploration and production industry strives to consistently improve well control competency of personnel involved with all oil and gas well operations throughout the world, and this is actively managed by those who accept the risks associated with well control events.

The second edition of Report 476 provided recommendations for improvements to current well control training, examination and certification processes.

In this third edition, particular emphasis has been placed on:

- General minor updates to wording to clarify and aid implementation of the document.
- Clarifying the previous Level 5 denomination of the Engineer and Approval Authority Level, to help reduce perceptions that this level can only happen subsequent to Level 4. Although individuals may take successive levels, this is not mandated nor inferred as required.
- The Enhanced Level 3 and 4 has been more specifically detailed into the body of the descriptions for level 3 and 4 to clarify that the Enhanced Level is successive for these levels. The intent is to structurally raise competency levels when repeat training is required to maintain certification. In this case, the Enhanced Level 3 or 4 are indeed successive to the "normal" Levels 3 and 4.
- Included methods to enable accreditation bodies to verify that operator internal development programs for Engineering and Technical Authorities conform to intent stated in this report.
- Enhanced wording and support for continuous learning in the workplace and the use of delivery methods other than classroom training.
- Section 7, Well Control Training for Specialised Operations, has been replaced by a new Section 7, Custom designed well control training to more accurately reflect current industry requirements. This also includes elements of scenario-based training and encourages accreditation bodies to find ways to accredit such training events.
- Further emphasise the need for practical assessments in the Well Intervention syllabi and -through that- further encourage the development of Well intervention simulators.
- The part on risk assessment/bow ties have been removed as it is covered in other IOGP documents.

1. Objectives of well control training

The foundations of well control training are prevention, detection, and management of well control incidents with the ultimate objective of avoiding uncontrolled release of hydrocarbons which may endanger life, the environment, public/private assets and company reputation.

Well control training should enable participants to receive and develop role- and operation- specific well control knowledge, and to learn and practice well control skills. Upon completion of training they should be able to execute their well control responsibilities. Overall, as a result of effective well control training, the risks of well control incidents and associated consequences should be minimised.

Well control responsibilities address, but are not limited to:

- identifying primary and secondary barriers across the well lifecycle
- recognising the importance of appropriate well design for well control safety
- explaining how well integrity is maintained
- recognising deviations from approved design
- identifying the well control risks associated with the tasks
- assessing the suitability of risk mitigations
- identifying risks, limitations, and proper actions for all operations per role and operation specific responsibilities
- recognising limitations of equipment, according to role specific responsibility.
- responding effectively when primary and/or secondary barriers fail
- maintaining primary well control and contributing to secondary well control operations
- explaining how to bring the well back under control and to normalise the situation.

The industry aim is to ensure that suitable training is available and that this training is administered, delivered, and assessed to an industry-recognised standard as delivered through industry accreditation bodies.

Well control training should strive to ensure that the following learning outcomes are emphasised:

- a common understanding of problem areas and solutions related to well control management
- the knowledge of well control responsibilities of personnel relevant to their function
- the focus on well control risks and contingency planning during well design and operations
- the importance of well integrity throughout well life cycle.

2. Well control training key topics

An individual's role and operation type will determine the emphasis required for each training key topic.

Individuals should learn what is relevant to their role and responsibilities. Learning content should support the individuals in achieving their well control assurance responsibilities.

Well control training key topics include:

1) The need for well control training
2) Well control risk management, management of change, and contingency planning
3) Well control risks and plans throughout the well lifecycle
4) Learning from past well control incidents
5) Pressure conditions in the well
6) Well design and barrier concepts, with corresponding calculation and barrier envelopes
7) Primary barrier envelope components and functions
8) Ensuring well integrity
9) Behaviors and characteristics of fluids used in wells
10) Primary well control operations of monitoring, detection, interpretation, analysis, and response
11) Drills, empowerment, and duty, including practical exercises
12) Detection of indicators that may lead to loss of well control or integrity
13) Equipment function and limitations
14) Controlling anomalous behavior, with defined well shut in and securing procedures
15) Regaining barrier integrity and safe resumption of operations
16) Human Factors/Crew Resource Management, HF/CRM.

3. General recommendations for well control training

3.1 Operation type, environment, and equipment

Complexities of well control can differ significantly with the nature of the operations being performed, the environment the activity is in, and the type and location of the rig or of the intervention unit.

Typical operations are:

1) Drilling, completion, and interventions that utilise surface well control equipment.
2) Drilling, completions and interventions and rig operations utilising subsea well control equipment.
3) Intervention, working predominantly on live wells (i.e., pressured well fluids at surface). Entering an existing wellbore for remedial, suspension, and/or abandonment purposes. This can include activities of wire-line, coiled tubing, snubbing, well maintenance and completion, suspension and abandonment. Activities could be carried out in various locations: land, shallow or deep water as rig/vessel supported or may be stand-alone.

There should be adequate training coverage, as appropriate for the role and specific operation, to ensure these programmes are designed and executed in an appropriate manner and fulfilling the required competence for the activities.

Suspension, completion, work-over, and abandonment operations should be covered in both drilling and intervention training categories.

3.2 Topics for emphasis in well control training

Topics that need emphasis in well control training programmes are noted in this section. It is recommended that these topics be fully integrated into the training programmes, providing real-life examples to illustrate good practice and what can go wrong.

3.2.1 Monitoring, detection, and response

Training should focus on the skills required to manage well barrier integrity as a key avoidance measure and for reducing the severity of a well control event. Maintaining well barrier integrity necessitates learners have the knowledge and skills with respect to best practices concerning well monitoring, detection of anomalous wellbore behaviour, and response.

Training should include the discussion of the well control management plan for every stage of the operation, ensuring that roles and responsibilities are clearly defined.

Lessons learned from past incidents should be used to illustrate best practice for each stage of monitoring, detection, and response.

Training with respect to monitoring should address barriers and all of the aspects of operations that can impact well control assurance. It should include as a minimum:

- monitoring the well parameters to identify possible anomalies for early kick detection and achieving safe, rapid, and effective 'shut-in'
- during well intervention operations on a well that is under pressure then monitoring is expected to occur for signs of failure of pressure control equipment (surface and subsea, as applicable)
- monitoring of well behaviours to stay within the predetermined operating envelope is required for all operations
- monitoring is expected to occur on all operations on wells, including dead wells and live wells (Dead wells could be reworked to reinvigorate and make live again: the Operations Team should be alert and prepared for change in well status)
- monitoring for signs of failure of subsurface pressure control equipment during well intervention operations on a live well, e.g., deep set or shallow set plugs, or downhole valves
- monitoring for signs of compromise of subsurface well integrity during all operations, including well intervention activity into a suspended or dead well, or whilst killing any well
- clear expectations around accountability and empowerment to -when in doubt- shut in the well without consulting superiors

The following elements of training should be adopted to improve the ability of the operations team to detect a possible influx or an unexpected anomaly at an early stage:

- the importance and maintenance of kick and leak detection/notification equipment being calibrated and activated when working on a well to minimise the size of any influx.
- accurate interpretation of sensor readings
- the different signs of anomalies and early detection techniques that may indicate influx potential

The learners will be taught that the well control management plans will include the expected response, like.

- explicit shut in plans for each operation.
- agreed communication lines.
- planned drills and exercises in support of the expected response.

Training should help foster a culture that does not ignore anomalies and empowers teams to "shut in, if in doubt". Well control training should communicate a strong message that if a well is suspected to be flowing unintentionally, the immediate response is to shut in the well, then investigate the potential influx or anomaly (not investigate and then shut-in).

In certain operations where the planned response is not a typical well shut-in (i.e., during underbalanced drilling, managed pressure drilling, well kill operations or cases where concern exists regarding barrier envelope capacity), training should help develop the skills needed to return the situation to normal.

Training should promote understanding of optimism or confirmation bias, or a false sense of security: it should encourage workers to be vigilant and thorough in monitoring, detecting, and responding.

3.2.2 Risk awareness and risk management

The objective is to develop risk awareness and risk management skills. It is recommended that fundamentals of risk management, as appropriate for each training, are covered.

Training should cover the fundamentals of risk management, and how they should be applied throughout the life cycle of a well. It should provide individuals with an appropriate and role-specific ability to:

- explain the overall risk management process and the elements within it
- recognise hazards, their potential consequences and assess the associated risk level
- recognise the significance of uncertainties
- participate in a risk management activity specific to their area of responsibility
- understand, or where appropriate implement, the process for determining the risk management approach necessary to manage specific activities
- recognise the importance of situational awareness by the complete operations team to managing well-site risks.
- explain the difference between an instruction, order and dialogue and recognize situations where different types of communications are appropriate.
- recognize how factors such as personal, interpersonal, workplace, cultural, contractual and dispersed location can impair effective teamwork.
- recognize the critical importance of effective leadership to the management of well control and safety.
- recognize that individual ability to remain alert and perform to a high standard is influenced by both personal factors and the work environment.

The operations team is the well operations personnel from oil and gas producing companies, drilling contractors, well intervention and well servicing companies, covering both well-site and office-based personnel, that support the activity.

There should be a strong emphasis placed on how deviations from the plan or changes to the process are to be managed, through an appropriate management of change (MOC) process with all applicable risks considered and managed accordingly.

3.2.3 Procedures and procedural discipline

Having appropriate procedures, which are followed and verified, is fundamental to delivering a safe well operation.

Procedural discipline (sometimes known as procedural compliance) is needed to guard against errors that can be induced by inappropriate substitutions or short-cuts.

It is important that training conveys that any modification to procedures that involves key barriers being installed, removed, or changed requires the following:

- a formal, job specific, risk assessment
- an appropriate management of change execution
- sign off by the designated approving authority.

3.2.4 Barrier management

Well control training should have a strong focus on the concept of barriers and barrier management. It should include barrier selection, verification, monitoring and repair, in relation to physical elements, management systems, and human barrier elements and associated controls.

Such training should:

- ensure a comprehensive and common understanding from well design through construction, operation and into suspension or abandonment – of what constitutes barriers to flow (primary and secondary), how they are verified, monitored and repaired
- ensure an understanding of well barrier elements and emphasizing the importance of dual barriers or redundancy in barriers

- convey the importance of maintaining dual barriers during operations on and below surface casing (i.e., when a blowout preventer (BOP) or Christmas tree is in place, or after barrier status changes like after cementing or when perforation has been undertaken) and management of the barrier systems when key barriers are installed, removed or changed
- indicate the importance of human intervention where a system requires human initiation to achieve the required barriers
- ensure all participants know the barriers for which they are responsible, e.g., on the basis of bow tie methodology as used in rig safety case analysis.

4. Well control learning delivery

A person will have many well control learning opportunities throughout his or her career. Methods are likely to be varied. Examples are set out here.

4.1 Role and operation specific well control training

The employer is responsible for assuring that all personnel who can impact the well barriers have role and operation specific well control training.

Training should be focused on specific roles and the training should enable individuals to gain the skills to demonstrate capability to fulfil their own well control responsibilities. Examples of the roles typically held by the wellsite support personnel are set out in Section 5 - Role-specific training levels.

Well control training for custom operations are set out in Section 6.

Role-specific training delivery may be in house or by third party training provider.

Assurance of the quality of the role-specific well control training may be carried out in house. Alternatively, some operators could choose to manage assurance of role-specific well control training via an accredited training body. These options are discussed in Section 7.

Well-site support personnel, for example those contributing from service companies, should have options for in-house focused training at the level of their supporting responsibilities specific to their impact on well control assurance.

4.2 Scenario-based training events

Scenario-based well control training is a term that refers to training activities where both technical and non-technical Human Factor/Well Operations Crew Resource Management (WOCRM or CRM) skills are able to be applied to particular challenging scenarios. This could utilise a well control simulator, other computer simulation or desktop-exercise or even be carried out on a training-rig. See Appendix B - Background on Well Operations Crew Resource Management.

Although scenario-based well control training has been available for several years, it should become widespread as an essential component of well control training and certification for personnel involved with the detection, shutting-in, and recovery from well control events for all well lifecycle activities. It is expected that Enhanced Level 3 and 4, described in Section 6, will be particularly beneficial.

Scenario-based well control training:

- can be applied to benefit both the drilling, completion, and the well intervention communities
- can enhance an operations team's ability to quickly recognise and mitigate well control events effectively and safely.

This method of learning, normally in a team (the team present in the class or the operational team, or sub-team, designated by the operator), is especially valuable when coupled with theory-based training and assessment.

Scenario-based training is of most benefit when entire rig or intervention teams can be trained together for their specific well challenges and particularly for complex wells (e.g., narrow margin wells and high pressure high temperature wells).

Drilling Well on Simulator (DWOS) and Complete Well on Simulator (CWOS) training events can create highly realistic and challenging scenarios that allow teams to practice technical knowledge and procedural compliance and understanding. This can help develop knowledge of Human Factors and the application of WOCRM skills.

These training events should be created to offer learning opportunities to all in the broad spectrum of team members. This should encourage learners to investigate and learn in a multi-disciplinary group setting, e.g., the preparations for achieving process safety. Such learning should improve knowledge and appreciation of the barriers that are available in complex scenarios, be they physical, procedural (human), or organisational.

Scenario-based training may also be performed together with office drilling/completion/intervention engineers in order to enhance the communication of risk identified and to obtain a better understanding as to how the plans and procedures are to be applied during operations.

Scenario-based training is ideally developed jointly between the operator and rig contractor and/or well intervention service company.

Scenario-based training can add particular value to difficult and complex well operations. It can also be considered for wider application. In all cases the training activity should allow "mistakes" to be made and promote learning in a safe training environment rather than during a real event on the job.

Scenario-based training can address many aspects and should be targeted to greatest relevant risks and criticality, based on the known and uncertain parameters (e.g., varying pore pressures, fracture strengths, permeability, pore content) leading to different type, size and kick intensity of influxes.

The relevance to the participants upcoming activities is normally the focus, e.g., the uncertainty of the relevant fracture strength window of the particular planned field activity. This could be for the construction of an exploration well, or of a section to be drilled with managed or underbalanced pressure drilling, MPD/UBD, method or of a well side-tracking activity. On the other hand, if a specific well intervention activity has unknown or uncertain variables that could produce a critical outcome, the training should be set up so that the response to these should be practiced.

4.3 Continuous learning in the workplace

In addition to instructor led training and assessment, personnel involved in well operations should also participate in continuous learning rather than relying only on classroom based training and assessment processes. Continuous learning can be achieved in a multitude of ways which may include online training, work site training, face-to-face refresher training, and documented simulation exercises and facilitated scenario based discussions with the crews at a work site.

Further examples include documented 'hands-on' well control simulation exercises and kick drills (please see IOGP Report 628 - *Recommendations for enhancements to well control drills in the oil and gas industry*). These should simulate the different types of potential well control problems that may occur in the planned operations.

These exercises should routinely involve supervisors and office-based staff, and include a formal debriefing on how the well control event was managed. This should not only serve to improve team response but will also serve to improve active awareness in the detection and avoidance of well control events. For office based teams, this can improve accurate problem diagnosis and formulation of an effective response plan.

Continuous learning for all is strongly recommended to maintain proficiency in order to keep focus on well control during design as technology, practices, designs, and standards evolve with time.

5. Role-Specific Training levels

Personnel should be trained and certified at a specific level appropriate to their role. They should maintain certification while employed in that role.

In addition to the normal criteria that typically dictate the type of well control training that a person receives (operation type, operating environment, rig type, blowout preventer (BOP), intervention equipment type, etc.), there should also be consideration of the role the person plays within the operations team in determining final training requirements.

Members of the operations team are each responsible for well control duties: these includes prevention, recognition, and response. The role-specific training levels match the responsibility according to the actions which would be expected of each person.

For example, of the well-site personnel – supervisory staff specify, oversee and verify; equipment operators act to prevent or respond; and the other personnel on site communicate any anomalous observations to the equipment operator and supervisory staff. See Appendix A - Managing risks, progression, and dispensation.

Table 1 provides a summary of the role-specific training levels, which is followed by a full specification of the responsibilities for each level.

The levels and responsibilities have also been collated into one chart: 476 chart - *Well Control Training – Levels Guidance Chart*, included as Appendix D of this report.

Table 1: Summary of the role-specific training levels

Level	Audience	Audience Role	Objective
1	Support personnel contributing to the Wells project	For individuals who need an awareness of what well control 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 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 advise within own area of expertise.
3	Equipment Operator Enhanced Version	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 Enhanced version	On site leadership and oversight to ensure that correct actions are carried out. In many cases, engineers and approving authorities 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.
	Engineer & Approving Authority	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 of training according to responsibilities for Well Control Assurance (WCA) needs.
NB: The Engineer & Approving Authority training can be completed at any point after an individual has completed the Level 1 training.

Level 1 Support Personnel Training

Desired skills to attain

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

Learning outcome

Describe the key topics of importance to well control incidents.

Repeat frequency

None

Content delivery method

Online modules or classroom. Include self-assessment questionnaires.

Formal assessment

An examination for this level is not mandatory.

Support Personnel Training is recommended as a minimum for personnel that are non-critical to well control operations, but 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 Operations 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 monitor, recognise irregularities and report on same (monitor, observe, detect, report).

Repeat frequency

Every five years.

Learning method

Classroom, or online modules combined with an on-the-job mentored programme.

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.

Operations Team Personnel Training is recommended as a basic level well control training module. Attendees should be any members of the well-site operations team who work in roles which could directly contribute to the creation, detection, or control of a well influx or lack of well integrity.

Support services should have 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).

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

Level 3 Equipment Operator training

Desired skills to attain

Ability to identify correct actions to take in case of irregularities and independently act.

Learning outcome

Ability to perform their role effectively. In particular, 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. Be able to recognise 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

Every two years.

Content delivery method

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

Formal assessment

Formal assessment will take place in a classroom environment with a qualified assessor. 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 would ideally involve a simulator, however, where such simulation equipment is not widely available, then assessment should include scenario-based exercises through alternate simulation techniques. Such exercises are to be formally monitored and graded.

Enhanced Level 3

As candidates come forward for repeat biyearly recertifications, Enhanced versions of Level 3 are encouraged in order to provide continued deepening of skills towards a mastery level of competency. Such Enhanced courses may be attended by individuals who have scored above 80% in their previous Level 3 assessment and should also include different well control scenarios. Whereas such Enhanced level training to date typically have been carried out for in-house programs, industry is encouraged to also develop open seat versions and accreditation routes.

Equipment Operator training is recommended for any role that is expected to shut-in a well such as a Driller, Assistant Driller and equivalent positions in completions, well-servicing or intervention operations.

Training at this level should be tailored to the specific environment (i.e., drilling or intervention) and type of well control equipment (surface well control equipment or subsea well control equipment). This training should be administered as a classroom-based training course including scenario based exercises enabled by simulation.

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

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 minimise the impact and restore the situation to normal. Ability to supervise recovery operations effectively.

Repeat frequency

Every two years.

Content delivery method

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

Formal assessment

A formal assessment will take place in a classroom environment with a qualified assessor. 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 would ideally involve a simulator; however, where such simulation equipment is not widely available, then assessment should include scenario based exercises through alternate simulation techniques. Such exercises are to be formally monitored and graded.

Enhanced Level 4

As candidates come forward for repeat biyearly recertifications, Enhanced versions of Level 4 are encouraged in order to provide continued deepening of skills towards mastery level of competency. Such Enhanced courses may be attended by individuals who

have scored above 80% in their previous Level 4 assessment, and should also include different well control scenarios. Whereas such Enhanced level training to date typically have been carried out for in-house programs, industry is encouraged to also develop open seat versions and accreditation routes.

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

Engineer and Approving Authority training

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.

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 monitor wells operations and ensure they remain within the accepted design envelope. 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

None prescribed at this point. However, continuous learning refreshers are recommended that 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.

Formal assessment

Accomplishment of this level of competency should be verified with a pass/ fail examination. This assessment may also be incorporated into a wells engineering examination process as part of a comprehensive wells development programme. An alternative route is to seek chartered engineering status for such programs.

Engineer and Approving Authority training: in addition to attending some level of operational well control training, all personnel with a key role in well design should attend a training course that includes elements of well control that need to be embedded into well design, well control equipment selection, and rig selection processes.

Attendance of Level 4 personnel to this training may be appropriate in some cases, but the competence or interventions sought are role specific and no mandated succession from Level 4 is inferred.

Many of the basic design concepts are similar between onshore and offshore wells, with the exception of well control equipment selection and rig type selection. Therefore, the training on well design need not be changed for different operation types, environments, and operating unit types.

The attainment of skill as an Engineer or Approving Authority is likely through a combination for formal training and experience, culminating in an assessed Engineer and Approving Authority industry course. It may also be attained through a comprehensive internal program that individual companies provide for their staff. It should include the elements described in the Appendix C [Well design and operational implications].

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

6. Custom designed well control training

Additional training may be necessary for personnel involved with specialised well operations. These courses may address more than just well control, but only the well control relevant component is addressed here.

Each custom course or program with relevance to well barriers or well control should address:

- an outline of the well control risks associated with each of the specialised operations
- how these well control risks may be avoided
- specialised detection needs for well control issues
- how the well should be controlled under the circumstances that could arise
- specialised well control equipment requirements
- any specialised well control procedures and processes.

Examples of situations that might require specialised courses are: Managed Pressure Drilling and Completion, High Pressure High Temperature (HPHT) Well Construction or Intervention, Deepwater Activities, impact of H2S or training on individual barrier elements like specialised drilling/completion fluids, cement, mechanical barriers and production chemistry aspects.

The party leading the project would normally identify any role specific specialised training necessary that may be in addition to the standard well control training.

The nature of such custom training means that individual accreditation of a course historically has been impractical. Accreditation bodies are encouraged to explore ways to efficiently review and accredit any such course content. Intent is that accredited training providers can support industry with relevant custom courses that has been subject to review, which will drive improvements and cross industry learning in this field.

7. Assuring the quality of well control training

Assuring the quality of well control training is underpinned by:

- the quality of the well control training programme
- the teaching, trainers, and assessors
- the currency, relevance and delivery method of the learning materials
- the performance criteria linked to certificate issuer
- the frequency and quality of repeat training
- the quality assurance audit, both external and internal, of all these aspects

7.1 Quality of Training Programme

Training providers for assessed well control training should be accredited by a recognised independent industry body.

The Wells Expert Committee (WEC) relies on independent industry accreditation bodies to audit the Training Programme of training providers. This helps ensure that training is aligned with industry needs.

IADC (International Association of Drilling Contractors) and IWCF (International Well Control Forum) are examples of organisations with peer input from operators, drilling contractors, and service companies.

Any such accreditation parties, including an independent body with knowledge of training and access to subject matter experts, may also carry out the accreditation or review of a company's 'in-house' programme, and issue a 'statement of conformance' with Report 476 at a particular point in time. This may be relevant for the Engineer and Approval Authority level which has not yet gained full traction in our industry. The approach is intended to provide traction towards a more structural accreditation system for such programs.

The quality of training has traditionally been based on an examination of generic well control examples and basic calculations. This should further evolve to ensure the quality of teaching and to ensure that learning objectives are met.

Training should be taught according to the stipulated syllabus. It is not sufficient to base training on 'test-similar' or 'test-identical' exam questions to help facilitate personnel passing the written exam. Industry accreditation bodies should assure this is not happening.

7.2 Teaching, trainers and assessors

Training providers should establish and implement programs such that all candidates are trained to competently perform their assigned well control duties to a consistently high level.

Instructors and assessors should be assessed and approved by industry accreditation bodies or to equivalent standards through an independent entity. Training providers should be responsible for the competency assurance process of instructors and assessors. The process should include assessment and verification of knowledge, skills, relevant well-site experience, behavioural skills, and teaching ability.

The instructors and assessors should undergo an evaluation process by the training provider no less than every two years. This evaluation process should ensure they are effectively teaching the appropriate physical principles and technical content in a way appropriate to the level of understanding of the audience. The teaching should include adequate focus on development of participants' behavioural skills. The evaluation process for instructors and assessors should include in-class assessment as well as reference to student feedback. The aim is to foster an appropriate culture towards well control throughout the industry.

If the well control training is by use of online or computer based learning tools, all subjects listed in the syllabuses and/or curriculum should be included in the training and be auditable.

7.3 Updating training materials and methodology

Training materials and methodology should be updated periodically per the accrediting body's requirements to reflect recent trends in well control events. Industry-run well control incident databases should be annually reviewed for this purpose and training subsequently updated. The most common types of well control incidents occurring in the industry should be included into the training materials.

Likewise, scenario-based training should be updated in the same manner and frequency.

7.4 Certification of individuals

The individual is normally issued with a certificate to represent their having attained the required performance criteria.

Records in support of an individual's well control certification should be archived along with documentation of their assessment per the auditable requirements of the programme.

The accreditation body should address what is accepted as a pass grade for assessment against the relevant performance criteria in a training environment. However, this does not in isolation provide an assurance of consistent and repeated use of a skill in the work-place.

7.5 Enhanced well control training

Experienced personnel with a successful history of attending well control training will gain more from Enhanced training than repetition of the same course.

Enhanced well control training courses should be encouraged for levels 3 and 4 (3E, 4E) level as an alternative to repeating the same course. Personnel should only be permitted to attend enhanced courses as an alternative to repeating the same level of course if they have:

- already attended their suitable level of role-specific training
- passed the examination requirements for their role level with a high pass mark (i.e., more than 80%).

While the enhanced courses are still expected to meet the requirements of the role-specific training, the content may differ somewhat from the basic course. Enhanced courses should be administered as a separate stand-alone course and not simply be part of the well control training for each level. They should contain scenarios based training and updates on recent events, as well as encourage participants to share their well control experiences.

Scenario-based simulator training should play a major part in this type of training. Candidates would undergo the same assessment process and receive the same certificate as the relevant role-specific training courses.

Accreditation bodies can certify training providers to deliver such enhanced courses.

7.6 Quality assurance audit of well control training programmes

A new well control training and examination programme should successfully undergo an initial on-site audit by an accreditation body.

To ensure the quality and consistency of training undertaken by training providers, an independent auditing process should be adopted to regularly confirm active enforcement of the training provider's processes. The independent auditing entity could be a suitable qualified third-party able to demonstrate auditing ability and knowledge of the key aspects of the training programme:

- the management system held by the organisation that assures training quality
- the course content and delivery materials and methods held by the organisation for each course
- the safe and suitable facilities held by the organisation for each delivery site
- the trainer instructional and technical competence including effective delivery of content
- the appropriate and effective simulation training and testing with assessments meeting a previously agreed set of performance criteria.

Both internal audits by the training ptovider and external audits by an independent auditing entity should be carried out. This can include random checks and depending on the findings the audit frequency should be adjusted. These audits should establish the training programme adequacy.

Appendix A. Managing risks, progression and dispensation

A.1 Managing the risks

Each employer has responsibility for assessing which level of training an individual employee should attend, and also for exemption if applicable.

A process of self-assurance should be carried out by employers in line with their obligations under their own competency management system. An example of such a system is described in ISO/TS 17969, *Petroleum, petrochemical and natural gas industries – Guidelines on competency for personnel.*

This might be satisfied by employer issued certificates following in-house training and assessment and need not involve certification from a formal accreditation body. Evidence should be available to support certificate issue against a particular syllabus.

In such cases, employers should find it beneficial to receive an independent audit to enable demonstration of improvement of their processes to support certification. Employers may alternatively prefer to use the processes of accrediting bodies to check that certification is appropriate.

Only guidance can be given by this report. Every situation will have a different context or set of variables affecting it, and the related hazards and the risks. Ultimately the employer, and usually the Petroleum Licence-Holder, has responsibility for managing those risks.

Additional training, where applicable to manage the risks, should be tailored specifically for the nature of the operations being performed, the environment the activity is in, the type and location of the rig or of the intervention unit.

A.2 Progression

Progression of training is usually from one level onwards to another level.

Personnel should maintain certification appropriate for their current role in the operation.

Progression as it pertains to levels is as follows:

Level 1	is considered stand-alone as it applies to many people, including those who do not participate in activities at the well-site.
Level 2 Level 3 Level 4	apply to personnel working at the well-site and to a few others who can significantly impact the work there. In a person's career path most people who spend some time at the well-site will have the opportunity to experience the responsibilities of Level 2. Some individuals will move on to a Level 3 role and a few will go further to perform the supervisory responsibilities at Level 4. The training scheme described lends itself to development of contractor personnel which may function within drilling, completion, well intervention or support roles. As an individual's role on the rig changes, individuals may need to take a slightly different training
	The Engineer and Approving Authority training is considered separate from the progression of Levels 2 to 3 to 4. Typically, this level is aligned with requirements for operator well design and supervisory personnel and any contractor design staff. This is due to the fact that such design personnel may, or may not, have gone through the roles of Levels 2, 3, or 4. Usually their work is carried out away from the well-site.

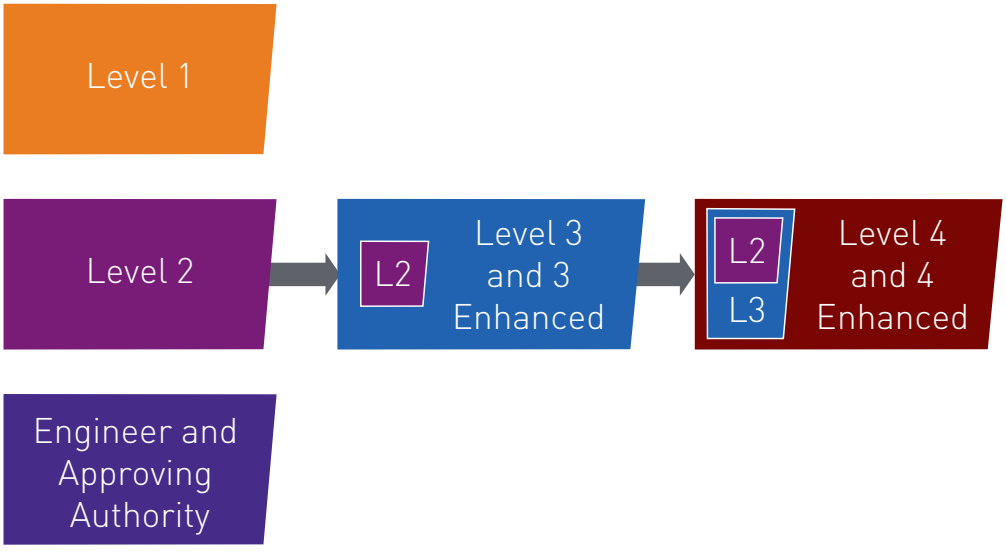

Figure A.1: Typical progression between the levels of Role-specific training

A.3 Dispensation

Most individuals in well-site roles will follow the route of progression described in A.2 but there may be exceptions in special cases.

Dispensation for personnel certified by methods other than sequential level training may be given by the operator to certain roles or functions where previous learning or experience can be demonstrated.

Qualifying examples of work-related experience that may lead to considering dispensation include:

- regional vocational training schemes
- operator in-house training programmes
- recognition for earlier expired qualifications
- operator staff qualifying from the outset at Level 4 due to other training

The employer should take responsibility for assessing which level of training an individual employee should attend.

Examples where dispensation from the progression may be considered include:

- operator personnel in well design and/or well planning roles
- operator representatives at the well-site
- an offsite manager such as a superintendent

Appendix B. Background on Human Factors/Performance or Well Operations Crew Resource Management

Crew Resource Management (CRM) began in the aviation industry to help flight crews improve their skills in areas such as teamwork, leadership, situation awareness, managing stress, and decision making. The concept has since been successfully translated to a wide range of other higher-hazard industries, such as the fire services, marine, rail, mining and healthcare. In the oil and gas industry, the terms Human Factors(HF)/Human Performance are becoming accepted.

HF/CRM instruction is still in the process of being broadly introduced, accepted and implemented within the industry. It may involve standalone training for some period. Eventually it should evolve to be embedded in the well control curriculum as well as industry practices and procedures.

The non-technical skills integral to HF/CRM are:

1) Situation awareness
2) Decision making
3) Communication
4) Teamwork
5) Leadership
6) Factors that impact human performance.

IOGP's Wells Expert Committee has developed a number of resources designed to promote non-technical skills in this sector of the upstream industry, known as Well Operations Crew Resource Management (WOCRM):

- Report 501 - *Crew Resource Management for Well Operations Teams*
- Report 502 - *Guidelines for implementing Well Operations Crew Resource Management training*
- Report 503 - *Introducing behavioural markers for non-technical skills in oil and gas operations*

These reports provide guidance on introducing training of HF/WOCRM skills in standalone courses that may or may not include simulation. Over time, these skills can be routinely practiced and assessed in ongoing technical well control training, the enhanced versions of Level 3 and 4, refreshers and in scenario based discussions or training.

The intent of HF/WOCRM is to foster a climate or culture where an individual has the duty to question decisions made by authority. The ability to pass on and to challenge the relevant information freely should be encouraged in order to recognise the discrepancy between what is happening and what should be happening, as this is often the first indicator that an error is occurring.

Recommendations:

1) HF/WOCRM training events should be employed. These events might suit a new team coming together or a seasoned team facing a more difficult challenge than they have already mastered.
2) Work teams should undertake HF/WOCRM training as a team during the training. That team might consist of personnel from several different employers.
3) Where crew team training is not yet possible or practical, then individuals should be given the benefit of training about non-technical skills and opportunities to practice these.
4) Training in non-technical skills should start early in a person's career and be reinforced by refreshers to address their new work environments.
5) Where possible, the training of non-technical skills should immerse the trainee in simulations and scenarios of real well-site events, even if this is a desktop exercise when simulators are not available.
6) Training should take advantage of debrief and feedback. The use of Behavioural Markers to assist with evaluation is encouraged.
7) Over time, supervisory staff should be trained to enhance their observational skills, perhaps using behavioural markers together with their own technical knowledge. The objective of having supervisory personnel undertake such training is to strengthen their skills so that they are able to recognise and address the human factor related issues as and when they arise.

Appendix C. Engineer & Approving Authority

All personnel involved with well design and approval of well designs should attend training that includes well integrity assurance with respect to well control.

This additional content is identified primarily for Engineer and Approving Authority training and should include (but is not limited to):

1) basics of geology, the impact of rock behaviour on well control (e.g., rock strength in relationship to wellbore pressures, the ratio of horizontal to vertical stress)
2) holistic design for well control, including primary and secondary barrier elements
3) uncertainties related to any of the inputs to the well design, construction and operation processes
4) instruction on barrier integrity assurance
5) barrier requirements and impact well design
6) importance of annular cement integrity including:
    a) cement testing and the importance of testing cement designs at the correct temperature
    b) pipe centralisation
    c) impact of gas flow during and after cementing, and how this may be mitigated
    d) how unstable wellbores can affect cement integrity
    e) impact of pressure testing (positive and negative) can impact cement sheath integrity.
7) understand the need for and limitations of well integrity verification techniques and requirements for tubular, valves, wellheads, cement and formation integrities including:
    a) pressure verification assurance methods
    b) negative (or in-flow) pressure testing
    c) electric log well integrity verification
8) well design according to the verification of integrity, including kick tolerance
9) well design to account for the management of corrosive well fluids and their compatibility with hardware for continued integrity
10) well integrity monitoring in construction and throughout life cycle
11) the importance of well maintenance and formal regular well integrity testing

12) how to manage failed integrity, repair and post-repair well integrity assurance including equipment redundancies and back-up equipment
13) principles for assessing risk and managing the risk through appropriate avoidance and mitigation measures using realistic probabilities (from industry data) of well control events
14) managing risks associated with programme or design changes and how these risks should be properly managed (Management of Change – MOC)
15) shallow gas surveying, offset well analysis during the well design phase and well design philosophies to manage shallow gas
16) appropriate design and subsequent operations practices to ensure wells are suspended and/or abandoned in an appropriate manner
17) a short introduction of current tertiary well control techniques including:
    a) relief well drilling, interception, and associated relief well kill techniques
    b) capping technologies that are available and under development
    c) subsea containment technologies and techniques
    d) oil spill clean-up technologies that are available and under development.

Appendix D - Well Control Training – Levels Guidance Chart

This chart can be found on the IOGP Members' Area as 476chart.

International Association of Oil & Gas Producers

Well Control Training – Levels Guidance Chart

476chart VERSION 2 | NOVEMBER 2019

Level	Training is on responsibilities for	Action may occur relative to Well Control Assurance [a]	What training this person needs	Learning Outcomes	Certificate for	Repeat Frequency	Learning Method	Formal Assessment	Guide to Typical Roles (Titles can vary between different companies, locations or facilities). The Level may need to be adjusted depending on responsibilities. This list is not exhaustive: the principle is that operator and employer review what training is required to manage the risks.
1	All Personnel contributing to the well project	For individuals who need an awareness of what well control is and those who could perform an action that might indirectly impact Well Control Assurance (WCA)	Awareness of the processes and terminology of well life cycle in order to develop adequate knowledge to provide the required support	Have relevant awareness knowledge of the Key Topics to provide effective support	A general overview of the life cycle of a well with emphasis on how everyone's role can affect well control	None (No repeat)	Online modules or classroom. Include Self-Assessment Quizzes	None	1) The following non well-site office based staff in an oil and gas operating company drilling or well operations department: a) Logistics coordination personnel and logistics supervisors b) Subsurface staff/geologists involved with well planning and well scheduling personnel 2) Offshore Installation Managers (OIMs) that do not have a primary function for drilling and/or well intervention (i.e. Production OIMs) 3) Roustabouts, deck crew, and platform and site location crane operators 4) Rig move captains or rig move Offshore Installation Managers (OIMs) 5) Oil and gas installation supply and support vessel Watch Officers and Captains 6) Other non-critical well-site personnel responsible for downhole and surface well equipment repair, inspection and operations such as: a) Remotely Operated Vehicle (ROV) personnel (non-supervisory) b) Other well-site non-supervisory and non-critical drilling or intervention personnel c) Tubular and rig inspection personnel
2	Operations Team personnel	Well-site based position whose action or inaction that could directly influence (WCA) [a][b]	Skills to act under guidance	Have knowledge and skills to effectively act under guidance (monitor, observe, detect, report)	Attention to Well Control Prevention and Response for the appropriate equipment scenarios (surface / subsea): 1) Drilling 2) Intervention 3) Support Services	Every 5 years	Classroom, online module or on the job mentored programme	Examination	**1) Drilling, Workover and Completions** a) Well-site operations engineer b) Well-site and office based operations geologist c) Roughneck d) Derrick-man e) Drilling Contractor Maintenance personnel (e.g., maintenance supervisor, rig mechanic) f) BOP Equipment Installation, re-work, repair or maintenance personnel **2) Intervention** a) Well-site operations engineer b) Intervention services crew members c) Well-site based wireline or slick-line crew members d) Coiled tubing services crew members e) Snubbing crew members f) Well test crew members g) Pumping and stimulation crew members **3) Support Services [e]** a) BOP / Subsea engineer, dynamic position operator b) Well-site ROV supervisor and crew c) Well-site drilling fluids, mud and completion fluids engineer d) Well-site directional driller e) Fishing engineer or fishing tool operator f) Mud logger or well-site drilling data engineer g) Well-site casing crew supervisors h) Well-site cementing operator i) Well head engineer j) MPD / UBD well-site service personnel (non-supervisory) k) Casing running personnel (non-supervisory) l) Directional surveying / MWD / LWD personnel m) Production staff / supervisors n) Crane operators suspending intervention equipment o) Well head maintenance crew p) Well-site oilfield equipment repair personnel q) Electric- supervisor and crew r) Subsea wellhead / Xmas Tree engineer
3 and 3E	Equipment Operator	Has to perform an action to ensure WCA [a][c] or to respond to well control incidents WCA [a][c]	Correct actions to take	Be able to perform their role effectively, in particular by identifying anomalies and performing the first actions independently, and recognise that they are empowered to do so. Proactively communicate with all personnel who provide support to maintaining well control (e.g. Level 2 personnel). *The Level 3E (Enhanced) is intended to deepen knowledge and can be attempted after having passed Level 3.*	Attention to Well Control Prevention and Response for the appropriate equipment scenarios (surface / subsea): 1) Drilling 2) Intervention 3) Support Services	Every 2 years Level 3E can be attempted 2 years after Level 3 has been successfully passed	Classroom and/or seminars [c]	Examination and Practical [d]	**1) Drilling, Workover and Completions** a) Driller b) Assistant driller **2) Intervention** a) Wireline, E-line, Slick-line operator b) N2 operator c) Wellhead / Tree installation engineer d) Hydraulic work-over (snubbing) operator e) Coiled tubing operator and equivalent positions in other well-servicing or intervention operations **3) Support Services [e]** a) Subsea BOP Engineer b) MPD / UBD well-site service supervisor c) Well testing crew d) LMRP Engineer
4 and 4E	Supervisor	Specifies and has oversight that correct actions are carried out	Skills to anticipate, plan, oversee and verify	Be able to establish consistent practices to assure continued primary well control and well integrity. When anomalous situations occur, or conditions escalate, they will be able to analyse the situation, develop plans to minimize the impact and recover the situation to the norm. *The Level 4E (Enhanced) is intended to deepen knowledge and can be attempted after having passed Level 4.*	Attention to Well Control Planning, Prevention and Response for the appropriate equipment scenarios (surface / subsea): 1) Drilling 2) Intervention 3) Support Services	Every 2 years Level 4E can be attempted 2 years after Level 4 has been successfully passed	Classroom and/or seminars [c]	Examination and Practical [d]	**1) Drilling, Workover and Completions** a) Drilling, Workover and Completions well-site supervisor, Superintendent or company man (day and night) b) Tool pusher c) Drilling contractor rig manager d) Office based Operational staff (e.g. Senior Well Engineer, Operational Well Engineer) **2) Intervention** a) Completion / work-over / intervention supervisor or superintendent b) Well-site completions / work-over supervisor c) Supervisors or crew chiefs for special service operations such as wireline, slick-line and coiled tubing operations, that provide specific well control equipment for these activities d) Office based Operational staff (e.g. Senior Completions / Well Interventions e) Engineer, Operational Completions / Well Intervention Engineer) **3) Support Services [e]** a) Offshore Installation Manager (OIM) for offshore units with a primary function for drilling or well intervention b) Well-site personnel supervising Managed Pressure Drilling (MPD) operations or Under-Balance Drilling (UBD) services c) Hydraulic work-over (snubbing) supervisor
	Engineer and Approving Authority [e]	Deliver the correct design and develop the normal operating envelope. Identify actions with the agreed design envelope and manage risk	Skills to design the well and well activities, including subsurface/geological knowledge. Skill to identify and to specify actions to be taken when stepping outside of the normal operating envelope	Have discipline-specific skills and subsurface/geological/production knowledge to be capable of planning and performing safe well design and/or intervention operations. Be able to evaluate technically on deviations to the well operations plan and advise accordingly	One discipline specific training course or program for all operations, environments and rig types	None (Continuous learning refreshers recommended) [f]	Classroom and/or seminars or a development program encompassing all elements of well planning [c]	Industry Examination, or auditable alternatives as deployed in some company programs.	1) Drilling engineer / Senior drilling engineer 2) Completion engineers / Senior completion engineer 3) Petroleum engineers / Senior petroleum engineers 4) Well service engineer / Senior well service engineer 5) Intervention engineer / Senior intervention engineer 6) Drilling / Intervention superintendent (if involved with well design) 7) Drilling manager (up to first line drilling management) 8) Drilling project managers (up to first line drilling management) 9) Well operations managers 10) Well services managers 11) Office based design personnel 12) Senior wells personnel, e.g. Team Leader and General Manager Wells

Chart excludes Well Integrity Assurance (WIA) during production use of the well.

a Well Control Assurance. WCA **(i)**: The assurance that primary well control is maintained. WCA **(ii)**: When this is not the case that the situation is properly contained and the status of the well returned safely to normality.
b Well Support Service providers (or their training partners) are to identify and deliver appropriate well control training to their staff requisite for services provided.
c Could be a fully auditable alternative. The Classroom is a Standard. The full capability should be demonstrated to meet or exceed the learning environment of the classroom.
d For Drilling (and for D/WO/C): Written examination and simulator assessment. For Well Intervention: Written examination and simulator assessment or approved alternative (e.g. scenario-based paper exercise).
e Approving Authority is the individual providing technical oversight for the design and for deviations.
f Refreshers recommended because technologies, practices, designs, standards, etc. change with time.

Registered Office
City Tower
Level 14
40 Basinghall Street
London EC2V 5DE
United Kingdom

T +44 (0)20 3763 9700
reception@iogp.org

Brussels Office
Avenue de Tervuren 188A
B-1150 Brussels
Belgium

T +32 (0)2 790 7762
eu-reception@iogp.org

Houston Office
19219 Katy Freeway
Suite 175
Houston, TX 77094
USA

T +1 (713) 261 0411
reception@iogp.org

www.iogp.org

This 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.

The content of this report applies to all types of onshore and offshore well control operations worldwide. Its recommendations are applicable to the personnel who plan, approve and execute well work at any stage of a well's life cycle.

This report is supported by 476chart, *Well Control Training – Levels Guidance Chart*.