International Association of Oil & Gas Producers

REPORT 476 | AUGUST 2016

Recommendations for enhancements to well control training, examination and certification

Acknowledgements

Wells Expert Committee

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Revision history

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

Contents

Foreword

The E&P industry must strive to consistently improve well control competency of personnel involved with all oil and gas well operations throughout the world, and this should be actively overseen by those who accept the risks associated with well control events. The industry has a focus on process safety and for well operations involving drilling, completion and well intervention, process safety means well control.

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

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

a) the scope: well drilling, completion and intervention throughout life cycle up to and including abandonment. Support services with well control responsibilities are also included

b) detection and immediate response to minimize well influxes or well integrity failure with the ultimate objective of minimizing uncontrolled hydrocarbon release

c) training concerning risk awareness and risk management specific to maintaining well control

d) well control training is recommended to be tailored specifically to roles and responsibilities. Well control training for support services should be tailored to meet their function in respect to their well control responsibilities

e) role-specific Levels 1–5 training is clarified. Examples are set out in 476chart, *Well Control Training – Levels Guidance Chart*, which is published at the same time as this report

f) methodology for formal assessment is clarified

g) certification records recommended to be kept by training providers and accreditation bodies where applicable

h) level progression and the dispensation guidance are given

i) elements of Human Factors/Crew Resource Management/Non-Technical skills being introduced within well control training

j) prescriptive examples of syllabuses for both standard and specialized courses from the first edition were removed because role-appropriate syllabuses are being developed by industry parties.

1. 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 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.

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

2. 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 danger to life, the environment and company reputation.

Well control training should enable participants to receive and develop role-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 risks of well control incidents and associated consequences should be minimized.

Well control responsibilities address, but are not limited to:

- recognizing the importance of appropriate well design for well control safety
- explaining how well integrity is maintained
- recognizing 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-specific responsibilities
- recognizing 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 normalize 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-recognized standard.

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

- 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.

3. Well control training key topics

An individual's role 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) Why do we need well control training?
2) risk awareness and risk management (risk identification, assessment, analysis, mitigation), Management of Change (MOC), and contingency planning
3) well control risks at each stage of the well life cycle
4) well control at each stage of the well life cycle
5) learnings from the past well control incidents, examples for every stage of the well life cycle
6) pressure: pore pressure (also known as formation pressure), fracture pressure, hydrostatic pressure, sub-normal pressures, over-pressures, surface pressures, circulating pressures, etc.
7) well design and barrier design concepts, together with the corresponding calculations, including primary, secondary, tertiary barrier envelopes, barrier identification and barrier management
8) the primary barrier envelope components and their function (e.g. hydrostatic head, wellhead seals, stuffing box seals)
9) well construction and intervention – assuring integrity (e.g. fluids, cement, barrier management, monitoring, testing)
10) fluids in wells – behaviours and characteristics (e.g. solubility, composition, temperature effects, compression, expansion) of gases and liquids including drilling fluids, completion fluids and work-over fluids
11) primary well control operations of monitoring, detection, interpretation, analysis and response
12) drills: empowerment and duty, including practical exercises
13) detection of indicators of changing conditions that may lead to loss of well control or loss of well integrity
14) equipment function and limitations that can affect Well Control Assurance during the span of the entire well life cycle, e.g. BOP equipment
15) controlling anomalous behaviour such as a fluid influx or loss within the wellbore with defined well shut-in and securing procedures
16) well control response methods and procedures to return the situation to normal, deciding on specific methods of well kill (e.g. reverse circulation and forward circulation, wait and weight and driller's method, volumetric, lubricate and bleed, combined volumetric stripping, bullhead) to include both management and calculations
17) completely regain the integrity of the well barrier and return safely to continue the operation on the well with primary well control
18) as appropriate Human Factors/Crew Resource Management/Non-Technical Skills

4. General recommendations for well control training

4.1 Operation type, environment and equipment

Complexities of well control can differ significantly between 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.

Typical operations are:

1) **Drilling with bottom-supported offshore installations and land-based installations that utilize surface well control equipment**
2) **Drilling with floating rig operations utilizing subsea well control equipment.** Differences in well control challenges should be identified for the following environments:
    - water depth varying in comparison from shallow to much deeper
    - moored drilling rigs versus dynamically positioned drilling rigs
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.

Drilling is intended to include the construction of a new wellbore and/or sidetrack, and subsequent operations such as well testing, completion and work-over operations until a well is handed over, suspended or abandoned.

There should be adequate training coverage, as appropriate for the role, to ensure these programmes are designed and executed in an appropriate manner. This is to ensure well integrity is assured both during and after the conclusion of these operations.

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

4.2 Topics for emphasis in well control training

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

4.2.1 Monitoring, detection, and response

Training should have a strong focus on the importance of maintaining well barrier integrity as a key avoidance measure and for significantly reducing the severity of a well control event. Maintaining well barrier integrity necessitates learners have 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.

Monitoring should address barriers and all of the aspects of operations that can impact well control assurance.

Training with respect to monitoring 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 for example on 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 health)
- monitoring for signs of failure of sub-surface pressure control equipment during well intervention operations on a live well, e.g. deep set or shallow set plugs, or down-hole valves
- monitoring for signs of compromise of sub-surface well integrity during all operations including well intervention activity into a suspended or dead well, or whilst killing any well.

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 of kick and leak detection equipment and how it is maintained
- accurate interpretation of sensor readings
- the different signs of anomalies and early detection techniques that may indicate influx potential
- the importance of fluid flow monitoring for early kick detection.

The learner will know that the Well Control Management plans will include the expected response.

Shutting-in the well should be seen as the right response action. Training should help foster a culture not to ignore anomalies and "if in doubt, shut in". 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 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 bias**, a false sense of security: instead, be vigilant and thorough in monitoring, detecting and responding.

4.2.2 Risk awareness and risk management

The objective is for everyone to develop their own risk awareness and risk management skills. It is recommended that the fundamentals of risk management as appropriate for each training are delivered.

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

- explain the overall risk management process and the elements within it
- recognize the significance of uncertainties
- recognize hazards and its potential consequences
- 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
- recognize the impact of **situational awareness** by the complete Operations Team to managing well site risks.

The Operations Team is the Well Operations personnel who are 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.

4.2.3 Procedures and procedural discipline

Fundamental to delivering a safe well operation is having in place appropriate procedures which are followed and verified compliant. This aspect of risk management should be emphasized throughout the training.

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 to convey during training that any modification to procedures, work instructions or a previously approved programme of work should include:

- a proper risk assessment
- an appropriate Management of Change execution
- sign off by the designated Approving Authority.

4.2.4 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 the importance of redundant 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) 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
- note the importance of maintaining dual barriers below surface when a well profile change is made, for example, when a cementation of perforation is undertaken
- highlight the importance of assuring dual barrier protection during suspension or abandonment operations (for example when BOPs and/or Christmas trees will be removed for extended/indefinite periods of time)
- ensure all participants know the barriers for which they are responsible, e.g. on the basis of bow tie methodology. See Appendix D for a brief description of the bow tie methodology.

5. Well control learning methods

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.

5.1 Role-specific well control training

The employer is responsible for assuring that all personnel who can impact the well barriers have role 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 6 (Role-Based Training levels).

Well control training for specialized operations are set out in section 7.

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. See section 8 (Assuring the quality of well control training).

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.

5.2 Scenario-based training events

Scenario-based well control training is a term that refers to training activities where both technical and non-technical / Well Operations Crew Resource Management (WOCRM or CRM) skills are able to be applied to particular challenging scenarios. This could utilize 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. This should be as relevant for well construction activities as it is for well servicing/intervention.

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 recognize 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) 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 CRM skills.

These training events should be created to offer learning opportunities to all in the broad spectrum of team members. This should encourage participants to investigate and learn in a multi-discipline 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 organizational.

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 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.

5.3 Continuous learning in the workplace

Personnel involved in well operations should also participate in continuous learning rather than relying only on a classroom based training and assessment processes. Continuous learning can be achieved in a multitude of ways which may include online training, rigsite training and face-to-face refresher training.

As an example of refresher training, a good methodology to achieve this is through regular and documented 'hands-on' well control simulation exercises or kick drills, or scenario-based discussions with the rig crews at the well-site. 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 is recommended to maintain Level 5 proficiency in order to keep focus on well control during design as technology, practices, designs, and standards evolve with time.

6. Role-Specific Training levels

Personnel should be trained and certified at a specific level appropriate to their role. They should maintain certification while performing within the 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: this 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.

These role-specific training levels are recommended to be adopted for oil and gas well operations. Training should always be tailored within each level according to the specific operation, environment, surface or subsea location of rig or intervention unit (e.g. BOP type).

See Appendix A (Managing risks, progression and dispensation).

Table 1 provides a summary of the Role-Based Training levels, which is followed by a full specification of the responsibilities for each level.

The levels and responsibilities have also been collated onto one large wall chart: 476chart, *Well Control Training – Levels Guidance Chart*, published at the same time as this report.

Table 1: Summary of the Role-Based Training levels

Level	Training is on responsibilities for	Action may occur relative to Well Control Assurance (WCA) [a]	What training this person needs
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 WCA	Have relevant awareness knowledge of the Key Topics to provide effective support.
2	Operations Team Personnel	Well-site based position whose action or inaction that could directly influence WCA	Have knowledge and skills to effectively act under guidance (monitor, observe, report)
3	Equipment Operator	Has to perform an action to prevent or to respond to well control incidents	Correct actions to take
4	Supervisor	Specifies and has oversight that correct actions are carried out	Skills to anticipate, plan, oversee and verify
5	Engineer & Approving Authority [b]	Getting the agreed design correct and developing the normal operating envelope. Identifying actions out-with the agreed design and managing the risk	Skills to design the well and the well activities. Skills to identify and to specify actions to be taken when stepping outside of the normal operating envelope.

[a] Well Control Assurance: The assurance that primary well control is maintained and, when this is not the case, that the situation is properly contained and the status of the well is returned safely to normality.

[b] Approving Authority is the individual providing technical oversight for the design and for deviations.

Level 1 All Personnel Training

What training this person needs

Awareness of the processes and terminology of well life cycle in order to develop adequate knowledge to provide the required support.

Learning outcome

Have relevant knowledge of the Key Topics to provide effective support.

Repeat frequency

None (no repeat).

Learning method

Online modules or classroom. Include Self-Assessment Questionnaires.

Formal assessment

An examination for this level is not mandatory.

All 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

What training this person needs

Skills to act under guidance.

Learning outcome

Have knowledge and skills to effectively act under guidance (monitor, observe, detect, report).

Repeat frequency

Every five years.

Learning method

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

Formal assessment

Accomplishment of this training level should be verified with a pass/fail examination. It is important that any knowledge gap which identified is filled by consultation or debrief.

Operations Team Personnel Training is recommended as a basic level well control training module. Attendees should be the members of the well-site Operations Team working 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 in the work-place reinforces knowledge and skills mastered by individuals on training courses and for the Operations Team to effectively carry out their well control responsibilities.

Level 3 Equipment Operator training

What training this person needs

Correct actions to take.

Learning outcome

Be able to perform their role effectively. In particular, assure effective well control barriers are in place and continuously maintained and monitored. Be able to identify kick indications and anomalies and perform the first actions independently. Be able 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

Every two years.

Learning method

Classroom using simulation, desktop exercises, presentations and discussions, possibly with on-line pre-work for knowledge content and practice. It is noted that as learning technologies and methodologies evolve, technologies and methodologies other than face to face classroom training may become available but these should be demonstrated to be as effective as classroom training.

Formal assessment

Accomplishment of this training level should be verified with a pass/fail examination, 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.

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 in the work-place reinforces knowledge and skills mastered by individuals on training courses and for the Operations Team to effectively carry out their well control responsibilities.

Level 4 Supervisor training

What training this person needs

Skills to anticipate, plan, oversee and verify.

Learning outcome

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.

Repeat frequency

Every two years.

Learning method

Classroom using simulation, desktop exercises, presentations and discussions, possibly with on-line pre-work for knowledge content and practice. It is noted that as learning technologies and methodologies evolve, technologies and methodologies other than face to face classroom training may become available but these should be demonstrated to be as effective as classroom training.

Formal assessment

Accomplishment of this training level should be verified with a pass/fail examination 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.

Continuous learning in the work-place reinforces knowledge and skills mastered by individuals on training courses and for the Operations Team to effectively carry out their well control responsibilities.

Level 5 Engineer and Approving Authority training

What training this person needs

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

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

Learning outcome

Have discipline-specific knowledge and skills, to be capable of planning and performing safe well design and/or intervention operations that maintain well control and integrity. Be able to evaluate technically on deviations to the well operations plan and advise accordingly.

Repeat frequency

None. However, continuous learning refreshers are recommended that include a specific focus on changing technologies, practices, designs, and standards.

Learning method

Classroom using simulation, desktop exercises, presentations and discussions, possibly with on-line pre-work for knowledge content and practice. It is noted that as learning technologies and methodologies evolve, technologies and methodologies other than face to face classroom training may become available but these should be demonstrated to be as effective as classroom training. Refreshers may specifically benefit from alternative delivery methodologies.

Formal assessment

Accomplishment of this training level should be verified with a pass/fail examination. This pass fail exam may also be incorporated into a drilling engineering examination process as part of a comprehensive drilling or well engineering training programme.

Engineer and Approving Authority training: in addition to attending some level of operational well control (Level 4 is recommended), 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 Level 5 training may be appropriate in some cases.

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 rig types.

This training may be designed so one training module or set of modules covers all aspects of well design awareness.

This training should be

- administered as a classroom training course (or equivalent per note above) to encourage discussion on the topics. It should include the elements described in the Appendix C [Well design and operational implications]
- alternatively incorporated into a comprehensive drilling or well intervention training programme that an individual undertakes.

Continuous learning in the work-place reinforces knowledge and skills mastered by individuals on training courses and for the Operations Team to effectively carry out their well control responsibilities. This is especially important for well design and well planning engineers so as to keep up with current technology. The new content and learning will come from many sources (e.g., seminars, conferences, forums, bulletins, alerts, online).

7. Well control training for specialized operations

Additional training is necessary for personnel involved with specialized well operations. Those specialized operations may require specialized courses. These courses may address more than just Well Control but only the Well Control component is addressed here.

Each specialized course should address:

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

Examples of situations that might require specialized courses are: Managed Pressure Drilling and Completion, High Pressure High Temperature (HPHT) Well Construction or Intervention, Deepwater Activities.

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

8. 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.

8.1 Quality of Training Programme

Training providers should be accredited by a recognized 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 organizations with peer input from operators, drilling contractors, and service companies.

Any accreditation party, including an independent body with knowledge of training and access to subject matter experts, may also carry out the accreditation of a company's "in-house" programme.

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.

8.2 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 certified according to industry accreditation bodies or to equivalent standards through an independent entity. Training Provider's should own 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 exam scores and reactions. 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.

8.3 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.

8.4 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. This evidence should be maintained by the training provider.

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

8.5 Repeat well control training

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

The use of shortened repeat or 'refresher' courses to maintain certification is discouraged, as this has been generally recognized as inadequate to assure continuous development of well control competency for an individual.

Enhanced well control training courses are therefore recommended for each 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-Based Training
- passed the examination requirements for their role level at least twice with a high pass mark (i.e. more than 80%).

While the enhanced courses are still expected to meet the requirements of the Role-Based 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 information and updates on recent events and actively encourage participants to share their well control experience.

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

8.6 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 independent third-party.

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 organization that assures training quality
- the course content and delivery materials and methods held by the organization for each course
- the safe and suitable facilities held by the organization 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 pre-agreed set of performance criteria.

Both internal audits by the Training Provider 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 and dispensation 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 very 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.
Level 5	is considered separate from the progression of Levels 2 to 3 to 4. Typically Level 5 is aligned with requirements for Operator Well Design personnel and Contractor Turn-Key Design Staff. This is due to the fact that Level 5 design personnel may, or may not, have gone through the roles of Levels 2 or 3 or 4. Usually their work at Level 5 is carried out away from the well-site.

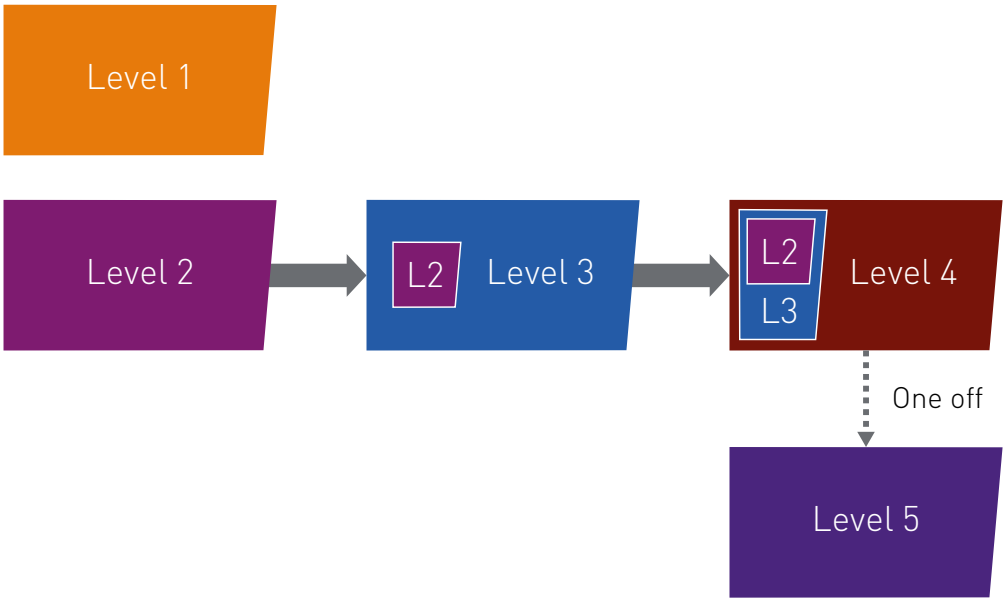

Figure A.1: Typical progression between the levels of Role-Based Training

A.3 Dispensation

Most individuals in well-site roles will follow the route of progression described in A.3 but there may be exceptions in special cases.

Dispensation for personnel certified by other than via 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 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.

CRM instruction is still in the process of being broadly introduced and 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 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*.

These reports provide guidance on introducing training of WOCRM skills in stand-alone courses that may or may not include simulation. Over time, these skills can be routinely practiced and assessed in ongoing technical well control training, refreshers and in scenario based discussions or training.

Essentially, the intent of WOCRM is to foster a climate or culture where an individual has the right to respectfully question decisions made by authority. The ability to pass on and to challenge the relevant information freely should be encouraged in order to recognize 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) WOCRM training events should be employed as much as possible where practical. These events might suit a new team coming together or a seasoned team facing a more difficult challenge than they have already mastered.
2) If possible, work teams should undertake 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 recognize and address the human factor related issues as and when they arise.

Appendix C. Level 5 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 Level 5 Engineer and Approving Authority well control 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
3) recognize and address uncertainty related to any of the inputs to the well design, construction and operation processes
4) instruction on barrier integrity assurance, for example, by bow-tie methodology
5) barrier implications to well design, e.g. shoe track to be classified as a barrier
6) importance of annular cement integrity including:
    a) cement testing and the importance of testing cement designs at the correct temperature
    b) pipe centralization
    c) impact of gas flow during and after cementing, and how this may be mitigated
    d) how unstable wellbores can affect cement integrity
7) 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 and its weaknesses
    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. Bow tie methodology

The bow tie methodology is a simple diagrammatic way of describing and analysing the pathways of risk from causes to consequences.

The focus of the bow tie is on the preventive measures between the causes and the risk, and the risk and consequences.

Bow tie methodology is often easy to understand and therefore can also be a useful communication tool. There are different approaches to the bow tie methodology. Choose one that is appropriate for your organization.

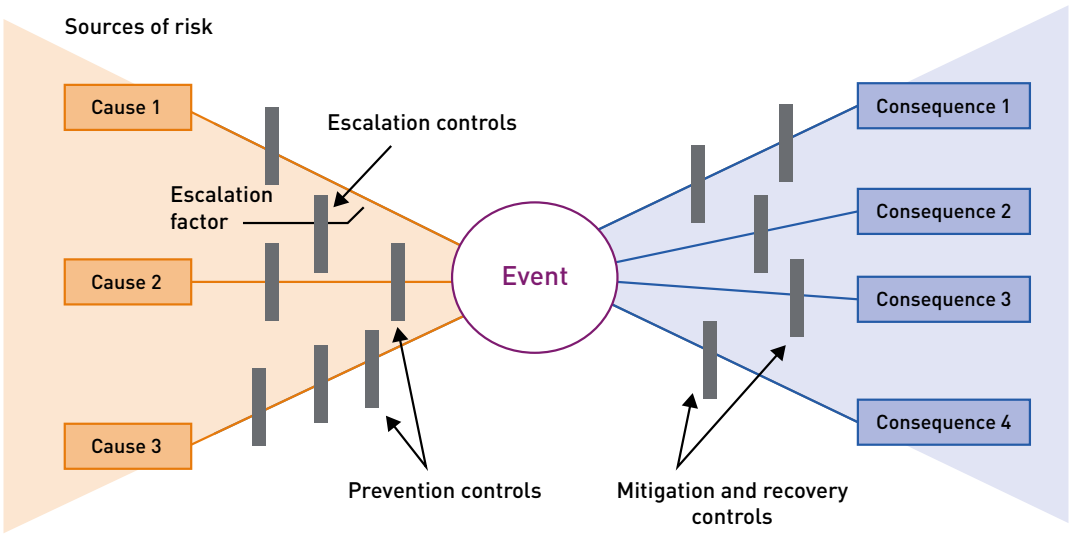

Figure D.1: A bow tie diagram

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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 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*.