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Authors	Colin Stuart and John Wright
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Draft 1	6/9/24	Independent Review of Well Blowout Risk Management at Torosa	C. Stuart J. Wright	C. Stuart J. Wright
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CURRENT REVISION:

Name	Position	Signature	Date
Prepared and Approved By:			
Colin Stuart	Managing & Technical Director of Stuart Wright Pte Ltd		10th September 2024

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Contents

1. Expert Witness Statement

I confirm that we (Colin Stuart and John Wright) have been asked by representatives of Woodside, to provide an Independent Review of Well Blowout Risk management at Torosa. A copy of the RFQ received from Woodside and a copy of the issued Purchase Order for the work Woodside have asked that a summary of the review findings that can be provided to external regulators as a summary of the review and outcomes in the form of a brief independent expert opinion statement. This summary statement can be found at the end of the Executive summary section.

I also confirm I reside at 33 Birdwood Circus Bicton, WA6157. I confirm I have read and complied with The Federal Court of Australia "EXPERT EVIDENCE PRACTICE NOTE (GPN-EXPT) General Practice" note while compiling my report.

I further confirm my understanding of the role of an Expert Witness under 4.1 of the Code of Practice "The *role of the expert witness is to provide relevant and impartial evidence in his or her area of expertise. An expert should never mislead the Court or become an advocate for the cause of the party that has retained the expert".*

My comments in the following document are in Blue and those of John Wright's are in Red. Extracts from other parties including Woodside, EPA, NOPSEMA and DMIRS are in Black.

Colin Stuart B.Eng FIMechE

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1.1 Expert Witness's past relationship (if any) with any of the Parties

I have conducted several technical support exercises and provided reports to Woodside in the past as an independent technical expert.

2. List of Abbreviations

Abbreviation	Description
ALARP	"ALARP" is short for "as low as reasonably practicable". Reasonably practicable involves weighing a risk against the trouble, time and money needed to control it. Thus, ALARP describes the level to which we expect to see workplace risks controlled.
AMOSC	The Australian Marine Oil Spill Centre Pty Ltd (AMOSC) operates the Australian oil industry's major oil spill response facility.
APB	Annulus pressure build up
API	American Petroleum Institute
APPEA	The Australian Petroleum Production & Exploration Association (APPEA) is the peak national body representing Australia"s oil and gas exploration and production industry.
B-Annulus	The annulus designation between the production casing and next outer casing.
BHP	Bottomhole pressure (or downhole pressure) is the pressure measured at the bottom of the hole in pounds per square inch (psi). It is the sum of the different pressures acting downhole or at the bottom of the drilled hole. For non-flow conditions, the downhole pressure is caused by the hydrostatic pressure exerted by the fluid in the wellbore and surface pressure. For flow conditions, when wellbore fluid is being circulated, it is the sum of the hydrostatic pressure and the friction pressure drop in the annulus.
BOCP	Blowout Contingency Plan
BOP	A blowout preventer (BOP) is a specialized valve or similar mechanical device, used to seal, control and monitor oil and gas wells to prevent blowouts, the uncontrolled release of crude oil or natural gas from a well.
CE	Completion Engineer
D&C	Drilling and Completions
DE	Drilling Engineer

Abbreviation	Description
DMIRS	The Department of Energy, Mines, Industry Regulation and Safety (DMIRS) is a department of the Government of Western Australia.
DP	Dynamic Positioning
ECD	Equivalent Circulating Density
EE	Environmental Engineer
EKD	Early Kick Detection
EMBA	Environment that may be affected
EP	Environmental Plan
EPA	The NSW Environment Protection Authority (EPA) is the primary environmental regulator for New South Wales.
FEED	Front-End Engineering Design
FID	Final Investment Decision
GI	Global Initiative (GI) programme
GoM	Gulf od Mexico
GWS	Global Well and Seismic
HAZOP	Hazard and Operability (HAZOP) study is a structured and systematic examination of a planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment, or prevent efficient operation.
HC	Hydrocarbon
HPHT	High Pressure High Temperature
IMT	Incident Management Team
IOGP	International Association of Oil and Gas Producers
IPIECA	Ipieca is the global oil and gas association for advancing environmental and social performance across the energy transition.
ISO	International Organization for Standardization
K-BOS	Kinetic Blowout Stopper
LEL	Lower Explosive Limit
LOC	Loss of Containment, a critical event that occurs when hazardous materials escape from their intended storage or containment
LOWC	Loss of Well Control
MAWHP	Maximum Anticipated Wellhead Pressure
MD	Measured Depth

Abbreviation	Description
MMscf/d	Million standard cubic feet per day is a unit of measurement for gases that is predominantly used in the United States.
MMV	Monitored, Measured, and Validated
MPD	Managed Pressure Drilling
MW	Mud Weight
NOPSEMA	The National Offshore Petroleum Safety and Environmental Management Authority
NORSOK	The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry
NWS	North West Shelf
OESI	Ocean Energy Institute
OPGGS	Offshore Petroleum and Greenhouse Gas Storage Act 2006
PC	Production Chemist
PCE	Process Safety Events
psi	Pounds per square inch
QA/QC	Quality Assurance / Quality Control
RA	Risk Assessment
RE	Reservoir Engineer
RFQ	Request for Quotation
ROV	Remotely Operated Vehicle
RP	Recommended Practise
RRM	Risk reduction measures
SCERP	Source Control Emergency Response Plan
SFRT	Subsea First Response Toolkit
SIMOPS	SIMOPs (Simultaneous Operations) are activities that occur at the same time in a process plant or facility, such as maintenance, construction, inspection, testing, or production
SINTEF	SINTEF is one of Europe's largest independent research organisations.
SSTT	Subsea Test Tree

Abbreviation	Description
stb	When referring to liquid volumes at stock tank conditions, units of Stock Tank Barrels (STB) are used as reference conditions for volumetric reservoir engineering calculations.
WAC	Well Acceptance Criteria are the performance standards that need to be attained during the well activity execution phase.
WCBD	Well Control Bridging Document
WCD	Worst Case Discharge (WCD) is a calculation used by the Bureau of Ocean Energy Management, Regulation and Enforcement to determine the maximum flow rate for an offshore oil well in the event of an oil spill.
WEL	Woodside Exploration Limited
WH	Wellhead
WMP	Well Management Plan (WMP), which details the geological prognosis and how the company will drill the well, the Environment Plan (EP) and the Safety Management System (SMS).
WOMP	Well operations management plan
WWC	Wild Well Control (WWC)
Xmas tree	Christmas tree, is an assembly of valves, casing spools, and fittings used to regulate the flow of pipes in an oil well.

3. Introduction and Background

3.1 Project Description and Purpose

The extracts below are the statements of Purpose for this independent study and the Objectives as written by Woodside in the RFQ issued to Stuart Wright Pte Ltd on, 28th June 2024:

Purpose

The purpose of this document is to describe the present the results of an independent review of the concept phase risk management work performed by Woodside (WEL) on the hazard posed by drilling the hydrocarbon bearing Torosa reservoir, located in proximity to Scott Reef.

- *The review is an independent, and impartial view of the WEL work and is intended to assess the work accomplished by Woodside. This work has been performed to ensure all relevant and applicable measures are and would be in place to reduce the risk of an uncontrolled release and , should this rare event occur, that environmental damage from an uncontrolled release of hydrocarbons from a Torosa well are kept to an acceptable minimum through regaining control of such a well in as short a time as possible.*

WEL shall provide available well related information required to conduct the assessment including:

1. *Browse to NWS Drilling & Completions Concept Definition Report.*
2. *Unplanned hydrocarbon spill modelling (well blowout scenario).*
3. *Overview of Proposed Browse to NWS Project Hydrocarbon Spill Risk Management Approach.*
4. *Torosa risk reduction control assessment.*
5. *NASA Probabilistic Risk Assessment (PRA) of Kinetic Blowout Stopper System (K-BOS).*
6. *Woodside Management System Documents (Procedures, Guidelines, Standards etc.).*

Upon award of the work by Woodside a Purchase Order was issued which stated the deliverables as follows:

- *Deliverables shall include a written report addressing the following objectives of the review: Review the proposed Browse approach against global contemporary industry 'best practice' for preventing and mitigating the risk of subsea well blowouts from development of gas/condensate wells at locations in close proximity to sensitive social or environmental receptors.*

- *Identify any additional prevention or mitigation barriers that should be assessed by Woodside to ensure environment risks from drilling Browse wells can be demonstrated to be as low as reasonably practicable and commensurate with global industry best practice.*
- *Provide a summary of review findings, that can be provided to external regulators as a summary of the review and outcomes, in the form of a brief independent expert opinion statement.*
- *Provide explanation in lay-man's terms to avoid technical or legal jargon where this may assist stakeholders.*

A Kick Off (KO) meeting was held with James Peyton at Woodside offices on Thursday 1st August 2024 with myelf, in person, with John Wright attending remotely from Houston and James Peyton of Woodside at their Perth headquarters.

In the KO meeting, James explained the environmental sensitivity of the Scott Reef system being only 3 km distant from the Torosa planned manifold location. James further explained the background to the project location and conceptual design challenges, with an emphasis on the EPA environmental impact assessment submission by Woodside as well as feedback from the EPA on this submission, together with comments from DMIRS. James explained that in the EPA environment impact submission, Woodside had explained their rationale for a worst-case discharge from a well in the Torosa field, and their standing response procedures for such an event.

This analysis by Woodside, presented to the EPA had shown at a conceptual design level WEL could contain a worst-case discharge by mobilising and deployment of the Singapore based WWC Capping stack system in 13 days, and if a relief well was in fact required to stop the worst-case discharge, that this would take 77 days. James explained that in the EPA response to Woodside, that in either case, damage to Scott Reef would be at an unacceptable level. James further demonstrated that on the prevention side, In Woodside's document "*Proposed Browse North West Shelf Development, ERD Response to submissions, Appendix B.3 Overview of Browse hydrocarbon Spill Risk Management Response, November 2023*", clearly identified that WEL's Well Engineering and Operations standards were of an internationally recognised quality which govern all wells activity at Torosa and reduce the likelihood of an uncontrolled release to at least the existing very low levels of 0.25 per 1000 wells drilled, as follows:

Reducing the likelihood of well loss of containment events.

A well loss of containment event is classified as any release of hydrocarbon (regardless of size or duration) from primary and secondary well control barriers. In undertaking this risk assessment of a potential major hydrocarbon release, the spill likelihood was evaluated using blowout and well release frequencies based on SINTEF offshore blowout database 2012 (Scandpower, 2013). This uses data from 1991-2010 to determine *likelihood for well blowouts and releases. For a gas well, the SINTEF calculated probability of blowout during drilling and completion is 2.93 X 10-4 which means for any given well it is estimated that there is less than 0.000293% probability of a loss of well containment event occurring. The SINTEF data supports a likelihood of 'highly unlikely' for a well blowout with potential to result in the worst-case credible spill. Furthermore, since the Gulf of Mexico Macondo event, significant improvements in engineering and management controls have been adopted by the industry, further reducing the likelihood of such an event occurring. This can be evidenced in the report by Exprosoft (2017) which reviewed all Loss of Well Control (LOWC) events reported in the SINTEF Offshore Blowout Database for the period 2000–2015. The report describes, categorizes, and analyzes the observed LOWC events for the period 2000–2015, and compares the LOWC frequencies in the US GoM with other regulated areas. For regulated areas (which includes Australia), the frequency of loss of well control events in deep zone of development or exploration wells was 0.25 per 1,000 wells drilled.*

The nature of the challenge for Woodside for the Browse development from an Environmental perspective is the proximity of proposed drilling facilities to the Scott Reef complex of Coral and Sandy islets as shown in Figure 1 below, and the potential damage a discharge from a well blowout could cause to the reef system and its' habitat and associated marine life.

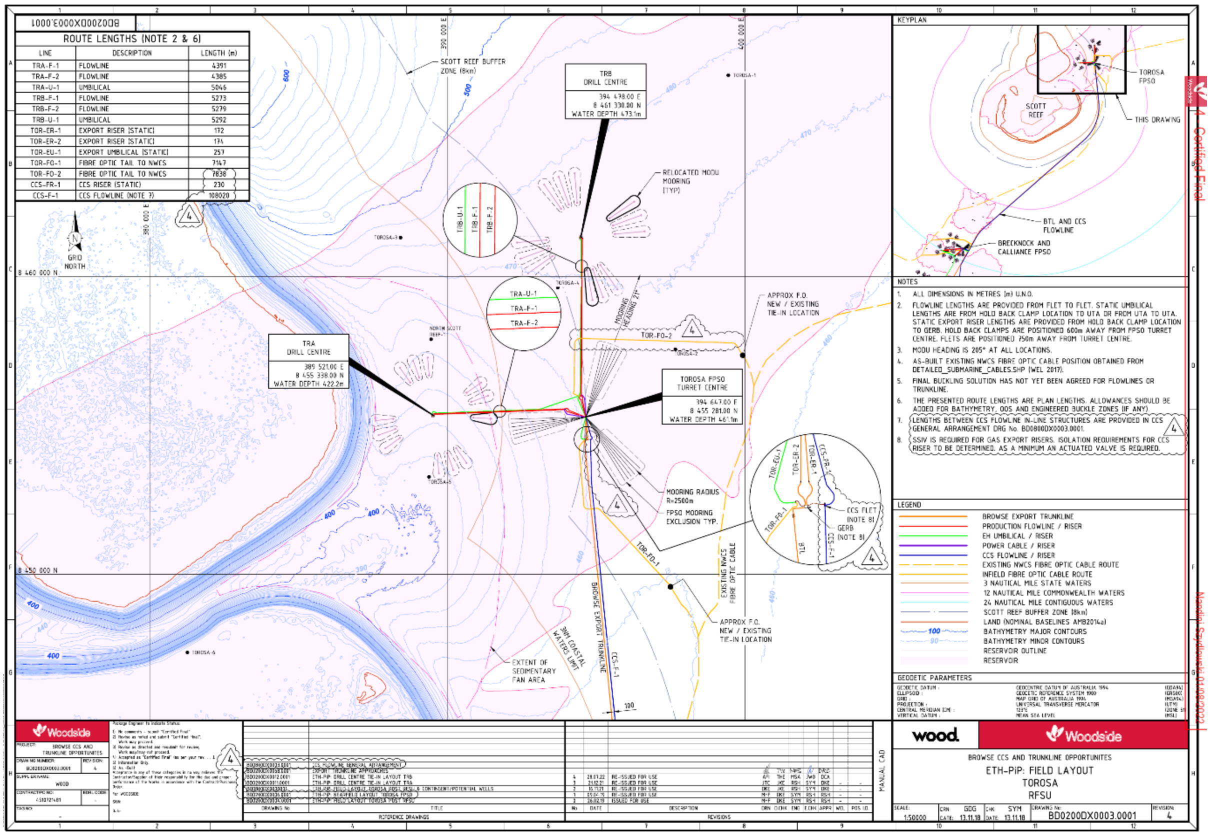


Figure 1. Proposed drilling facilities to the Scott Reef complex of Coral and Sandy islets.

The Figure 2 below shows the Scott Reef complex of islands as extracted the following document supplied by Woodside:

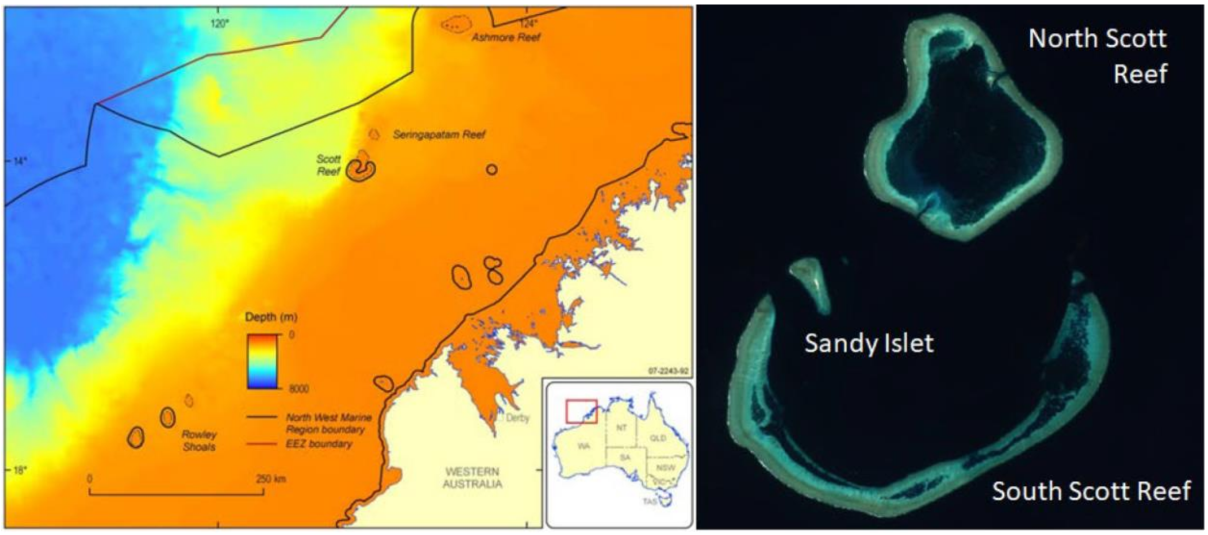


Figure 2. Scott Reef Complex.

Sandy Islet Subsidence Assessment – Internal Report

Client: DWER

Author: Dr Matt Eliot

Damara Project No. 326

Contact: Leanne Thompson

Date: 09 Oct 2023

Document Number 326-01-B

The position of Woodside as stated above is that the Reef system is in effect protected by the extremely low likelihood of an uncontrolled well event to cause a pollution incident in the first place *2.93 X 10-4 which means for any given well it is estimated that there is less than 0.000293% probability of a loss of well containment event occurring,* and that this extremely low probability will be further lowered through new and emerging methodologies between now and drilling taking place in 2027 at the earliest. On the mitigation side of Woodside's analysis, should this extremely rare event occur, it has been fed back to Woodside by the EPA that credible oil spill scenarios must be demonstrated. A period of 24 hours was considered by WEL as a duration to allow time for independent response and activation of the K-BOS independently of the drilling unit. WEL has also now conducted spill modelling for 24 hours.

The worst-case blowout assumption currently is as follows:

- A maximum blow rate of 1340MMscf/d was assumed as per relief well modelling assumptions.

- And 13,534 stb of condensate per day

This assessment by the EPA in effect means that the current proposed method of mobilisation of a Capping stack from Singapore in 13 days to stop the flow, followed by a relief well, in 77 days, to stop the flow if the capping stack is not successful, would not be acceptable to the EPA. As a consequence, Woodside have been evaluating the potential deployment of the K-BOS explosive ram system which can be deployed to the BOP and provides assurance that a blowout from the the well could be shut in in a matter of 24 hours in the worst-case scenario, but in the mostly likely case this could be significantly faster with activation of the K-BOS from the drilling unit.

4. Contents of My Report and Related Material

A list of documents provided to me by Woodside is shown as in Section 6.2 including the Letter of Instruction.

All documents received are quoted using Woodside reference stamps.

As instructed, I have considered the assumed facts as stated in the documents issued to me by Woodside, as listed in Section 6.2.

In addition, I have referenced in my report several emails[i] from Woodside relating to and/or amending the Assumed facts document as follows:

'Emails from Woodside (James Peyton dated 6,7,9,15,16,19,20,26 August 2024

I confirm the contents of my report conforms to the requirements as set out in the "FEDERAL COURT OF AUSTRALIA EXPERT EVIDENCE PRACTISE NOTE (GPN-EXPPT) General Practice Note".

I acknowledge that:

- I have read and complied with the "Practice Note" and agree to be bound by it; and
- my opinions are based wholly or substantially on specialised knowledge arising from my training, study and experience.

The Objectives of this report are in compliance with Woodside's stated requirements in the RFQ issued on 28 June 20224. An extract of the Purpose and Scope from the RFQ follows:

> 3.1 PURPOSE
>
> The purpose of this document is to describe the scope of work for an independent review of concept phase risk management of the hazard posed by drilling hydrocarbon bearing Torosa reservoir, located in proximity to Scott Reef. The review is intended to support Woodside in ensuring all relevant and applicable measures are in place to reduce oil spill risks and to support

demonstration of this via an independent review to external stakeholders, including environmental regulators and government agencies.

3.2 OBJECTIVES

- Review the proposed Browse approach against global contemporary industry 'best practice' for preventing and mitigating the risk of subsea well blowouts from development of gas/condensate wells at locations in close proximity to sensitive social or environmental receptors.
- Identify any additional prevention or mitigation barriers that should be assessed by Woodside to ensure environment risks from drilling Browse wells can be demonstrated to be as low as reasonably practicable and commensurate with global industry best practice.
- Provide a summary of review findings, that can be provided to external regulators as a summary of the review and outcomes, in the form of a brief independent expert opinion statement.
- Provide explanation in lay-man's terms to avoid technical or legal jargon where this may assist stakeholders.

5. Answers to the Questions posed by Woodside.

5.1 Question 1 Prevention Practices

What is your independent opinion on the adequacy of Woodside's Prevention Practices for the risk of subsea Well Blowout at the Torosa field offshore Browse Basin, WA compared to International best practice?

My Summary Opinion is stated in section 5.1.5. Prior to this, I have made several building statements as follows on the various materials and documents presented to me to provide the necessary background to the opinion.

5.1.1 Causes of Blowouts or total loss of Containment

A blowout from an oil and gas well is an uncontrolled flow of hydrocarbons to the surface, flowing into the environment and atmosphere. All Primary and Secondary barriers in a wellbore must have failed or temporarily failed to have been activated, for a blowout to occur. The blowout will continue until either the flow stops naturally due to 'bridging' or primary control is regained either using the existing rig and associated equipment to shut in the well if available or using remedial recovery methods such as a capping stack or drilling of a relief well(s) depending on how many are required.

For a drilling well in the worst-case scenario envisaged in Woodside's current conceptual worst case blowout modelling for Torosa, Primary well control must first be lost. In the drilling case, the primary barrier is always the fluid column. The fluid column exerts a hydrostatic pressure overbalance against the formation(s) being drilled and must always be in excess of the pore pressure within that formation.

The fluid Primary barrier is actually part of a barrier envelope including other well components which make up the entirety of the primary and secondary envelope.

The secondary components of the envelope are only relied upon when a well is shut in at the BOP. These components include:

- The casing string.
- The cement around the casing string
- The formation strength at the casing shoe and below that, to the current total depth
- The wellhead
- The BOP

When a well is shut in at the BOP's the secondary barriers become the Primary barrier, since the Primary Fluid barrier has failed to exert the necessary excess hydrostatic pressure against the formation and is no longer considered a barrier. A failure of the Primary barrier results in a flow of hydrocarbons from the formation is called an influx or kick. An influx can occur if the actual formation pressure is higher than predicted, hence the hydrostatic pressure exerted by the drilling fluid is too low as the formation is entered and hydrocarbons will flow into the wellbore as an influx volume. This type of influx is typically called a 'drilled kick' and occurs when the minimum required overbalance has been eroded. A common way that the minimum required overbalance is eroded is through swabbing in the well, i.e., moving the pipe in an upwards directly too quickly, resulting in a pressure drop at the bottom of the well, or physically failing to maintain the fluid column.

A blowout of a drilling well, must be preceded by an influx, which in turn can only occur if the Primary fluid barrier has failed to exert the necessary overbalance to the formation. It is best practice to define the minimum acceptable overbalance required by the fluid column. This minimum value, usually defined in psi must exist across all operations and activities while drilling the well. It is enforced by operators in their standards and must be stated in the WOMP (Well Operations Management Plan) submitted to NOPSEMA.

Therefore, it can be stated that the enforcement and protection of the minimum overbalance at all times is a key focus in the design, planning, operations, and blowout risk management for any well at the Torosa or any field development.

The blowout itself may arise from a dynamic failure of the fluid column and failure to shut in the well for some equipment because that may or may not be recoverable using the existing on-site equipment. BOP control systems can fail, resulting in the need to activate the BOP using Auto-shear, Deadman, ROV intervention or other devices.

Should all of the above devices fail to shut in the well, then a Capping stack and relief well operation will be required to regain control of the well.

The blowout may also arise after the well is successfully shut in on an influx, due to failure of any of the secondary barrier components as described above.

All prevention best practices, standards and procedures in drilling are designed to achieve the following:

- Select the appropriate drilling rig with the appropriate capacity and rating to construct Torosa wells.
- Ensure a proper Pore Pressure Prediction has been provided by the subsurface team.
- Protect the minimum required overbalance through drilling fluid design and MW strategy.

- Design the Well in all aspects; Fluid column density, the casing scheme, casing cementing, the Wellhead specification, and the BOP rating and function, to ensure the integrity of both Primary and Secondary barriers at all times.
- Ensure that the well and all associated equipment is monitored, measured, and Validated (MMV) to ensure the Integrity of the well is understood at all times.

The Oil & Gas industry has developed many minimum standards that capture the requirements for prevention of loss. Most of the relevant standards are produced by the API (American Petroleum Institute) and the ISO (International standards organisation) and are followed by Operators globally such as Woodside.

Having defined the broad approach in Industry best practices above for the prevention of Blowouts as part of this project Scope I have been provided with Woodside's critical relevant standards documents to review. These documents are listed below together with my opinion as to their effectiveness in meeting international best practice.

5.1.2 Review of WEL Policies & Standards for Prevention on LOWC as provided.

WEL has prepared a document describing the overall approach to minimising their prevention and response approach to the Browse basin project:

ERD RESPONSE TO SUBMISSIONS, APPENDIX B.3 - Overview of Browse Hydrocarbon Spill Risk Management Approach, November 2023

This document has been reviewed by the author(s) to assess and provide an option as requested by Woodside as to whether WEL's approach meets international norms. In this report WEL describes their standard prevention of LOC (Loss of containment) practices. These practices as stated include the following:

The D&C Management System Framework is based on international standards, codes and best practices, informed by international agencies such as the American Petroleum Institute (API), NORSOK and the International Association of Oil and Gas Producers (IOGP). Below is a non-exhaustive list such standards published by these agencies to which Woodside's management framework complies or will be applied (as relevant) to the proposed Browse to NWS Project.

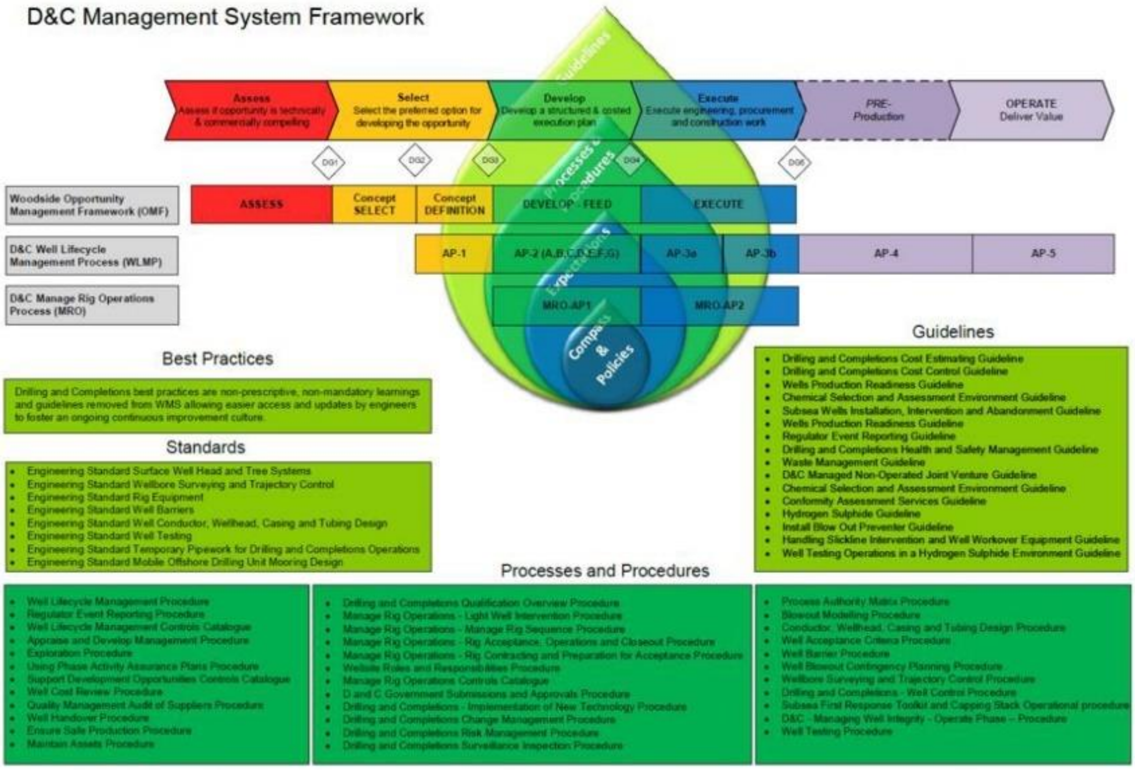


Figure 3. Woodside Drilling and Completions Management System Framework

<u>API ST 53 - Well Control Equipment Systems for Drilling Wells</u>

The purpose of this standard is to provide requirements for the installation and testing of blowout prevention equipment systems on land and marine drilling rigs.

<u>API ST 64 - Recommended Practice for Diverter Systems Equipment and Operations</u>

This standard is intended to provide information on the design, manufacture, quality control, installation, maintenance and testing of the diverter system, and associated components. The diverter system provides a flow control system to direct controlled or uncontrolled wellbore fluids away from the immediate drilling area for the safety of personnel and equipment.

<u>API TR 5C3 - Calculating Performance Properties of Pipe Used as Casing or Tubing</u>

This technical report illustrates the equations and templates necessary to calculate the various pipe properties.

<u>API RP 5C5 - Procedures for Testing Casing and Tubing Connections</u>

This Recommended Practice (RP) defines tests to determine the galling tendency, sealing performance, and structural integrity of threaded casing and tubing connections.

<u>API SPEC 5CT - Specification for Casing and Tubing</u>

This standard specifies the technical delivery conditions for steel pipes (casing, tubing, and pup joints), coupling stock, coupling material, and accessory material, and establishes requirements for three product specification levels.

<u>NORSOK D-007 – Well Testing Systems</u>

This document describes the technical, functional, and operational requirements for temporary well testing, production clean-up and bleed-off equipment and systems. The equipment and systems are used for hydrocarbon flow from exploration or development wells on both mobile units and fixed platforms.

<u>NORSOK D002 - System requirements well intervention equipment</u>

This standard describes the design, installation and commissioning principles and requirements for the well intervention equipment and their systems and equipment.

<u>IOGP Report 476 - Recommendations for enhancements to well control training, examination and certification</u>

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.

In addition:

Woodside's involvement in industry forums allows it to remain involved in and abreast of the latest.
industry best practice guidance, this involvement includes:

- *active participant of APPEA's Oil Spill Preparedness and Response Working Group*
- *active participant of APPEA's Drilling Industry Steering Committees*
- *current chair of the AMOSC Subsea First Response Toolkit Steering Committee*
- *member of IOGP industry committees e.g., Wells Engineering Committee*
- *member of the IPIECA Oil Spill Working Group*
- *member of both the International Maritime Organization Global Initiative groups for Southeast Asia (GI SEA) and West and Central Africa (GI WACAF) (NB GI program is administered by IPIECA).*
- *member of Oil Spill Response Limited (OSRL) - the leading industry spill response organisation.*

In addition to the provision of equipment and personnel response resources during a spill event, OSRL provides advice and guidance to members on good practice during planning. Woodside subscribes to OSRL's quality-assurance review service for pre-submission review of Australian regulatory oil spill plans.

In detail terms the *ERD RESPONSE TO SUBMISSIONS, APPENDIX B.3 - Overview of Browse Hydrocarbon Spill Risk Management Approach, November 2023'* defines the practices during the well planning and operations life cycle WEL will follow to minimise the risk of loss of containment occurring on the browse project. These practices have been re-stated here as they do represent in my opinion the current status of industry best practices for the prevention of an uncontrolled release event.

Table 2-1: Prevention measures to be implemented for the proposed Browse to NWS Project to reduce the likelihood of a hydrocarbon spill

Measure	Description	Benefit	Comment
Regulator acceptance of a Well Operations Management Plan (WOMP)	At the completion of the well design and planning phase, a WOMP will be submitted to NOPSEMA/DMIRS (depending on well jurisdiction) for approval. It will summarise the well design and demonstrate that the well integrity risks have been managed to ALARP. The well design will be in accordance with D&C System and Management Framework and latest best practices at the time of undertaking this work. The sections below summarise in more detail the type of work and activities that go into developing a WOMP.	• Demonstration that the well design and construction process has successfully demonstrated that well integrity risk is ALARP.	Meeting Australian legislation requirements
Engineering Design	The following measures to be considered during well engineering design to reduce the likelihood of a hydrocarbon release (loss of well integrity) to ALARP: • Utilise industry and Woodside best practices. • Implement learnings from offset wells and hazards encountered. • Perform pore pressure prediction modelling using offset data. • Design fluids to maintain sufficient pressure overbalance to hydrocarbon pressure during well construction and maintain sufficient integrity in the presence of well contaminants. • Design cement barriers to limit the risk of loss of containment of well to ALARP. • Design well architecture (wellhead, conductor, casing, and tubing) to provide or support well barriers that can withstand all planned, foreseeable and survival load cases.	• Understanding the pore pressure regime of the area, utilising area-specific hazard information and using best practices during the well's engineering design allows the creation of a well design that reduces the risk of loss of well control to ALARP.	Best Practice ALARP is project and operator specific. New technology development may assist to re-define what is "RP" and thereby allow risk of loss to be lowered from the current level.

Measure	Description	Benefit	Comment
	• Design well shoe placement with sufficient kick tolerance to allow an influx to be safely circulated out of the well without breaking down the formation at the open hole weak point. • Prepare well barrier diagrams and well acceptance criteria to demonstrate a two-barrier approach to hydrocarbons is utilised during well construction operations. • Create well activity risk management bowtie diagrams to identify controls to manage a hazard. • Conduct a peer review of engineering design with Woodside and JVP subject matter experts. • All wells to be designed to ensure that well kill can occur via a single relief well • Capping stack will be capable of interfacing with wellhead and BOP connectors		Maximum well limits and safety factors to be defined, otherwise a standard industry approach.
Processes and Procedures	The following processes and procedures to be considered to ensure well construction is executed as planned: • Well Programs and Guidelines, e.g. Detailed Drilling Program (DDP) and Detailed Completions Guideline (DCG), to provide step-by-step instructions to execute drilling and completions activities, and inform operations teams of key hazards and risks pertaining to well construction activities. • Standard Instructions to Drillers (SIDs): detailed step-by-step instructions for each operational activity distributed to all pertinent personnel at the operational site to facilitate a cohesive approach to execution of the activity.	• Processes and procedures allow learnings and best practices to be communicated from well design through to well construction.	Best practice, incudes detailed review between teams.
Personnel Selection, Placement and Competency	Personnel competency is assessed to ensure employees, contractors, and service providers engaged in well construction activities understand their process safety responsibilities. This may be done through the following methods: • Operations supervisors to have a valid Well Control certification pertaining to their role. • Contracts with drilling service providers detailing minimum experience required from third party personnel. • Qualification to Fly (QOF) system to track third-party personnel experience and competence prior to approving their travel to the operations site.	• Process Safety is integrated into the way D&C conducts well activities on a day-to-day basis. This ensures all parties, employees, contractors and service providers engaged in D&C well activities become exposed and involved in Process Safety.	Best practice. Would be helpful to explain further how Process Safety will workday today.

Measure	Description	Benefit
	• All emergency duty personnel and their deputies must possess the skills and awareness necessary to carry out their respective emergency management roles. Well control drills and exercises are implemented to maintain personnel competency in emergency response. This may be done through the following methods: • An Emergency Communications Exercise conducted by each rig withing 48 hours of arriving at a new location. • A scenario-based exercise involving the facility emergency response teams and activation of the Contractor's onshore emergency centres and the Corporate Incident Coordination Centre (CICC), must be conducted within one month of the commencement of a campaign, and as a minimum at six month intervals thereafter. This Level 2 exercise must include an oil spill related event once a year.	
Operational Status Monitoring	The monitoring of well integrity and adherence to well programs and procedures may be obtained through the following methods: • Daily Drilling Reports (DDRs) provide a summary of each day's operations and outline key reportable outcomes and activities used to monitor the integrity of the well • Well Acceptance Criteria (WAC) list the requirements for establishing the appropriate barriers and controls to ensure well integrity is maintained throughout the well construction phase. The achievement of WAC is witnessed by the offshore supervisor, verified by the responsible party onshore and documented in the DDR. • Well Barrier Diagrams define all barriers that must be in place through well construction activities and are verified by the operations supervisor prior to commencing the respective activity. • Management of Change process: any temporary or permanent deviations from the approved well design or approved procedures and guidelines require a risk assessment and formal approval sought from responsible parties via a Change Control Request Form. • Leading Process Safety Metrics track the status of vulnerable operational processes observed in recent industry events and are included in the DDR. Examples of	• The monitoring of well integrity and adherence to well programs and procedures allows visibility of well control status and a swifter emergency response should there be a loss of well control, thereby reducing the risk of loss of well containment.

Best Practice.

It is normal practice for WEL to conduct a Level I or Level 2 exercise be also conducted i.e., practice prevention of escalation to LOC

Best Practice.

Consider more live monitoring from the office including real time data centre and real time well status not just periodic (daily or by section), Situational awareness and Leading indicator of LOC tracking.

Measure	Description	Benefit
	metrics include well control equipment checks, any deviations to D&C Standards and fluid column status.	
Primary Well Control	The implementation and on-going verification of primary well control may be obtained through the following measures: • A minimum of two well barrier enveloped to isolate reservoirs and/or zones with flow potential to subsea/surface. • Well barriers are selected and installed to limit the risk of loss of containment to ALARP. • If the primary well barrier is a fluid column, the following must be met to qualify and verify the barrier: – The hydrostatic head margin exerted by the fluid exceeds the predicted most likely formation pressure at the point of overbalance. – Critical fluid properties and specifications are described prior to any operation – The hydrostatic pressure does not exceed the formation fracture pressure (SHmin) in the open hole including a safety margin which considers circulation events. – The fluid level can be measured, maintained and monitored. – Fluid density changes due to temperature and compressibility in the wellbore are factored into overbalance estimates. – Fluid volumes and flow rates are monitored and flow checks are performed.	• Establishing, qualifying and verifying primary barriers allows reduction of the risk of loss of well containment to ALARP.
Secondary Well Control	Secondary well control is established to mitigate the risk of loss of primary well control. This may be done through the following measures: • The assessment of well control equipment requirements must be conducted for all new campaigns. • Surface well control and associated equipment requirements for well intervention must follow the requirements of NORSOK D002 Well Intervention Equipment Rev 2013. • A third-party Woodside Control equipment Inspector must inspect the well control equipment for workover and subsea intervention prior to each campaign.	• Establishing, qualifying and verifying secondary barriers allows well control to be maintained should primary well control barriers be lost, reducing the risk of loss of well containment to ALARP.

As above

Best practice is to define the overbalance minimum in psi which for WEL is 150 psi with marine riser installed per their Guideline Drilling Barrier Qualification.

Measure	Description	Benefit
	• Two independent systems for monitoring critical well bore data should be provided (typically by the drilling contractor and mudloggers). • A diverter system must be installed. • Surface BOP stacks must have a minimum 5000 psi configuration. • Subsea BOP stack must be consistent with the requirements of API Standard 53. • Consideration must be given to the appropriate BOP ram configuration and control systems to ensure BOP will reduce risks to ALARP. • A full BOP pressure test must be carried out once the BOP is initially landed Subsequent pressure test frequency is not to exceed 21 days. • BOP rams must be function tested from surface, and remotely (via ROV) every 7 days.	
Well Control Preparedness / Managing Loss of Primary Well Control	Well control preparedness may be accomplished through the following measures: • Formation Integrity Tests (FIT) or Leak-off Tests (LOT) must be carried out after a string of casing has been cemented and before a new section of hole is drilled. • A well "termination rate" sheet must be updated at least daily when a new hole is being drilled. • Best practices and procedures must be followed to prevent kicks while tripping and drilling • Well control drills. • Flow checks must be made as per best practices. • Pit volumes must be independently monitored and any anomalies investigated.	• Well control preparedness allows for a swifter response to the loss of primary well control, reducing the likelihood of a hydrocarbon spill.

Best practice is to conduct thorough pre-hire rig audit including all well control equipment design, specification, reliability statistics and maintenance. WEL standards will meet this and is mandated by their Manage Campaign Operstions procedure (MCO)

Best practice by WEL. Consideration could be given to utilising critical wells (HPHT) wellbore monitoring practices

I have during 2024 worked offshore in Australia and Malaysia on separate projects involving the drilling of complex wells in a High Pressure, High Temperature environment involving Jack up drilling rigs and a semi-submersible drilling unit. I can confirm that the practices stated by WEL in the above referenced Browse management document represent the current best practice for well control incident prevention. Success in achieving zero incidents using these practices relies on their detailed implementation involving the operator WEL, the drilling contractor and all third parties deployed to the rig site. Critical to this success is also the onshore drilling management and technical support team and their senior management reports, having complete alignment with the rig team and a collective understanding and agreement on the current well condition. I am confident WEL have the experience, standards and practices to implement the current state of the art best practices. WEL have also stated in this document that they are keeping abreast of new improved technologies and methods that could reduce the likelihood of a well control event even further than the quoted SINTEF numbers as follows:

For a gas well, the SINTEF calculated probability of blowout during drilling and completion is 2.93 X 10-4 which means for any given well it is estimated that there is less than 0.000293% probability of a loss of well containment event occurring.

Furthermore, since the Gulf of Mexico Macondo event, significant improvements in engineering and management controls have been adopted by the industry, further reducing the likelihood of such an event occurring. This can be evidenced in the report by Exprosoft (2017) which reviewed all Loss of Well Control (LOWC) events reported in the SINTEF Offshore Blowout Database for the period 2000–2015. The report describes, categorizes, and analyzes the observed LOWC events for the period 2000–2015, and compares the LOWC frequencies in the US GoM with other regulated areas. For regulated areas (which includes Australia), the frequency of loss of well control events in deep zone of development or exploration wells was 0.25 per 1,000 wells drilled.

While the SINTEF report will be accurate for regulated areas, it should be pointed out that the authors have investigated or been involved in relief well projects or blowout investigations for a significant number of wells over the last 40 years including several in regulated areas. Causes for loss of containment vary but typically the top four causes are:

1. Inattention to Operations
2. Signal negligence
3. Inadequate Supervision
4. Equipment failure

These typical causes highlight the possibility of human error is still present in any high-risk activity such as offshore drilling. Current and future developments in monitoring, measuring and validation using on-line and predictive methods will continue to develop, and we are confident should technologies in these areas develop reliably, they will be considered as a way to reduce the risk potential very significantly of errors leading to Loss of containment in the Torosa project.

Woodside is adopting the correct approach of stating their consideration of any future technologies to reduce risk based on their effectiveness and applicability. This is a sensible and measured approach in the Torosa time frame of approximately 4 years before drilling commences.

5.1.3 List of WWL Guidelines, Standards and Procedures reviewed with Comments

5.1.3.1 DC0000MD1401643987_2_Guideline - Completions Barriers Qualification and Verification [1]

Covers:

- Suitable selection of well barrier elements.
- Suitable qualification of well barrier elements.
- Suitable verification of well barrier elements

Does not cover Well Integrity in the Operate phase – covered elsewhere.

A high-level guideline which is of an international standard best practice in my opinion.

5.1.3.2 DC0000MD1401644005_0_Guideline - Drilling and Completions Pressure Testing [1]

Covers:

- Categories of pressure tests
- Test durations and acceptance criteria
- For well barrier elements and other well-related equipment
- During well construction, well intervention, well workover and permanent abandonment activities only

This guideline does not cover:

- Leak off tests and formation integrity tests.
- Maintenance testing of the Containment Response System Capping Stack
- Pressure testing conducted during the Operate phase of the well lifecycle.

The guideline refers to an internationally accepted guideline for acceptable leak rates for all completion components including SSSV's and SSV's (API 14B Inflow Test and API 6AV2 Inflow Test). Reliability of SSV's has improved significantly though this is difficult to demonstrate other than lab testing.

This guideline is of an international standard best practice in my opinion.

5.1.3.3 DC0000MD1401648721_1_Guideline - Drilling Barriers Qualification and Verification [1]

Covers:

- Barriers for Drilling activities including well construction, suspension and abandonment.

- Suitable selection of well barrier elements.
- Suitable qualification of well barrier elements.
- Suitable verification of well barrier elements.
- Within the boundaries of a well.

The Primary Barrier is a fluid column during drilling and intervention activities and the criteria for this is well covered in the guideline. However, I would make the following observation with regards to point 2.3 as follows:

Quote: iii. Pressure changes from swab when tripping out of the wellbore are estimated and accounted for in the above safety margins.

It could be more clearly stated that the modelled swab affects for a trip out of the hole at a given speed will not reduce the BHP below the minimum overbalance of 150 psi on the BHP and under 2.4

A fluid column is verified as a barrier in Drilling operations with the marine riser connected when all of the following are met:

Quote: a. The fluid level can be measured, maintained and monitored, Equivalent Static Density (ESD) readings.

ESD devices have temperature sensitive batteries which may not be suitable depending on the well temperature. A comment to this effect and appropriate contingency would be useful.

This guideline is of an international standard best practice in my opinion.

5.1.3.4 Source Control Emergency Response Planning Guideline

1. This Guideline outlines how to meet expectations in the planning and preparation of the following two Planning documents: Campaign- or Region-specific Engineering Assessment for Source Control
2. Source Control Emergency Response Plan (SCERP) for Subsea operations across Drilling and Completions (D&C).

It supports the implementation of the Worst-Case Discharge Modelling Procedure and Relief Well Planning Procedure.

Source control response strategies include:

1. Blowout prevention (BOP) intervention – Attempt an intervention on existing BOP stack on source well head (if conditions allow).
2. Debris removal – Prepare the subsea well head / BOP for running of the capping stack.
3. If debris is detected during the initial survey, it should be removed from around the wellhead prior to undertaking any capping operations. Debris removal is critical to ensuring a safe working environment and to provide access to the wellsite for intervention.
4. Capping stack – A pressure containment device is installed on top of a BOP or well head / Xmas tree to either shut in or contain the flow of hydrocarbons to the marine environment.
5. Relief well drilling and dynamic kill – This entails drilling a well to intersect the source and killing (stopping) the release of hydrocarbons by dynamic killing and re-establishing well barriers. A separate procedure is in place for this particular technique and is not covered in this Guideline.

Table 2 from the SCERPG (shown below) shows the planning timeline for Source control in WEL.

WEL has performed a considerable part of the first two stages in the planning cycle, the results of which were included in their document:

"*Proposed Browse North West Shelf Development, ERD Response to submissions, Appendix B.3 Overview of Browse hydrocarbon Spill Risk Management Response, November 2023",*

This guideline is a very comprehensive check list for internal planning and resourcing a blowout incident from within WEL and clearly defines the external support from Specialist source control companies, as well as industry arrangements in place for personnel and asset resource transfer as needed. WEL states they have defined the resources needed for all critical roles and have the internal resources to manage an incident with WEL staff. External specialist support will be added as needed.

A full BOCP /SCERP specific to the Torosa field will be a necessary and important task as the project moves to the approval stage.

This guideline is of an international standard best practice in my opinion.

Table 2: Source Control Planning Timeline

Phase	During FEED Engineering	Prior to EP Submission	Operations (Prior to drilling potential HC zone)	During an Emergency Response
Topics to be analysed, completed	Casing design and structural analysis	Capping stack selection	Logistics Plan	Re-evaluate engineering studies for actual scenario parameters and selected response vessel/s
	Worst Case Discharge calculations	Location specific considerations	BOP, WH interface verification	Finalise vessel specific installation procedures
	Plume analysis	Select deployment method/s	Tracking response vessels	Conduct HAZOP
	Capping stack landing analysis	Identify response vessels and commence tracking	Operational deployment plans	Safety case review
	BOP, WH interface check	Calculate Response timeframes		
		Regulatory commitments for Source control response		

5.1.4 Standards and Procedures Review

5.1.4.1 Conductor, Wellhead, Casing and Tubing Design Procedure (1)

The Objective of this Procedure as stated by WEL:

To detail the steps performed to meet the requirements set out in the Engineering Standard Well Conductor, Wellhead, Casing and Tubing Design.

This Procedure sets out the design methodology for well architecture (wellhead, conductor, casing and tubing), which is to provide (with each component), or support, well barriers that can withstand all planned and foreseeable load cases, so that the risk of loss of containment can be managed to as low as reasonably practicable (ALARP).

This is achieved by adherence to the Well Lifecycle Management Plan, the Engineering Standard Well Conductor, Wellhead, Casing and Tubing Design, and this Procedure.

This document provides essential and specific instructions to engineers performing casing design in WEL. It clearly defines the logical process steps to casing design, the critical choices which operators need to make on design assumptions such as Load cases; material selection; casing wear; Pore

Pressure, fracture gradient and Temperature boundaries. The procedure clearly shows the design process as follows in Figure 4:

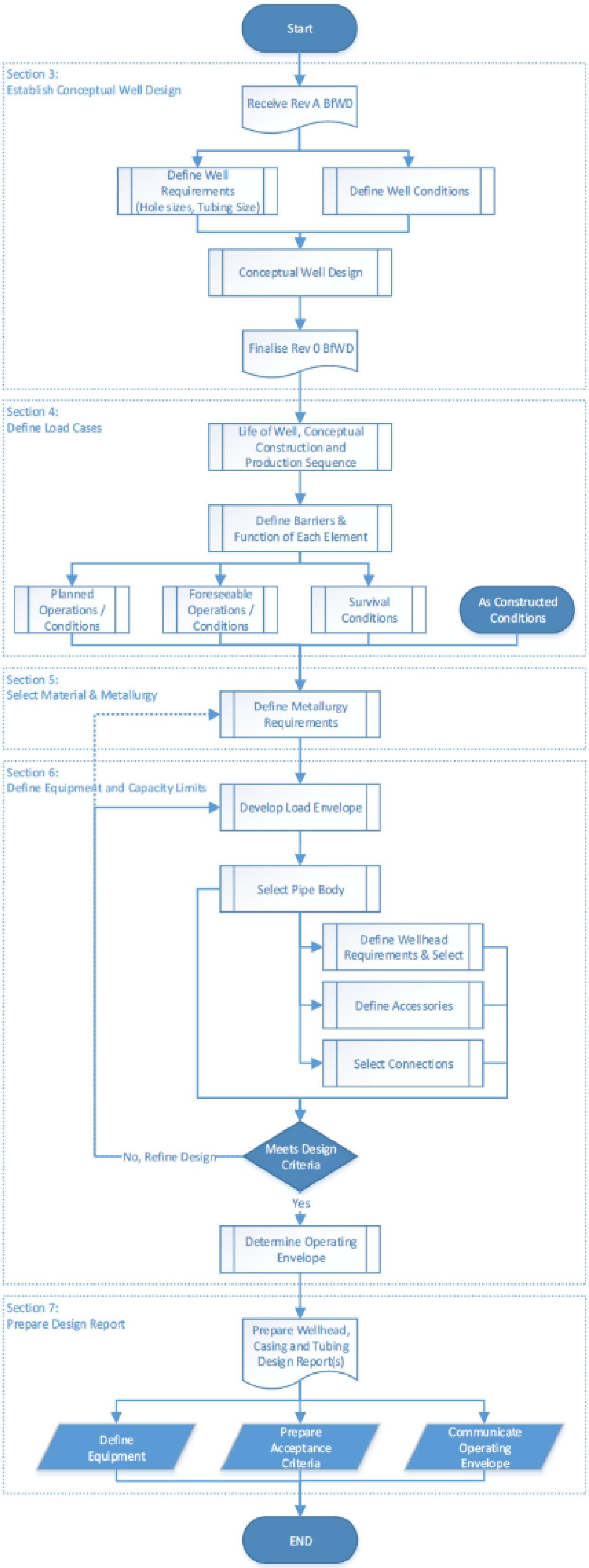


Figure 4. String Design Process.

WEL Casing design procedures states a series of International normative references which are standard across the International Oil & Gas industry as follows:

NORMATIVE REFERENCES

Title	Reference
Calculating Performance Properties of Pipe Used as Casing or Tubing	API 5C3
Procedures for Testing Casing and Tubing Connections	API 5C5 (2017) – Current ISO 13679:2002 – Superseded
Specification for Corrosion-resistant Alloy Seamless Tubes for Use as Casing, Tubing, and Coupling Stock	API SPEC 5CRA
Specification for Line Pipe	API 5L
Specification for Wellhead and Christmas Tree Equipment	API 6A

In the Informative references no mention is made of ISO1650-1,-2 which is the Well Integrity management standard for the Life Cycle of Wells, including annulus pressure management. Reference is made in the WEL document to B annulus pressure relief using formation strength factors or Burst discs. WEL will select the appropriate methodology to manage the B annulus APB (annulus pressure build up) during detailed casing design. I would suggest ISO16530-1,2 be reviewed for consideration as an Informative reference in casing design.

This procedure is of an international standard best practice in my opinion.

5.1.4.2 Drilling and Completions Change Management Procedure

Objective as stated by WEL:

This Procedure provides details of the requirements that must apply to ensure that change is appropriately considered, assessed and implemented in a controlled manner and managed in accordance with the Change Management Procedure and the Risk Management Procedure.

and:

In a GWS context, change occurs across a range of activities that are captured in the Well Lifecycle Management Procedure, and the Manage Campaign Operations Standard. Change may occur for many reasons, including unexpected events, unexpected equipment performance, alteration of operational steps, new information, and new technology. As a result, the planned and accepted GWS risk may change and requires to be re-assessed, controls established (or re-validated), and the results communicated to others, before proceeding.

Due to the nature of the GWS business, process safety, health, personal safety, environmental, financial and reputational risks are common and require appropriate consideration under all instances of change.

All D&C changes are managed using the online D&C Technical Change Control Request Form (TCCRF)

and:

Change management must be conducted in accordance with local regulatory requirements and this Procedure. Where no local regulatory requirements exist or where they are less onerous than those contained in this Procedure, the requirements of this Procedure must apply.

This procedure clearly demonstrates the mandatory requirements within WEL for managing change. The document explains that RRM (Risk reduction measures) must be implemented following Risk Assessment. While RRM's must be demonstrated to be practicable and reducing risk to ALARP, there is a separate WEL document that demonstrates the ALARP procedure within WEL. I would suggest this procedure be reviewed in the context of Torosa to determine if any adjustment to ALARP thinking with regards to Torosa is appropriate or otherwise.

This procedure is of an international standard best practice in my opinion.

5.1.4.3 Drilling and Completions Risk Management Procedure

Objective as stated by WEL:

The objectives of this Procedure are to supplement the Woodside Risk Management (Woodside Energy) Procedure by explaining how risk is managed in Global Well and Seismic (GWS) Drilling and Completions (D&C) activities. In doing so it:

- *details the risk management process to be applied to GWS well activities*
- *aims to ensure process safety risks associated with D&C activities are managed to a level that is as low as reasonably practicable (ALARP) and demonstrable.*

And further states:

2.2.1 D&C Risk Management Procedure Overview

Although this Procedure is intended to cover all GWS D&C activities, it primarily focusses on maintaining well integrity (process safety) for the full lifecycle, which is founded during the well design and construction phases. As such, this Procedure is mainly focussed on well planning and execution activities.

This Procedure aims to translate the Risk Management (Woodside Energy) Procedure into actions, deliverables, and workflows that form the GWS D&C risk management process.

It is a mandatory requirement to ensure all risks encountered during well activities are identified and managed by the application of:

- *This risk management process.*
- *Inherent safety principles.*
- *Well Lifecycle Management Procedure.*
- *Manage Campaign Operations Procedure.*
- *Drilling and Completions Change Management Procedure.*

The objective is an acceptable well design and well activity where the residual risks are ALARP.

WEL explains ALARP which is a key factor in how each operator choses to approach risk management as follows:

2.2.10 Demonstration of ALARP

Under Australian regulations, it is necessary to demonstrate that all risks are reduced to ALARP, but what is ALARP in a Wells context? To help delineate the answer, it is best to split Wells activities into two components:

1. How to safely construct a well or undertake a well activity.

2. Well design and effective construction (matters of well integrity).

In a simplistic view, the Drilling Contractor is primarily responsible for ensuring things are done safely which is achieved via Safety Case, and Woodside GWS Wells are responsible for demonstrating ALARP around well design and effective construction which is achieved via the WOMP. Figure 5 has been extracted from API Bulletin 97, *Well Construction Interface Document* and provides a useful model to illustrate the concept.

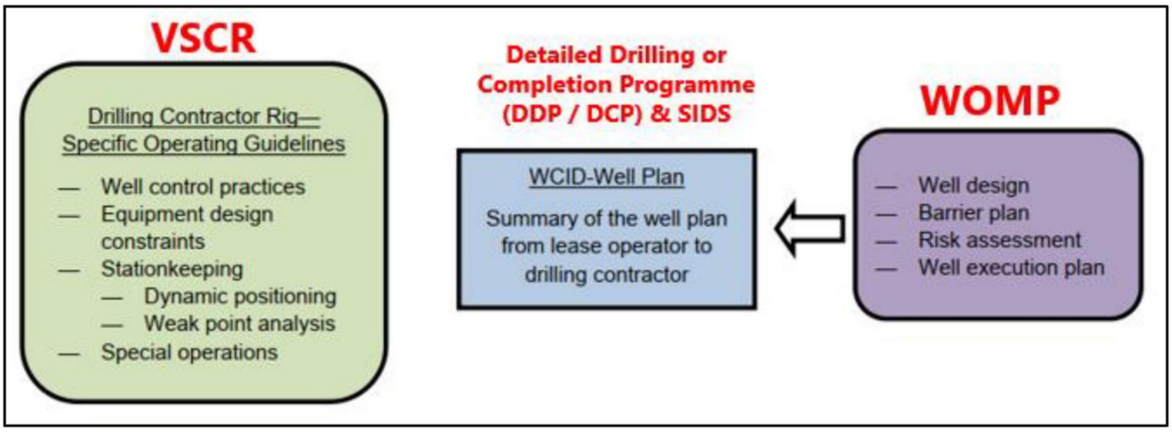


Figure 5. Demarcation of responsibilities as modelled in API Bulletin 97.

and:

Figure 5 is the generally accepted working model for ALARP demonstration. Most well risks fall within the Factor A or Factor B types. Risks around new technology, High Pressure High Temperature (HPHT) or Managed Pressure Drilling (MPD) would probably fall into the Factor C type risks which are treated on a case-by-case basis.

Importantly this procedure also references the Safety Case legislation and associated responsibilities. WEL explains its role as the licence holder and the Vessel owners under the regulations pertinent in Australia:

2.4 Safety Case and Revisions

WEL states:

2.4.1 Safety Case Overview

Safety case legislation globally is designed to address the risks to health and safety of personnel on offshore facilities.

In Australian Commonwealth waters, the law that applies to offshore petroleum facilities, including drilling rigs, is Schedule 3 of the Offshore Petroleum and Greenhouse Gas Storage Act (2006) and the Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations (2009).

These regulations require the operator of each offshore facility to prepare a safety case for submission to NOPSEMA. The safety case is a document prepared and submitted by the operator of the facility.

There are a significant number of cross reference documents in this procedure which is to be expected since risk covers all aspects of an operator's activities and management.

At the appropriate timeframe a campaign and well specific RA must be performed using this procedure of a Blowout risk on the Torosa project. This Risk assessment will require the involvement of the Vessel Owners and will be cross referenced in the Safety Case.

WEL demonstrate in this document that they are fully aware of their responsibilities for Risk management under the regulations and those of the Vessell owners operating on their licenced areas.

This procedure is of an international standard best practice in my opinion and very specific to Australian jurisdiction.

5.1.4.4 GWS Process Safety Metric Rev 4

This is a presentation on process Safety Metrics containing IOGP guidelines that WEL have adopted on definition of certain incidents i.e., Tier 1 to Tier 4 type PCE's (Process Safety Events). The presentation goes further in classifying Critical Control Variations into Leading and Lagging indicators and gives guidance for example incidents and their classification under the Tier 1 to 4 structure.

This procedure is a good example of the attempt to capture Leading and Lagging indicators and their classification. It is not clear to me t present how these metrics are communicated but I am satisfied there is an appropriate collection and dissemination of these critical factors, and that this would be in place for the Torosa project.

5.1.4.5 Relief Well Planning Procedure

This a useful high-level plan in the steps required for a relief well including:

- WCD
- Location
- Rig selection
- Ranging
- Well kill modelling
- Intersection depth
- Intersection strategy

In practice a relief well requires specialist support to design and execute and is not normally planned to be an in-house resourced activity. While it is essential for the operator to overall manage the relief well activity and for the critical steps to be understood as defined usefully in this document, I would recommend the earliest detailed relief well planning to be conducted by specialist outside support for the Torosa field to ensure a kill plan for the WCD can feasibly be delivered by a single drilling unit, likely to be available in Australia at the time of the project.

See John Wright's opinion on P 58.

5.1.4.6 W1000SD7189654_4_Engineering Standard Well Barriers [2]

This Engineering Standard defines the engineering practices and technical requirements which shall be applied for Well Barriers throughout the well management lifecycle.

A specific well barrier plan with defined barriers and verification of those barriers will be performed for Torosa wells as per the Well Specific Barrier requirements, Well Acceptance Criteria, and as required by NOPSEMA and DMIRS as part of the WOMP/WMP

5.1.4.7 W1000SD7193656_3_Engineering Standard Well Conductor, Wellhead, Casing and Tubing Design [1]

Objective of the Standard as defined by WEL:

1.1 Scope

This Engineering Standard defines the engineering practices and technical requirements which shall be applied for the specification and design of casing, tubing, wellheads and accessories as defined in the Woodside Barrier Standard deployed in all wells for which Woodside is the nominated Operator.

1. This standard describes the International codes to which all WEL casings and tubings must conform to as follows:

2.2 Woodside Standards and Referenced Documents

The documents listed below must be conformed to as they apply to the scope of this standard. Where a section is nominated, only the content in this section is applicable. Where Full Conformance is nominated, the entire content is applicable.

Reference	Title	Applicable Section Header or Full Conformance
DC0000AP3871501	D&C Process Authority Matrix	Full Conformance
W1000SL001	Engineering Standard Materials Selection and Corrosion Control - Amendments to ISO 21457, ISO 13628-1 and ISO 17348	Full Conformance
W1000SQ8474523	Engineering Standard Quality Requirements for Supply of Products and Services	Full Conformance
W1000SD7189654	Engineering Standard Well Barriers	Full Conformance
WM0000PG10824733	Conductor, Wellhead, Casing and Tubing Design Procedure	Full Conformance

2.3 Regulations, Codes and Standards

Reference	Title	Revision or Issue Date
API TR 5C3	Calculating Performance Properties of Pipe Used as Casing or Tubing	2008
API RP 5C5	Procedures for Testing Casing and Tubing Connections	2017
API SPEC 5CT	Specification for Casing and Tubing	2018
API SPEC 5L	Specification for Line Pipe	2018
API SPEC 5CRA	Specification for Corrosion-resistant Alloy Seamless Tubes for Use as Casing, Tubing, and Coupling Stock	2010
API SPEC 6A	Specification for Wellhead and Christmas Tree Equipment	2010

The standard describes

- documentation;

- records;
- Load cases;
- Design & Safety Factors;
- applicability;
- capacity ratings;
- connections;
- and supply

This standard is linked to the Procedure for casing design reviewed earlier and represents a typical International standard practice for casing design in my opinion.

5.1.4.8 Well Acceptance Criteria Procedure

As defined by WEL in this **mandatory** WAC criteria:

Well Acceptance Criteria (WAC) are the performance standards that need to be attained during the well activity execution phase. WAC fall into two broad categories, those related to Well Integrity and therefore Process Safety, and those that fall into quality of well product.

The WAC themselves form a series of pre-defined, as-built checks that must be completed during well operations to ensure that a minimum acceptable standard is met. When formulating WAC, future needs such as Operate Phase maintenance and Workover/Intervention or Abandonment should be considered.

WAC that support well integrity require formal acceptance and an auditable record of evidence that supports the acceptance. They must be supported by established and defined criteria (performance standards in National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) communications).

In the "Approve Well Acceptance Criteria" WEL states:

D&C Superintendent or Engineering Manager or Well Site Leader reviews the supporting evidence and verifies that the relevant criterion has been met in the SharePoint WAC register. This must occur within a reasonable timeframe following completion of the operation.

In my opinion the verification of critical barriers, particularly Primary Barriers needs to be performed upon installation or prior to that Barrier being exposed to the predicted loads eg a casing prior to drilling into the next hole section. The verification of barriers in my opinion is worthy of daily discussion at a level given to daily personnel safety discussions. This would in my opinion give considerable credence to a process Safety Culture, which in all other evidence reviewed, WEL certainly does adhere to.

5.1.4.9 Well Barrier Design and Installation Procedure

WEL describes this procedure as follows:

2 Well Barrier Design and Installation Procedure

The Well Barrier Design and Installation process is shown in overview in Figure 1.

Define Objectives	Qualify and Verify	Optimise	Assure
Governing Document: Engineering Standard Well Barriers	Governing Documents: Guideline: Drilling and Completions Pressure Testing Guideline: Completions Barrier Qualification and Verification Guideline: Subsea and Well Access Barrier Qualification and Verification Guideline: Drilling Barrier Qualification and Verification	Governing Document: Best Practices	Governing Document: Well Lifecycle Management Procedure

Figure 1: Well Barrier Design and Installation

2.1 Define Objectives

Well barriers must meet the objectives in the Engineering Standard Well Barriers.

2.2 Qualify and Verify

To design, select and install well barriers in a manner that limits the risk of loss of containment of well contents to ALARP, well barrier elements must either:

1. Meet the requirements of the Guideline: Drilling and Completions Pressure Testing, as well as those of the appropriate Guideline listed below:
   a. Guideline: Drilling Barrier Qualification and Verification, or
   b. Guideline: Completions Barrier Qualification and Verification, or
   c. Guideline: Subsea and Well Access Barrier Qualification and Verification.

   OR

2. Be subject to formal Change Control, in accordance with the Drilling and Completions Change Management Procedure, containing a revised Well Barrier Diagram showing the final state of the well at the end of the wellsite activity.

This is a useful high-level guide. In my opinion the "Quantity and Verify" guidance given here for the selection and installation of barriers to limit loss of containment of well contents to ALARP needs further consideration wrt the unique environmental risks posed by the Torosa project.

5.1.4.10 Well Control Procedure

As stated by WEL:

To describe Woodside's Well Control Procedures for all Drilling and Completions (D&C) planned and operational activities.

and:

Note: The information in this Procedure does not necessarily assume priority over a rig contractor's policies and procedures. Prior to commencement of operations with a new rig, a Well Control Bridging Document (WCBD) must be prepared using the Well Control Bridging Document (WCBD) Template, that reconciles any differences between the rig contractor's well control policies, the Woodside Well Control Procedure, (this document) and any other applicable procedures and standards. The reference standard for the development of the WCBD should be API Bulletin 97, Well Construction Interface Document Guidelines.

This Procedure and associated bridging documents must be adhered to by all employees, contractors and personnel involved in D&C design, planning and operations for any Woodside well.

Deviations to this Procedure must be managed in accordance with the Drilling and Completions Change Management Procedure.

Where this document sits in relation to other WEL standards, procedures, guidelines and best practices is clearly shown in the attached table from the WEL Well Control Procedure document.

2 Well Control Process

This Procedure references several D&C Engineering Standards and Procedures. It fits within the D&C document hierarchy as depicted in Figure 1.

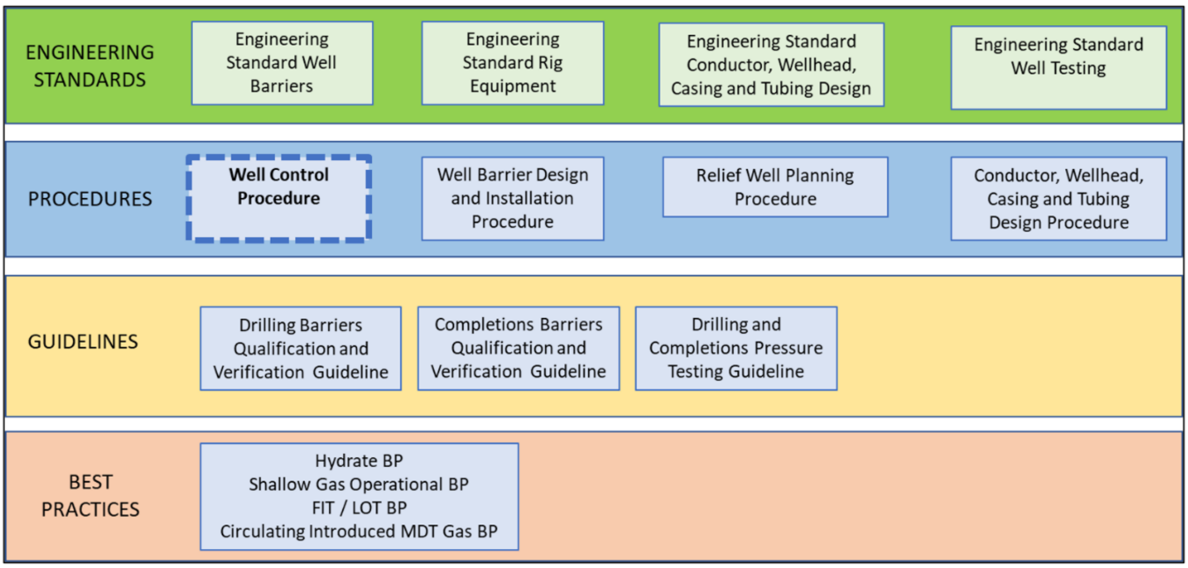


Figure 1: Well Control Procedure Position in D&C Document Hierarchy

The document states that the following international standards are to be used as reference but are specifically **not mandatory**:

- API Specification 16D - Specification for Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment
- API Recommended Practice 59 - Recommended Practices for Well Control Operations
- API Specification 16A - Specification for Drill-Through Equipment
- ISO 13533:2001 - Petroleum and natural gas industries -- Drilling and production equipment - Drill-through equipment (Modified).
- ISO 13624-1:2009 - Petroleum and natural gas industries -- Drilling and production equipment -- Part 1: Design and operation of marine drilling riser equipment.
- NORSOK D-010 Well Integrity in Drilling and Well Operations
- NORSOK D-002 Well Intervention Equipment.

The WEL document very usefully and clearly states the following with regards to the Standards' requirements:

3.2 Standard Requirements

3.2.1 Bridging to Rig Contractor's Well Control Policies and Procedures

A Well Control Bridging Document (WCBD) must be prepared for all Woodside's D&C operations to clarify the differences between this Procedure and the Contractor's well control procedures and policies.

The WCBD will also capture any deviations from the following:

- *Engineering Standard Rig Equipment*
- *Engineering Standard Well Barriers*
- *Well Barrier Design and Installation Procedure*
- *API Standard 53 - Well Control Equipment Systems for Drilling Wells*
- *API Standard 64 - Diverter Equipment Systems.*

As part of the WCBD process, a documented Blowout Preventer (BOP) Risk Assessment must be performed to capture all the project specific risks and mitigations related to the rig BOP and associated well control equipment and procedures. This BOP Risk Assessment must comply to API Standard 53 - Well Control Equipment Systems for Drilling Wells , and must identify Ram placements and configurations and take into account all well related activities, including:

- *all tubulars to be run*

- *drilling fluids*
- *possible well bore fluids*
- *wellbore and seabed temperatures*
- *hydrates*
- *Remotely Operated Vehicle (ROV) assisted closing functions*
- *actions for non shearables across the BOPs*
- *actions for well shut-in while performing wireline and function*
- *the use of any dead man auto shear systems.*
- *WCBD template: Well Control Bridging Document (WCBD) Template (sharepoint.com)*

Pressure test values for each BOP element must be specified in the Detailed Drilling and Completion/Intervention/Abandonment program and agreed with the drilling contractor.

If working on a development project with the Subsea Wells Group, a Subsea Well Control Manual is incorporated as an addendum to the WCBD, which typically includes tubing hanger running and installation, intervention operations through a Subsea Test Tree (SSTT), well clean-up, and Active Heave draw-works operations during locked-to-bottom operations for DP rigs.

This standard very clearly states the obligation of WEL towards ensuring the drilling contractors' BOP, (the Primary barrier in the event of a well shut in condition and the critical last control for the prevention of loss of containment) is fit for purpose for all the Torosa well specific activities and criteria:

The document clearly states the requirements for the following elements of an effective well control standard:

Mandatory Training	Kick Tolerance	Surveying for relief wells	Hydrates	Cementing	Rig equipment	Mobile rigs
Wellbore Monitoring	Diverters	Surface BOPs	Subsea BOPs	BOP Consumables	BOP control equipment	Internal BOP equipment

Wireline Logging shut in	Circulating Swedge	Equipment Testing	Maximum Anticipated Wellhead Pressure (MAWHP)	Pressure Test Frequency	Well control preparedness	Well Control procedures
Well Kill Decision Analysis	Well Kill Methods	Displacing the Riser to Kill Mud	Evacuating Trapped Gas from Blowout Preventers	Shallow Gas Considerations in Well Planning	Completion, Well Intervention and Workover	Incident Response

- *all tubulars to be run*
- *drilling fluids*
- *possible well bore fluids*
- *wellbore and seabed temperatures*
- *hydrates*
- *Remotely Operated Vehicle (ROV) assisted closing functions*
- *actions for non shearables across the BOPs*
- *actions for well shut-in while performing wireline and function*
- *the use of any dead man auto shear systems*
- WCBD template: Well Control Bridging Document (WCBD) Template (sharepoint.com)

- Pressure test values for each BOP element must be specified in the Detailed Drilling and Completion/Intervention/Abandonment program and agreed with the drilling contractor.

This is a detailed document and is an essential reference for reviewing the contractors Well Control Manual to produce a WCBD (Well Control Bridging document)

In my opinion this is best practice well control document, particularly the decision-making section for well kill and the actual well kill section itself. Based on my critical wells offshore experience gas levels are an essential diagnostic tool during drilling and the various forms of gas are important to be defined. This document could be improved further by having a WEL approved gas definitions section.

5.1.4.11 Worst Case Discharge Modelling Procedure

The Objective of this procedure according to WEL:

To describe the process required to quantify the rates and volumes of hydrocarbons released in the event of an uncontrolled discharge. This procedure covers the:

- Input assumptions for Worst Case Discharge Modelling and their origin.
- Worst Case Discharge Modelling methodology.
- Outputs of Worst Case Discharge Modelling that will be used as inputs for Oil Spill Modelling, Source Control Emergency Response Planning, and Relief Well Planning. The outputs must be consistent.

and:

The modelling outlined in this procedure is conducted to assess worst case discharge, as defined by Society of Petroleum Engineers (SPE) -174705 – Technical Report (TR) Calculation of Worst-Case Discharge (WCD). It is not intended to address:

- Well killability.
- Capping feasibility.
- Maximum volume of hydrocarbons lost to the environment.

Section 3 of the procedure shows the workflow for Worst case discharge calculation and the relevant party within WEL as follows:

3 Worst Case Discharge Modelling Procedure

The Worst Case Discharge Modelling scope requires input from several functions throughout the work flow. The responsible party for each of the procedural steps during the development phase is summarised in Table 1, with further detail in subsequent sections. Responsible parties include:

- Environmental Engineer (EE)
- Drilling Engineer (DE)
- Completion Engineer (CE)
- Reservoir Engineer (RE)
- Production Chemist (PC).

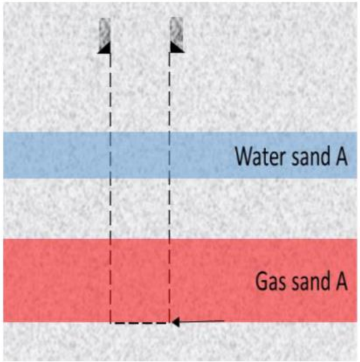
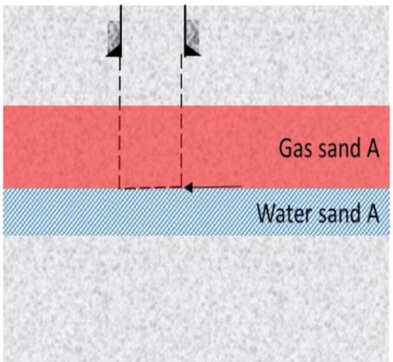
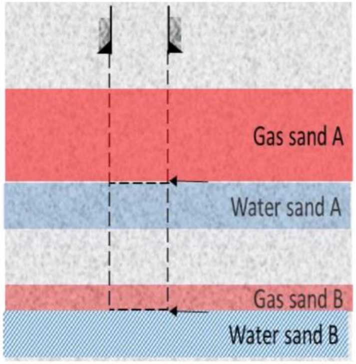
For details on the procedural steps for exploration well and production/operate phase modelling, refer to Table 9 and Table 10 in APPENDIX A.

Table 1: Development well procedural steps and responsible parties

Procedural Step	Description	Responsible Party
3.1	Work Flow Initiation	EE or DE
3.2	Identification of Discharge Scenarios	DE
3.3	Define Reservoir Characteristics	RE
3.4	Define Hydrocarbon Characteristics	PC
3.5	Review and Approval of Assigned Characteristics	RE
3.6	Multi-well and Well Configuration Screening	RE, DE & CE
3.7	Determination of Discharge Duration	DE
3.8	Determination of Flow to Surface	DE
3.9	Inflow Performance Relationship (IPR) Generation	RE
3.10	Vertical Lift Performance (VLP) Generation	CE
3.11	Discharge Modelling	RE
3.12	Output Results and Sign-Off	RE, DE & CE

The scenarios for the derivation of WCD with regards to hydrocarbon bearing zones including at the surface are shown in the document as follows:

Table 2: Reservoir penetration scenarios

Scenario 1	Scenario 2	Scenario 3
		
The depth for Worst Case Discharge Modelling is taken at the base of “Gas Sand A”. This accounts for the benefit of water in the column during a discharge.	The depth for Worst Case Discharge Modelling is base of “Gas Sand A”. The water is excluded from the calculation.	Two cases are run: one at the base of “Gas Sand A” and one at the base of “Gas Sand B”. The worst outcome of these two is used for Worst Case Discharge Modelling. “Gas Sand A” as a large zone may be a worse outcome on its own than including the underlying water sand and the smaller “Gas sand B”. In no situation would Water Sand B be used.

These scenarios are considered credible and in line with United Kingdom Oil and Gas Guidelines and Norwegian Standards Organisation (NORSOK) D-10. The Reservoir Engineer is responsible for determining the impact of multiple hydrocarbon and water sands on discharge rates and pressures.

For the critical assessment of killing a blowout by relief well on Torosa and estimate off 77 days has been provided to the EPA. This document states that the following estimates have already been calculated:

Mobilisation of rig within Australia = 21 days

Duration of drilling to the point prior to drilling in the reservoir = TBA

Intersect and kill=14 days

This would mean that the total drilling time has been estimated to be 77 days – 35 = 42 days.

The following is a comment by John Wright:

I have reviewed the Woodside Worst Case Discharge Modelling Procedure. In my opinion I find it to be well organized, thorough and consistent with top international standards. It follows the specification as outlined in:

Oil & Gas UK - Guidelines on relief well planning January 2012.

Society of Petroleum Engineers (SPE) -174705 – Technical Report (TR) Calculation of Worst-Case Discharge (WCD).

Additional inputs beyond this specification are reviewed based on regional regulatory requirements, and appropriate additions or amendments are made to the procedure.

The workflow is well documented with concise procedures and responsible parties. I agree with the identification of discharge scenarios to determine a true worst-case scenario for the objective producing interval. Both drilling and completion scenarios are considered. For the drilling phase, I would recommend that any shallower hydrocarbon zones (drilled prior to the objective reservoir hole section) be reviewed for WCD. As these shallower zones with larger hole diameters can be more difficult to control than the objective reservoirs. QA/QC is added to the results as each reservoir and hydrocarbon characteristic input into the model is reviewed by each responsible function and approved by the appropriate technical focal points.

WCD duration is calculated by the drilling engineer according to predicted time to control the blowout by a relief well. Discharge duration = Rib mobilisation + Drilling Time + Intersect and Kill Time. Rig mob time from the region is estimated at 21 days. Intersect and kill time (additional ranging & surveying, and hydraulic kill) at 14 days. There is not probability assigned to these values, but I would put it at P10 to P30 from my experience on the time assigned to intersect and kill. There is a section in the document that describes deviation from these assumptions, e.g., delays in getting a rig, well design complexity, drilling issues, etc.

5.1.5 My Summary Opinion on Question 1.

What is your independent opinion on the adequacy of Woodside's Prevention Practices for the risk of subsea Well Blowout at the Torosa field offshore Browse Basin, WA compared to International best practice?

For this Conceptual stage of development planning, WEL has conducted a considerable amount of work particularly in the worst-case discharge area and response. I find this work to be thorough for this stage and of an International best practice standard. I have also reviewed WEL's Guidelines, Standards, and Procedures designed to Prevent Loss of containment incidents, and find these also to be of Industry best practice standard with some suggestions for improvement based on my experience. I have further made three suggestions (Additional Barriers) for Woodside's consideration to reduce the low probability of a LOC incident even further on Torosa, and to consider having the goal of setting in new industry benchmark in reducing the probability of LOC events.

5.2 Additional Barriers

Additional Controls that Woodside may wish to consider improving the prevention of Blowouts and improve the Risk Management of Blowout risk in Torosa.

5.2.1 The need to aim for Zero Blowout risk through improved Process Safety in Wells

In my opinion as we are increasingly focused on eliminating harm to the environment because of energy industry activities, we can apply this focus to Wells and blowout risk specifically, which is essentially about Process Safety Improvement in Wells. WEL has excellent industry standards for the prevention of Loss of containment, and perhaps better than many other operators, in many other countries. The standard Blowout risk for a development well has been clearly shown to be equivalent to less than one in one thousand wells. However, when such an event occurs, the consequences can be devastating. It is my personal opinion that we can and should apply the same zero tolerance to blowout risk as we have done for personal injury and aim for zero risk. The Scot Reef project provides an opportunity to strive for even lower risk, since the proximity of wells makes the timeline for responding and stopping an uncontrolled release very challenging.

WEL's record shows they have not experienced a blowout in their entire history and have been excellent stewards of responsible environmental care particularly in their well activities. The Scott Reef project and timing gives WEL the opportunity and space to set a new standard for Blowout risk reduction. This could be achieved by a concerted focus on the top four root causes of blowouts to see what new and evolving ways can reduce the risk even further than the current benchmark norm.

5.2.2 MPD (Managed Pressure Drilling)

I have spent some time this year offshore on MPD in an HPHT context in different countries so I can speak from experience. The main advantage of MD systems is the ability to quickly adjust bottom hole pressure through adjustment of the applied back pressure on the annulus. This results in an almost instant reduction or increase in ECD which can reduce kick size significantly. Coupled with an EKD (Early Kick Detection) system, an MPD solution for Torosa could be shown to reduce the probability of a blowout further from the already low levels. A decision to introduce MPD requires a considerable amount of analysis on the benefits and the selection of the right MPD solution also requires considerable expertise in drafting appropriate tender documentation, which in the Torosa case would require careful analysis.

5.2.3 Predictive methodology for detecting imminent barrier failure.

Currently there are limitations in real-time monitoring technologies provided by mud logging companies for example which lack sensitivity and corelation of measured data. There are also difficulties in large volumes of data integration and analysis. Despite all of the MMV process typical today in any offshore well operation there are inadequate predictive models to forecast failure scenarios or triggering response mechanisms. Further, we have a lack of accurate and detailed wellbore representation that can assist on rapid interpretation of a predicted failure.

The above statement is a summary of an industry challenge area defined by the OESI (Ocean Energy Institute) requiring improvement through research funded activity. Stuart Wright Pte ltd via our association with John Wright Company (John Wright is a co-founder of Stuart Wright) is in the process of proposing a solution in this area to the OESI. Our proposal involves the integration of our AutoWells wellbore visualisation system with a Big Data Platform system called Affectli. The concept is to create a Digital Well Twin embedded within a large data aggregator tool for the express purpose of creating a predictive tool to forecast well failure scenarios. This tool could have the prevention of loss of containment in the drilling phase as a key component.

I have chosen to mention this initiative since Torosa wells are likely to be four years away from drilling and such a predictive tool could have the benefit of reducing the risk of a blowout by an order of magnitude due to the preventative focus aspect. This could be one of many initiatives that could be pursued between now and the drilling of Torosa to improve the prevention and risk management process for Torosa, thereby enhancing the protection of critically important environmental features.

5.3 Question 2 Response Practices

What is your independent opinion on the adequacy of Woodside's Mitigation response in the event of a subsea Well Blowout at the Torosa field offshore Browse Basin, WA compared to International best practice.

A loss of well control (LOWC) incident, or more commonly referred to as a Blowout, is one of the biggest risks to the global offshore petroleum industry, though frequency is rare. The mitigation of the consequences of a Blowout requires thorough and detailed response planning so that impacts and risks can be reduced to as low as reasonably practical (ALARP). NOPSEMA, the national Oil & Gas industry regulator for Australia has issued a Source Control planning and procedures document to assist operators in their response preparedness and expectations under the regulations for the industry.

While Woodside's Torosa project is still at a **concept stage** of development and approval planning, we have been tasked with providing an independent opinion as follows in the extract from the Woodside RFQ:

Review the proposed Browse approach against global contemporary industry 'best practice' for preventing and mitigating the risk of subsea well blowouts from development of gas/condensate wells at locations in close proximity to sensitive social or environmental receptors.

In our (SW) opinion in terms of best practice assessment, at the very least, the proposed Browse approach to mitigating the risk of Subsea well blowouts in close proximity to sensitive environmental receptors, could be very effectively compared to expectations stated in the *NOPSEMA Source control planning and procedures, information paper, Document No: N-04750-IP1979 A787102, dated 10/01/2024*. Consequently, the NOPSEMA Source Control Technical note is used as a series of chapter headings in the following assessment with comments made by SW as to the effectiveness against the regulators' expectations under the regulation.

The NOPSEMA document states:

"The purpose of this Information Paper is to describe NOPSEMA expectations with regards to source control planning content of the Environmental Plan (EP), Well Operating Management Plan (WOMP) and the Source Control Emergency Response Plan (SCERP), and to describe the regulatory assessment focus of the EP and WOMP and the compliance monitoring inspection process and focus of the SCERP.

Additionally, in the event that a source control response is activated, vessel and drilling rig operators undertaking the response will require regulatory assessment and approval of the relevant Safety Cases. This Information Paper identifies the source control activities that would require a Safety Case to demonstrate the activity can be undertaken safely, and provides context regarding regulatory expectations of the Safety Case inclusions".

5.3.1 Review of WEL Mitigation Practices for Blowouts

Under each of the chapter headings in the NOPSEMA Source Control Technical Note are guidance as to the relevant regulations, relevant international organisation publications such as IOGP, and other critical documents such as the EP (Environmental Plan) required from Operators and vessel holders, must include for example details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an acceptable level.

We (SW) have used the Source Control document as a guide in providing feedback to WEL as to our opinion. Where necessary we have quoted (Italics) and/or summarised certain NOPSEMA statements within the document to assist WEL and others in understanding our opinion.

Source control planning and procedures
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Report ref.	NOPSEMA reference	Nopsema guidance heading
4.3.1.1	2.	Source control planning documents

The OPGGS (RMA) Regulations and OPGGS (Environment) Regulations work together to ensure effective arrangements and planning for timely source control in the case of a loss of well integrity.
The WOMP *requires demonstration of the* ***engineering and technical suitability*** *of the well design and integrity to enable source control measures for regaining well control.*

Reg. 5.09(1)(c) requires a description and explanation of the design, construction, operation and management of the well, showing how risks to the integrity of the well will be reduced to as low as reasonably practicable, including a description of the standards applied for planning the blowout contingency plan.

Reg. 5.09(1)(k) requires a description of the measures and arrangements that will be used to regain control of the well if there is a loss of integrity. This includes a summary description of the blowout contingency plan and *source control plan, demonstrating that the plan to regain control after a loss of well integrity is fit for purpose, based on a realistically modelled case, and will be available prior to commencing the well activity.*

The EP *requires demonstration of the* ***effectiveness and timeliness*** *of the control measures and arrangements to minimise the volume of hydrocarbon released to ALARP.*

As per Part 4 of the OPGGS (Environment) Regulations 2023, the EP must demonstrate that the environmental impacts and risks of the activity will be reduced to as low as reasonably practical (ALARP) and include an appropriate implementation strategy, including an oil pollution emergency plan, to respond to an emergency and implement oil spill response control measures and arrangements.

Reg. 21(5)(c): The environment plan must include … details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an acceptable level;

Reg. 22(3): The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to … emergencies and potential emergencies;

Reg. 22(9)(a): The … emergency plan must include adequate arrangements for responding to … oil pollution, including … the control measures necessary for timely response to an emergency that results or may result in oil pollution;

Reg. 22(12): The implementation strategy must include arrangements for testing response arrangements in the … emergency plan.

The SCERP *is the* ***response procedure*** *used to plan and respond to a LOWC event.*
The SCERP is not required to be submitted for assessment, but some of the content of the source control emergency response plan and arrangements must be presented in the WOMP and EP in sufficient detail to address the acceptance criteria of the WOMP and EP.

In respect of the Torosa development, a WOMP will not be submitted until after FID and all the necessary well design and planning work has been accomplished, which in the Torosa time frame is perhaps two or more years away, I have included the NOPSEMA guidance simply for reference. Woodside has however commenced work on the WCD and so it is worthwhile to include NOPSEMA expectations in respect of WCD:

The deployment activities described in the SCERP will require an approved ***Safety Case*** *to* ***demonstrate how the safety risks will be managed****.*
The Safety Case is to be developed by operators of vessels and drilling rigs undertaking source control response activities. The Safety Case should address all risks associated with the activities operating in abnormal marine conditions, such as within potential hydrocarbon plume locations. The SCERP content expectations presented in this Information Paper are consistent with ***IOGP Report 594*** *and* ***IOGP Report 592****.*

Reference material for developing a SCERP, complete with source control information requirements of the EP and WOMP, can be found in the ***APPEA Australian Offshore Titleholders Source Control Guideline****.*

Comment on Woodside Source Control Documentation

Clearly the proposed development of the Torosa and associated fields has not reached the stage of FID and therefore the required documents have not been developed by Woodside. However, Woodside have a Source control and SCERP guideline document which will be followed to prepare the SCERP specific plan for the Torosa field.

Highlights of the WEL document follow:

1.1 Objective

This Guideline outlines how to meet expectations in the planning and preparation of the following two Planning documents:

1. *Campaign- or Region-specific Engineering Assessment for Source Control*
2. *Source Control Emergency Response Plan (SCERP) for Subsea operations across Drilling and Completions (D&C).*

It supports the implementation of the Worst-Case Discharge Modelling Procedure and Relief Well Planning Procedure.

1.2 Scope

This Guideline applies to Woodside Drilling, Completions and Well Intervention operations worldwide. It is applicable to subsea wells only. Platform and land operations are not considered.

The WEL SCERP document describes the mobilisation of critical resources for a BOP Capping stack, A contract for the provision of the Capping stack maintained in Singapore by Wild Well Control is in place. Minimum engineering studies are identified to ensure the suitability of the Capping stack and its' safe deployment are identified as is the outline content of a site specific SCERP. The procurement process of a suitable drilling unit should a relief well be required is not included in this document.

The WEL Source control guideline could be usefully updated to ensure expectations of NOPSEMA per their Source control Technical note and, subject to Torosa development approvals, a Torosa specific Engineering Assessment and campaign SCERP will be developed as required by NOPSEMA and at the appropriate time in line with secondary WEL approval activities.The specific SCERP will need definition on SFRT Equipment (Australia Specific) details and deployment and will need to address drilling unit(s) procurement and availability based on having the necessary horsepower and capacity for a worst-case discharge well kill. However, as a demonstrator that WEL follows best practice for source control documentation preparation the WEL Source Control guidance is sufficient.

A summary of the NOPSEMA Source Control Technical note follows:

Environmental Plan (EP)

Worst Case Discharge (WCD) Analysis

Provide a summary of the parameters and assumptions used to estimate the WCD, and demonstrate the WCD has been applied to define the worst-case potential consequences of an oil pollution incident.

The EP must demonstrate the control measures and response arrangements for source control and well kill that are appropriate for up to and including the WCD.

Context

WCD analysis evaluates the range of possible blowout scenarios of the activity to identify the worst-case hydrocarbon discharge characteristics that could occur. WCD is defined by the maximum rate a well will flow based on reservoir characteristics, open hole of the well, no obstructions in the well, and zero mechanical skin factor.

It's noted that the WCD value calculated for the EP may be refined through the ongoing well engineering process, and the WCD presented in the WOMP and SCERP may be different to the WCD presented in the EP.

WCD information is used in the EP to:

- *Establish the environment that may be affected (EMBA) in the event of a LOWC incident*
- *Define and scale oil spill response control measures and arrangements that will contribute to reducing oil pollution risk to ALARP*
- *Evaluate feasibility of source control options through the range of possible discharge rates and hydrocarbon characteristics up to and including WCD.*

WEL has conducted several worst-case discharge studies resulting in advice to EPA of the following worst Case discharge details:

Hole size

Max rate of gas

Max rate of condensate

Capping stack mobilisation, preparation, load-out, logistics, and deployment plan

Demonstrate the arrangements for timely activation and mobilisation of source control equipment (capping stack, ancillary equipment, etc.).

Provide ALARP assessment of alternative and improvement options to achieve shortest reasonably practicable timeframes.

WEL has conducted a study of the mobilisation and deployment considerations of a Capping stack by WWC of Houston. This has resulted in approx. 13 days to mobilise, instal and shut in a blowout at the Torosa field.

The following comment is from John Wright:

I have reviewed the "SUBSEA CAPPING STACK DEPLOYMENT AND INSTALLATION PROCEDURE - SYSTEM II" prepared by Wild Well Control in February 2023, the document is a procedural outline which describes general steps for mobilization, vessel preparation, deployment subsea, and land-out on the well. In my opinion, I find this level of assessment would meet international standards of best practice for this early phase of well planning.

The capping stack in stored in state of constant readiness and subject to continual maintenance as per program, upon initiation of the emergency response plan, WWC will instruct the logistics company to mobilize. Mobilization will be made either by seafreight or airfreight, whichever is deemed the fastest. Seafreight appears to be the quickest if a suitable deployment vessel can be contracted within the allocated time frame of 4 days. Seafreight time from Singapore callout to arrival at the wellsite is estimated at ~11 days. A Perth based capping stack would take approximately the same mobilization time.

Simultaneously with the capping stack mobilization a suitable stack deployment vessel (minimum DP2 crane vessel) and associated equipment will need to be sourced and mobilized to the site. The details about the equipment specifications are outlined in the report. Crane vessels typically are contracted out in different regions for construction or salvage projects and then move on. It is difficult to know where suitable crane vessels will be too far in advance. Once wells operations start, however, suitable vessels could be sourced in the region over a specific time period. These cranes may not have the length of cable required to lower the capping stack to the seabed, the extra cable would also have to made available.

If the crane vessel and all required equipment was ready when the stack arrived, weather was favorable, etc, it is estimated that the stack could be placed in a fast as 2 days, or 13 days total from callout.

Site challenges were addressed with respect to a large gas plume in the relatively shallow water under WCD gas rates to the surface. This plume was estimated at a worst case of 65m radius for 10% LEL hazardous exclusion zone. This large exclusion zone would require either a large crane vessel with sufficient reach to lower the stack vertically over the upwind & up current side of the plume (e.g., a Sheerleg Crane Vessel). The larger vessel could take longer to source and mobilize. An alternative option (included in the report), is to use a subsea winch and a smaller crane vessel to pull the stack over the center of the well. This equipment would also need to be sourced and mobilized, if required. In addition to these steps, there might also be the need to clear debris from the subsea wellhead (similar to the Deepwater Horizon blowout) before capping could be attempted.

I would recommend that in a future risk mitigation phase, prior to drilling, consider a more detailed subsea capping strategy/drill as to where all the required equipment could be sourced, and probabilistic time estimates to mobilize to site as well as probabilistic time estimates for preparing for capping under different scenarios.

5.3.2 SCERP content and compliance monitoring

4.1. Source Control Emergency Response Plan (SCERP)

4.1.1. Plume Study

4.1.2. Capping Stack Landing

4.1.3. Selection of Capping Stack and Ancillary Equipment

4.1.4. Well or BOP to Capping Stack interface analysis and Clash Checks

4.1.5. Capping Stack actuation and ROV interface points verification

4.1.6. BOP ROV Panel

4.1.7. Capping Stack mobilisation, preparation, load-out, logistics and deployment

4.1.8. Relief Well locations, design, and Dynamic Kill Plan

4.1.9. Back-up equipment, drill strings and casing for relief well drilling

4.1.10. SIMOPS: Relief Well and Capping Stack operations interfacing

4.1.11. Debris Clearance

4.1.12. Subsea Dispersant Operations

4.1.13. Subsea Dispersant Supply

4.1.14. Source Control IMT arrangements

5. Safety case and validation considerations

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5.1. Capping Stack Deployment and Operation

5.2. Relief well drilling rig(s)

Woodside have made it clear to me that the Torosa project is not at this level of detailed planning, still being in the concept stage. However, WEL have advised they are well aware of the details required by NOPSEMA as illustrated in the list of required information above.

I can say that WEL has commenced work on:

Plume Study.

Selection of Capping Stack and Ancillary Equipment

Capping stack actuation and ROV interface points

Capping stack mobilisation, preparation, Load-out logistics and deployment

For the conceptual stage of development Woodside has met typical international standards in their Capping stack considerations, though more work is required to consider this a practical solution under relevant LOC circumstances at Torosa.

In respect of Relief Well Locations, design, and Dynamic Kill plan work is still required in this area to produce a workable Relief well plan including suitable rig capacity for the LOC WCD values under consideration.

The following Comment is from John Wright:

I have read the Woodside Relief Well Planning Procedure and a Specific Relief Well Plan for Torosa TOA03L Well, produced by Schlumberger, both of these plans can be considered as meeting international standards for this conceptual stage development. I would recommend a more detailed plan before the drilling phase commences supported by a relief well specialist. There are many factors that could potentially make a relief well take longer than planned, but historically in my experience there have been very little lost time, A relief well is the ultimate last resort, even if delayed they will eventually control the blowout. Relief wells have historically been used in approximately 5% of all blowout control methods.

5.3.3 The K-BOS initiative for the BOP_closure

Since early feedback from the EPA has indicated only a maximum 24-hour LOC timeframe would be acceptable at this stage to the EPA, Woodside have reviewed a pyrotechnically operated shear ram known as a Kinetic Blowout Stopper (K-BOS). The K-BOS is designed to close and seal an undersea well head, shearing any pipe or casing within the Blowout Preventer (BOP) in fractions of a second. The system has been deployed in the GOM and elsewhere including with Woodside Internationally. Kinetic Pressure Control has commissioned NASA to conduct a Probabilistic study to determine the expected probabilities of failure for a generic BOP with hydraulically operated rams and BOPs with K-BOSs replacing hydraulic rams, in alternative configurations. The study focused on the reliability of a K-BOS system to shear pipe and therefore shut in a well and stop the LOC. The result of the reliability study indicated a large potential improvement in reliably shutting in a well with the K-BOS system compared to a conventional hydraulic BOP. Woodside will conduct further research in this area to determine if the K-BOS system should be deployed on the Torosa project with the potential advantage calculated of getting a well under control in 24 hours thereby significantly limiting environmental damage should a Blowout occur.

The following Comment is from John Wright:

I have read the K-BOS material and discussed their deployment with Petrobras and Equinor engineers familiar with the system. Neither has had an incident that required the system to be used in anger, They run it above the existing hydraulic blind shear ram, It is planned as a last resort ram in a situation where the conventional shear ram failed or other issue such as non-shearable pipe across the ram. They do not test it and have it serviced by the vendor every two years as required. They do not view it as a replacement for a capping stack but as an extra tool to lower the probability of having to deploy a capping stack. There remains a risk no matter how small that the K-BOS when activated does not function and this needs to be identified in any probabilistic analysis.We note advice from WEL that the that the manufacturer of K-BOS has conducted testing aligning to the intent of API 16A PR2 certified by DNV confirming shear and seal ability, and that test firing on subsea has been required by BSEE for initil deployments. Further we are advised that the system employs continuous monitoring of the firing circuit to detect if there is a failure which can then be resolved.

5.3.4 My Summary Opinion on Question 2

WEL's stage of planning for WCD and response on the low probability of a blowout on Torosa can be considered as meeting international standards for this conceptual stage development.

For a relief well, I would recommend a more detailed planning before the drilling phase commences supported by a relief well specialist. There are many factors that could potentially make a relief well take longer than planned.

For the Capping stack, I would also recommend more detailed planning, before the drilling phase commences; to confirm its' deployment is practicable and a probability analysis be done on the time it may take to deploy effectively. There are many factors that affect its' successful and timely deployment. I understand that detailed planning is a given and part of the normal process for any Oil & Gas development. I make this statement since I have only been able to review the current high-level status of the planning cycle.

For the WCD I find the work done to date to meet an international standard. I would recommend that all hydrocarbon bearing zones penetrated by the wellbore, from spud to total depth, be assessed for WCD. In my experience I have observed shallower zones in larger hole sizes can be more difficult to control than the objective reservoirs.

6. Annexure

6.1 Annexure A – RFQ and Project Brief from Woodside

REQUEST FOR QUOTATION ('RFQ')

WOODSIDE ENERGY LTD (ABN 63 005 482 986)
11 Mount Street, Perth WA 6000, Australia ("**Company**")

DOCUMENT INFORMATION	
PROJECT	Browse
RFQ TITLE	Independent Review of Well Blowout Risk Management at Torosa
RFQ NUMBER	TBC
COMPANY FOCAL POINT	James Peyton
TERMS AND CONDITIONS / FRAME AGREEMENT	Purchase Order Terms and Conditions for Goods and Services -Australia – June 2024. Browse and Scarborough.
ISSUE DATE	28 June 2024
DUE DATE 2PM AWST	12 July 2024
VALIDITY PERIOD	90 days

6.2 Annexure B – Data Received from Woodside

S/No.	Document No.	Document Title
001	General – 01	Torosa RFSU layout
002	General – 02	Torosa Capping Stack Feasibility
003	General – 03	Torosa DEMIRS Discussion (DRAFT)
004	General - 04	JSC-SAA-NA-25032-01-Kinetics Report_Final
005	General – 05	Calliance RFSU layout
006	General - 06	230222 - K-BOS Value Cases for Australia
007	Policies - 01	Conductor, Wellhead, Casing and Tubing Design Procedure (1)
008	Policies – 02	Drilling and Completions Change Management Procedure
009	Policies – 03	Drilling and Completions Risk Management Procedure
010	Policies – 04	EPA Preliminary View to Woodside - 7-02-24
011	Policies – 05	GWS Process Safety Metric Rev 4
012	Policies – 06	Relief Well Planning Procedure
013	Policies – 07	W1000SD7189654_4_Engineering Standard Well Barriers[2]
014	Policies – 08	W1000SD7193656_3_Engineering Standard Well Conductor, Wellhead, Casing and Tubing Design[1]
015	Policies – 09	Well Acceptance Criteria Procedure
016	Policies – 10	Well Barrier Design and Installation Procedure
017	Policies – 11	Well Control Procedure
018	Policies – 12	Worst Case Discharge Modelling Procedure
019	Guidelines - 01	Source Control Emergency Response Planning Guideline
020	Guidelines – 02	DC0000MD1401648721_1_Guideline - Drilling Barriers Qualification and Verification[1]
021	Guidelines – 03	DC0000MD1401644005_0_Guideline - Drilling and Completions Pressure Testing[1]
022	Guidelines - 04	DC0000MD1401643987_2_Guideline - Completions Barriers Qualification and Verification[1]

6.3 Annexure F – Colin Stuart Curriculum Vitae

Name:	Colin STUART, B.Eng. FIMechE
Gender:	Male
Company:	Stuart Wright Pte Ltd
Job Position:	CEO and Technical Director (Founder)

PROFILE:

Regulator Advisor Supporting the Queensland Regulator to develop a well examination framework, and perform well examination duties for the design and construction of nominated wells. Technical Advisor to WorkSafe New Zealand and WOODSIDE Australia. Also conducted well examinations for geothermal wells in Indonesia.

Blowout Resilience System Designer Created and co-developed a Blowout Resilience improving software system - RTBC. Focuses on dynamically validating critical Well barriers throughout the Well lifecycle.

Well Control Engineering Well Control kick support/remediation/engineering and root cause analysis. Have worked on remote support or in client offices or on site as situation demands.

Well Design ERD optimization, casing design, drill string analysis, cement job planning, well control, and smart completions.

Drilling tasks has included well design verification, daily tasks supervision, performance monitoring and improvement.

Management of one well to multi-well drilling tasks, offshore drilling supervision, created and managed 90 men well engineering department for major drilling contractor.

Experience in Petroleum Engineering has included PanOil Pan Gas well test analysis package user, well test job planning, completions design, completions procurement, subsea well planning and tasks, rig site testing and completions supervision, reservoir equity studies.

Training has included basic and advanced drilling engineering; basic and advanced petroleum engineering, risk management; HPHT well planning and well control.

Computing skills have included being a trainer for DSP Well Engineering software, Word/Excel/PPT etc. Skilled Wellplan and Stresscheck/Wellcat user.

Published Author: SPE Paper Summaries including:

- "20,000 PSI Dual Well Control Systems"
- "A 20 K Well Planning and Tasks Experience"
- "Training Well Engineers in the Outsourced Era"
- "Contracting in the Outsourced Era"

SPE Forum Co-Chair 2004 "Completions 2007 and Beyond"

Fellow of the Institute of Mechanical Engineers

Expert Witness appointment in 2011/2012as an Expert Witness in major loss of Well Integrity event projects to both Australian and USA regulation authorities.

Teaching: Casing Design Theory and Computer apps. Hydraulics Theory and computer apps. Introduction to Well Engineering/well planning; HPHT well design; HPHT rig crew training; HPHT rig capability audits.

LANGUAGES	Native language is English	
AVAILABILITY	Available for entire project duration.	
QUALIFICATIONS:	B.Eng (Mechanical), 1979, Liverpool University	
	Chartered Engineer. FIMECHE Fellow of the Institute of Mechanical Engineers	
TRAINING & CERTIFICATION:	UKOOA Medical	Valid till May 2020
	BOSIET	Valid till Nov 2018
	Wellplan/Stresscheck well design software	2002/03/04
	Negotiation skills	2000
	Reservoir Engineering, Amoco,	1985
	Production Optimisation, Amoco	1984
	Advanced Drilling Engineering OGS,	1982
	Drilling Engineering, Preston Moore,	1980
	UKCS Well Control Certificate,	1979 - repeated every two years

October 2006 to present

CEO AND TECHNICAL DIRECTOR - Stuart Wright Pte Ltd (Singapore)

- Established an independent Well Engineering company based in Singapore, focusing on providing specialist, high value support to help our clients ensure the efficiency, safety and reliability of their well activities.
- Specialising in well engineering, well examination, well integrity, well control, HPHT and decommissioning - over 100 projects completed worldwide.
- Other consulting services provided include acting as an independent expert or witness into well control incidents, including acting as the expert witness for the Montara blowout.
- Developed a range of in-house oil and gas software solutions to support our clients and engineers, including the development of a well barrier monitoring software which helps Operators to monitor barrier condition and compliance with company set barrier policies.

October 2005 to September 2006

WELL DESIGN ENGINEER - John Wright Co (Singapore)

- Working for John Wright Well Control, Singapore, designing intersection well projects, primarily for Shell in Brunei. Projects include working on the design of the novel Conductor Connector well concept, for first trial execution in November 2006, and a relief/abandonment well by intersection.

- Planned and executed the abandonment using the relief well method from concept to execution including tasks management of rig and all third parties.

2002- October 2005

SENIOR ASSET ENGINEER BRUNEI/DEPUTY PROJECT LEADER - Shell (Brunei)

- Working on front end well design for Champion West Phase 2. ERD wells with 'Smart' completions. Integral part of subsurface and drilling teams. Drilled 5 complex snake/ERD wells in multiple stacked reservoirs with digital hydraulics smart completions c/w selective drawdown capability along 3.5 km horizontals.
- Skilled in Stresscheck/Wellplan/Wellcat/Peak Probabilistic software. Developed deterministic well cost software for Brunei Shell & resource planning system.
- Conducted well design and received budget approvals for phase 3 Champion West ERD Oil wells, plus high Pressure Gas wells. Special tasks included lead role in a serious well control incident recovery exercise, and the recovery of a slumped splitter wellhead, resulting in the saving of a $20 mm smart completion oil producer.

2000 – 2002

WELL ENGINEERING TEAM LEADER – Woodside Energy Ltd (Australia)

- Well Engineering Team Leader for the Sunrise Gas project. A $1,000 MM drilling project for which I had conceptual design and budget responsibility.
- ERD well designs plus subsea clusters.
- Design and conceptual to detailed level planning. Supervised a team of 7 engineers including drilling/completion/costing.

1998 – 2000

INTERNATIONAL DRILLING CONSULTANT – Kelly Down Consultants (Australia)

- Worked on Various Assignments planning and site supervision in the UK/ New Caledonia. /Papua New Guinea/New Zealand and Australia.
- Well design/ equipment and rig procurement. Programme preparation and drilling superintendent duties. Also wrote and supervised well tests on several wild cat wells.

1998

ASSISTANT GENERAL MANAGER AND CONSULTANT WELL ENGINEERING MANAGER –Techdrill North Sea (UK)

- Assisted in establishing well engineering services for a well engineering computer software company, DSP-1 well planning software expert user. Licensed DSP-1 user.
- Contract and sales negotiations for Techdrill North Sea

1994 - 1998

WELL ENGINEERING MANAGER – Santa Fe Ltd (UK)

- Established and managed the UK Well Engineering Group, providing integrated well construction services, comprising 90 staff after 4 years. Turnover £4 MM per annum.
- Project Management and incentive drilling. Customers included BP/Shell/Amoco/B.Gas/Amerada Hess

1990 – 1993 **DRILLING SUPERINTENDENT - Ranger Oil Ltd (UK)**

- Planned and managed Southern Northern Sea development drilling programme on the Anglia Field. Template drilling and platform tiebacks.
- Senior Drilling Engineer providing technical support for an HPHT 20 K PSI offshore well including Superintendent cover.
- Superintendent for Subsea development of Anglia West Field. Set up and managed remote base in Gt Yarmouth. Totally responsible for all aspects of supply and tasks base management.

1990 **DRILLING TASKS ENGINEER (Consultant) - BP (Southern North Sea)**

- Well planning and daily support for development drilling tasks on Amethyst Field. Multiwell deviated gas development.

1989 – 1990 **DRILLING TASKS ENGINEER (Consultant) - Shell Expro (Southern North Sea)**

- Planning for eight well workover tasks on Sean Field, Southern North Sea.

1989 **PETROLEUM ENGINEER (Consultant) - British Gas**

- On site Petroleum Engineer supervising slant rig completion and production well testing.

1987 – 1988 **PETROLEUM ENGINEER/WELL TASKS ENGINEER (Staff) - Amoco UK (Yarmouth, UK)**

- Planned and supervised offshore platform well testing, completions, coiled tubing nitrogen tasks and production logging. Supervised several offshore DST's on exploration jackups.

1983 – 1987 **DRILLING ENGINEER (Staff) - Amoco UK (London, UK)**

- Appraised new discoveries, prepared development recommendations.
- Appraised and evaluated Gas Condensate Fields in North Sea resulting in full field development of Everest Fields.

1981 – 1983 **DRILLING ENGINEER (Staff) - Sohio Alaska Petroleum Co. (Canada)**

- Development Drilling Engineer planning and working in rotation on N. Slope running a seven rig drilling programme as on-site engineer.

1980 – 1981 **DRILLING ENGINEER (Staff) - BP Petroleum (Aberdeen, Scotland)**

	- Development drilling and well workover programmes for Forties Field, including on site engineering supervision.
1980	**DRILLING ENGINEER (Staff) – BP (Norway)**
	- Offshore semi-submersible exploration programme.
	- Supported tasks onshore and worked rig-site as Offshore Engineer.
1979 – 1980	**DRILLING ENGINEER IN TRAINING (Staff) - BP Petroleum (Aberdeen, Scotland)**
	- Spent six months training in roughneck position on Forties drilling rigs.
	- Received training in drilling engineering techniques during onshore assignments.

6.4 Annexure F – John Wright Curriculum Vitae

Name:	John W Wright, P.E.
Gender:	Male
Company:	John Wright International, LLC
Job Position:	Managing Director
	Well Control Incident Response Specialist
	Relief Well Advisor

Technical Expertise

Summary:
John is a graduate and a member of the distinguished Alumni in Mechanical Engineering at Texas A&M University. His specific operational expertise is in the design and execution of relief wells. He has 46 years' experience working on 101 relief well and intersection P&A projects around the world, personally supervising 48. Mr. Wright pioneered the development of relief well delivery processes that integrated normal well construction with blowout control, borehole intersections and hydraulic kill design. He developed the first commercial service for relief well contingency plans in 1989, introduced the first OLGA transient software for hydraulic kill design and has written hundreds of plans covering most all of the oil and gas operating environments worldwide.

WORK EXPERIENCE

2021 – *2024*	**Company:** **Job Title:** **Responsibilities:**	***John Wright International, LLC*** ***Managing Director*** John Wright is subcontracted to Wild Well Control, Inc. maintaining the role of Global Relief Well Advisor. Partner in Stuart Wright
2014 – *2021*	**Company:** **Job Title:** **Responsibilities:**	***Wild Well Control, Inc.*** ***Global Relief Well Advisor, Relief Well Group*** Bearco International's personnel merged with WWC in 2014. Mr. Wright is leading a newly developed Relief Well Group. The goal is to continue to maintain industry leadership in relief well technology and intervention and to train the next generation of engineers. Mr. Wright advises clients on a global basis in all aspects of relief well design and execution.
2011 – 2014	**Company:** **Job Title:** **Responsibilities:**	**Bearco International** **Managing Director** Halliburton bought Boots & Coots in 2010 and Mr. Wright formed Bearco International in 2011 with Jim Woodruff and Bill McElduff. The company focus was exclusively on relief well contingency plans and relief well operations. Four relief wells were executed during this period in Mississippi, Libya, offshore India and Texas. Dozens of relief well response and well specific contingency plans were written during this period, including: gas storage field, deep water, platforms, dual relief wells, arctic, high kill rate complexity, passive magnetic ranging and magnetized casing for salt. Mr. Wright developed a procedure for using dual relief wells from two floaters with a single intersection to the blowout.

2009 – 2011	**Company:**	***Boots and Coots***
	Job Title:	***Sr. VP of Technology***
	Responsibilities:	Boots & Coots acquired John Wright Company in 2009. Mar Wright was tasked with leading the development and integration of blowout control and related technologies including: software, process and best practices management, risk management and relief well intervention. He managed two relief well projects during this period, one on the North Slope in Alaska and the Macando blowout in the Gulf of Mexico
1989 – 2009	**Company:**	***John Wright***
	Job Title:	***Company President***
	Responsibilities:	Mr. Wright formed John Wright Company in August 1989 to provide blowout control engineering design, specialist personnel and related special services general contracting for relief wells and underground blowouts. During this time Mr. Wright has designed and supervised dozens of relief well and borehole intersection projects around the world, was instrumental in pioneering blowout control contingency plans, developing procedures for special services and response organizations, and introducing a comprehensive "Well Control Management System". Mr. Wright co-founded WELL FLOW DYNAMICS in December 1991 to provide the first commercial two-phase transient kill simulations with OLGA-WELL-KILL for blowouts. He managed the field operations of Vector Magnetics Inc., a casing detection firm in 1991 and 1992 and maintained a close collaboration and general contracting relationship.
1981 – 1989	**Company:**	***Eastman Whipstock/Eastman Christensen***
	Job Title:	***Technical Services Surveying Engineer & Manager/ Relief Well Team Manager***
	Responsibilities:	New tool development, survey accuracy quantification, training, and quality assurance. "President's Award" for field introduction of Seeker Gyro in 1983. Supervised surveying, drilling tools, computers, and technical procedures for worldwide operations. Responsible for the technical design and operations of Eastman Christensen's Relief Well Team in execution of seven relief well projects during this time period. Pioneered well trajectory methodologies to best utilize electro-magnetic ranging technology.
1978 – 1981	**Company:**	***Schlumberger Offshore Services***
	Job Title:	Offshore Wireline Logging Engineer
	Responsibilities:	Working mostly openhole in the Gulf of Mexico with panel units

LICENSES AND CERTIFICATES

- State of Texas Registered Professional Engineer, Serial Number 63698, since 1988

PUBLICATIONS

- John P de Wardt; Steve Mullin; John L Thorogood; John Wright; Robert Bacon., "Well Bore Collision Avoidance and Interceptions - State of the Art", SPE/IADC 163411, 2013
- Wright, J. W., Oskarsen, R.T., Walzel, D., "Analysis of Gas Flow Yields Recommendations for Best Cementing Practices", World Oil, January 2010.
- Wright, J. W. Shaikhan Al-Khodhori/PDO Oman, Hamoud AlRiyami/Shell Brunei, Philip Holweg/Shell Brunei :" Connector Conductor Wells Technology In Brunei Shell Petroleum Achieving High Profitability Through Multiwell Bores and Downhole Connections" SPE 111441, (Mar 2008)
- Wright, J.W.: "Unique intervention safeguards platform after kick-induced gas broach", World Oil (January 2006)
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- Flak, L. H., Wright, J. W., & Ely, J. W.: "Part 1 Blowout control: Response, intervention and management–Strategy and planning", World Oil (November 1993), p.p. 71-78.
- Flak, L. H., Wright, J. W., & Tuppen, J. A: "Part 2 Blowout control: Response, intervention and management– Logistics", World Oil (December 1993), p.p. 55-61.
- Wright, J. W., Woodruff, J. W., & Thompson, D.: "Part 4 Blowout control: Response, intervention and management– Contingency Plans", World Oil (March 1994), p.p. 53-56.
- Rygg, O. B., Smestad P., & Wright J. W.: "Part 5 Blowout control: Response, intervention and management– Hydraulic Simulations", World Oil (April 1994).
- Flak, L. H. & Wright, J. W.: "Part 11 Blowout control: Response, intervention and management – Relief Wells", World Oil (December 1994), p.p. 59-64.
- Flak, L. H. & Wright, J. W.: "Part 12 Blowout control: Response, intervention and management – Incident Management", World Oil (April 1995), p.p. 105 - 112.
- Wright, J. W.: "Relief Well Technology Can Solve Ordinary Problems", O&GJ, (January 18, 1993), p.p. 30-33.
- Rygg, O.B., Smestad, P. & Wright J.: "Dynamic Two-Phase Flow Simulator: A Powerful Tool for Blowout and Relief Well Kill Analysis", SPE 24578, 1992.
- Wright, J. W.: "Blowout Intervention Preparedness Through Relief Well Contingency Planning", presented at IADC European Well Control Conference, (June 1991).
- Wright, J. W., Thompson, B. G., Zachary, M. B., Leraand, Frode: "Relief-Well Planning and Drilling for a North Sea Underground Blowout", J. Pet. Tech., (March, 1992), p.p. 266-273.
- Voisin, J., Quiroz, G. A., Wright, J. W., Pounds, R., Bierman, K.: "Relief Well Planning and Drilling for SLB-5-4X Blowout, paper SPE 16677 presented at the 1987 SPE Annual Technical Conference and Exhibition, Dallas, Sept. 27-30.
- Wright, J. W.: "Directional Drilling Azimuth Reference Systems", SPE17212, (February 1988).
- Wright, J. W.: "Rate Gyro Surveying of Wellbores in the Rocky Mountains", SPE 11841, (May 1983).
- Wright, J. W.: "New Generation Survey System Using Gyrocompassing Techniques", SPE 11169, (September 1982).

Relief Well Projects

John Wright Personnel Lifetime Relief Well Project List

Project #	CUSTOMER	Type of Project	Location	Year	Location	RW Drilled to Intersect
1	Apache Corporation	Relief Well	Texas	1982		1
2	Independent	Relief Well	Gulf of Mexico	1984	offshore	
3	Lagoven	Relief Well	Venezuela	1986	offshore	
4	Shell Oil	Relief Well Response	Gulf of Mexico	1987	offshore	1
5	Ormat Energy	Relief Well	Nevada	1988		1
6	ARCO U.K.	Relief Well Response	Scotland	1988	offshore	
7	Occidental U.K.	Relief Well	Scotland	1988	offshore	
8	Marathon	Relief Well	Alaska	1988	offshore	2
9	Saga	Relief Well	Norway	1989	offshore	1
10	Corporven, SA	Relief Well	Venezuela	1990		1
11	Shell Western E&P Inc.	Relief Well P&A	Texas	1991		1
12	Marathon Oil Company	Relief Well P&A	California	1991		1
13	South Cal Oil	Relief Well P&A	California	1991		1
14	Shell Oil	Relief Well P&A	Texas	1991		1
15	Phillips Midland	Relief Well P&A	Texas	1991		1
16	ONGC	Relief Well Electromagnetic Ranging	India	1991	offshore	
17	Conoco	Relief Well Response Engineering	Louisiana	1991		
18	Calpine Corporation	Relief Well	California	1991		1
19	ARCO Oil & Gas	Relief Well P&A	Texas	1991		1
20	Unocal	Relief Well Response	Thailand	1992	offshore	
21	Mobil	Relief Well Response	Texas	1992		
22	QGPC	Relief Well Study	Qatar	1992	offshore	
23	Vern Jones	Relief Well Response	California	1992		
24	Sunrise Energy	Relief Well Re-entry	Kansas	1992		1
25	Socal	Relief Well P&A	California	1992		1
26	QGPC	Surface Kill	Qatar	1992	offshore	
27	Phillips	Subsurface mapping project	Louisiana	1992		
28	Lasmo Nova Scotia	Relief Well P&A	Nova Scotia	1992	offshore	1
29	CNG Producing Company	Surface Kill	Gulf of Mexico	1993	offshore	
30	Chevron	Relief Well Response	Angola	1993	offshore	
31	Elf Nigeria	Relief Well	Nigeria	1993	Barge	1

32	Shell Nigeria	Relief Well Response	Nigeria	1993		
33	Arrow Drilling Company	Relief Well	Texas	1993		1
34	CNG Producing Company	Relief Well Response	Gulf of Mexico	1993	offshore	
35	BP Exploration	Relief Well Response	Vietnam	1993	offshore	
36	Banoco	Relief Well	Bahrain	1993		1
37	Mexpetrol	Relief Well & Surface Capping	Argentina	1993		1
38	Amoco	Relief Well Response & Surface Kill	Texas	1993		
39	BP- Vietnam	Relief Well HAZOP	Vietnam	1994	offshore	
40	Jones	Relief Well	Texas	1994		1
41	Shell Offshore Inc.	Relief Well Plan	Gulf of Mexico	1995	offshore	
42	Al Farat	Three Relief Wells & Surface Kill	Syria	1995		2
43	Elf Aquitaine	Relief Well Plan	France	1996		
44	Elf Aquitaine	Relief Well, P&A	France	1996		1
45	Banoco	Relief Well	Bahrain	1996		1
46	Mobil	Relief Well Plan	Louisiana	1996	offshore	
47	PDO	Relief Well	Oman	1996	offshore	1
48	OGDC	Relief Well	Pakistan	1996		
49	Occidental Bangladesh	Relief Well	Bangladesh	1997		1
50	Barrett Resources Corp.	Relief Well	USA	1998		1
51	Dowell Schlumberger	Well Control and Relief Well Plan	Mexico	1998		
52	Bellevue Resources	Relief Well	California	1999		1
53	Newfield Exploration	Relief Well	Gulf of Mexico	1999	offshore	1
54	Sonotrach	Relief Well & Surface Kill Engineering	Algeria	2000		
55	Cabot Oil & Gas	Relief Well	Gulf of Mexico	2000	offshore	
56	Apache Corporation	Relief Well & Kill Design	Australia	2000	offshore	
57	Aspect Resources	Relief Well & Kill Design	Anahauc, Texas	2000		
58	Cabinda Gulf Oil	Relief Well Design	Angola	2000	offshore	
59	MOL	Relief Well	Hungary	2000		1
60	Gen-Nan Company	Relief Well Design	Brookshire Texas	2001		
61	Devon Energy Corp.	Relief Well Design	Houston	2001		
62	Newfield Exploration	Relief Well & Bullhead Kill Design	Gulf of Mexico	1999	offshore	
63	Shell Bangladesh	Relief Well	Bangladesh	2001	offshore	1
64	Aera Energy	Wellbore Intersection Design	California	2001	offshore	
65	Aspect Resources	Relief Well Design	Louisiana	2001	offshore	
66	Murphy Sarawak Oil Co.	Relief Well Design	Malaysia	2001	offshore	
67	Brunei Shell Petroleum	Relief Well	Brunei	2002	offshore	1
68	Brunei Shell Petroleum	Relief Well P&A Project	Brunei	2002	offshore	1
69	Chevron	Well Intersection Canyon Crossing	Angola	2003	offshore	
70	Uzbek Oil Company	Relief Well Design Engineering	Uzbekistan	2003		
71	LGDC	Relief Well	Crosby, Texas	2005		1
72	Brunei Shell Petroleum	Relief Well P&A Project	Brunei	2006	offshore	1
73	Shell Nigeria	Relief Well Design	Nigeria	2006	offshore	
74	Brunei Shell Petroleum	Conductor Connect	Brunei	2007	offshore	1
75	Al Farat	Relief Well	Syria	2007		1
76	PTTEP	Relief Well Plan	Thailand	2008	offshore	
77	Shell UK	Relief Well Plan P&A	North Sea	2008	offshore	
78	ConocoPhillips	Relief Well P&A	Alaska	2009		1
79	Taylor Energy	Relief Well P&A	Gulf of Mexico	2009	offshore	1
80	Taylor Energy	Relief Well P&A	Gulf of Mexico	2009	offshore	1
81	Taylor Energy	Relief Well P&A	Gulf of Mexico	2009	offshore	1
82	Taylor Energy	Relief Well P&A	Gulf of Mexico	2009	offshore	1
83	Taylor Energy	Relief Well P&A	Gulf of Mexico	2009	offshore	1
84	Taylor Energy	Relief Well P&A	Gulf of Mexico	2009	offshore	1
85	BP	Relief Well	Gulf of Mexico	2010	offshore	1
86	Taylor Energy	Relief Well P&A	Gulf of Mexico	2010	offshore	1
87	Taylor Energy	Relief Well P&A	Gulf of Mexico	2010	offshore	1
88	Taylor Energy	Relief Well P&A	Gulf of Mexico	2011	offshore	1
89	Dunbury	Relief Well P&A	Mississippi	2011		1
90	Zuietina	Relief Well	Libya	2011		1
91	ONGC	Relief Well P&A	Bay of Bengal	2011	offshore	1
92	BHP	Relief Well Intersection Re-entry	Texas	2013		1
93	Denbury	Relief Well P&A Dual Intersection	Louisiana	2013		1
94	XTO	Relief Well P&A	Louisiana	2014		1
95	SoCal Gas	Relief Well	California	2016		1
96	Petrobras	Relief Well P&A	Brazil	2017	offshore	1
97	Repsol-Sinopec	Relief Well P&A Re-entry, 2 Intersect	North Sea	2018	offshore	2
98	Hilcorp	Relief Well P&A Re-entry	Louisiana	2019	offshore	1
99	Shell	Relief Well P&A Re-entry	North Sea	2023`	offshore	1