PETROLEUMSTILSYNET

Investigation report

Report	
Report title Investigation of the incident in well 7132/2-1, unintentional disconnection of the lower marine riser package (LMRP) on *West Hercules*, 16 January 2019	Activity number 404008005

Security grading		
☑ Public	☐ Restricted	☐ Strictly confidential
☐ Not publicly available	☐ Confidential	

Involved	
Team T-F	Approved by/date Irja Viste-Ollestad/29 April 2019
Members of the investigation team Kristen Kjeldstad, Eigil Sørensen, Fredrik Dørum, Linn Iren Vestly Bergh and Amir Gergerechi	Investigation leader Amir Gergerechi

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SUMMARY

At 22.46 on 16 January 2019, the lower marine riser package (LMRP) was unintentionally disconnected as the bottom hole assembly (BHA) passed down the blowout preventer (BOP).

Equinor is operator for well 7132/2-1 in the Barents Sea. Work on the well was conducted by the *West Hercules* semi-submersible drilling facility operated and owned by Seadrill.

The incident occurred during preparations to drill the 12 ¼-inch section. Drilling of the 42- and 17 ½-inch sections at the Gjøkåsen location had been completed. This involved drilling, cementing and pressure testing of the most recently set casing string – 20-inch x 13 3/8-inch – at a measured depth of 595 metres.

The sea was calm with 0.4 metres of heave and good weather conditions. The water depth at the location is 293 metres. The blind shear ram (BSR) activated automatically, and liquid (seawater) from the riser was drained (dumped) to the sea. Subsequent observations showed that the BSR had failed to cut the drill string, which was struck in the BOP's BSR.

A decision was taken by the Petroleum Safety Authority Norway (PSA) on 18 January 2019 to launch an investigation of the incident. The investigation team's mandate included clarifying the course of events and assessing direct and underlying causes with the emphasis on human, technical and organisational (HTO) as well as operational conditions from a barrier perspective. This mandate covered conditions up to the time of the incident.

No personal injuries or harmful discharges to the environment were caused by the incident.

The incident occurred while the well was secured with casing and a cement plug at the bottom. No risk accordingly existed of discharges from the reservoir to the environment.

Had the same incident occurred at a later time, with hydrocarbons present, however, the position could have been more demanding with environmentally harmful discharges from formations in the 12 ¼- or 8 ½-inch sections.

The direct cause of the incident was a fault in the automatic disconnect system (ADS), which issued a signal to disconnect the LMRP from the BOP.

Six nonconformities have been identified by the investigation. These relate to

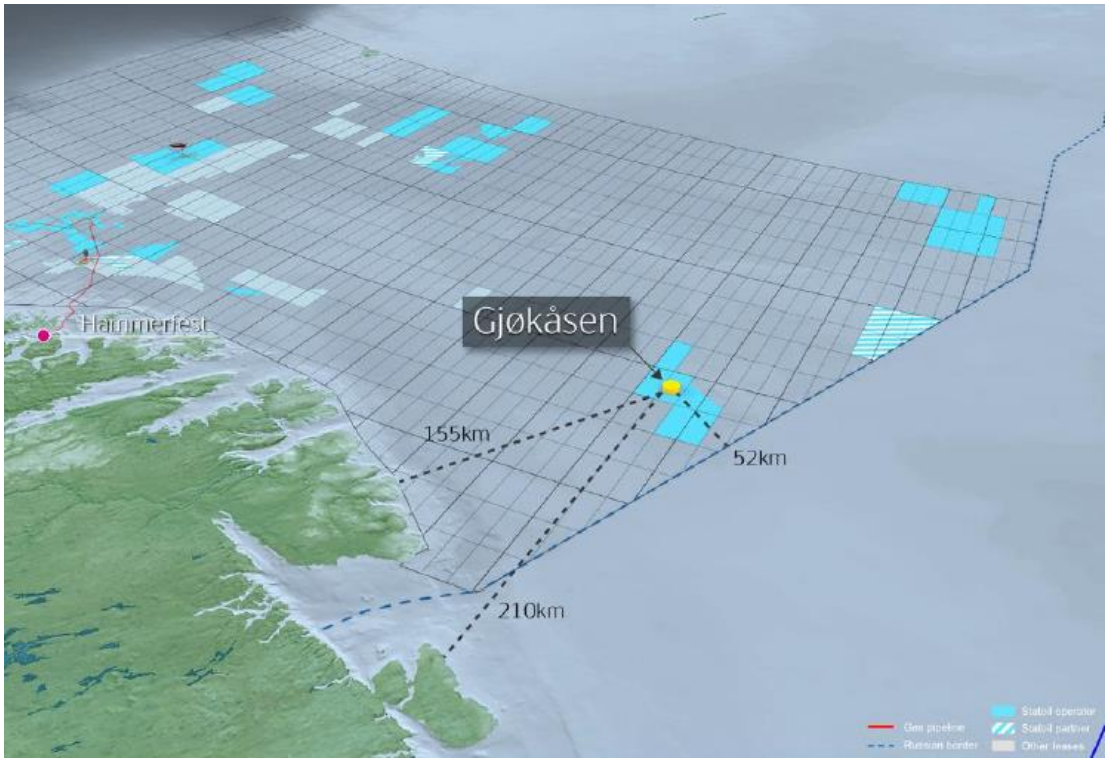
- risk management
- competence and capacity
- procedures and compliance
- maintenance
- management of change (MOC)
- see-to-it duty.

No improvement points were identified.

1 BACKGROUND INFORMATION

At the time of the incident, *West Hercules* was drilling the Gjøkåsen wildcat for Equinor in the Barents Sea.

The location and map have been taken from the application for consent to drill (*Søknad om samtykke til leteboring med* West Hercules *på Gjøkåsen 7132/2-1 PL 857*).



The licence organisation for the 7132/2-1 wildcat in PL 857 was as follows.

Company	Percentage
Equinor AS (operator)	40
Lundin Norway AS	20
Petoro AS	20
Aker BP AS	20

Objectives with drilling on Gjøkåsen included proving oil in the Realgrunnen subgroup and acquiring sufficient data to evaluate commerciality/need for future exploration wells in the area.

The well had the following casing profile: 9 7/8-inch pilot hole, 36-inch conductor casing, 20-inch x 13 5/8-inch surface casing and 9 5/8-inch liner. Plans called for the well to be drilled with seawater and viscous fluids (pills) in the top hole and 17 ½-inch sections, and with water-based drilling fluid in the 12 ¼- and 8 ½-inch sections.

Water depth at the well location is 293 metres below MSL, and *West Hercules* was originally due to maintain position with the aid of thruster-assisted mooring. When the consent

application was submitted, the use of dynamic positioning was under evaluation and this was the solution finally chosen for the Gjøkåsen location.

1.1 DESCRIPTION OF FACILITY AND ORGANISATION

West Hercules is a sixth-generation GVA 7500 semi-submersible DP drilling facility, built at DSME in Korea and completed in 2008. An acknowledgement of compliance (AoC) was issued for it in December 2012. It is owned and operated by Seadrill, with day-to-day operation handled from Stavanger. Parts of the company's support organisation for technical and subsea disciplines are located in Dubai and Houston.

The facility is registered under the Panamanian flag and has DNV GL class certificates. In recent years, it has been active on both Norwegian and foreign continental shelves. From October 2016 to April 2018, the rig was laid up in Skipavika. It was reactivated, crewed up and classed to drill a well for Siccar Point Energy (SPE) on the UK continental shelf in the spring of 2018. Equinor received consent to use *West Hercules* for exploration drilling on Gjøkåsen in July 2018.

Figure 1: The semi-submersible West Hercules *drilling facility. (Source: Seadrill)*

1.2 STATUS BEFORE THE INCIDENT

Operations in the days before the incident involved batch drilling of the top hole sections on Gjøkåsen and Gjøkåsen Deep. These wells are about 3.5 kilometres apart. Top hole sections in a subsea well are drilled without a BOP, which is installed after running and cementing the 20-inch casing. The top hole sections in both wells were drilled and the casing had been cemented and pressure-tested before the incident occurred.

The incident occurred when the drilling team was running the drill string for the 12 ¼-inch section through the BOP. The sea was calm with 0.4 metres of heave and good weather.

1.3 EQUIPMENT INVOLVED

Plans called for the ADS and the electronic well specific operational guidelines (e-WSOG) to be installed while the rig was completing the top hole sections.

The ADS is delivered by Future Production A/S (Future). An additional and independent system installed on a flexible joint (flexjoint), it is meant to send a signal which activates disconnection of the LMRP if communication between BOP and rig fails. This signal is given if the flexjoint angle exceeds a predetermined limit, set at six degrees on *West Hercules*. It activates the emergency disconnect sequence (EDS).

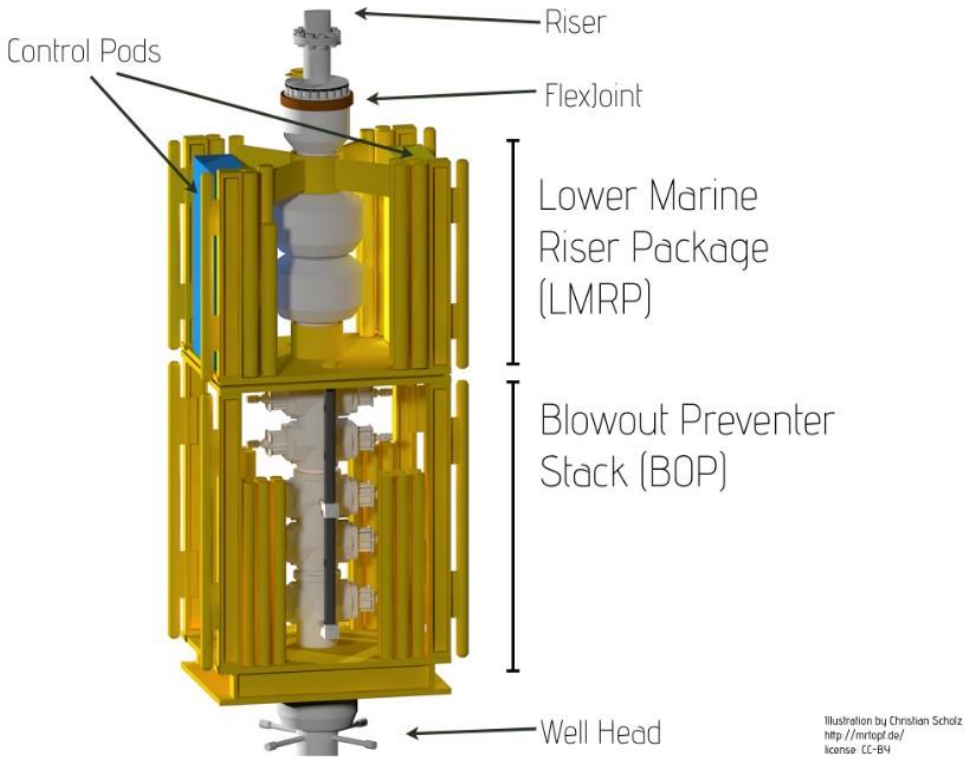


Figure 2: Example of a subsea BOP and LMRP.

The EDS makes it possible to disconnect the LMRP in cases where a rig with DP is drifting off location. At the same time, the borehole is secured by closing the BSR. A predefined sequence causes the LMRP to disconnect from the BOP after the EDS has been activated. The disconnection sequence takes about 55 seconds.

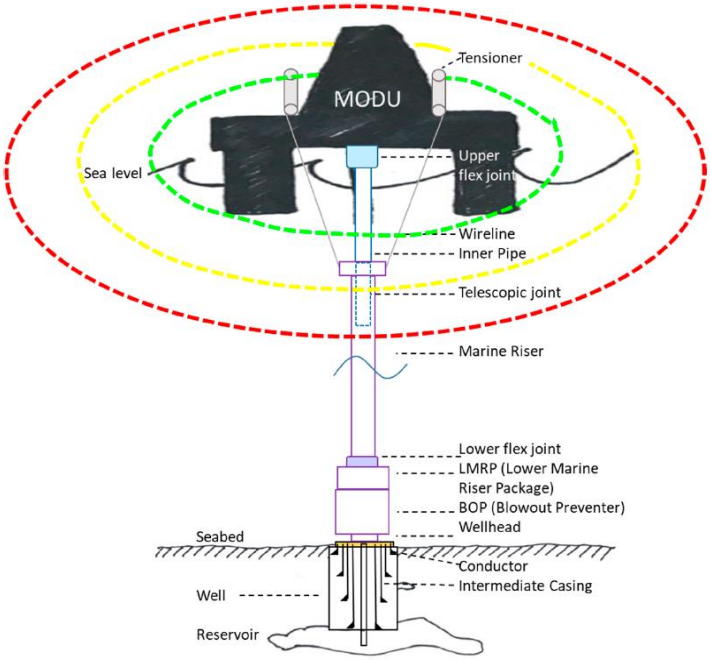


Figure 3: The green circle in the diagram indicates the safe working area and the yellow one shows when the EDS initiates disconnection. (Source: Journal of Marine Science and Engineering*)*

The ADS was developed by Smedvig and Future in 2002 at the request of Norsk Hydro on the Troll field. Seadrill holds the patent for the ADS.

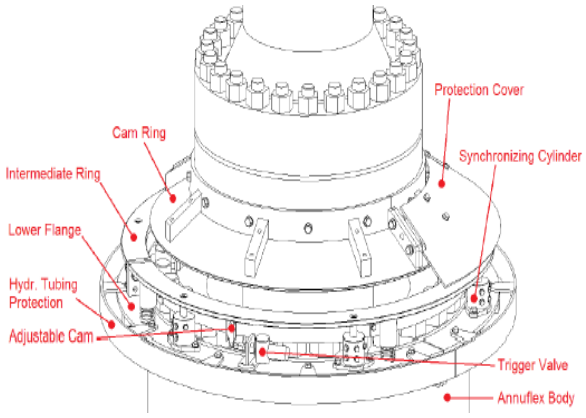


Figure 4: Outline of the ADS disconnect mechanism with all components. (Source: Seadrill)

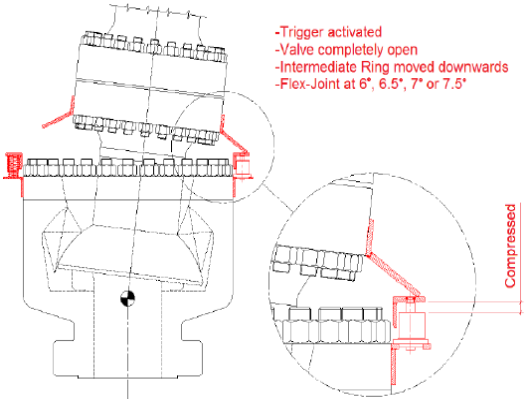


Figure 5: Outline of ADS activation of the disconnect mechanism. (Source: Seadrill)

Figure 6: The ADS installed on the West Hercules *flexjoint. (Source: Seadrill)*

Figure 7: The ADS installed on the West Hercules *test bench. (Source: Seadrill)*

An LMRP disconnect signal is sent by the ADS when the angle of the flexjoint exceeds six degrees. The ADS signal is sent to the EDS, which actually activates the disconnection. The BSR closes automatically when LMRP disconnection occurs.

The e-WSOG is used for electronic load measurement in order to identify the total effect of waves and drilling on the wellhead. This information is advantageous for finding the best operational criteria to prevent fatigue in the steel.

It emerged from the interviews that the level of activity for the subsea personnel had been high. Installing the ADS and e-WSOG represented extra jobs in addition to normal work done on the BOP. After they were in place, the BOP and riser were installed on the wellhead and the connection tested before running in the string to drill the 12 ¼-inch section.

1.4 ABBREVIATIONS AND EXPLANATIONS

ADS	Automatic disconnect system
AoC	Acknowledgement of compliance from the PSA
BAH	Bottom hole assembly
BOP	Blowout preventer
BSR	Blind shear ram
CCTV	Closed circuit television
DAT	Direct acting tensioner
DP	Dynamic positioning
DSME	Daewoo Shipbuilding & Marine Engineering
EDS	Emergency disconnect sequence
e-WSOG	Electronic well specific operating guidelines
FAT	Factory acceptance test
Flexjoint	Flexible joint in the riser system
FMECA	Failure mode, effects and criticality analysis
Hazop	Hazardous operation analysis
GVA	Götaverken Arendal – rig designer and builder
HTO	Human, technology and organisation
LMRP	Lower marine riser package
MOC	Management of change
MSL	Mean sea level
Primary barrier	Casing and cement under the incident
PSA	Petroleum Safety Authority Norway
Riser margin	Safety margin in the specific gravity of the drilling fluid
ROV	Remotely operated vehicle
Secondary barrier	BOP
VOR	Variation order request

2 THE PSA'S INVESTIGATION

The PSA was notified of the incident by Seadrill at 13.50 on 17 January 2019 and decided on 18 January 2019 to initiate its own investigation of the incident.

Composition of the investigation team:
Amir Gergerechi, F-drilling and well technology (investigation leader)
Kristen Kjeldstad, F-drilling and well technology
Eigil Sørensen, F-drilling and well technology
Fredrik Dørum, F-drilling and well technology
Linn Iren Vestly Bergh, F-occupational health and safety

2.1 MANDATE FOR THE INVESTIGATION

The mandate for the investigation was established in accordance with section 4.1.2 in the PSA's procedure for investigating incidents.

a. Clarify the incident's scope and course
b. Assess actual and potential consequences
    1. harm caused to people, material assets and the environment
    2. the potential of the incident for harming people, material assets and the environment
c. Assess direct and underlying causes
d. Identify nonconformities and improvement points related to the regulations (and internal requirements)
e. Discuss and describe possible uncertainties/unclear aspects
f. Discuss barriers which have functioned (in other words, those which have helped to prevent a hazard from developing into an accident, or which have reduced the consequences of an accident)
g. Assess the player's own investigation report
h. Prepare a report and accompanying letter (possibly with proposed use of enforcement powers) in accordance with the template.
i. Recommend – and normally contribute to – further follow-up by the PSA
j. Assess the relationship between causes and measures related to cost reductions, efficiency improvements and the level of activity

2.2 LIMITATIONS

The investigation covers clarification of direct and underlying causes until the incident date.

2.3 INTERVIEWS, VERIFICATION ON THE FACILITY AND ASSESSMENT OF DOCUMENTS

It was decided that the investigation should be conducted on land, without an inspection on *West Hercules*.

Interviews were conducted with Seadrill, Equinor and Future. A total of 25 people were interviewed during the investigation.

Technical investigations conducted by Seadrill, Equinor and Future have also been utilised.

In addition, documents were reviewed as part of the investigation.

3 COURSE OF EVENTS

On 16 January 2019, work was underway on running the 12 ¼-inch drill string into the well during preparations for drilling the 12 ¼-inch section.

The sea was calm with 0.4 metres of heave and good weather.

After running the BHA, the crew began running drill pipe at about 22.00.

An unusual noise heard at 22.51 coincided with a rig movement. Loss of drilling fluid from the trip tank was then observed.

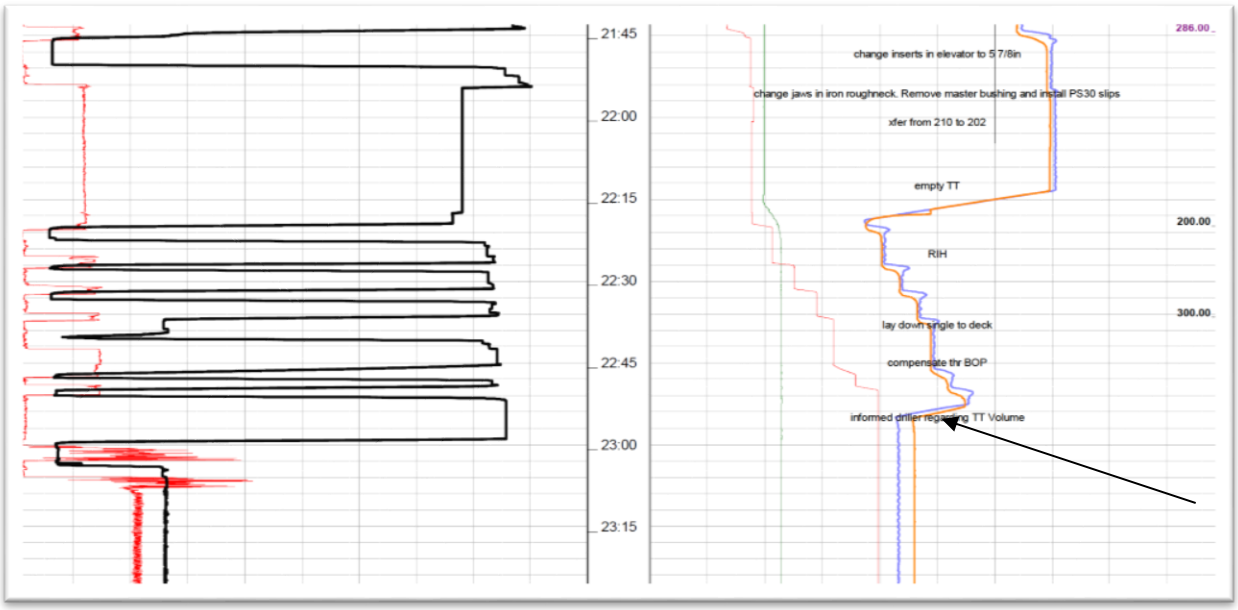


Figure 8: Activity log and loss of fluid. (Source: Seadrill)

Observation of the riser's telescopic joint with CCTV from the drill floor showed that the DAT cylinders were contracted – confirming that the riser was disconnected from the BOP.

The drill string was observed to be stuck, and the heave compensator was therefore connected to it.

An ROV was launched a few minutes later to observe the condition of the riser and BOP at the seabed.

ROV surveys confirmed that the LMRP was disconnected. The drill string was centred and stuck in the BOP. Later investigations showed that automatic closure of the BSR had been activated because of the disconnection

Figure 9: Images taken by ROV after the unintentional disconnection. (Source: Seadrill)

The eight-inch drill collars forming part of the BHA were caught in the BSR when the latter was automatically activated. These collars cannot be cut and were therefore stuck in the BOP's partially closed BSR.

Figure 10: This image of an eight-inch drill collar on deck after the incident shows damage after the collar was crushed in the BSR. (Source: Seadrill)

The crew on *West Hercules* and technical specialists on land worked out that the ADS had activated and caused a disconnection. This followed ROV inspections down on the BOP and a review of logs from the Cameron BOP control system on board.

4 POTENTIAL OF THE INCIDENT

4.1 ACTUAL CONSEQUENCES

The actual consequences of the incident are limited to financial loss. This relates to downtime in connection with operations and replacing damaged equipment in the BOP.

No personal injury was caused by the incident

The incident did no damage to the environment. The discharge from the riser was seawater. The BSR in the BOP was damaged and replaced. Other material damage was limited.

4.2 POTENTIAL CONSEQUENCES

When the incident occurred, the well was secured with casing and a cement plug at the bottom. No danger therefore existed of discharges to the environment from potential reservoir zones. The ADS was activated at an arbitrary time. Had the same incident occurred later, with hydrocarbons present in the formation, the position could have been more demanding. The well would not have been secured, and hydrocarbons could have been discharged from potential reservoir zones.

The detailed operation plan (DOP) and interviews describe drilling the 12 ¼- and 8 ½-inch sections without a riser margin. This means no margin was planned for the loss of the pressure contribution in the well from the fluid column in the riser. In cases with weak primary barriers and no secondary barriers, as described above, communication could arise between potential reservoir zones in the 12 ¼- or 8 ½-inch sections and the environment.

Had the incident occurred after the riser was filled with drilling fluid, the latter could have drained to the sea and caused environmental pollution.

5 DIRECT AND UNDERLYING CAUSES

5.1 DIRECT CAUSES

The direct cause of the incident was a fault in the ADS which sent a signal to disconnect the LMRP from the BOP.

This disconnect signal derived from an incorrectly installed trigger valve on the ADS.

5.2 UNDERLYING CAUSES

The investigation has identified several underlying causes of the unintended disconnection of the LMRP. These relate primarily to:

- risk management
- competence and capacity
- procedures and compliance
- management of change (MOC)

- see-to-it duty.

5.2.1 RISK MANAGEMENT

Several processes in Seadrill's management system describe when and how a hazardous operation analysis (Hazop) is to be conducted. According to the company's internal procedures, this must include technical, organisational and operational conditions.

A Hazop was conducted for installing the ADS. The Hazop meeting was held on the facility about three months before installation. At that time, uncertainty prevailed about the timing of the installation and about an overview of the ADS equipment. The investigation has found that the Hazop was not reviewed ahead of the work to be done, and risk associated with the installation was consequently not communicated to the executing personnel.

Several risk-reducing measures were identified by the Hazop. A number of the risks were identified as green/checked off as acceptable without systematic verification that the measures taken had achieved the intended effect. The Hazop refers, for example, to inadequate procedures which did not contain critical information required for installing the ADS. Installation of the ADS on *West Hercules* in 2012 was regarded as a risk-reducing measure even though several changes had occurred since that earlier occasion. See 5.2.3.

The participant list for the Hazop shows that neither equipment supplier Future nor the operator took part.

The Hazop did not include uncertainty assessments related to human and organisational conditions, such as training/experience with the ADS equipment and the significance of the increased workload.

Interviews and the document review reveal that neither executing nor supervisory personnel were adequately acquainted with and conscious of the risk associated with installing and using the ADS.

5.2.2 COMPETENCE AND CAPACITY

Interviews and the governing document review reveal that no training was established for the ADS. According to PRO-00-0510, Seadrill requires that each facility establishes an competence matrix and makes provision on board for tailored on-the-job training. Such training related to the ADS was not included in the *West Hercules* competence matrix and none was conducted for ADS equipment.

Knowledge of possible challenges related to machine-machine communication was also lacking. Nor was the organisation sufficiently aware that the BSR would close when the LMRP was disconnected from the BOP because of ADS activation, even when the BOP control system is placed in a mode where it should not close.

Interviews and the document review show that employees experienced an increased workload and inadequate planning of the ADS installation job ahead of the incident. Installing the ADS was an extra job on top of the work to be done on the BOP. The investigation has found that the potential risk related to these conditions (scope of work, training) was not identified/ addressed by the Hazop, and that a lack of continuity existed in project execution. The package owner initially leading and organising the project was not involved in its installation phase.

The investigation shows that inadequate provision was made for the overall scope of work, which included installation of extra equipment (ADS and e-WSOG) in addition to ordinary jobs within the time allocated. Nor was provision made for necessary measures to enhance the competence of the executing personnel.

Inadequate knowledge of ADS and pressure/scope of work were reinforced by the failure of the company to make appropriate procedures for ADS available in order to ensure prudent planning and execution of the work.

5.2.3 PROCEDURES AND COMPLIANCE

Procedures and documentation related to testing, installing and maintaining the ADS are considered inadequate. Critical measurements for ensuring that the equipment functioned as intended were not made, for example. No documents describing how to install the system have been presented.

Interviews and the document review also show that the DIR-00-0034 Risk Analysis procedure for Hazop was not followed in the Hazop meeting ahead of the ADS installation.

5.2.4 MANAGEMENT OF CHANGE

Interviews and the document review reveal that changes related to ADS installation and the BOP system in 2012 and 2018 were not followed up. According to the DIR-37-0015 and PRO-37-0249 procedures, an MOC process must be implemented for changes related to installation of new equipment or systems.

The ADS was installed by Future for the first time in 2012 on *West Hercules* and was part of the BOP system until 2014. A Synergi case (1092560) was created in 2012. The investigation team found no documentation in the Synergi case concerning the conduct of FMECA and Hazop analyses or other risk assessments when installing and using the ADS in 2012. A change request document was also created. This describes such requirements as risk evaluation and worker participation. These have not been selected as elements in the change request. The assessments underlying this decision are not described.

In 2014, the ADS was uninstalled and placed in storage before the rig moved to Canada.

The decision to reinstall the ADS was taken in 2018, and contained in a variation order request (VOR) from Equinor to Seadrill dated 28 May 2018. Before work started on Gjøkåsen, the ADS was taken from storage and recertified by Future. Before the ADS was dispatched, Future carried out a factory acceptance test (FAT) on 12 October 2018 in the presence of DNV GL. Future was not on *West Hercules* when the ADS was installed by Seadrill personnel. This was not picked up as a change pursuant to the MOC procedure.

Interviews and the document review also reveal documentation missing in the MOC process. No FMECA analyses were conducted, for example, ahead of installing the ADS.

5.2.5 SEE-TO-IT DUTY

Interviews and the document review reveal inadequate performance of the operator's see-to-it duty. The VOR from Equinor covered certification and installation of the ADS, which is safety-critical equipment. Equinor did not adequately check that Seadrill had the competence to carry out this type of work itself. Nor did it follow up whether risk assessments were conducted in relation to installing extra equipment. Equinor thereby failed to satisfy itself that planning and preparations for installing safety-critical equipment were conducted in a prudent manner and in accordance with the regulations

5.3 ORGANISATIONAL CHANGES, COST REDUCTIONS AND INCREASED EMPHASIS ON EFFICIENCY

The investigation team's mandate required it to assess whether any connection existed between identified causes and measures related cost reductions, enhanced efficiency and the level of activity. No absolute connections have been found, but the following have emerged.

- *West Hercules'* new drilling contract requires the contractor to perform more work than in earlier contracts, while the rig rate is relatively low.

- In recent years, Seadrill has undergone several organisational changes both offshore and on land. *West Hercules* has been mothballed and the crew laid off. The rig was then reactivated and crewed up. The head office and technical support have been moved and reorganised several times, and are now in Dubai and the USA respectively.

- Interviews and the document review show deficiencies in overview and management. The investigation has revealed, for example, a lack of risk assessments and documentation in the MOC process. This has clearly had consequences for planning and execution. See 5.2.

- Interviews and the document review reveal that the workload was perceived to be high. This was also reported/communicated to support personnel on land in Seadrill.

- Despite a lack of competence and experience, Seadrill decided not to involve the equipment supplier, Future, in installing the ADS.

- Projects in Seadrill were previously led/organised/followed up by the package owner, a qualified person on land who supervised projects. This function was used in the initial phase of the ADS and e-WSOG projects, but dropped towards the end of these.

- Several conditions also arose during the installation which should have prompted a halt and a new risk assessment, but this did not happen. Measurements made during installation on board, for example, failed to accord with results from the FAT. Procedures were also deficient. These involve measurements which are critically important for the equipment functioning as intended.

6 OBSERVATIONS

The PSA's observations fall generally into two categories.

- Nonconformities: observations where a breach of the regulations has been proven.
- Improvement points: observations where inadequacies are seen, but insufficient information is available to prove a breach of the regulations.

6.1 NONCONFORMITIES

6.1.1 RISK MANAGEMENT

Nonconformity

Deficiencies in risk analyses intended to provide a nuanced and integrated picture of the risk associated with installing the ADS. Insufficient risk analysis was carried out, nor was an adequate decision base available before ADS installation.

Grounds

- According to the document review, the Hazop was not reviewed before work started.
- The Hazop participant list shows that the equipment supplier was not present.
- No account was taken in the Hazop of human and organisational conditions, such as training and experience with the ADS equipment and the significance of an increased workload.
- Several risk-reducing measures were identified by the Hazop. A number of the risks are identified as green and accepted without an adequate assessment of the quality of the measures.
- The document review shows that the Hazop conducted was not signed as approved.

Requirements

Section 17 of the management regulations on risk analyses and emergency preparedness assessments
Section 11 of the management regulations on the basis for making decisions and decision criteria

6.1.2 COMPETENCE AND CAPACITY

Nonconformity
Personnel with responsibility for planning and executing the installation had limited competence about the ADS. The work was not adequately organised to reduce the probability of errors which could lead to hazards and accidents.

Grounds
- It emerged from interviews that personnel given responsibility for installing equipment on the facility were not provided with the qualifications to do the work:
  - personnel involved had not acquired sufficient experience and training with the ADS
  - the competence matrix does not include the ADS and no training programme has been established.
- The investigation has identified a lack of provision for the total scope of work. This included the installation of extra equipment (ADS and e-WSOG) on top of the ordinary assignments to be completed within the specified time frame. In addition, necessary measures for enhancing the competence of executing personnel were not provided.

Requirements
Section 21 of the activities regulations on competence
Section 33 of the activities regulations on organisation of work

6.1.3 PROCEDURES AND COMPLIANCE

Nonconformity
Inadequate procedures and failure to comply with procedures.

Grounds
Documentation for the ADS has several deficiencies, including:
- lack of important measurements related to installation
- no specific procedure for installation
- inadequate procedure for maintenance.

In addition, interviews and the document review reveal that the DIR-00-0034 Risk Analysis procedure was not observed when conducting a Hazop meeting ahead of ADS installation.

Requirements
Section 24, paragraph 2 of the activities regulations on procedures
Section 23 of the framework regulations on general requirements for material and information

6.1.4 MAINTENANCE

Nonconformity
Failure to establish routines for follow-up and maintenance of the ADS.

Grounds
Interviews and the document review show that no routines were established in the maintenance management system for conducting and following up maintenance of the ADS. The ADS was initially adopted on *West Hercules* in 2012. When the incident occurred, no routines for the ADS had been established in the maintenance management system. No class survey was conducted, for example, or criteria established for testing the equipment. The investigation has found that a possible recertification (class survey) of the equipment every five years had not been assessed. In addition, documentation on maintenance from the supplier was deficient. See 6.2.4.

Requirements
Section 47 of the activities regulations on maintenance programme
Section 46 of the activities regulations on classification

6.1.5 MANAGEMENT OF CHANGE

Nonconformity
No MOC was conducted in relation to upgrading the BOP and installing the ADS on *West Hercules*. Issues related to health, safety and the environment were not adequately identified or followed up.

Grounds
The ADS was installed on *West Hercules* for the first time by Future in 2012 and was part of the BOP system until 2014. No documentation has been found by the investigation team for FMECA, Hazop and other risk assessments related to installation of the ADS in 2012 and 2019.

Interviews and the document review reveal that changes related to ADS installation and the BOP system in 2012 and 2018 were not followed up. According to the DIR-37-0015 and PRO-37-0249 procedures, an MOC process must be implemented for changes related to installation of new equipment or systems.

Requirement
Section 11 of the management regulations on basis for making decisions and decision criteria

6.1.6 SEE-TO-IT DUTY

Nonconformity
Failure to exercise see-to-it-duty.

Grounds
Installing the ADS was an Equinor requirement. This was a VOR for work on and with safety-critical equipment.

Equinor failed to follow up whether Seadrill had sufficient competence to reinstall this equipment itself or whether risk assessments were conducted in relation to installing extra equipment. The company failed to assure itself that planning and preparations for installing safety-critical equipment were conducted in a prudent manner and in accordance with the regulations.

Requirement
Section 7, second paragraph, and section 18 of the framework regulations on responsibilities pursuant to these regulations and on qualification and follow-up of other participants respectively

7 BARRIER STATUS

Table 1: Overview of barrier status

Time	Barriers which have functioned	Barriers which have not functioned	Technical barrier element	Organisational barrier element	Operational barrier element	Factors affecting performance
2012		FMECA not done for first-time installation				X
2018		Hazop without participation by equipment supplier				X
2019	Casing		X			
2019	Casing cement job		X			
2019		ADS not installed by supplier				X
2019		BOP BSR	X			
2018-19		See-to-it duty		X		
2018-19		Measures from Hazop			X	
2019		Procedure for ADS installation				X

8 DISCUSSION OF UNCERTAINTIES

Some uncertainty prevails about the condition of the ADS equipment on its delivery offshore to *West Hercules*. This refers to measurements made during installation on board which did not conform with the FAT results. See the final bullet point in section 6.3

9 ASSESSMENT OF THE PLAYER'S INVESTIGATION REPORT

With participation by Equinor, Seadrill investigated the incident and completed its report on 3 April 2019. The report found that the unplanned disconnection of the LMRP was unintentionally activated by the ADS. The BSR was also automatically activated because it had not been disarmed.

The PSA team observes that has Seadrill applied probability calculations in its assessments of the potential of the incident where the BSR failed to seal the well. The probability that the BSR would be activated against components which cannot be cut is low. However, the relevant incident shows that such a position could arise. The team therefore takes the view that the Seadrill report does not describe the full potential of the incident.

Underlying causes relate to the lack of quality control processes in Seadrill, Future and Equinor. The investigation report describes several specific proposals for further follow-up to avoid similar incidents recurring.

The PSA team considers that observations in this report largely coincide with the observations made in the PSA's investigation report.

10 APPENDICES

A: HTO diagram
B: List of documents utilised in the investigation
C: Overview of personnel interviewed