PETROLEUMSTILSYNET

Investigation report

Report	
Report title Investigation of incident in transformer and fire-pump room on Sleipner A	Activity number 001046023

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

Involved	
Team T-1	Approved by/date Tore Endresen/23 June 2022
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Contents

1 Summary

A short circuit occurred on 29 October 2021 in a transformer located in transformer room D21 on Sleipner A. Fire pumps were activated because smoke was detected. One fire pump broke down during the course of events, with flame detection in fire-pump room B. During blowdown, flame detection also occurred on Sleipner T. This is assumed to be a result of reflection from the flaring.

Against this background, the Petroleum Safety Authority Norway (PSA) decided on 1 November 2021 to investigate the incident.

A general alarm sounded at 18.24 on Sleipner A, and emergency response organisation and other personnel mustered as planned. The alarm was activated by six smoke detectors in a transformer room in module D2 as the result of a short circuit in a transformer. These alarms automatically activated the fire pumps as planned. Shortly afterwards, a new general alarm was activated by flame detectors in fire-pump room B, where a fire pump had broken down. Production was halted and the facility blown down. This blowdown caused a high level of flaring on Sleipner T, which activated flame detectors on the weather deck and a new general alarm.

The short circuit in the transformer room caused material damage and had financial consequences:

- destroyed transformer
- destruction of flexible coupling and auxiliary hydraulic pump for fire pump B
- fire pump B out of action

- destroyed servomechanism for diesel supply shut-off valve to fire pump B
- loss of power supply to Sleipner B and Gudrun
- trip of Gina Krog
- consequent loss of production.

Nobody was injured.

The PSA team's assessment is that neither the incident in the transformer room nor the consequential incident in the fire-pump room had a major accident potential. A large fire could have broken out in the pump room, but the team considers it unlikely that this would have escalated out of the room.

An internal fault in the high-voltage winding is almost certainly the direct cause of the short circuit in the transformer. The direct cause of the incident in the fire-pump room is the failure of the flexible coupling installed in the shaft between the auxiliary hydraulic pump and the diesel engine for fire pump B.

The investigation found several underlying causes which could have been significant for the incident both with the transformer and in fire-pump room B.

Underlying causes for the transformer incident:

- design weaknesses and ageing
- organisational – Equinor has considered that it is not necessary to replace this type of transformer in the technical operating life programme, although the weakness was known.

Underlying causes of the fire pump breakdown:

- ageing of the rubber element and loss of flexibility in the coupling
- lack of preventive maintenance (PM)
- inadequate follow up of 2018 lessons-learnt report
- weaknesses in the system for sharing experience and learning lessons.

The investigation team has identified five nonconformities:

- maintenance deficiencies
- inadequate system for experience-based knowledge and information
- deficiencies in barrier understanding and expertise
- inadequate tagging/signage
- lack of selective disconnection in the event of a short circuit.

2 Background information

A short circuit occurred on 29 October 2021 in a transformer located in transformer room D21 on Sleipner A. This caused fire pumps to start up on smoke detection.

During the incident, one of the fire pumps failed, resulting in flame detection in fire-pump room B. During blowdown, flame detection also occurred on Sleipner T, which is considered to have been due to reflection from flaring.

2.1 Description of facility and organisation

Sleipner A sits on the Sleipner field, where the facilities comprise:

- Sleipner A: production, drilling and quarters platform
- Sleipner B: unmanned production platform
- Sleipner R: riser platform for gas and oil export
- Sleipner T: platform for processing and removing CO_2.

Sleipner T and Sleipner R are linked to Sleipner A by permanent bridges.

The Sleipner field lies on the Utsira High in the North Sea, 140 kilometres west of Stavanger, and comprises Sleipner East, Gungne and Sleipner West. Their facilities also process hydrocarbons from the tied-back Sigyn and Gudrun fields, and rich gas from the Gina Krog field.

Sleipner A is a Condeep platform standing in block 15/9 on Sleipner East, which was discovered in 1981. A plan for development and operation (PDO) was approved in 1986, and the platform came on stream in August 1993.

Equinor is the operator for Sleipner.

Operation of Sleipner forms part of the Sleipner multifield and southern North Sea (SLSN) business unit (RE) in the company’s exploration and production south (EPN South) business cluster. The RE is responsible for safe, efficient and sustainable operation of Sleipner, Gina Krog, Gudrun and Draupner.

The SLSN’s organisational structure accords with Equinor’s standard operating model, where the onshore operations organisation is the main contact point for the offshore organisation and coordinates with other units.

The onshore operations organisation comprises the maintenance and production managers, who report to the business unit, and the operations group comprising resources allocated long-term from technology and support units. SSU support is allocated from the function’s skills centre.

This model maintains independence between:

- the cluster/unit operating and maintaining the facilities, with associated system and area responsibility

- the organisation responsible for the technical integrity of the facilities, with associated technical system, technical discipline and PS responsibility – global operating technology (OTE).

2.2 Position before the incident

Activity on board during the incident day was normal, with 180 people present.

According to Equinor's main log, wind strength on Sleipner A was 42 knots. Wave heights were 2.9-4.8 metres, while the whiteboard in Sleipner A's emergency room noted 2.8 metres. Visibility was good at the time of the incident and would not have hindered possible helicopter flights. The main log noted that fog was forecast.

2.3 Abbreviations

CCR	Central control room
EPN	Exploration and production Norway
Equinor	Equinor Energy AS
FAK	Facility discipline contact
OBE	Operational barrier element
OTE	Global operations technology (Equinor designation)
PM	Programme for preventive maintenance in Equinor
POB	Personnel on board
PS	Performance standard
PSA	Petroleum Safety Authority Norway
RE	Business unit
SLA	Sleipner A
SLSN	Sleipner multifield and southern North Sea
SLT	Sleipner T
SSU	Safety, security and sustainability
TIMM	Technical integrity and maintenance management
Timp	Technical integrity management programme
TPA	Person with technical platform responsibility
TMS	Maintenance and technical services

2.4 The PSA's investigation

The PSA was notified by Equinor at 18.41 on 29 October 2021 of a fire on Sleipner A. On the basis of that information, a team was assembled in the PSA emergency centre to follow up Equinor's handling of the incident. The incident was soon cleared up, and the PSA demobilised after a short time.

A follow-up meeting was held with Equinor on 1 November 2021, and the PSA subsequently decided to investigate the incident.

2.5 Mandate

The mandate was established in consultation between the investigation group and the head of supervision.

The following mandate was determined.

a. Investigate the incident(s) without going offshore.
b. Clarify the incident's scope and course of events (with the aid of a systematic review which typically describes time lines and incidents).
c. Assess the actual and potential consequences:
    1. harm caused to people, material assets and the environment
    2. potential to harm people, material assets and the environment.
d. Assess direct and underlying causes (barriers which have failed to function).
e. Identify nonconformities and improvement points related to the regulations (and internal requirements).
f. Discuss and describe possible uncertainties/unclear points.
g. Discuss barriers which have functioned (in other words, those which have contributed to preventing a hazard from developing into an accident or reduced the consequences of an accident).
h. Assess the player's own investigation report.
i. Prepare a report and a covering letter (possibly with proposals for the use of reactions) in accordance with the template.
j. Recommend – and normally contribute to – further follow-up.

Composition of the investigation team:

Anita Oplenskedal	F-logistics and emergency preparedness (leader)
Eivind Sande	F-process integrity
Else Riis Rasmussen	F-process integrity

2.6 Procedure

Because of the coronavirus position, it was decided to conduct the investigation from land. The team conducted interviews via Teams with personnel in the offshore and onshore organisations for Sleipner A. It also reviewed documents relevant to the incident. Eight interviews were conducted, involving 21 people, in addition to a meeting where a detailed review of the organisation structure related to Sleipner was provided. The team also reviewed Equinor's own investigation report, which is commented on in chapter 14.

The team has compiled its report on the basis of interviews, meetings and a review of documents received. It has not conducted its own technical investigations.

Documents received in connection with the investigation are listed in chapter 15.

3 Course of events

The course of events on 29 October 2021 began at 18.24.26, when a short circuit occurred in a transformer located in transformer room D21 on Sleipner A. As a result of the short circuit, a circuit breaker on the 13.8 kV input to the transformer activated automatically, halting power supply to the fault site. No fire developed beyond the damage caused by the short circuit. At the same time as the circuit breaker protecting the transformer disconnected, two other breakers activated and caused power cuts on Gudrun and Sleipner B respectively.

An arc flash occurred as a result of the short circuit inside the transformer casing. Smoke developing from the short circuit was detected by all five detectors in the transformer room, as well as by one outside the room.

The first early warning of smoke in the transformer room was registered in the alarm log at 28.24.39, and two of the smoke detectors activated three seconds later. Fire pumps start automatically on Sleipner A with two smoke alarms.

According to the alarm log, the fire-pump start signal was given at 18.24.46 and a general (muster) alarm was simultaneously activated on Sleipner A. The emergency response organisation and other personnel then mustered as specified in the plans.

Furthermore, the alarm log shows that fire pump A was operational at 18.25.03, fire pump 2 at 18.25.04 and fire pump B at 18.25.25. Fire pump C, the last of these units on Sleipner A, did not start on the signal. This accords with the start-up logic, where one pump is in reserve and starts up 10 seconds later if any of the others have failed.

Four seconds after it started up, an alarm was registered from fire pump B. This is shown in the CCR as a general breakdown, and further information must be read off locally in the fire-pump room. The registered alarm did not immediately cause fire pump C to start up. It was operational from 18.33.00.

The alarm log shows that the remaining smoke detectors near the transformer activated and notified at 18.38. At roughly this time, the ventilation system was also restarted to air out the area.

At 18.47, an alarm was received from the flame detectors in fire-pump room B. This automatically activated the water mist extinguishing in the room.

Since fire detection had now occurred at short intervals in two different areas of Sleipner A, the incident command decided at 18.49 to implement a manual blowdown of Sleipner A and T. This interrupted the supply of gas to the turbines for main power, which converted to diesel operation. One of the main generators failed to manage the transfer and dropped out. That had no consequence, since one generator alone provided sufficient power for the systems which were operational. At 18.59, the fire area incorporating fire pump B was reinstated by the CCR since no indications were being received from the flame detectors in that fire-pump room. The CCR display at this time showed that the fire pump was no longer in operation, and no indications were arriving from the flame detectors for the room. When the fire area was reinstated, the fire dampers opened and ventilation restarted for the fire-pump room.

With blowdown initiated, gas was flared on Sleipner T and R. Flames from the flares were detected by two flame detectors on Sleipner T at 19.09, which automatically activated deluge in the area covered by the detectors. The CCR quickly established that Sleipner T did not have a genuine fire by contacting the on-scene commander who was beside fire pump B.

The fire team which had mustered to fire pump B eventually received clearance to enter the fire-pump room to check conditions. It was informed by the CCR that the fire pump had stopped. When team members opened the fire door, they saw to their surprise that the fire pump's diesel engine was running. They then shut the door and did not enter the room.

Two of the team members went to shut off diesel supply to the fire pump from a valve which could be operated from outside the room. The shut-off valve proved difficult to operate, and they were uncertain whether it had been closed. Greater force was therefore applied, which caused the handle to break. The alarm log shows that five alarms were received for start-up failure of fire pump B from 19.18.15. This shows the diesel supply had been shut off at that point.

The fire team then entered the fire-pump room and saw that a coupling on the fire pump was deformed and melted. Moisture forming on the team's masks when entering the room indicated the presence of water vapour. When team members eventually removed their masks, they could smell burnt rubber. They also registered a high temperature in the room, and that the diesel engine showed a temperature of 115-120°C. The range of the temperature gauge went only as high as 120°C.

No traces of leaked hydraulic, lube or diesel oil were observed in the fire-pump room.

By 19.26, the offshore installation manager (OIM) had received confirmation that no fire was burning and that no flames were being detected in any of the rooms.

Resources on their way to evacuate personnel were cancelled at 19.36.
Demobilisation and normalisation began at 19.40.

4 Earlier incidents

In interviews, the PSA team was made aware of earlier incident involving both transformers and fire pumps.

4.1 Earlier transformer-related incidents

Equinor has informed the team of three earlier incidents with the same type of transformer on Sleipner. These date from 1998, 2003 and 2004.

The 1998 incident involved transformer 81-ET01A, a 13.8/6 kV unit on Sleipner A with an output of 12.5 MVA.

In 2003, the incident involved transformer 82-ET01A, a 13.8/0.44 kV unit on Sleipner A with an output of 3.5 MVA.

The 2004 incident involved transformer G-81-ET02, a 13.8/6 kV unit on Sleipner T with an output of eight MVA.

These are dry-insulated transformers where partial discharges have been found to cause a breakdown in the insulation between the turns in the high-voltage winding. The insulation comprises a layer of Nomex class F. The Nomex insulation has some small cavities between the paper layers which have not been filled with insulation, and these air bubbles have lower resistance than the insulation material.

In addition, investigations of these earlier incidents had identified that the design of the high-voltage winding causes double stress on the insulation in certain areas.

Action taken after these earlier incidents was to repair the damaged transformer. The assessment has been that a deterioration in the insulation as a result of internal air bubbles will occur during the first few years of operation, and that no need exists to repair the identified weaknesses in the other transformers of the same type.

4.2 Earlier incidents related to flexible coupling between diesel engines and hydraulic pumps

At the kick-off meeting for the investigation, the PSA team was informed of the lessons-learnt report of an incident involving the failure of a flexible coupling between a diesel engine and a hydraulic pump in fire-pump room A on Snorre A on 5 November 2018, and that this could contain relevant information related to the breakdown in fire-pump room B on Sleipner A on 29 October 2021. See also chapter 6.

5 Equipment involved, maintenance, roles and responsibilities

5.1 Equipment involved

5.1.1 Transformer

The transformer which broke down was delivered by Siemens and manufactured by Trafo Union. Its model type is given in the data sheet as TG 6444 K. It forms part of the original design for the facility.

This unit is a three-phase transformer with rated voltages of 13.8 kV on the primary side and 440 V on the secondary side. Its output is 2 500 kVA.

The transformer is dry-insulated, and has a foil-type high-voltage winding.

According to information provided by Siemens to Equinor, the expected operating life of such a transformer is 30 years at 80 per cent load. The relevant unit on Sleipner A has had a load of about 10 per cent over the past 15 years. This low load reflects the fact that drilling no longer takes place on Sleipner A. Lower temperature has a positive influence on the transformer’s operating life.

5.1.2 Fire-pump room B

Fire water system
Sleipner A has four fire water pump units. These four (including three in operation and one in reserve) are intended to ensure that a constant pressure of 12.5 barg is maintained in the 16-inch ring main around the platform. The water is taken from the utility shaft on Sleipner A. Sleipner T is linked to Sleipner A by three 16-inch fire water pipes over the bridge. The pipes to Sleipner T are connected directly to the ring main on the Sleipner A. The fire water system is completely independent.

Like the other three units, fire pump unit 71-XD01B comprises a hydraulically driven submerged shaft pump (71-PS01B) plus booster pump 71-PB01B, which is driven directly by the pump unit’s dedicated diesel engine (71-PA01B D). The fire water shaft pump (71-PS01B) sucks in seawater from the seawater intake and lifts it to the booster pump (71-PA01B).

Hydraulic system and auxiliary hydraulic pump
Pressurised hydraulic oil is fed into the hydraulic system by two hydraulic pumps, both connected to and mechanically driven by diesel engine 71-PA01B. The hydraulic system for the fire pump unit comprises two hydraulic loops, one closed and the other open. The main hydraulic pump 71-PB01B is a booster unit and installed in the closed loop, while the auxiliary hydraulic pump 71-PB02B is installed in the open loop to supply filtered hydraulic oil and maintain pressure in the closed loop.

Flexible coupling between hydraulic pump and diesel engine
Couplings with rubber elements are installed in the shaft between hydraulic pumps and diesel engines in order to dampen and provide flexibility in the power transfer between engine and pump.

The auxiliary hydraulic pump is a Rexroth 80 DR/60 L type, with a Stromag GEG-700R coupling and rubber element. This is the flexible coupling which failed. In connection with its plant integrity project in 2012-16, Equinor defined a generic maintenance concept, MD0500, for fire water diesel engines. This includes two activities where maintenance of flexible couplings between engine and diesel-driven equipment are described – MD0500-0005, which recommends 12-monthly visual inspection of the coupling (without disassembly), and MD0500-0006, which recommends a 60-monthly check of coupling condition. These maintenance concepts were not implemented in the PM programme on Sleipner.

It emerged from the PSA team's correspondence with Stromag that the supplier recommends a programme for regular visual checks and condition-based replacement. It recommends that the coupling is also checked visually at fixed maintenance intervals, so that it can be replaced in time before failure, and reports that the coupling may well fail before 10 years have passed, depending on external influences. At the time of the incident on Sleipner, the MD0500 generic maintenance concept did not include the activity for replacing the coupling every 10th year, as recommended by the supplier.

Fire-pump room B and relevant safety systems
Fire-pump room B is located in C01 and its walls, ceiling and floor have an A60 fire rating. In addition to the pump unit, the fire-pump rooms include the hydraulic system, diesel day tank, supply lines and so forth.

It is not possible to shut down the diesel engine for the fire pump from the SCR. If the pump must be turned off in connection with an incident in the fire-pump room, this can be accomplished by operating a manual shut-down valve for diesel supply from outside the pump room.

Fire-pump room B is covered by water mist system 71-SN01. This is equipped with two water tanks and operated by a pre-programmed sequence. With automatic or manual local activation, the fire dampers in the relevant area will be closed directly via the fire and gas (F&G) system.

5.2 Maintenance

5.2.1 Operationalisation of generic maintenance concepts

Generic maintenance concepts were developed by the plant integrity project in 2012-16. According to Equinor's own investigation, each facility is responsible for revising its PM programme in line with the generic maintenance concepts. It emerged from the investigation that maintenance of diesel engines for fire water pumps is defined in such generic concepts, and these specify activities for maintaining flexible couplings between engines and diesel-driven equipment. However, these concepts are not operationalised and implemented in the PM programmes for Sleipner. It emerged from interviews that the generic maintenance concepts were developed before the 2018 incident on Snorre A, but had still not been operationalised on relevant facilities. According to an e-mail from Equinor of 9 June 2022, the concept was not revised to include the activity for replacing the coupling in line with the supplier's recommendation after the incident on Snorre in 2018. This was first done after the Sleipner incident, with a revised MD0500 concept in January 2022.

Interviewees told the PSA team that the line management end-to-end (EtE) initiative in 2020 focused attention on reviewing maintenance programmes on the facilities. That includes implementing the remaining generic maintenance concepts in the templates for PM at facility level. It appeared that the work is far-reaching and time-consuming, and must be prioritised concept by concept as and when required.

The PSA team was informed in interviews that the discipline responsible for technical integrity has opted to prioritise implementing the maintenance concepts for turbines during the first half of 2022. Concepts related to flexible couplings between engines and diesel-driven equipment are set to follow.

5.2.2 Transformer maintenance

The SAP maintenance system specifies that preventing maintenance on the transformer which failed is done by the drilling contractor. Information from interviews and work-order history shows that this work is actually carried out by Equinor. Little maintenance can be done on such a transformer. The PM programme specifies cleaning around it and looking for external damage. Up to 2013 (2014 in Equinor's investigation report), thermographic surveys were conducted with the transformers. This was discontinued to avoid exposing personnel to danger by opening a live transformer. The PSA team takes the view that thermography is unlikely to have identified that this incident was developing.

5.2.3 Maintaining flexible coupling between diesel engine and hydraulic pump

When reviewing SAP in interviews, the team was shown a corrective work order (AO 20549759) related to a defective auxiliary pump in fire-pump room B. No cause was given for the defect. However, documentation was found which indicates that pump 71-PB02B with rubber coupling was replaced in 2004, and that original spare parts were used. There was no trace in the maintenance system that the flexible connection had been replaced on later occasions.

The PM programme for the fire pump package on Sleipner A has no maintenance activity related to the flexible coupling between engine and pump. It emerged from interviews that the coupling with rubber element is hidden and that the only access for visual inspection required removal of the cover.

During its investigation, the team was told that, after the incident on Snorre A in 2018, certain of the flexible couplings related to main hydraulic pumps on Sleipner A were inspected visually. However, both the scope of the inspection and when it was conducted were unclear. But it emerged that the couplings for auxiliary fire pumps were not inspected.

5.2.4 Maintenance of shut-off valves for diesel supply

Practice varies on Sleipner for tagging and maintenance descriptions of shut-off valves for diesel supply to the fire pumps. While the valve for pump 2 is tagged "71-XV 004 fuel emergency shutdown" and has a maintenance description, this is lacking for the three other fire pump packages.

The PM programme for fire pump packages A, B and C on Sleipner A includes a general item related to testing the manual emergency shutdown function. According to Equinor, this item can be interpreted to embrace manual shutdown valves for diesel supply to the fire pump, but the PSA team takes the view that this is not clear enough. Extract from MD0500-009:

- Test of emergency stop function, including dampers and overspeed control:
  - test manual emergency stop functions (including dampers on engines fitted with this
  - test overspeed control pursuant to the operating manual/local supplements.

During the investigation, Equinor was unable to present documentation that the relevant shut-off valve connected to fire pump package B had been maintained.

5.3 Organisation, roles and responsibilities

This section deals briefly with the organisational structure, roles, responsibilities and interfaces which the team considered relevant to its investigation. The information is based on the company's documentation related to organisation, management and control. See the overview of OMC 01 documentation in chapter 15.

5.3.1 Organisation of Sleipner multifield and southern North Sea (SLSN)

Operation of Sleipner rests with the Sleipner multifield and southern North Sea (SLSN) RE in EPN south, which is responsible for safe, efficient and sustainable operation of the fields/facilities allocated to it.

The RE’s head has total responsibility for safe, effective and sustainable operation for their allocated facilities/plants. The onshore operations organisation comprises the maintenance and production managers, who report to the RE vice president, and the operations group comprising resources allocated long-term from technology and support units. SSU support is allocated from the function’s skills centre.

The maintenance manager has an integrated responsibility for management and continuous improvement of the RE’s overall maintenance on the facilities/at the plants and responsibility for operational planning processes and efficient resource utilisation in the maintenance loop, as well as being the main contact with OTE for maintenance in the RE

The SLSN’s operational model complies with the common Equinor model, which maintains independence between:

- the cluster/unit operating and maintaining the facilities with associated system and area responsibility
- the organisation responsible for the technical integrity of the facilities with associated technical system, technical discipline and PS responsibility – OTE.

5.3.2 Technical integrity and maintenance management (TIMM)

The TIMM delivery unit in OTE has overall responsibility for technical integrity, delivers engineering support and manages relevant disciplines.

Technical system, technical discipline and PS responsibility are delegated to discipline leaders, while overall responsibility (person accountable) lies with the TI&KAM leader assigned to the relevant RE, in this case SLSN.

The delivery unit is also responsible for “improving the maintenance programme and intervals” and “establishing and developing maintenance requirements as well as the technical content of maintenance concepts in the unit’s area of responsibility”.

The person with technical responsibility on Sleipner A (TPA SLA) exercises the TI&KAM leader’s responsibility on the facility, including “being the contact with the operations management for integrity tasks on relevant facilities (cross-disciplinary, across delivery units)” and “ensuring the right prioritisation and implementation of measures from lessons-learnt reports”.

The discipline leader for process and technical safety reports to TIMM (TIMM PTS).

The technical plant contact (FAK) for technical safety on Sleipner reports to TIMM PTS, and has delegated duties related to the discipline, relevant PSs (9, 10, 14 and 15) and the system.

5.3.3 Maintenance and technical services (TMS)

The maintenance and technical services (TMS) delivery unit in OTE has integrated responsibility related to maintaining and improving safety in the unit's deliveries, and delivers engineering support and exercises discipline leadership for relevant systems, disciplines and services.

As with TIMM, the TMS unit is responsible for "improving the maintenance programme and intervals" and "establishing and developing maintenance requirements as well as the technical content of maintenance concepts in the unit's area of responsibility".

TMS incorporates discipline leaders for several areas/services, including automation systems (TMS ACSS) and electrical systems (TMS ELS). In addition to system responsibility, this unit also has PS responsibilities.

The discipline manager for rotating services is also part of TMS, owns specific equipment (relevant tag) on the facilities and is responsible for "handling concepts for PM" – including "planning, risk assessment and execution of maintenance tasks" related to rotating machinery. The PSA team's understanding is that maintenance is largely performed with own resources. Rotating services does not have PS responsibilities, but contributes to manifesting the technical conditions of its own equipment in order to contribute to the total overview (Timp) of technical integrity.

The FAK for automation systems on Sleipner reports to TMS ACCSS, with delegated duties related to the discipline, relevant PSs (3, 4, 7, 22 and 23) and the system.

The FAK for electrical systems on Sleipner reports to TMS ELS, with delegated duties related to the discipline, relevant PSs (6 and 11) and system.

The FAK for rotating services on Sleipner has delegated disciplines duties related to SLSN.

In the PSA team's view, the FAKs have delegated duties related to the whole of SLSN, and not Sleipner alone.

6 Equinor's system for lessons-learnt reports

Equinor's process for reporting lessons learnt assigns a key role to the discipline leader, both in preparing and quality assuring the report and in ensuring the necessary checks of relevant facilities.

The FAK's role relates to manifesting any weakening in Timp and identified measures, while the TPA's role is to verify measures for their own facility as well as ensuring the prioritisation and initiation of measures.

The role of OTE TI SSU is to verify status and close the lessons-learnt report.

This system is based on Sharepoint, with an e-mail being sent to relevant people when the lessons-learnt report is available for checking.

It emerged from interviews that today's system does not make adequate provision for necessary follow-up across the facilities. Nor does the system support adequate tracing related to the status of actions, measures, learning and closure of the management loop.

Equinor acknowledges that the system has weaknesses and is currently updating and implementing a new solution.

The PSA team notes that nonconformity 11.1.2 with associated grounds relates to the system used at the time of the incident. It has not verified that the weaknesses identified in the grounds will be dealt with by Equinor's updated system for lessons-learnt reports.

6.1 Lessons-learnt report 2018 – coupling MTU diesel engine Snorre A

A lessons-learnt report was issued in 2018 following an incident on Snorre A with smoke development and the smell of burnt rubber after running fire pump A. The incident occurred during deluge testing, when the fire pumps were much in use.

Prepared and distributed to such recipients as the discipline area responsible for technical integrity of rotating machinery, the report provides background information and describes the issue as follows.

- Delivered by Frank Mohn, the diesel-hydraulic fire pump had an MTU 12V396TC34 diesel engine with a directly coupled Framo PB400 booster pump at one end and a Rexroth A7V500DR hydraulic pump at the other.
- After a good deal of fault-seeking, it was clarified that the coupling between diesel engine and main hydraulic pump had failed.
- The rubber element was a Vulkan Vulastik L-2211 type.
- According to the supplier, this should be replaced every 10 years.
- The rubber element is built in/inaccessible to visual inspection without disassembling the engine. This is not normally done as part of PM.
- The coupling had not been replaced since Snorre A came on stream in 1992.

The report also specifies lessons to be checked on other facilities.

- Check the specific Vulkan coupling between diesel engine and hydraulic pump on the facilities with the same equipment as on Snorre A.
- Check that inspection of couplings (plural) is specified in the PM programmes for the fire pumps.
- Check the PM programme shows the right interval for replacing couplings.

While the coupling which failed on Sleipner A is a Stromag GEG-700R, the one covered by the lessons-learnt report is a Vulkan Vulastik L-2211. The function of the rubber element in both types is to provide damping and flexibility in power transfer between pump and engine. It emerges clearly from various interviews that the ageing challenges posed by such rubber elements are in principle the same, and that this is known in relevant disciplines. Nevertheless, it appears that the way the lessons-learnt report is written, by specifying the coupling supplier, has meant that similar devices from other manufacturers have not been checked. The same applies to whether the coupling is connected to the main or auxiliary hydraulic pumps. In principle, all flexible couplings should have been checked.

7 Barrier understanding and expertise

During its investigation, the PSA team observed conditions associated with barrier understanding and expertise which do not relate to the direct or underlying causes of the incident. Some of these influenced management of the incident, without affecting its outcome. The team's impression is that a lack of expertise created uncertainty among personnel involved during the incident.

It emerged from interviews with offshore personnel that the CCR operators were unclear about how the water mist sequence functioned, which created uncertainty. They were, for example, unsure whether water mist system had halted when the CCR reset the flame detectors in fire-pump room B. The system description for the water mist system clearly describes its programmed sequence, but how to initiate a new sequence as and when required is unclear.

During the course of events, the CCR informed the on-scene commander that fire pump B had stopped. This was based on a signal on the CCR matrix. The PSA team's assessment is that both the CCR and the response organisation interpreted the signal incorrectly to mean that the actual diesel engine had also stopped. It therefore took a long time (about 31 minutes) before diesel supply to the fire-pump room was shut off from outside the room. It was very noisy in the area because of the full blowdown. At a point in time after the message was received from the CCR that the pump had stopped, the search and rescue team peeked inside the pump room and discovered that the diesel engine was still running. Only then was manual closure of the diesel supply initiated and implemented by the search and rescue team.

Uncertainty also prevailed about how to operate the shut-off valve for diesel supply, and about whether the valve had actually closed on the first attempt. A new try caused the handle to break, but closure of the supply was eventually confirmed. The signage for the shut-off valve failed to describe clearly how it should be operated.

Air was admitted to the fire-pump room before diesel supply to the room and the diesel engine had been discontinued, including when the search and rescue team peeked inside the door and saw that the engine for the fire pump was still running. Admitting air could have caused re-ignition in the room.

Furthermore, the whole fire area had been reinstated. Fire dampers to the fire-pump room were thereby opened on the basis that the flame detectors were no longer indicating, but without using the search and rescue team in advance to confirm physical conditions in the room.

Operational barrier elements (OBE) on Sleipner A have been mapped, and those identified are incorporated in the safety strategy. A gap analysis has also been conducted to assess which OBEs were already covered in existing emergency response or other training. For OBEs found to be not covered by existing training or drills, "15-minute scenarios" have been constructed

Where PS1 – prevent leaks is concerned, closure of the diesel supply from day tank to engine in the event of a fire in the fire-pump room has been identified as an OBE which, according to the gap analysis, is considered to covered by existing training or drills. The OBE states:

> In the event of fire detection or leakage in rooms with day tanks and diesel engines, the CCR operator must shut off diesel supply from the CCR or the process operator must close the diesel valve outside the relevant room. This applies to the fire-pump room (four units). The valve must be closed immediately after the leakage/fire. Successful closure can be confirmed when the diesel pump stops as supply ceases.

The description of this OBE is not correct, and relevant personnel offshore were not aware of any specific training or drills for closing this type of valve.

It emerged from interviews in the onshore organisation that Equinor is pursuing improvement activities related to training and drills for emergencies. The PSA team also learnt that a detailed internal platform verification (PIV) related to training and drills was conducted in late 2021. This identified a number of deficiencies which are under assessment.

8 Consequences and potential of the incident

8.1 Actual consequences

Images from the transformer room show that much heat developed from the short circuit, but that damage was confined to the relevant transformer. This is built into a metal casing with inspection window. No damage is visible outside the casing.

Where the consequential incident in fire-pump room B is concerned, flames probably developed in connection with the failure of the flexible coupling between the diesel engine and the auxiliary hydraulic pump.

Material damage and financial consequences:

1. destroyed transformer
2. destruction of flexible coupling and auxiliary hydraulic pump for fire pump B
3. fire pump B out of action
4. destroyed servomechanism for diesel supply shut-off valve to fire pump B
5. loss of power supply to Sleipner B and Gudrun
6. trip of Gina Krog
7. consequent loss of production.

Nobody was injured.

8.2 Potential consequences

The PSA team's assessment is that neither the incident in the transformer room nor the consequential incident in the fire-pump room had a major accident potential.

8.2.1 Potential consequences transformer

The incident is not considered to have involved a fire risk, since the earth fault relay disconnected and shut down the power supply. Very little flammable material is available in the area. Should the actual short circuit have caused a fire – in insulation material, for example – it is very unlikely that this would have spread outside the room, which has A60-rated walls against adjacent rooms.

Had personnel been present in the room when the short circuit occurred, it is very unlikely that they would have been directly exposed to anything other than noise and possible fumes in the seconds it took them to leave the room. The transformer itself is encapsulated in a metal casing with inspection window.

8.2.2 Potential consequences fire pump

A large fire might have occurred in the fire-pump room, but the PSA team considers it unlikely that this would have escalated out of the room.

The fire-pump room is surrounded by A60-rated walls and ceiling, and equipped with a water mist system and fire dampers to prevent air intrusion in the event of a fire. With confirmed flame detection, the water mist system was automatically initiated and ran its predetermined sequence. Sufficient water remained in the tank to meet a further possible need for extinguishing.

The door to the fire-pump room was opened by the search and rescue team when no further indications were given by the flame detectors, but this was before the diesel engine had stopped. After the whole fire area was reinstated by the CCR when the detectors ceased indicating, the fire dampers opened in the fire-pump room.

Re-ignition could have occurred from the admission of air. When the room was first entered after the diesel engine stopped, the search and rescue team registered a slightly elevated temperature on surfaces and a strong smell of burnt rubber.

Flammable materials are present in the room, both diesel and hydraulic oil.

The diesel engine ran for about 31 minutes after the first flame detection before the fuel supply was shut off from the outside.

However, a new fire in the fire-pump room is unlikely to have escalated out.

9 Direct and underlying causes

9.1 Direct causes

9.1.1 Transformer

An internal fault in the high-voltage winding is highly likely to be the direct cause of the transformer short circuit. That probability is supported by earlier incidents and known design weaknesses related to the type of transformer used on Sleipner.

9.1.2 Fire pump

The direct cause of the incident in the fire-pump room is the failure of the flexible coupling installed in the shaft between the auxiliary hydraulic pump and the diesel engine belonging to fire pump B.

9.2 Underlying causes

The investigation has revealed several underlying causes which could have been significant for both the transformer and the fire-pump room B incidents.

9.2.1 Underlying causes transformer

Design weakness and ageing
According to Equinor, this type of transformer used on Sleipner has a known design weakness. Three incidents occurred with the same type of transformer before 2004, as described in section 4.1.

The investigations into these earlier incidents found the following.

1. Air bubbles in the insulation material cause partial discharges and breakdown of the material over time.
2. The design causes twice the voltage to occur in certain areas of the winding compared with the normal potential difference between its turns.

Organisational
Equinor has so far considered that it is not necessary to replace this type of transformer in the technical operating life programme, even though the weakness is known. This is against the background of the need for adequate redundancy.

9.2.2 Underlying causes fire pump

Ageing
The flexible coupling in the shaft between the diesel engine and the auxiliary hydraulic pump has not been inspected or replaced since 2004.

According to Equinor, this type of flexible coupling will weaken over time, particularly if the rubber element is exposed to oil spills – such as engine oil.

Failure to roll out PM
As part of the plant integrity project from 2012-16, relevant maintenance programmes were produced at the conceptual level – known as generic maintenance concepts for PM. The concepts for this type of flexible coupling includes such preventive activities as annual visual inspection and condition checks every fifth year where the cover is removed.

These preventive activities were not implemented in the PM programme (and thereby not carried out) for this type of equipment on Sleipner.

Inadequate follow-up of 2018 lessons-learnt report
A lessons-learnt report was issued in 2018 following an incident on Snorre A with smoke development and the smell of burnt rubber after running fire pump A.

Prepared and distributed to the discipline area responsible for the technical integrity of rotating equipment, the report specifies lessons for checks on other facilities.

- Check the specific Vulkan coupling between diesel engine and hydraulic pump on the facilities with the same equipment as on Snorre A.
- Check that inspection of couplings (plural) is specified in the PM programmes for the fire pumps.
- Check the PM programme shows the right interval for replacing couplings.

On the basis of this lessons-learnt report, visual checks were conducted on Sleipner with the flexible couplings for the main hydraulic pumps but not with the corresponding couplings for the auxiliary hydraulic pumps. Nor was the maintenance programme amended in line with the recommendations in the lessons-learnt report.

System for lessons-learnt reports

Equinor's system for lessons-learnt reports is based on a team site in Sharepoint. The system does not make adequate provision for necessary follow up across the facilities. Nor does it provide adequate traceability related to the status of actions, measures, learning and closing of the management loop.

10 Emergency response

A general alarm sounded at 18.24 on Sleipner A, with a subsequent PA announcement of fire in transformer room in D21. The emergency response leadership and response personnel mustered as planned, while the remaining personnel mustered to the lifeboats.

At 18.47, a general alarm sounded on Sleipner A with a subsequent PA announcement on fire in pump room B.

Two incidents had to be dealt with by the response organisation in two different locations on the facility. The search and rescue team mustered at the incident command centre divided in two, with one party sent to the transformer room with the person responsible for the circuit and the other to fire-pump room B. Both groups knew that POB was being checked before entering the areas.

Everyone involved in the incident commented that communication was good between everyone involved throughout the course of events.

At 19.40, the response organisation and other personnel were demobilised.

The timeline for the incident is presented in the table below. Times are taken from Equinor's response and alarm logs, and are approximate since clocks on the facility are not synchronised.

18.24	Short circuit in transformer room
18.24.39	Smoke detection in transformer room in D21
18.24	**General alarm – PA announcement: fire in transformer room in D21**
	Mustering of response organisation and other personnel
18.28.34	Smoke detection in transformer room D21
18.36	Detectors reset – no further indications

18.47.05	Flame detection in fire-pump room B
18.47.22	Water mist activated in fire-pump room B
18.47	**General alarm – PA announcement: fire in fire-pump room B**
18.49.21	Emergency shutdown SLA/SLT
18.49.44	Blowdown SLA/SLT
18.50	POB check
18.59.34	Water mist reset and halted (fire-pump room)
19.09.20	Deluge activated on SLT
19.09	**General alarm – PA announcement: fire on SLT weatherdeck**
19.13	First helicopter landed, prepares for evacuation to other facilities
19.18	Manual closure of diesel supply to fire pump B
19.26	OIM confirms no fire, no detection in the room
19.36	Resources for personnel evacuation cancelled
19.40	Demobilisation and normalisation

Notification was given in accordance with the Sleipner A emergency response plan.

The PSA was notified of the incident and established its own response centre to supervise Equinor's handling of the incident. Its impression was that Equinor's first line handled the incident in a good manner, and the PSA received adequate and updated information from the company's second line response.

The PSA team's impression is that the emergency response on Sleipner A was well-handled.

11 Observations

The PSA's observations fall generally into two categories.

- Nonconformities: this category embraces observations which the PSA believes to be a breach of the regulations.
- Improvement points: these relate to observations where deficiencies are seen, but insufficient information is available to establish a breach of the regulations.

11.1 Nonconformities

11.1.1 Maintenance deficiencies

Nonconformity

Fire pump package B was not maintained so that it could perform its intended function. The failure modes for flexible couplings between engine and diesel-driven equipment and for the manual shut-off valve for diesel supply were not prevented systematically through a maintenance programme.

The manual shut-off valve for diesel oil supply was not maintained, so that a failure mode which was either under development or had occurred was not identified and corrected.

Grounds
No maintenance programme was implemented for flexible couplings between engines and diesel-driven equipment.

The MD0500 maintenance concept for fire water diesel engines which was produced by the plant integrity project in 2012-16 had not been implemented in the PM programme for the fire pump packages on Sleipner. MD05000 includes two activities where maintenance of flexible couplings between engine and diesel-driven equipment are described – MD0500-0005, with annual visual inspection of the coupling without disassembly, and MD0500-0006, with condition checks of flexible couplings every five years.

Nor was the PM programme for this type of coupling on Sleipner amended after the failure mode was identified by an incident on Snorre A in 2018, with a lessons-learnt report sent to relevant parts of the organisation. See nonconformity 11.1.2 below.

Verification of the maintenance system showed that the relevant coupling for fire pump B was last replaced in 2004.

In addition, the manual shut-off valve for diesel supply was not adequately maintained.

Requirements
Section 45 of the activities regulations on maintenance
Section 47, paragraphs 1 and 2 of the activities regulations on maintenance programme

11.1.2 Inadequate system for experience-based knowledge and information

Nonconformity
No provision was made for using lessons learnt from the company's own operations in improvement work. The need to acquire, process and communicate information related to maintenance was not dealt with by the information system.

Grounds
Information from the 2012-16 plant integrity project has not been utilised in planning maintenance activities on Sleipner A. The maintenance concepts for PM established by the project are not implemented in the PM programme for the fire pump packages on Sleipner. See nonconformity 11.1.1.

The MD0500 concept for fire water diesel engines was revised to include replacing the flexible coupling every 10 years, as recommended by the supplier, after the incident on Sleipner in October 2021. The supplier's recommendation is contained in Equinor's lessons-learnt report after the incident on Snorre A in 2018 involving a corresponding coupling.

The system for sharing lessons-learnt reports does not communicate information in such a way that lessons learnt from incidents can be easily followed up and used in improvement work.

It emerged from interviews that lessons-learnt reports fail to make sufficient provision for necessary follow-up across the facilities. Nor does the system provide adequate traceability related to the status of actions, measures, learning and closing.

During the investigation, information was provided that a flexible coupling for a diesel-hydraulic fire water pump had failed on Snorre A in 2018. Neither the discipline area responsible for the technical integrity of rotating machinery nor the Sleipner organisation could document how this report was followed up, but it was known and some initiatives for checking similar flexible couplings had been taken.

The above-mentioned lessons-learnt report was also formulated in a way which failed to provide for sufficiently broad learning. It was not clear that similar flexible couplings from other manufacturers should also be checked. The investigation found that the organisation is aware that the challenges posed by flexible couplings with rubber elements are general and not related to a specific supplier.

Requirements
Section 23, paragraph 3 of the management regulations on continuous improvement
Section 15, paragraph 3 of the management regulations on information

11.1.3 Deficiencies in barrier understanding and expertise

Nonconformity
Equinor has failed to ensure that personnel involved have the expertise required to be able at all times to handle faults, hazards and accidents in an effective manner.

Grounds
The investigation identified some deficiencies in barrier understanding and expertise related to the incident, which caused uncertainty during the course of events.

It emerged from interviews with offshore employees that uncertainties existed during the incident, including among CCR personnel, over how the water mist sequence was intended to function.

During the incident, the CCR informed the on-scene commander that fire pump B had stopped. This was based on a signal on the CCR matrix. The PSA team's assessment is that both the CCR and the response organisation interpreted the signal incorrectly to mean that the actual diesel engine had also stopped.

Air was admitted on two occasions to the fire-pump room before the diesel supply to the room and the diesel engine was shut off:

- The search and rescue team peeked inside the door and saw that the engine for the fire pump was still running. Admitting air could have caused re-ignition in the room.
- The whole fire area was reinstated and fire dampers to the fire-pump room were thereby opened on the basis that the flame detectors were no longer indicating, but without using the search and rescue team in advance to confirm physical conditions in the room.

Uncertainty moreover prevailed in the search and rescue team on how the shut-off valve for diesel supply should be operated, and whether the valve had actually closed on the first attempt. Shutting off diesel supply from the day tank to the engine in the event of fire in the fire-pump room is identified as an OBE in PS1 – prevent leaks. The OBE specifies that diesel supply can be shut off by the operator from the CCR or by a process operator closing the diesel valve outside the relevant room. However, the search and rescue team is responsible for operating this valve in an emergency, and the valve is not supposed to be operable from the CCR.

The established training programme for the search and rescue team does not include manual closure of such valves for diesel supply. During the incident, it turned out that the search and rescue team was uncertain how this diesel valve should be closed, and whether they had pulled the handle far enough down. In addition to inadequate training, the uncertainty could be partly attributable to the presence of three different information signs by the diesel valve on how it should be closed.

Requirements
Section 21, paragraph 1 of the activities regulations on competence, see section 5, paragraph 4 of the management regulations on barriers
Section 23 of the activities regulations on training and drills

11.1.4 Inadequate tagging/signage

Nonconformity
The manual shut-off valve for diesel supply to fire-pump room B is not tagged in a way which ensures safe operation and prudent maintenance.

Grounds
The text on the signs for the manual shut-off valve for diesel supply to fire pump B does not clarify how the valve is to be operated.

- The Norwegian and English texts do not correspond. In Norwegian, it says “trekk spaken helt ned” (pull handle right down) and the English version says “Pull handle to stop”. The search and rescue team was unable to pull the valve handle right down, creating uncertainty over whether the valve had actually closed.
- One of the signs describes the valve as a “bryter” (switch).
    - “Emergency Stop, Push Button for Fire Pump 71-XD01B”
    - “Nødstoppbryter for vannpumpe 71-XD01B” (emergency switch for water pump 71-XD01B).

Requirement
Section 10, paragraph 2 of the facilities regulations on installations, systems and equipment

11.1.5 Lack of selective disconnection after a short circuit

Nonconformity
No provision had been made for selective disconnection after a short circuit.

Grounds
When a short circuit occurs in the transformer on Sleipner A, Sleipner B and Gudrun are also disconnected. This means that no selective disconnection occurs with the consumer causing the overload.

The following disconnections are logged in the alarm list at 18:24:26:

- breaker 80-EF05 disconnects the transformer with the short circuit
- breaker 80-EF22 disconnects supply to Sleipner B
- breaker 80-EF30 disconnects supply to Gudrun.

Requirements
Section 82, no 2 of the facility regulations on entry into force, see section 14 of the regulations relating to electrical installations in the petroleum activities (established 8 January 1991), see section 16 of the regulations for electrical installations – maritime regulations (FEA-M) on distribution facilities and switchboards, section 1615 on short circuit and overload protection

12 Barriers which have functioned

When the transformer short circuited, the fault was automatically disconnected by the overcurrent protection. The smoke detectors automatically notified smoke development in the transformer room, and the fire pumps started up as planned.

The failure of the coupling in fire-pump room B was detected by the flame detectors in the room, and the water mist system activated automatically following confirmed flame detection. The fire dampers into the area closed automatically in accordance with the logic.

The manual shut-off valve for diesel supply to the fire pumps worked when required to stop fire pump B.

The emergency response organisation mustered and notified as planned.

13 Discussion of uncertainties

Uncertainty prevails about the exact year when the Stromag coupling was replaced. On the basis of the SAP review and corrective order WO 20549759, the PSA team has noted 2004, while Equinor specifies 2005 in its report. The team nevertheless considers this to have little significance for the incident.

The team's investigation has failed fully to clarify how the water mist system actually functions and whether the sequence started was interrupted because the CCR reset the flame detectors. This is also unclear in Equinor's own investigation, which states "a look must be taken at the logic in connection with reinstating the node, so that the water mist sequence does not end before it has been completed". The report also refers to appendix 4.12, which appears to relate to the logic for the fire pump rather than the water mist system.

Interviews have failed to clarify whether the protective cover around the failed coupling was removed after the incident or came loose in connection with the failure. Images from the incident site show that rubber residues have sprayed from the destroyed coupling up to the diesel day tank, which makes it likely that the cover came loose in connection with the failure.

The extent of damage to the actual engine for the fire water pump was not identified and known at the time of the "active" stage of the PSA investigation. Nor does it emerge from Equinor's own report.

14 Assessment of the player's investigation report

Equinor has investigated the incident, which was assigned to category 3 in the company's investigation ranking. The PSA received the report on 3 December 2021.

The Equinor investigation identifies several learning points and measures related to:

1. transformer
2. fire pump logic
3. screening of flame detectors on the weatherdeck
4. interlocking of air intake and outlet for HVAC in D21
5. node reinstatement related to the water mist sequence.

Where item 3 is concerned, Equinor points to important general lessons learnt with regard to vulnerability and robustness.

Two detectors on Sleipner T, the neighbouring platform, reported confirmed flame/fire and activated deluge as a consequence of flaring on Sleipner T during pressure blowdown related to the Sleipner A incident.

It emerges that one consequence in a scenario could be that total fire water capacity is exceeded by activating deluge in an area other than the one where the initial incident occurred.

Equinor makes a brief mention in its report of the 2012-16 plant integrity project, where generic maintenance concepts were developed, and says lack of resources led to a decision that each facility should be responsible for revising its PM programme to accord with the new concepts. Mention is also made that end-to-end (EtE) was initiated in 2020 to ensure achievement of the company's maintenance strategy. That included reviewing maintenance programmes on the facilities and implementing the concepts in those of the PM programmes where this remained undone. This supplements the information which emerged from the PSA team's interviews that implementing the maintenance concepts is time- and resource-intensive.

The Equinor report comes across as thorough, and its description of the course of events and the probable direct causes coincides with the PSA team's observations and assessments with regard to the incidents in both the transformer room and fire-pump room B.

15 Appendices

The following documents have been drawn on in the investigation.

OMC01 – Global Driftsteknologi (EPN OTE) – Organisasjon, ledelse og styring
Timp for PS9, SLA

Forebyggende vedlikehold (FV-maler) for Fire pump B: program for1 mnd, 6 mnd, 12 mnd, 24 mnd og 48 mnd.
Systembeskrivelse – Sleipner A-System 71- Fire water mist system
Operasjonelle barriereelement PS 9 Sleipner
Utkobling av sikkerhetssystemer 29.10.21
Levetidsvurdering knyttet til trafo
Service life of GEAFOL trans.
Service life of GEAFO transformers, Siemens
Bilder fra tavlerom (trafo)
Bilder fra fire pump B
Bilder fire pump B
Bilder fire-pump room
OMC01 Sleipner flerfelt (EPN EPS SLF)
Beredskapsanalyse Sleipner, 05.05.2020
Hovedlogg, hendelse SLA
IMT incident brief
Alarmliste (SLP hendelser)
OBE for PS 4, 7,8 14
Lasteforsyning Trafo 16-ET02A
Informasjon angående vedlikehold mot trafo 16-ET02A
SAP historikk Fire pump B
Fire pump 12 mnd FV
Fire pump 1 mnd FV
24 mnd fire pumppakke 71-XD01B
16 mnd fire pumppakke 71-XD01B
12 mnd FV-IG P034B fire pumppakke B
48 mnd FV-IG P034B fire pumppakke B
24 mnd FV-IG P034B fire pumppakke B
Drawings:

- Loop for temperatur overvåking, C007-E-D21-EL-101-01
- Schematic: Temp sensor inn på termistor rele – alarm utgang, NHTF314285
- Schematic: Temp sensor inn på termistor rele 2, NHTF314297
- Schematic: Temp sensor inn på termistor rele 3, NHTF314297
- Schematic: Temp sensor inn på termistor rele, NHTF314285
- P&ID 1033-026-1 Fire pump B Hydraulikk system
- Fire pump B i drift status lys i HKR, C007-C-000-JE-923-01
- Control panel Wiring, C007-C-C02D-JA-0001.01
- Controller, C-007-C-C02D-JJ-030-01
- Controllers med 71 -ST 204 Fire pump B i drift output, C007-C-C02D-JJ-020-01
- Firepump controller – general arrangement side 1, C007-C-C02D-JA-0001.01
- Firepump controller – general arrangement side 3, C007-C-C02D-JA-0001.01
- P&ID relatert til fire pump, 1033-027-1
- P&ID fire pump og ringmain, C007-C-000-PW-101-01

- General arrangement trafo, 0610 634-A3
- Layoyt transformer room, C007-E-D21-EA-301-01
- Hydraulic Oil P&ID , 1033-026-1
- Overall single line diagram AC power system, C007-C-000-EE-101-01
- Overall single line diagram AC power system, C007-C-000-EE-101-01, B2
- B&G Layout Fire pump B, C007-C-C01D-JP-362-01
- B&G layout transformer room D21, C007-E-D21-JA-823-01
- JB PAD layout fire pump B, C007-C-C01D- JP-352-01
- Lighting layout fire pump B, C007-C-C01D-EA-201-01
- Main deck fire pump B, C007-C-C01D-LP-101-01
- MSF layout fire pump B, 05-03-PT-SP001

C007-E-D21-EE-101 page 1-9 Single line Diagram 440V MA
C007-E-D31-EE-101 page 1-7 single line diagram 440V SW
VDU- Ringmain og fire pumpr
701710-70-FA 215 Transformer rom
701740 V – 70-FA-215 Transformer rom
702104-70-FA 012-Fire-pump room
702104 V-70-FA 012-Fire-pump room
706401-Øvre værdekk SLT MOWA med tag nr.
706401-Øvre værdekk SLT MOWA
710100 Brannvann 71
771600 Dødstart Venvakt S60E i D21
801200 13,8 KV med tag nr.
801200 13,8 KV
801401 16-EN02 med tag nr
801401 16- EN02
Trykkavlastning SLA
Trykkavlastning SLT
701710-70-FA 215 Transformer rom
Signal tag mellom B&G fire pump
C007-E-S-DY-012 Flamme I fire pump B
C007-E-S-DY-215 Røykdetektor i transformerrom
C034-A-S-DY-MOWA Flammedetektorer på SLA
Erfaringsmelding Snorre A-kobling MTU diselmotor
Granskingsmandat Hendelse Sleipner A
Presentasjon fra oppstartsmøtet 03.11.2021
Presentasjon fire pump B SLA, havarert kobling 71-PB02B, oppdatert 8.11.2021
Datablad trafo, C007-E-E-DE-105
Cause and effect fire pump logikk
Fire system description, 1033-214-4
SLA ELE DIST BOARD 16 EN02
Product datasheet: BH-500/S Optical smoke detector with SelfVerify

Instrument data sheet S01 fire and gas detector
Examination certificate tidlig røykdetektor
Instructions 95-8527 Protect IR Multispectrum IR flame detector X3301
Ex certificate X3301
Bilde: lokalt kontrollpanel (1)
Bilde: lokalt kontrollpanel tag nr 71-JB01B (3)
Bilde: lokalt kontrollpanel, tag nr 71-JB01B (4)
Bilde: Fire pump panel matrise
Bilde: brannvannsbilde PCDA
SLP hendelser ASR tabell oppdatert med merking
SLA STIDele distribution board 230V normal supply 16- EL12
SLA STIDele distribution board 230V normal supply 16- EL14
Jobber mot 1140-71-PB02, fire pump B
Tag liste med tag material nummer
Fire pump B tekst
Fire-pump room – vanntåke sekvens
Eventlogg for fire pump B
EN02 hovedtavle
Transformer inngangsbryter
Sleipner 15 minutters trening på Operasjonelle Barriereelementer (OBE) beskrevet i SLP sikkerhetsstrategi
Identifiserte OBE Sleipner – GAP analyse
Granskingsrapport fra Equinor - Granskingsnivå 3. Røykdeteksjon i transformerrom D21 på Sleipner A 29.10.2021
861.00011F_e Expertise of the highly flexible rubber elements in Stromag GE-couplings

A: Overview of personnel interviewed.