Havtil
Havindustritilsynet

Investigation report

Report	
Report title Revised investigation report following fire on Sleipner B on 22.10.2024	Activity number 001046030

Classification	
☒ Unclassified	☐ Exempt from publication

Parties involved	
Team A1	Approved by / date Elin S. Witsø / 30.9.2025
Investigation team participants [redacted]	Investigation leader [redacted]

Contents

1 Summary

On Tuesday 22 October 2024, a fire broke out in the high voltage room in the M40 module on Equinor's Sleipner B (SLB) facility. On 22 October 2024, the Norwegian Ocean Industry Authority (Havtil) decided to investigate the incident and was also asked to assist the police in their investigation.

SLB is a production platform in the Sleipner field. It is controlled remotely from Sleipner A (SLA), but periodically has operating and maintenance personnel on board. At the time the fire broke out, no one was on board SLB, and the incident handled by the emergency preparedness team on SLA.

At 04:35:48 on 22 October 2024, the first of several smoke alarms was triggered in the high voltage room in the M40 module on SLB.
The emergency preparedness management team was alerted in accordance with the emergency preparedness plan and emergency preparedness vessels summoned. SLB was shut down and depressurised, and the platform de-energised. The facility was then supplied by UPS power.

A team of seven persons were mobilised on SLA, which was to travel to SLB in order to obtain an overview of what had happened. They were to check the switchboard room and vent the smoke that had been observed on camera, and restore UPS charging.
Based on what has emerged during the investigation, it appears that a lot of attention was paid to Sleipner B's imminent loss of power (UPS), and that this affected the actions that were taken and the decisions that were made.

The team on SLB reported to SLA that they could not find any obvious cause of the smoke, leading the emergency preparedness management team to consider that the situation was under control.

On SLB, they attempted to restore the power supply, but smoke once again began to develop. The power supply was again isolated and the team on board withdrew and returned to SLA. Smoke was last observed approximately 13 hours after the first smoke was detected, and preventive cooling was terminated after approximately 17 hours.

The equipment that was burning in the high voltage room was a VSD.
VSD is an abbreviation for Variable Speed Drive and refers to a device that controls the speed of an electric motor by adjusting the frequency and voltage supplied to the motor.
This VSD regulates the RPM of the electric motor that drives the export gas compressor.

The VSD consists of several cabinets containing various components. It was the inverter part of the VSD that caught fire, but our investigation did not reveal the direct cause of the fire in the VSD.
During the investigation, we were informed that there have been many challenges associated with the VSD. Given that there is uncertainty over the direct cause of the fire, there is also uncertainty relating to any underlying causes. Heat generation and cooling water leakage were observed internally in the VSD, but there is an uncertainty over whether the heating caused the cooling water leakage or whether it occurred as a result of the leak.

The actual consequence of the incident was material damage and loss of production. The material damage resulting from the fire was a completely destroyed VSD, smoke and soot damage in the rest of the high voltage room, in addition to some smoke and soot damage in nearby rooms. In addition, thermal insulation in the ceiling above the VSD was damaged.
In addition to the damage caused by the fire, substantial material damage was also caused to the facility following the use of FIFI to cool the area.
During the investigation, we concluded that there was little risk of the fire spreading beyond the module in which it occurred. As there were no personnel on board, we have concluded that there was no danger to the life and health of personnel.

During the investigation, we identified seven non-conformities.

Non-conformity:

- Inadequate management of risk and technical solutions
- Deficiencies in handling of hazard and accident situations
- Deficiencies in fire division
- Missing navigation lights
- Documentation not updated
- Deficiencies in ventilation
- Inadequate facility-specific training and drills

The incident on SLB has led the investigation group to draw up a proposal to amend the guideline text for Section 37 of the Facilities Regulations on fixed firefighting systems on facilities that are not permanently manned.

2 Background information

On 22 October 2024, a fire broke out on Equinor's SLB facility. The fire occurred in the high voltage room in the M40 module. The facility was unmanned at the time the fire broke out.

2.1 Description of facility and organisation

The Sleipner fields are located on the Utsira High in the North Sea, 140 kilometres west of Stavanger. The Sleipner fields include the Sleipner East, Gungne and Sleipner West gas and condensate fields. In addition, the Sleipner facilities process hydrocarbons from the tie-in fields of Sigyn, Utgard and Gudrun, and rich gas from Gina Krog.

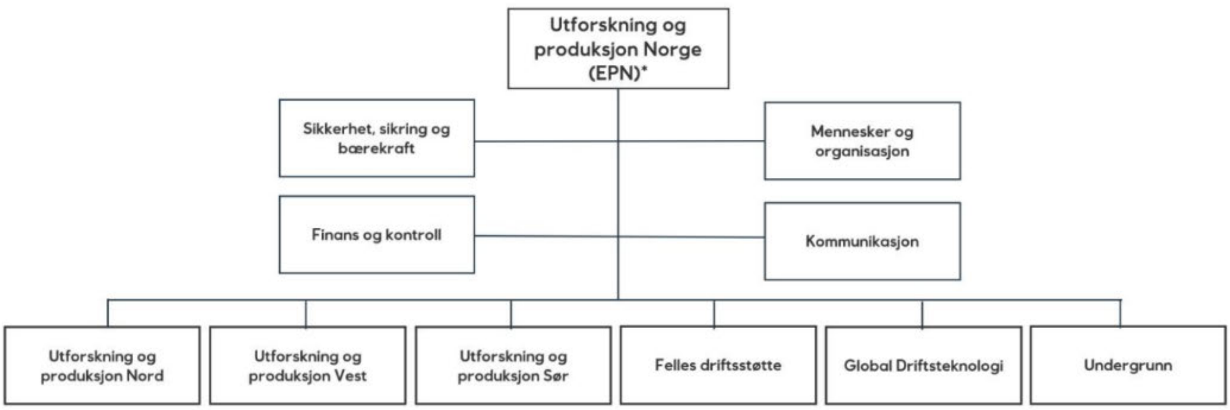
SLB is part of the Sleipner field, which comprises:
• SLA: Drilling, processing and living quarters platform
• SLB: Production platform (Sleipner West field), remotely controlled from Sleipner A (SLA), but periodically has operations and maintenance personnel on board.
• Sleipner R: Riser platform for gas and oil export
• Sleipner T: Platform for processing and removal of CO2

The Plan for Development and Operation of Sleipner West (PDO) was approved in 1992, and SLB was installed in 1996 and came on stream on 1 April 1997. The high voltage room where the fire broke out is located in the M40 module. This module was installed as part of major modifications for which consent was granted on the 26th of April 2006. The module was installed in summer 2008.

SLB is located approximately 12km west of SLA and exports gas and condensate to Sleipner T.

Equinor is the operator of Sleipner. The operation of Sleipner comes under the Exploration and Production South (EPS) business area under the "Sleipner multi-field and Southern North Sea" (SLSN) business unit, which is responsible for ensuring the safe, efficient and sustainable operations of its fields/facilities: Sleipner, Gudrun and Draupner.

The EPN consists of the following business areas and staff units:



* Juridisk (LEG) er assosiert medlem av Utforskning og produksjon Norges Ledergruppe

SLSN has an organisational structure that follows Equinor’s common operating model, where the onshore operating organisation acts as the main point of contact for the offshore organisation and coordinates with respect to other units. Onshore, the operating organisation consists of the Maintenance Manager and Production Manager, who report to the business unit, as well as the operations group, which is composed of long-term allocated resources from competence centres.

2.2 Situation before the incident

On the day of the incident, SLB was operating normally, and there were no personnel on board. A maintenance team was scheduled to travel to SLB on Monday, the day before the incident, but they remained on SLA due to the presence of fog in the area. There were 217 persons on board (POB) SLA. Only the emergency preparedness management team on SLA mustered when the incident occurred.

According to Equinor's main log, the wind direction was 245 degrees (VSV), the wind strength on SLB was 25 knots, while the wave height was 2.3 m significant with a maximum of 3.7 m at the the time of the incident. Visibility was good and the weather conditions had no negative impact on either the incident or its management.

2.3 Abbreviations

AM	Amplitude Modulation
AMC	Advanced Motion Controller
APS	Abandon Platform Shutdown
CAP	Critical Action Panel
CCTV	Closed Circuit TeleVision
CFD	Computational Fluid Dynamics
D&V	Operation and Maintenance
DDM	Drive Data Manager
DECT	Digitally Enhanced Cordless Telecommunication
DSHA	Defined Situation of Hazard and Accident
EPN	Exploration & Production Norway
EPS	Exploration and Production South
EVP	Executive Vice President
FIFI	Fire Fighting
FLIR	Forward Looking Infrared
FPDS	Fire Protection Data Sheet
PM	Preventive Maintenance
JSF	Johan Sverdrup Field Centre
HVAC	Heating Ventilation Air Conditioning
JRCC	Joint Rescue Coordination Centre
IGBT	Insulated Gate Bipolar Transistor
LCP	Local Control Panel
LER	Local Equipment Room
LIR	Local Instrument Room
LOP	Local Operation Panel
LUR	Alternative abbreviation for LER (Local Equipment Room)
MUX	Multiplexes
NAS	Emergency shutdown

NDB	Non-Directional Beacon
PABX	Private Automatic Branch Exchange
PAGA	Public Address and General Alarm
PAS	Process shutdown
PEC	Power Electronic Controller
PI-Vision	Digital storage system for historical process data
PIB	Power Interface Board
PLC	Programmable Logic Control
POB	People On Board
PS	Performance Standard
PDO	Plan for Development and Operation
RLC	Resistor, Inductor, Condenser (filter)
RTD	Resistance Temperature Detector
SAP	Software used to manage maintenance activities, among other things
SAR	Search and Rescue helicopter
SIL	Safety Integrity Level
S&R	Search And Rescue team
SKR	Central control room
SLA	Sleipner A
SLB	Sleipner B
SLSN	Sleipner multi-field and Southern North Sea business unit
STEP	Sequential Timed Event Plotting
UHF	Ultra High Frequency
UPS	Uninterruptible Power Supply
VDC	Volts Direct Current
VDU	Visual Display Unit
VHF	Very High Frequency
VSD	Variable Speed Drive

3 The Norwegian Ocean Industry Authority’s investigation

On Tuesday 22 October 2024 at 05:11, we were notified by Equinor of a fire on SLB. Based on this information, we established a dedicated emergency response centre to follow up Equinor’s handling of the incident. Based on the information we received during the incident, we decided to conduct an investigation. This decision was communicated to Equinor on the same day during a follow-up meeting concerning the incident.

The police decided to investigate the incident and we provided them with technical assistance.

3.1 Mandate

The following mandate was approved for the investigation team:

- a. *Determine the scope and course of the incident (using a systematic review that typically describes timeline and events).*
- b. *Assess the actual and potential consequences of*
    1. *Harm sustained by people, property and the environment.*
    2. *The incident's potential for harm to people, property and the environment.*
- c. *Assess direct and underlying causes.*
- d. *Identify regulatory non-conformities and improvements relating to regulations (and internal requirements).*
- e. *Discuss and describe any uncertainties/unclear issues.*
- f. *Consider barriers that did function. (i.e. barriers that helped to prevent a hazard from developing into an accident, or barriers that mitigated the consequences of an accident.)*
- g. *Assess previous similar events on SLB and other facilities in the Sleipner field*
- h. *Assess the company's own investigation report.*
- i. *Prepare a report and cover letter (potentially including suggestions for use of tools) according to the template.*
- j. *Recommend – and normally contribute to – further follow-up*

Composition of the investigation team:

[redacted]

3.2 Method

As the scene of the fire was being secured and the surrounding area assessed by the firefighting crew from Mongstad, the outbound trip was postponed until Sunday 27.10.2024.

The investigation team conducted an inspection on SLB, along with interviews, during the period 27.10-30.10.2024. Some interviews were also conducted via Teams. We assisted the police while conducting our own investigation.

During the investigation, we stayed on SLA and were flown over to SLB by the SAR helicopter. As SLB had no power supply and no safety systems were in place, there were limitations on both the number of people that could be on board at any one time and the length of time that they could stay. The number of trips was also limited

by the availability of the SAR helicopter. We were on board SLB twice, for about two and a half hours on the first occasion, and about four hours on the second.
Inside the high voltage switchboard room where the fire had occurred, respirator masks were used due to high concentrations of soot and particles in the atmosphere, as recommended by the firefighting crew from Mongstad.

A joint inspection was conducted with the police in a high voltage switchboard room on Sleipner T, where we looked at a VSD (not of the same type) in order to gain an impression of how the equipment was arranged on SLB.
Havtil also took part in an inspection of the central control room on SLA, where we looked at warning systems, the CAP panel and screens for SLB.

Havtil conducted two interviews and provided the police with technical assistance during eight interviews on board SLA.
Afterwards, Havtil conducted three interviews onshore. We have conducted document reviews both on board SLA and onshore, and we have also conducted a review of SAP and PI-Vision (a system which contains historical process data) at Equinor's premises.

The primary focus of the investigation has been to clarify the sequence of events, direct and underlying causes of the fire, the handling of the fire after it was discovered, and an assessment of barriers linked to the area.

During the investigation, we used STEP as a method for obtaining a clear picture of the parties involved and identifying links more readily.

The M40 module, in which the fire occurred, was installed as part of major modifications for which consent was granted on 26.04.2006. We have therefore used this as a basis for regulatory references as regards technical requirements; cf. the Facilities Regulations, Section 82 (4).

4 Description of technical solutions

4.1 Power supply

4.1.1 Main power supply

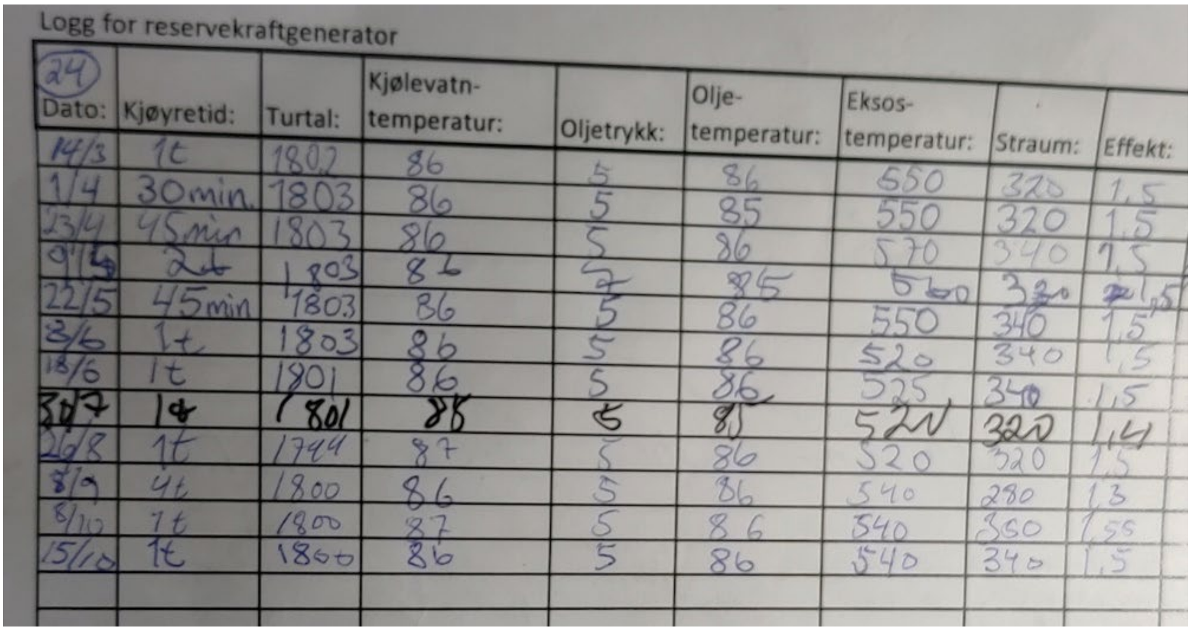
SLB receives its power supply through a cable from SLA. This power cable is connected to the 13.8kV switchboard located in the high voltage room in the M40 module on SLB.

4.1.2 Back-up supply

On SLB, a diesel-powered back-up generator is located in a dedicated container with an H-60 fire division on the deck above the high voltage room. Equinor has not defined the back-up generator as an emergency or safety system.

In the event of the loss of the main power supply from SLA, the back-up generator should start up automatically and supply power to the fire pumps and other equipment. If the back-up generator does not start up, only local UPS emergency power will be supplied on SLB. In such a case, it will not be possible to operate the fire pumps.

The back-up <u>back-up</u>generator is connected to the 3kV switchboard located in the high voltage room. The back-up back-upgenerator is designed to supply the power required by a fire pump, vital platform functions, and battery and uninterruptible power supplies for a minimum of 48 hours. The back-up back-upgenerator must be function-tested in conjunction with each trip to SLB. The test run is logged on a form which is kept with the back-up back-upgenerator; see Figure 1.



Logg for reservekraftgenerator

24

Dato:	Kjøyretid:	Turtal:	Kjølevatn-temperatur:	Oljetrykk:	Olje-temperatur:	Eksos-temperatur:	Straum:	Effekt:
14/3	1t	1802	86	5	86	550	320	1,5
1/4	30min.	1803	86	5	85	550	320	1,5
23/4	45min	1803	86	5	86	570	340	1,5
9/5	2t	1803	86	5	85	560	320	1,5
22/5	45min	1803	86	5	86	550	340	1,5
3/6	1t	1803	86	5	86	520	340	1,5
18/6	1t	1801	86	5	86	525	340	1,5
31/7	1t	1801	88	5	85	520	320	1,4
26/8	1t	1799	87	5	86	520	320	1,5
8/9	4t	1800	86	5	86	540	280	1,3
8/10	1t	1800	87	5	86	540	360	1,55
15/10	1t	1800	86	5	86	540	340	1,5

Figure 1 Log of back-upback-upgenerator test run. The last test run before the fire occurred was carried out on 15.10.2024. (Source: Havtil)

The safety strategy for SLB (PS 9) states that, if the main power supply via the subsea cable from SLA fails and alarms have been activated inside the back-upback-upgenerator (e.g. low cooling water level), the back-upback-upgenerator will not start. The back-upback-upgenerator is normally in auto mode, and machine and all other protection will then be operational. Personnel will then have to travel to SLB and switch the back-upback-upgenerator to manual mode, meaning that the back-upgenerator will then be controlled locally. In manual mode, the back-up generator will be in “unprotected mode”.

4.1.2.1 Back-upgenerator during the incident

The back-up generator did not start up during the incident. We have been informed that the personnel who arrived on SLB during the incident observed that the back-up generator was in “auto mode” and that alarms were displayed on the control panel. The alarm was interpreted as an undervoltage alarm by the response personnel.

At the same time as the first alarms were received from the VSD at 04:43:00, an alarm was also received from local control panel A (LCP A) and local control panel B (LCP B) for the back-up generator.
A little later in the sequence of events (05:01:14), the power supply to the control panel for the back-up generator was isolated. This was a direct consequence of the 440V switchboard W-82-EN03 being switched off, as the first step in isolating the power supply to the high voltage room. There are internal batteries in the control panel which are intended to ensure that the panel remains operational, even after this power supply has been isolated. The same alarms from LCP A and B were then received again. In addition, two new alarms were received from both LCP A and B. There are no text descriptions in the alarm list linked to these alarms.

A few seconds later (05:01:22), an alarm was received indicating that the back-up generator was unavailable.

During the investigation, we did not receive confirmation as to whether these alarms were linked to the internal batteries in the control panel. We have not received confirmation that the alarms were the reason why the back-up generator did not start up. The attempt to retrieve the alarm log from the control panel failed due to soot and condensation damage to the laptop which contains the software for communicating with the control panel.

The photograph in Figure 2 shows the control panel for the back-up generator. The photograph was taken during Havtil's inspection on SLB after the fire.

Figure 2 Local control panel for the back-up generator on SLB. The photograph was taken during Havtil's inspection after the fire. The 'Mode selector' in the bottom centre of the photograph is in Auto mode. We have unsuccessfully attempted to gain access to any alarms from the alarm panel. (Source: Havtil)

4.1.3 Emergency power supply

The safety strategy states that "There is no emergency power supply installed on SLB, as it is normally an unmanned facility." and "The UPS systems on board act as an emergency power supply on SLB".

The UPS room is located in the utility area in module C30. There are two main UPSs on SLB (2 x 100% system). A 2 x 100% system means that if one UPS system drops out, the other UPS system will have sufficient capacity to power defined consumers. The UPS systems supply power to nodes, control power to switchboards, helicopter landing and marking lights, emergency lights in connection with lifeboats and in the M40 compressor module. Each of the main UPS systems has a 40kVA rating and sufficient battery capacity to last 60 minutes. The UPS systems will not shut down in the event of APS, but they will in the event of ignition source isolation, level three (ISI III level).

Navigation lights have their own battery banks and should continue to function for at least 96 hours. Telecommunications equipment has its own UPS systems and is also equipped with 2 x 100% systems where required.

Emergency lighting
In the M40 compressor module, emergency lights are supplied from central UPS systems. This is designed so that in the event of the one of the two main UPS systems dropping out, the evacuation lights
will maintain a minimum of 1 lux along all evacuation routes. In confined spaces (equipment rooms, LER), there are also some light sources which have a battery above the exit door as an additional
safety measure.
Apart from module M40, all emergency lighting is equipped with internal batteries, which ensure a minimum brightness for evacuation for at least 30 minutes.

Loss of UPS (emergency power supply)
If the emergency power supply is not available from the UPS, e.g. due to it not being possible to activate the battery switches on both UPS systems or the UPS batteries being fully discharged, the back-up generator must be started manually in order to power the UPS distribution systems. The back-upgenerator is dependent on the auxiliary systems for the generator being supplied with power from switchboard W-82-EN03. If the main power supply from SLA is not available, it will be challenging to restart the generator in order to recharge the UPS batteries. If switchboard W-82-EN03 has no power supply when the generator starts up, it will trip after 10 to 15 minutes of running due to lack of cooling.
Because of these dependencies, it will very probably be necessary to connect a generator directly to the rectifier on the UPS systems in order to recharge the batteries.

4.1.3.1 Emergency power supply/UPS during the incident

During the incident, the power supply from SLA to SLB was isolated and the back-upgenerator on SLB did not start up automatically. The back-upgenerator could also not be started when an attempt was made to start it before personnel travelled across to SLB. Personnel did not attempt to start the back-upgenerator while they were on board SLB. This meant that the emergency power consumers supplied from the UPS system would only remain operational until the UPS battery banks became fully discharged. This meant that the personnel who travelled to SLB had a limited amount of time available and that restoring charging to the UPS systems was a priority task.

4.1.4 Power supply during the incident

Before the incident occurred, SLB was being supplied with power from SLA and the facility was operating normally, with the export gas compressor in operation. The back-upgenerator was not operational.

During the first four hours after the incident first occurred, a number of connections were made in the facility. The first change linked to the power supply was that the

VSD supplying the export gas compressor was tripped by the protection system. In addition, several consumers were isolated as a result of the emergency and process shutdown which was implemented from the central control room on SLA. The following four figures show the parts of the facility that were electrically live during this four-hour period. Each figure covers a cycle of one hour. The green marking indicates electrically live.

The yellow indicates that there is uncertainty regarding whether these parts of the facility were being supplied with power. As regards the 13.8kV switchboard, the alarm list indicates that it was energised at 05:45:19. The emergency preparedness log contains information which indicates that an unsuccessful attempt was made to energise the switchboard. The response personnel on board SLB found that the switchboard was not energised when they arrived on SLB, and that they had to close the input switch (W-80-EF03) to the switchboard in order to energise it. It is possible that the screens on SLA may have been misleading as regards the electrical systems because of a communication link to SLB (Profibus) which had not been operational since the August 2024 turnaround.

The second yellow marking concerns equipment that was isolated when shutdown levels NAS 2.0 and PAS 3.0 were activated. After 07:35, when both the 440V switchboard in the M40 and C30 modules were energised, the central control room was notified that they could begin to normalise by re-energising equipment that had been isolated.

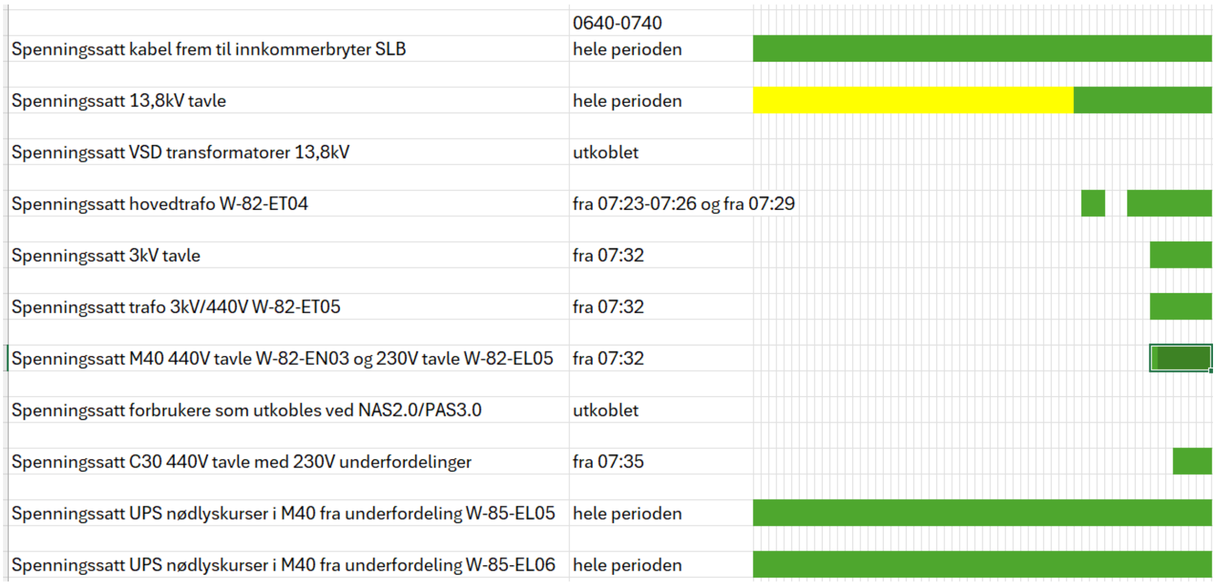
The shutdown levels were reset over the following minutes. There were also several alarms associated with the VSD during this time. It was during this period that the fire increased in intensity. In the attempt to stop the increasing smoke generation, the response personnel isolated the switch that supplied the main transformer (07:47:10), and then isolated the input switch (W-80-EF03) to the 13.8kV switchboard (07:50:46). In addition, the cable from SLA was isolated on SLA (07:54:30). The emergency lighting circuits in the M40 module, which are supplied from UPS subdistribution board W-85-EL05, were isolated (07:52) and from W-85-EL06 (08:34).

	0440-0540
Spenningssatt kabel frem til innkommerbryter SLB	hele perioden
Spenningssatt 13,8kV tavle	frem til 05:04:43
Spenningssatt VSD transformatorer 13,8kV	frem til 04:43:00
Spenningssatt hovedtrafo W-82-ET04	frem til 05:04:43
Spenningssatt 3kV tavle	frem til 05:04:43
Spenningssatt trafo 3kV/440V W-82-ET05	frem til 05:01:14
Spenningssatt M40 440V tavle W-82-EN03 og 230V tavle W-82-EL05	frem til 05:01:14
Spenningssatt forbrukere som utkobles ved NAS2.0/PAS3.0	frem til 04:47:45
Spenningssatt C30 440V tavle med 230V underfordelinger	frem til 05:04:43
Spenningssatt UPS nødlyskurser i M40 fra underfordeling W-85-EL05	hele perioden
Spenningssatt UPS nødlyskurser i M40 fra underfordeling W-85-EL06	hele perioden

Figure 3 Energised parts of the facility 04:40-05:40

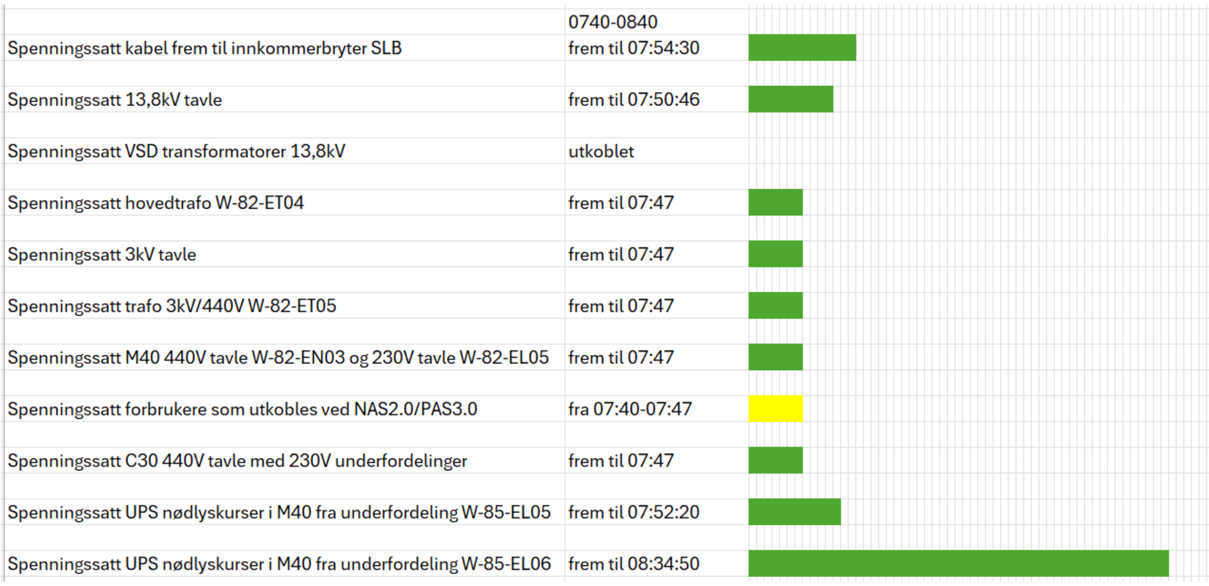
	0540-0640
Spenningssatt kabel frem til innkommerbryter SLB	hele perioden
Spenningssatt 13,8kV tavle	fra 05:45:19
Spenningssatt VSD transformatorer 13,8kV	utkoblet
Spenningssatt hovedtrafo W-82-ET04	utkoblet
Spenningssatt 3kV tavle	utkoblet
Spenningssatt trafo 3kV/440V W-82-ET05	utkoblet
Spenningssatt M40 440V tavle W-82-EN03 og 230V tavle W-82-EL05	utkoblet
Spenningssatt forbrukere som utkobles ved NAS2.0/PAS3.0	utkoblet
Spenningssatt C30 440V tavle med 230V underfordelinger	utkoblet
Spenningssatt UPS nødlyskurser i M40 fra underfordeling W-85-EL05	hele perioden
Spenningssatt UPS nødlyskurser i M40 fra underfordeling W-85-EL06	hele perioden

Figure 4 Energised parts of the facility 05:40-06:40



	0640-0740
Spenningssatt kabel frem til innkommerbryter SLB	hele perioden
Spenningssatt 13,8kV tavle	hele perioden
Spenningssatt VSD transformatorer 13,8kV	utkoblet
Spenningssatt hovedtrafo W-82-ET04	fra 07:23-07:26 og fra 07:29
Spenningssatt 3kV tavle	fra 07:32
Spenningssatt trafo 3kV/440V W-82-ET05	fra 07:32
Spenningssatt M40 440V tavle W-82-EN03 og 230V tavle W-82-EL05	fra 07:32
Spenningssatt forbrukere som utkobles ved NAS2.0/PAS3.0	utkoblet
Spenningssatt C30 440V tavle med 230V underfordelinger	fra 07:35
Spenningssatt UPS nødlyskurser i M40 fra underfordeling W-85-EL05	hele perioden
Spenningssatt UPS nødlyskurser i M40 fra underfordeling W-85-EL06	hele perioden

Figure 5 Energised parts of the facility 06:40-07:40



	0740-0840
Spenningssatt kabel frem til innkommerbryter SLB	frem til 07:54:30
Spenningssatt 13,8kV tavle	frem til 07:50:46
Spenningssatt VSD transformatorer 13,8kV	utkoblet
Spenningssatt hovedtrafo W-82-ET04	frem til 07:47
Spenningssatt 3kV tavle	frem til 07:47
Spenningssatt trafo 3kV/440V W-82-ET05	frem til 07:47
Spenningssatt M40 440V tavle W-82-EN03 og 230V tavle W-82-EL05	frem til 07:47
Spenningssatt forbrukere som utkobles ved NAS2.0/PAS3.0	fra 07:40-07:47
Spenningssatt C30 440V tavle med 230V underfordelinger	frem til 07:47
Spenningssatt UPS nødlyskurser i M40 fra underfordeling W-85-EL05	frem til 07:52:20
Spenningssatt UPS nødlyskurser i M40 fra underfordeling W-85-EL06	frem til 08:34:50

Figure 6 Energised parts of the facility 07:40-08:40

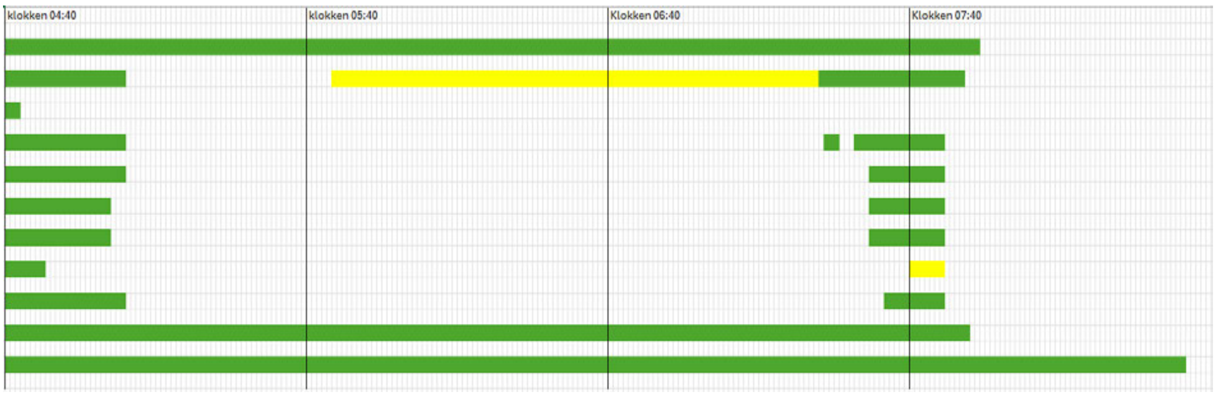


Figure 7 Energised parts of the facility 04:40-08:40 combined into one figure

4.2 Description of the VSD

VSD is an abbreviation for Variable Speed Drive and refers to a device that controls the speed of an electric motor by adjusting the frequency and voltage supplied to the motor.

On SLB, the VSD concerned regulates the RPM of the electric motor that drives the export gas compressor.

In the VSD, the voltage is reduced from 13.8KV to 1865V in two 12-pulse transformers. The voltage is then rectified with the aid of diodes. A DC link with capacitors acts as an intermediate storage device for DC power between the rectifier and inverter.

The current and frequency supplied to the compressor motor is built up by the DC link voltage using IGBTs (Insulated Gate Bipolar Transistors), which switch on and off rapidly. This is used to create a series of pulses that form an alternating current with the required frequency and voltage. This AC supply is used to power the compressor motor at the requisite RPM and torque.

The VSD device on SLB consists of a series of cabinet modules with a total of 13 cabinet doors. These are numbered from zero to eleven based on the markers shown in Figure 10.

0	1	1	2	3	4	5	6	7	8	9	10	11

Figure 8 Numbering of doors on the cabinet modules of the VSD

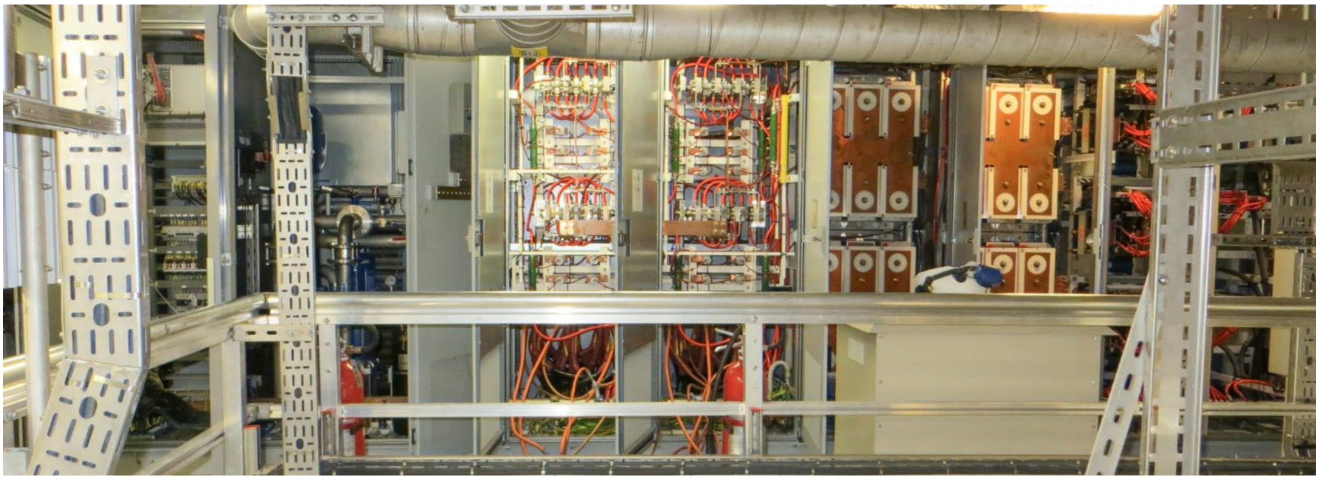


Figure 9 Photograph of the VSD with the cabinet doors open before the fire. The photograph shows what is behind cabinet doors 0 to 7 inclusive. This photograph was taken in March 2019 in connection with an fire-related incident in the rectifier section of the VSD. (Source: Equinor)

Figure 10 Photograph of the VSD after the fire. The photograph shows cabinet doors 2 to 11. (Source: Norwegian Police)

Equipment behind the various doors

From the left (numbering based on markers applied by the police in the photograph in Figure 10):

0: Local Control Cubicle

Contains, among other things, a regulator (PEC Controller) which regulates the RPM and torque of the compressor motor. This regulation requires measurements of

current and RPM from the motor as input values. Based on these measurements, the ignition pulses of the IGBTs are controlled behind doors 6 and 7. This regulator also controls the circuit breaker to the VSD (W-80-EF06).
The panel also contains an AMC Controller, which controls auxiliary systems such as the VSD transformers, external cooling circuit and system filter.

1: Cooling system for the VSD based on deionised water
Contains circulation pumps for cooling for power electronics components in the VSD. Deionised water is topped up every 14 days when personnel are on board SLB. The cooling system containing deionised water is a closed cooling circuit.
The cabinet also contains a heat exchanger, where deionised water is cooled by a cooling circuit which uses freshwater. The freshwater is further cooled in a heat exchanger by an external cooling circuit based on seawater. This external cooling circuit forms part of the platform systems and is not located in the high voltage room.

2 and 3: Rectifier bridge, 24-pulse diode rectifier bridge
The diodes are connected in series and cooled by deionised water. The diodes are designed to withstand a worst-case overcurrent without being damaged provided that the circuit breaker to the VSD interrupts the power supply within 100 ms of receiving a trip signal from the VSD controller.

4 and 5: DC link capacitors
Capacitors between the positive terminal of the DC link and the mid-point are located behind door 4, while capacitors connected between the mid-point and the negative terminal are located behind door 5. The capacitors are of the dry film self-healing type.
We have not received any information about the material that the capacitors consist of, but this type of capacitor typically contains large quantities of polypropylene.

Polypropylene is a flammable plastic that melts before it ignites. The flash point of polypropylene is 345°C. When polypropylene burns, it produces a thick black smoke.

Water-cooled resistors are connected between the terminals of the DC link. According to documentation that has been received, these will discharge the capacitors to a voltage of 50VDC in approximately 5 minutes when the circuit breaker to the VSD is open.

The voltage between the mid-point of the DC link and ground is monitored. In the event of a ground fault being detected, the PEC controller will send a trip signal to the VSD circuit breaker.

6 and 7: Inverter (IGBTs)
The inverter consists of three inverter legs, each of which has eight IGBTs. The output current is measured in each of the output phases U, V and W. In addition, the panel contains a common 24V DC power supply to the IGBT control boards.

The IGBTs are water-cooled via deionised water from the cooling circuit.

This part of the VSD was destroyed by the fire.

The IGBTs primarily consist of silicon and are very fire-resistant. When silicon burns, it burns at very high temperatures, normally over 1400 °C.

The control boards for each IGBT contain components such as circuit boards, electronic components and wires that are flammable at lower temperatures. In addition, there is an extensive network of cooling hoses made from insulating material in the inverter part.

The IGBT stacks also contain voltage-limiting capacitors (clamp capacitors) which, among other things, perform the function of preventing overheating by limiting the voltage across the IGBTs to a safe level.

8 and 9: Output filter (dv/dt filter)
The output filter is a three-phase RLC filter with the star point connected to the mid-point of the DC link. This part of the VSD was also destroyed by the fire. Photographs taken after the fire show that the upper part of the panel doors had become discoloured as a result of heat exposure, with the most extensive discolouration being on door 8.

10 and 11: Output cables and ground switch
This section contains output cables for the compressor motor and a ground switch for the VSD.

4.2.1 The VSD during the fire incident

The VSD receives power from the following sources which are shown on a sign mounted on the cabinet doors of the VSD.
- Main voltage of 13.8kV from switch W-80-EF06. This was automatically isolated by the protection system at 04:43:00, as shown in Figure 3. This was not re-energised at any time.
- Power supply of 440V to the "pre-charge transformer" from switchboard W-82-EN03. This is normally only closed when switch W-80-EF06 is activated in order to limit the inrush current when the VSD transformers are magnetised. There have been no observations which suggest that this was connected at any time during the incident.

- Power supply for cooling pumps A and B. These are supplied from switchboard W-82-EN03 and are redundant circulation pumps for the internal cooling water circuit in the VSD. Only one of them is in operation at any one time. During the incident, these were energised until emergency shutdown was initiated at 04:47. Switchboard W-82-EN03 was isolated at 05:01 and energised again during the period between 07:32 and 07:47. Emergency shutdown was reset at 07:40. The cooling pumps may have been energised during the period between 07:40 and 07:47, although there is some uncertainty concerning this.
- The power supply to the heater comes from switchboard W-82-EL05, which is a 230V subdistribution board to 440V switchboard W-82-EN03. This board had a power supply until 05:01 and thereafter during the time interval from 07:32 to 07:47. We have been unable to determine whether the heater was also isolated during the emergency shutdown. If it was, the heater would have been energised during the same time interval as the cooling pumps in the bullet point above.
- The power supply to the VSD control supply comes from UPS subdistribution board W-85-EL05. This subdistribution board supplied the VSD with power until approximately 07:53. At this time, the emergency lighting circuits in W-85-EL05 were isolated, and it is also apparent that the last alarm was recorded on the LOP panel at 07:53. In addition, there was an alarm on the LOP panel with the text "Fan Supply OFF Alm" at 07:43. These exhaust fans, which are mounted on the top of each cabinet, are supplied from this UPS subdistribution board.

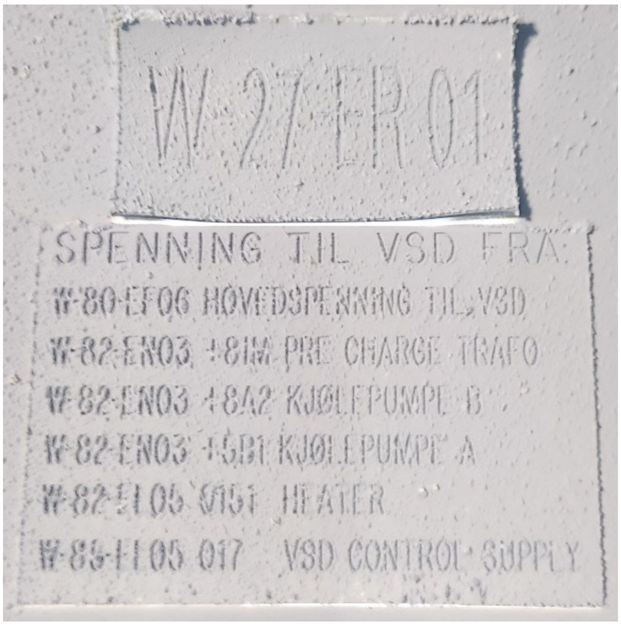


Figure 11 Sign showing the source of the power supply to the VSD (Source: Havtil)

After the fire, a number of circuit breakers and motor protection systems on the local control panel were tripped.

A circuit breaker connected to the normal 230V supply was tripped. This was listed as a back-up (spare) in parts of the documentation that has been received and as a supply to the MV7000 DDM keypad supply in the Hardware training manual. DDM is an abbreviation for Drive Data Manager. This is stated as being mounted on the front door of the local control panel and is intended to show fault alarms and warnings detected by the regulator (PEC controller) that controls the motor operation.

The remaining circuit breakers and motor protection that were tripped were all connected to the UPS supply.

- Motor protection for fan extraction on the top of cabinet 2 (rectifier bridge)
- Motor protection for fan extraction on the top of cabinet 3 (rectifier bridge)
- Motor protection for fan extraction on the top of cabinet 4 (DC link capacitors)
- Motor protection for fan extraction on the top of cabinet 5 (DC link capacitors)
- Motor protection for fan extraction on the top of cabinet 6 (inverter)
- Motor protection for fan extraction on the top of cabinet 7 (inverter)
- Motor protection for fan extraction on the top of cabinet 8 (output filter)
- Motor protection for fan extraction on the top of cabinet 9 (output filter)
- Circuit breaker no. 1 for supplying 24V DC to the IGBTs in inverter
- Circuit breaker no. 2 for supplying 24V DC to the IGBTs in inverter
- Circuit breaker for "Fault relaying"

The motor protection for fan extraction on the top of cabinet 0 (local control panel) and cabinet 1 (cooling system for the VSD) was not tripped.

"Fault relaying" is a function that is intended to ensure that any faults are detected rapidly and dealt with quickly and efficiently. If the fuse for "fault relaying" has tripped, this normally means that the function is not available.

The 24V DC supply to an IGBT is required to power the IGBT gate circuit. Loss of gate control means that the IGBT cannot be properly switched on or off. This could result in the IGBT remaining in an open or closed state. If the IGBT remains in a state where it conducts current continuously, it could lead to overheating and potentially damage the IGBT.

During the interviews, it emerged that when the response team arrived in the high voltage equipment room during the incident, they observed white smoke, which they described as "theatre smoke", in the room. They also noticed water on the floor in front of cabinet 6 (inverter). The response team concluded that there was no time to carry out further investigations at this time. The cabinet doors have to be opened using a detailed locking procedure to ensure that the isolation, grounding and discharging of the VSD components takes place in the correct sequence and over a sufficient period of time. Based on past experience of troubleshooting the VSD, it is estimated that it takes 1.5 hours to follow the locking procedure to open the cabinet doors. They therefore decided to prioritise re-establishing charging of the UPS batteries first.

In an imaginary scenario of "white smoke" in the situation in question, this could have been due to one or more capacitors having failed and emitting white smoke. Another possibility is that the white smoke was caused by overheating of the cooling water hoses. In the latter case, this may have been combined with water vapour from a cooling water leak.

The 24 IGBTs behind doors 6 and 7 (inverter) trigger alarms at three different times. They all only triggered an alarm once. The bottom eight are associated with phase W, while the eight in the middle are associated with phase U. The alarm times from these (see Figure 12) were as follows:

- 04:43:00, marked in red
- 04:54:23, marked in green
- 07:46:23, marked in yellow

It is apparent from this illustration that all the IGBTs in cabinet 6 (red and green) had triggered an alarm at the time when water was observed on the floor in front of the same cabinet.

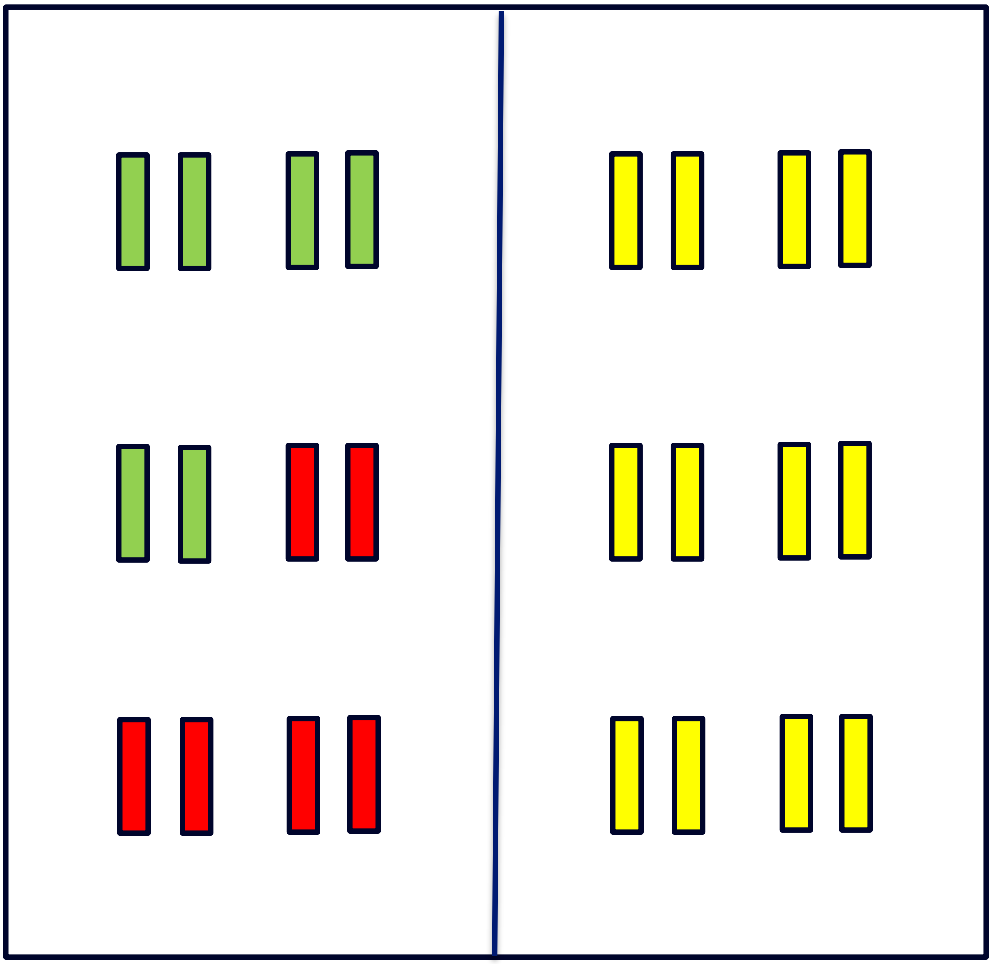


Figure 12 IGBTs in inverter with colour indicating the timing of the associated alarm (cabinets 6 and 7)

4.3 Layout of the high voltage equipment room

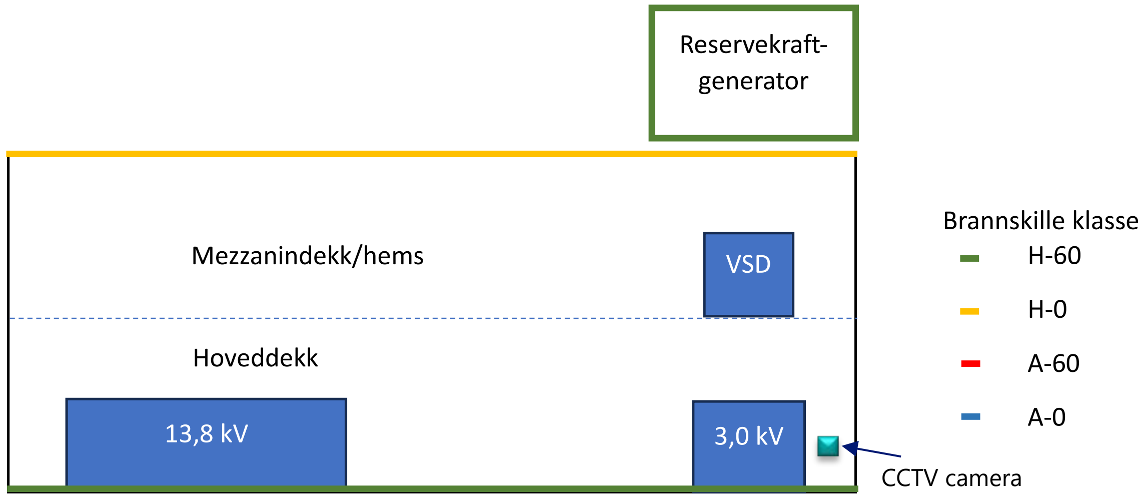


Figure 13 Overview of the layout of the high voltage room with relevant equipment and fire divisions (roof/deck) included. The fire ratings of the divisions are shown in Figure 14 and Figure 15.

The high voltage equipment room is a large module (measuring approx. L:12.7m x W:9.5m x H:7m) and consists of numerous essential items of electrical equipment. Examples of the equipment located in the high voltage equipment room are:

- <u>13.8kV high voltage switchboard:</u> The power cable from SLA comes in via the 13.8kV high voltage switchboard, which is located in high voltage equipment room M40 on the main deck.
- <u>3kV high voltage switchboard</u>: The 3kV high voltage switchboard is located in high voltage equipment room M40 on the main deck. The 3kV high voltage switchboard is supplied by the 13.8kV switchboard (the power cable during normal operation). In the event that the power cable from SLA fails, the back-up generator will supply the 3kV high voltage switchboard. The 3kV switchboard also supplies the 440V low voltage switchboard (located in low voltage equipment room (LER) M40 on the main deck, which is the adjacent room). The 440V low voltage switchboard supplies/energises auxiliary equipment such as the oil circulation unit (the cooling oil system for the seawater pumps/fire pumps)
- The VSD (variable speed drive) is located on the mezzanine deck/"open loft" in high voltage equipment room M40, mezzanine deck/"open loft".
- A surveillance camera (CCTV camera) has been installed on the main deck of the high voltage room. The location of the camera is shown in Figure 13 and Figure 14. The area covered by the camera can be adjusted horizontally and vertically.

The back-up generator is located in a separate container on the weather deck (the deck above).

4.3.1 Weaknesses linked to the layout of the high voltage room in the event of an incident involving fire

Both the 13.8kV high voltage switchboard and the 3kV high voltage switchboard panel are located in the high voltage room (shown in Figure 13). The philosophy in the event of a fire in the high voltage room (the equipment room) is to isolate the power supply (energy) to the room (ref. section 4.7 firefighting). This means that, in the event of a fire in the high voltage room, the 13.8kV high voltage switchboard and 3kV high voltage switchboard will not be operational. Operation of the fire pumps is dependent on a power supply from SLA (13.8kV high voltage switchboard) or the back-upgenerator on SLB (3kV high voltage switchboard). In such a situation, there is no fire water (deluge/hydrants/monitors) on SLB.

4.4 Fire divisions

The high voltage room is enclosed by the following fire divisions; see Figure 14 and Figure 15:

- deck with fire rating H-60 (see Figure 13)
- roof with fire rating H-0 (see Figure 13). The underside of the roof is insulated with thermal insulation (not passive fire protection).
- wall with fire rating A-60 abutting the HVAC room,
- wall with fire class A-60 abutting the low voltage equipment room (main deck)
- wall with fire rating A-60 abutting the local instrument room (mezzanine deck)
- wall with fire rating A-0 facing the open area towards the sea
- The process area is enclosed by an H-60 fire division abutting the HVAC room.
- The back-up generator is located in a separate container enclosed by a H-60 fire division (see Figure 13)

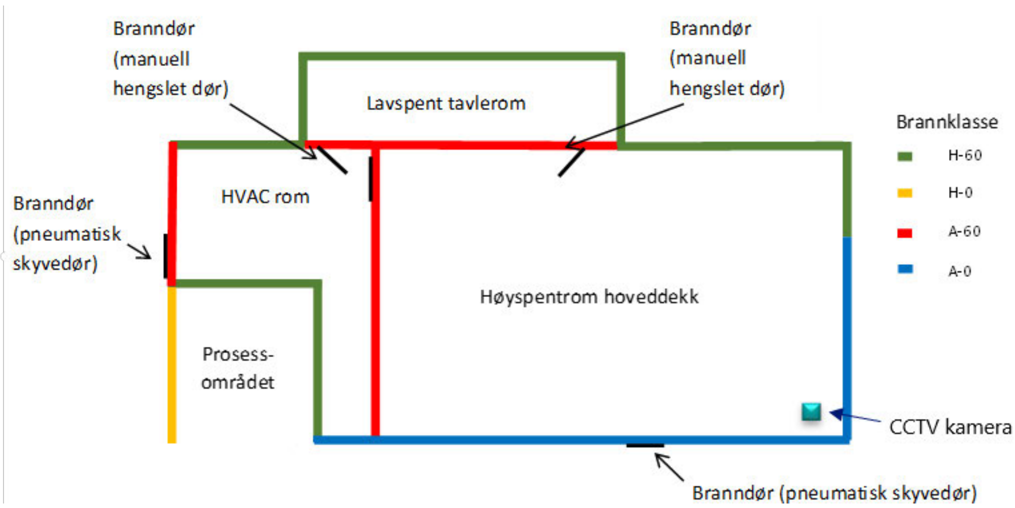


Figure 14 Overview of fire divisions, including fire doors in M40, main deck (top view). The drawing also shows the location of the CCTV camera.

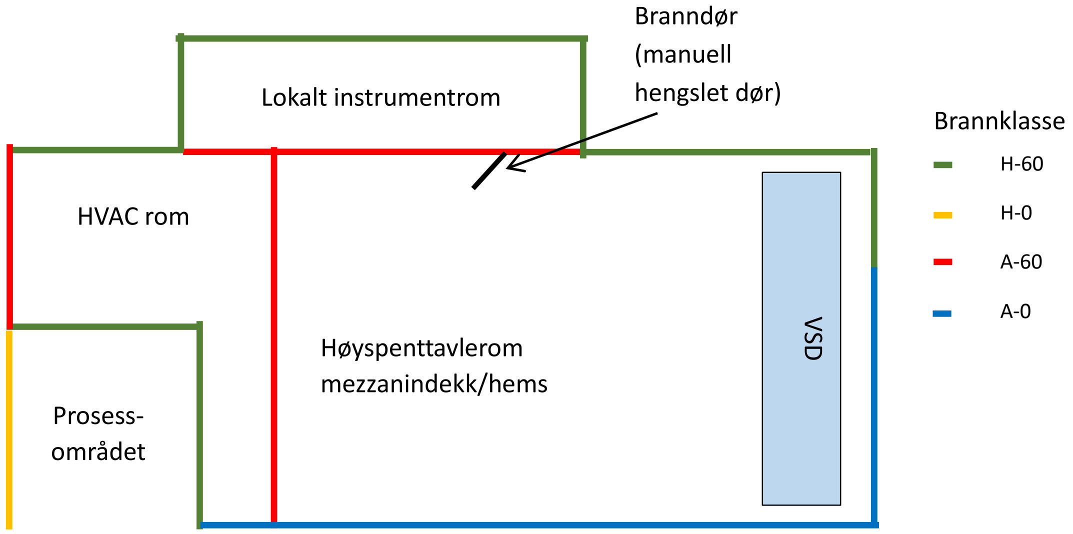


Figure 15 Overview of fire divisions, including fire doors in M40 mezzanine deck.

Figure 14 and Figure 15 show the fire doors on the main and mezzanine decks.

There is one fire damper in the air inlet to the M40 module and one fire damper on the exhaust duct. These dampers will close in the event of gas being detected in the HVAC duct or the high voltage room. There is no fire damper inside the M40 module.

4.4.1 Fire divisions after the fire in the high voltage room

The fire in the high voltage room lasted for several hours. The fire divisions surrounding the high voltage room were not designed to maintain integrity for such a long period of time. However, we observed that the fire divisions prevented the flames from spreading to the surrounding areas throughout the course of the fire, although smoke did spread.

As Figure 15 shows, there is a fire division with fire rating A-60 between the high voltage room and the local instrument room (LIR room). Fire divisions with a rating of A-60 are intended to prevent the spreading of smoke for at least one hour. A smoke detector located in LIR triggered an alarm indicating smoke 25 minutes after the first smoke detector in the high voltage room was triggered, resulting in the spreading of smoke to neighbouring rooms (thus, the fire division did not meet the requirement to prevent the spreading of smoke for at least one hour). The photograph below was taken in the LIR room and shows soot penetration through a small gap in the fire division.

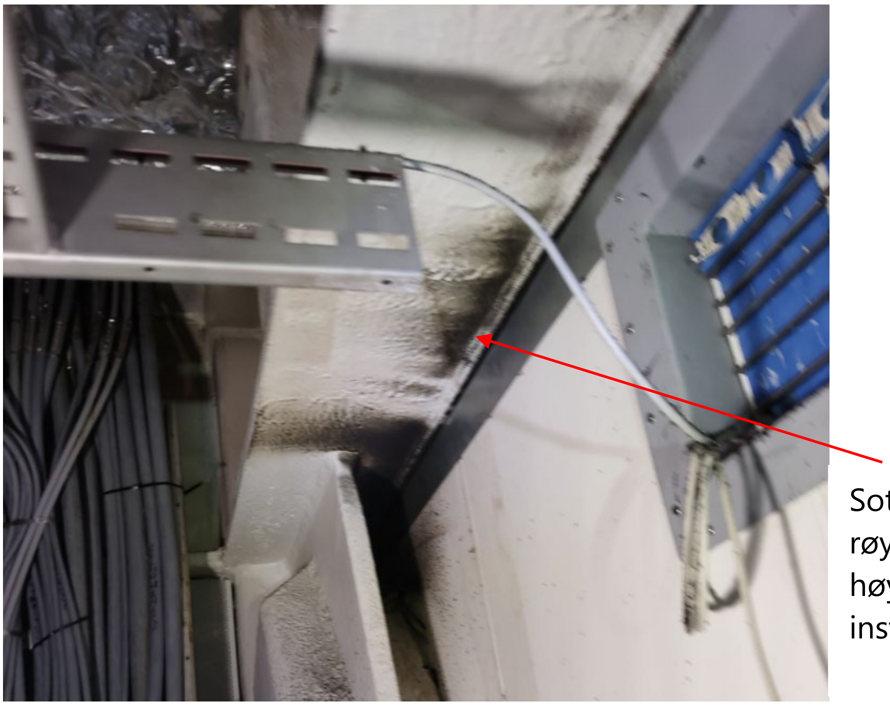


Figure 16 Soot marks following the spreading of smoke to the neighbouring room (local instrument room) (Source: Havtil)

During the inspection on SLB after the incident, we observed that the fire door (pneumatic sliding door in a fire division with fire rating of A-0) was in the open position. The photograph below shows the fire door and two containers pushed in towards the door as a result of water spray from the monitors on adjacent vessels (see Figure 17).

Figure 17 Pneumatic sliding door into the high voltage room. In the photograph, the two containers have been pushed towards the door as a result of being doused with water from water cannons on adjacent vessels (Source: Havtil)

The photograph below shows the roof of the high voltage room/deck above the high voltage room viewed from the outside (just below the back-up generator container). Two marked black areas are apparent which show the effect of heat from the fire in the VSD switchboard.

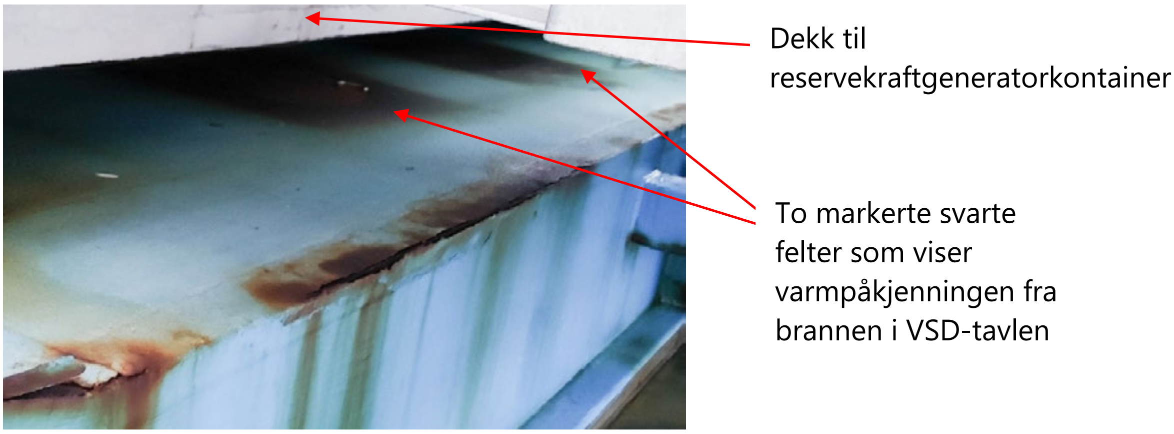


Figure 18 Top of the roof of the high voltage room after the fire (Source: Havtil)

4.5 Fire detection

The philosophy applied for fire detection in electrical rooms/equipment rooms is to use early detection (high sensitivity optical smoke detectors) and conventional smoke detectors. A smoke detector works through smoke particles absorbing light and a photoelectric source in the smoke detector detecting the resultant change in light conditions, which triggers the detector. An early detector (high sensitivity detector) is a detector which is equipped with a high sensitivity detector which detects small amounts of smoke particles at an early stage during the combustion process.

According to the Fire Protection Data Sheet (FPDS), the following effects and actions in the event of fire (smoke) being detected in high voltage rooms apply on SLB/SLA:

- an activated early detector or conventional smoke detector triggers a warning/alarm in the control room (both visual and audible) on the VDU panel on SLA.
- confirmed fire: two activated early detectors, one activated early smoke detector + one activated conventional smoke detector, or two activated conventional smoke detectors
- confirmed fire detection will start the fire pump (if the seawater pump is not already in operation), general alarm on SLB, and alarm (both visual and audible) in the control room on SLA.

In the event of a confirmed fire in the high voltage room, the fire pump will therefore start up (if the seawater pump is not already in operation). No fixed fire protection system has been installed in the high voltage room; thus, confirmed fire detection will not result in the fire pump/seawater pump operating in firewater mode ("PUMP IN FIREWATER MODE"). Firewater mode means that the back-up generator that supplies the fire pumps will only receive stop signals indicating overspeed/inrush or a short-circuit fault on the generator. Thus, machine protection is not active in this mode.

4.5.1 Fire detection in the area during the incident

Early and conventional smoke detectors are installed in electrical rooms in M40 (such as the high voltage room, local instrument room and low voltage room). A number of smoke detectors were installed in the area where the incident occurred; see the figures below (there were additional detectors in the local instrument room, but only one detector is shown in Figure 19). The sequence in which detectors received an indication of smoke (i.e. a smoke/alarm warning) is also shown.

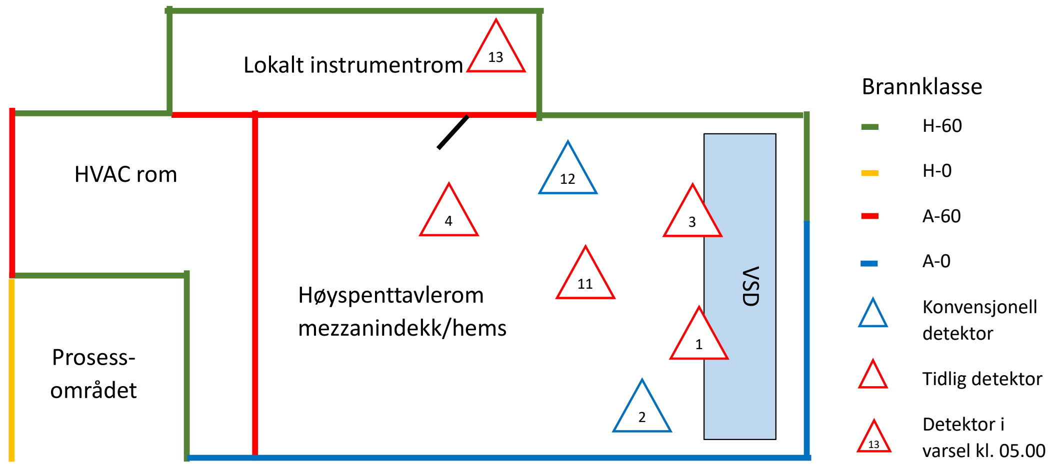


Figure 19 Drawing showing the smoke detectors on the mezzanine deck in the high voltage room and LIR room, and the sequence in which the various detectors triggered a warning/alarm.

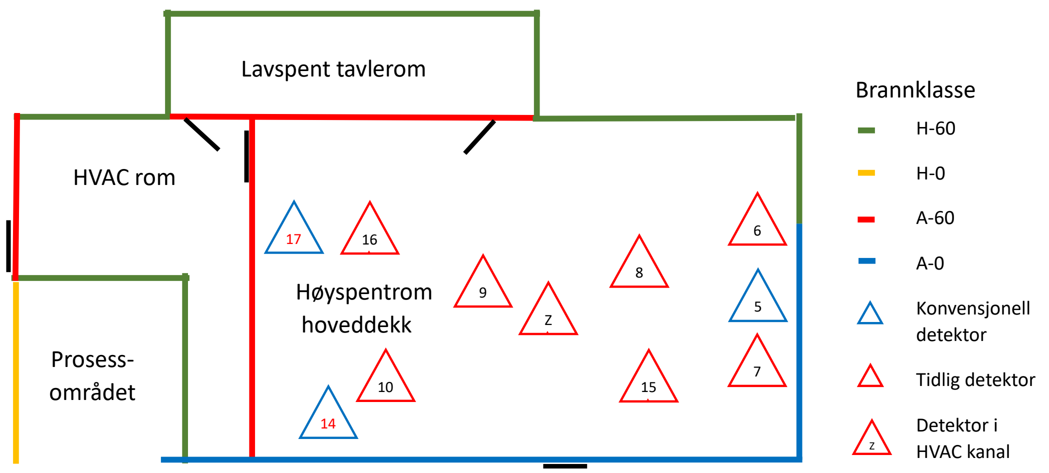


Figure 20 Drawing showing the smoke detectors on the main deck in the high voltage room and LER room, and the sequence in which the various detectors triggered a warning/alarm.

Detector	Type	Deck	Warning	Alarm	Heat signal missing	Point not responding
1	early	mezzanine		04.35.48		07.50.45
2	conventional	mezzanine	04.42.26	04.42.31		07.49.16
3	early	mezzanine	04.43.11	04.43.45	08.08.14	08.49.15
4	early	mezzanine	04.43.48	04.43.50		05.32.54
5	conventional	main deck	04.43.58	04.50.21		
6	early	main deck	04.43.59	04.44.51		
7	early	main deck	04.44.01	04.44.07		
8	early	main deck	04.44.26	05.01.42		
9	early	main deck	04.45.36	04.53.05		
10	early	main deck	04.53.19	04.53.48		
11	early	mezzanine	04.59.31	07.53.49		08.52.17
12	conventional	mezzanine	05.00.46	05.08.00	08.16.28	
13	early	mezzanine	05.00.53			
14	conventional	main deck	05.01.09	05.15.28		
15	early	main deck	05.01.55	05.01.59		
16	early	main deck	05.02.30	05.02.32		07.40.42

17	early	main deck	05.03.41	05.18.29		

Table 1 Overview of the times at which the smoke detectors triggered warnings and alarms. The data is taken from the alarm list in the control room on SLA. The timings show new "events" where the detectors have triggered a warning, alarm or signal error.

The alarm list in the control room shows both detectors in warning mode (indication of smoke, but not enough smoke for the detector to trigger an alarm), detectors in alarm mode (the amount of smoke causes the detector to trigger an alarm), and where the detector has got a signal error.

As the table shows, the first smoke detector (early detector no. 1) switched to alarm mode at 04:35. The detector was located above the part of the VSD which consisted of inverters (IGBTs) (cabinet no. 6, ref. Figure 8). Smoke detector no. 2 (conventional) switched to warning/alarm mode at 04:42. This detector was located at height above the inverter (IGBTs) (cabinet nos. 6 and 7 in Figure 8). Smoke development continued, and two additional detectors (early detectors 3 and 4 shown in Figure 19) on the mezzanine deck switched to warning/alarm mode. Smoke detectors (detectors nos. 5, 6 and 7) located below the VSD on (the main deck) switched to warning/alarm mode between 04:43 – 04:50. The table shows that the smoke continued to spread and all smoke detectors in the high voltage room triggered a warning/alarm signal during the period 04:35:48 – 05:03:41.

At 04:45, the action log in the emergency preparedness room on SLA showed "Smoke detection SLB 2 room". At this time, none of the smoke detectors in rooms around the high voltage room had detected smoke. Smoke detector no. 4 located in the high voltage room had the following description in the event log "SLB M40NM LIR TidlV". The indication that detector no. 4 was located in the LIR room led to misinformation concerning the extent of smoke spreading at this point in time.

Smoke detector no. 13 located in the LIR (a neighbouring room to the high voltage room) received a warning of smoke at 05:00:53. Smoke was spreading to the neighbouring room 25 minutes after the first detector in the high voltage room switched to alarm mode (ref. chapter 4 on fire divisions).

Detector no.	Time of detector triggering alarm (new event)	
1	04.35	
	04.42	
	05.08	
	05.32	
	05.35	
	05.45	
	05.49	
	06.03	
	06.54	
	07.13	
	07.15	
	07.37	The alarm list shows fire detection frequently being reset. The fire develops.
	07.40	
	07.40	
	07.42	
	07.44	
	07.45	
2	04.42	
	05.08	
	05.33	
	05.36	
	05.46	
	05.52	
	06.23	
	06.54	
	07.12	
	07.15	
	07.38	The alarm list shows fire detection frequently being reset. The fire develops.
	07.40	
	07.40	
	07.42	
	07.44	
	07.45	
3	04.43	
	05.08	
	05.33	
	05.35	
	05.46	
	05.49	
	06.03	
	06.54	
	07.12	
	07.15	
	07.37	The alarm list shows fire detection frequently being reset. The fire develops.
	07.40	
	07.42	
	07.44	
	07.45	

Table 2 Overview of the three smoke detectors located closest to the VSD switchboard (detectors nos. 1, 2 and 3) and the time at which the detector switched to alarm mode. The timings are taken from the alarm list, with the list sorted by "new event" and detector in alarm mode.

Table 2 shows an overview of smoke detectors nos. 1, 2 and 3 (ref. Figure 19 and Figure 20) in alarm mode from initial smoke detection until the last recorded detection. The table shows that smoke was present in the high voltage room throughout the entire sequence of events, with a constant signal indicating detectors in alarm mode. We have been informed that the personnel who arrived on SLB opened two fire doors in to the high voltage room at approximately 07:10. The room was full of smoke and the doors were opened to allow the smoke to escape. The wind direction was such that the wind was blowing through the room, which resulted in less smoke and good visibility. Personnel entered the high voltage room at approximately 07:25 and observed white smoke/"theatre smoke". Eventually, the smoke changed to a thick black smoke, with a strong odour emerging from the module.

As can be seen from the table, the frequency of smoke detectors being in alarm mode increased from 07:37 until 07:45. During this period, the alarm list indicates the frequent resetting of the fire detection system and the detectors immediately returning to alarm mode. This indicates that the fire is developing and increasing in intensity during this time. The ventilation of the room may have provided sufficient air for smoke development to escalate and develop into visible flames/fire.

During the investigation, we also obtained confirmation that the supply of power (energy) to electrical equipment in the high voltage room was not isolated at any stage throughout the entire sequence of events (see Figure 3 to Figure 6).

The following equipment was energised:

- At 07:32, the 3kV switchboard and W-81-ET05 (in to the transformer) in the high voltage room were operational.
- At 07:35, a Cooling Unit Low Pressure Alarm was triggered on the LOP panel of the VSD, which may have indicated the start-up of pumps supplied from the 440V panel in the high voltage room.
- UPS switchboard W-85-EL05 (which supplies the VSD with control voltage, ref. the sign shown in Figure 11) was operational throughout the entire incident.

Energising of the abovementioned equipment (compared with increased smoke development from 07:37) may also have contributed to the development of the fire in the high voltage room.

4.6 Ventilation/HVAC

The HVAC system that supplies the fire area in module M40 consists of a power supply unit with the TAG number W-77-GA04 and an extraction unit with the TAG number W-77-GA05. Both units have redundant fans with 2x100% capacity. Three gas detectors are located at the inlet grate. Fire dampers for the module are only installed at the air inlet and air outlet. The control philosophy for the HVAC system in the event of a fire inside the module is for the system to continue operating during the fire in order to vent smoke and any unburned combustion gases from the area of the fire. This is called ‘active smoke control’, and the idea behind it is to ensure that smoke-free evacuation routes are available in the event of a fire.

Requirements for the HVAC system.

- The Facilities Regulations set out requirements for ventilation in Section 14:
  - *… The ventilation shall also be designed so that smoke from fires can be controlled.*
  - The guidelines related to Section 14 refer to the following standards: NS-EN ISO 15138, Norsok H-003 and Norsok S-001.
- Norsok S-001 specifies dependencies for the HVAC system
  - *The HVAC system’s performance is dependent on an emergency power supply in order to maintain ventilation if the main power supply fails.*
- The safety strategy for the Sleipner field specifies Equinor’s internal requirements for the ‘natural ventilation and HVAC’ safety system.
  - The roles of the safety system (inter alia)
    - *Secure smoke-free evacuation routes and vent smoke and unburned combustion gases from fire areas in the event of a fire (active smoke control).*
    - *Maintain necessary ventilation and cooling of rooms that must remain operational in an emergency.*
  - To fulfill the role of the safety system in technical rooms, the following requirements are stipulated:

- *Technical rooms are mechanically ventilated to ensure that a satisfactory environment is maintained for the equipment in the rooms. The rooms are balanced via overpressure. All important rooms containing safety-critical equipment (Group 3), i.e. control rooms, emergency preparedness rooms, emergency generator, etc., have their own ventilation system with 2x100% capacity and are connected to the main air inlet. This is connected to an emergency power supply and will be operational in an emergency. In the event of gas being confirmed in the main air inlet, ventilation of these rooms will be stopped and the damper closed to prevent the gas from coming into contact with ignition sources.*

All four fan motors are supplied from switchboard W-82-EN03. The only emergency power supplies on SLB comprise two UPS systems, each of 40kVA. They do not have sufficient capacity to ensure operation of the HVAC system if the main power supply fails. Thus, the requirements listed above cannot be met.

4.6.1 HVAC during the incident

Prior to the incident, fans W-77-GK03B and W-77-GK04B were operational. After the fire had been confirmed, both fans continued to operate continuously until 05:01. They then stopped as a result of the 440V supply being lost from switchboard W-82-EN03, after switch W-81-EF05 was opened. After this time, the HVAC system was out of operation.

4.7 Firefighting

4.7.1 Fire in electrical room

There are no fixed firefighting systems in the high voltage equipment room. The safety strategy (5.3.9 PS 9 Active fire protection) for SLB describes the philosophy in the event of an incident involving a fire in an electrical room. "*Electrical rooms are protected through early detection and isolation of the power supply (energy) to the room, and any additional manual response. Isolation of the power supply for personal safety reasons in connection with fire-extinguishing must be carried out for all voltage levels from 230V and above. This requirement is aimed at preventing any potential touch hazards for unprotected first-line personnel who are attempting to extinguish a fire using handheld equipment. Handheld CO_2 extinguishers are located near or in these rooms.)*"

According to the "Safety Plot Plan" drawing, six 5kg CO_2 handheld fire extinguishers are available on both the main deck and the mezzanine deck. A different type of powder fire-extinguisher is also installed nearby. In the area outside, there are hose reels/fire hoses (referred to as 'fire posts' in the safety strategy) which are supplied by the fire water system. The nearest fire hose is installed in the process area shown in Figure 21.

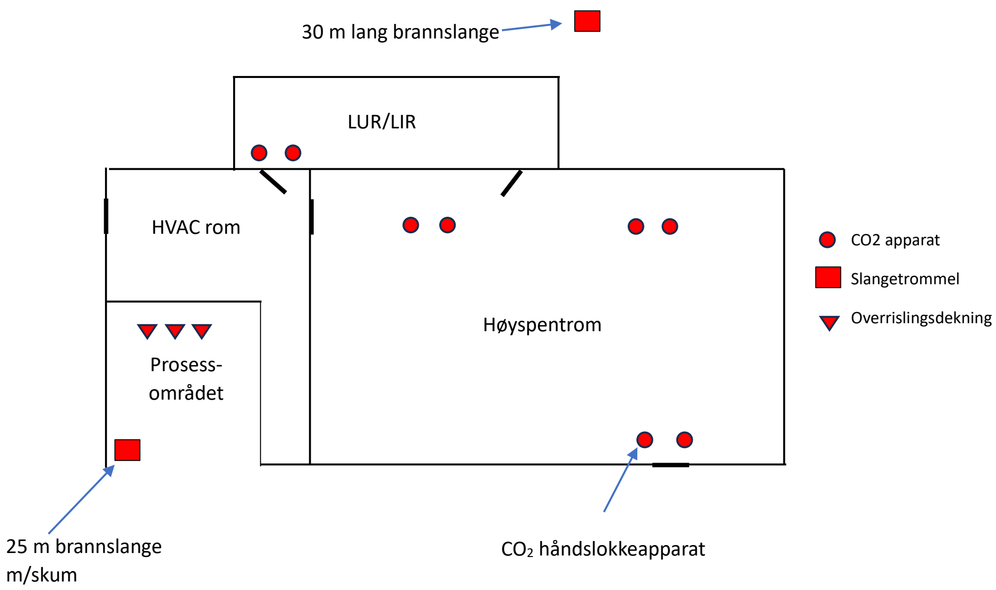


Figure 21 Overview of firefighting equipment in the high voltage room and surrounding areas. The drawing also shows the fire doors with regard to access in connection with the manual extinguishing of a fire in the high voltage room

In addition, there is deluge coverage/fixed firefighting systems in adjacent process areas.

4.7.2 The fire water system

4.7.2.1 Fire pumps

SLB has two electrically operated fire pumps which are combined seawater pumps, one of which is normally in operation. The fire/seawater pumps are powered from a power supply from SLA (power cable between SLA and B). The power cable enters the 13.8kV switchboard, which is located in high voltage room M40. The fire pumps do not have an independent dedicated diesel generator which will start up in the event of failure of the power supply from SLA. In the event of the power supply from SLA being lost, a diesel back-upgenerator will start up automatically and supply power to one of the fire pumps. The back-up generator is connected to the 3kV switchboard located in the high voltage room.

According to the system description for the fire water system, the capacity of the pumps is 1,300m^3/h at 12.6 barg. A fire pump must at all times have the capacity to supply fire water to the deluge system in the process and wellhead area (739 m^3/h) and the deluge system in the compression module (624 m3/h) in the event of simultaneous discharge.

4.7.2.2 Fire water for consumers

- Fire extinguishing system

  The pumps supply fire water to the following fire-extinguishing systems on SLB: deluge systems in the process and wellhead area and the compression module, monitors on the helicopter deck and fire hydrants for manual firefighting. The two fire pumps are supplied from the 3kV switchboard located in high voltage room M40.
- Oil circulation unit (the cooling oil system)

  The cooling oil system is supplied with cooling water from the fire water system (5 m^3/h). The cooling oil system cools the electric pump motors, and the system must be in operation whenever the fire pumps are in operation. In addition, the system is intended to prevent seawater from entering the electric motors. The cooling oil system is supplied from the 440V switchboard located in low voltage equipment room (LER) M40, which is separated from the high voltage room by an A-60 fire division. Fire pump A is dependent on the A side of the 440V switchboard. Fire pump B is dependent on the B side of the 440V switchboard. The 440V switchboard is dependent on receiving its power supply from the 3kV switchboard, which is located in high voltage room M40 or from 440V switchboard W-82-EN01 in C30.
- Cooling of the back-up generator motor

  Fire water is used as cooling water for cooling the diesel engine for the back-up generator (seawater/fire water consumption rate $60m^3/h$). To ensure that the motor does not become too hot and fail, a cooling pump must be available whenever the back-upgenerator is operating (the generator can be operated for 10 minutes without a cooling water supply). The cooling pump receives its power supply from the 440V switchboard located in low voltage equipment room (LER) M40. The 440V switchboard is dependent on receiving its power supply from the 3kV switchboard, which is located in high voltage room M40 or from 440V switchboard W-82-EN01 in C30.

4.7.2.3 SIL and vulnerability analysis

During the compressor module project, it was decided to replace the fire water system that was installed on SLB at the time. Among other things, two new seawater/fire pumps (combined) and a water mist system were installed in the back-up generator container. A SIL analysis entitled "SIL Analysis and Firewater and Water Mist Systems at SLB" was prepared. This analysis also includes a vulnerability analysis "Appendix A: "Vulnerability Analysis of the Firewater System."

The SIL analysis only covers the safety system. The various components that supply power to the fire pumps (e.g. power cable, back-up generator) have not been considered part of the safety system. Thus, the power supply to the fire pumps is not included in the SIL calculations. The analysis concluded that the fire water system complies with the SIL requirement, which is SIL 2.

The vulnerability analysis concluded that the technical solution, where the power supply to the fire pumps (power cable, back-up generator) passes through the high voltage room (all switchboards and relays are located in the same room), is the most vulnerable part of the safety system. This technical solution was designated category C by the vulnerability analysis based on an undesirable event involving a fire, explosion and gas exposure. As regards undesirable events involving a fire, it states the following: *"Fire can occur, short circuit, electrical failures. A fire will cause the power to be cut to isolate all ignition sources. This causes a total loss of the firewater function (no power to the pumps)"*. Category C in the analysis is defined as: *"Large effect on the system or loss of redundancy. The system can most likely not perform its function"*. The vulnerability analysis goes on to provide the following recommendation: *"It should be considered whether the position of the main switch board, including both opportunities for power to the firewater pumps, is safe enough"*. Based on this recommendation, the project conducted an internal assessment of the main equipment room (high voltage room). The minutes from the internal assessment state that the purpose of the internal review was to look at whether the proposed design based on a switchboard with a bus-tie switch was a good solution. Furthermore, it is concluded in the minutes that the solution was satisfactory. *"The probability of the entire switchboard going down is small and, if we lose one side, we are down for a short period of time before we have sorted the problem and bypassed it, and are up again with electricity/fire water"*. The internal assessment thus concluded that the technical solution was safe, although minor small adjustments were implemented. We have not been informed exactly what adjustments were made. The internal assessment did not include an assessment of the technical design of the main equipment room with regard to an undesirable event involving a fire in the room which results in loss of the power supply to SLB. The internal assessment only looks at a proposed design with a 3kV switchboard with bus-tie switch and considers this design to be a good solution, with no need to separate the 3kV and 13.8kV switchboards into two separate rooms.

In conjunction with the SIL analysis which was conducted on the fire water system, no account appears to have been taken of faults on auxiliary equipment which could put the system out of operation.

4.7.2.4 Situations resulting in loss of fire water

- Simultaneous loss of main power supply (power cable) and non-availability of back-up generator.
- Incidents involving fire in the high voltage room will result in loss of the 13.8kV switchboard (supplied via the power cable) and the 3kV switchboard (supplied from the back-up generator). The fire pumps are dependent on the power supply from the 3kV switchboard. Either the A or B bus on the 3kV switchboard must be energised.

- 440V switchboard located in the low voltage equipment room (LER) in M40. If fire pump A is in operation, the A bus in the 440V switchboard must be in operation. Similarly, with pump B, the B bus must be in operation.
- The safety strategy for SLB states that the back-up generator will not start if the main power supply via the subsea cable from SLA fails and alarms have been activated inside the back-upgenerator (e.g. low cooling water). The back-upgenerator is normally in auto mode, and machine and all other protection will then be operational. In such a case, the fire pumps will be without any power supply. Personnel must then transfer across to SLB and set the back-upgenerator in manual mode, thus causing the control to ignore the alarms locally on the back-upgenerator (in manual mode, the back-upgenerator is in "unprotected mode"). Thus, an alarm from the back-upgenerator will result in the loss of fire water if the power supply from SLA drops out
- A number of systems are dependent on the seawater/fire pumps being in operation. In the event that the seawater/fire pumps are not operational, the back-upgenerator or diesel engine will not be cooled.
- Operation of the fire pumps is dependent on several circuit breakers and transformers. Different issues require different switch arrangements.

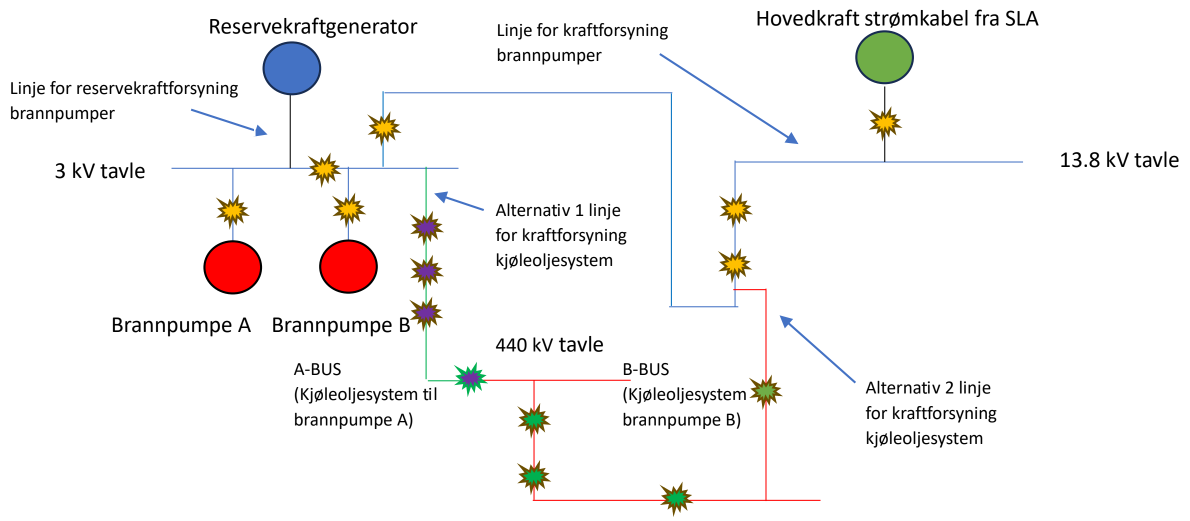


Figure 22 Diagram showing the circuit breakers and transformers that form part of the power supply for the fire pumps on SLB.

Description for Figure 22:

Indicates switches/transformer where failure of the various components could result in the loss of fire water in connection with the power supply from the SLA subsea cable.

Indicates switches/transformer where failure could result in the failure of the cooling oil system for fire pumps A/B (there are also individual faults/failures in the components that would result in the loss of fire water). Operation of fire pumps A/B is dependent on the cooling oil system. The figure shows two options for supplying power to the cooling oil system for fire pumps A/B (the purple and green symbols)

The figure shows that the adopted design solution is vulnerable, as dependencies in the system could cause the fire pumps not to start up when needed.

4.7.2.5 The fire water system during the incident involving fire in the high voltage room

The fire pumps did not start up during the incident.
The emergency stop button for the two fire pumps was pressed upon arrival on SLB.
The valves for the fixed firefighting systems that supply the process areas (C30 and M40) are set in the closed position upon arrival on SLB
There is no fixed extinguishing system in the high voltage room; only the CO_2 handheld extinguisher is available for fighting the fire in the high voltage room.

4.8 Communication systems

On SLB, the following communication equipment was available for external/internal communication:

- Aircraft radio (VHF AM)
- Fixed and portable VHF
- Handheld UHF connected to external outdoor directional antenna.
- Telephone, DECT wireless telephone
- There was also mobile coverage in the outdoor areas on SLB from the base station on SLA
- Duplicated PAGA systems
- UHF base station connected to the local distribution network with antennae and a “leaky” cable (two unique channels for SLB, and three channels shared with SLA).
- Non-Directional Beacon (NDB)

Central telecommunication equipment for the abovementioned systems and fixed radios are supplied from five different UPS systems on SLB.
The PAGA A and B system is supplied from two independent 48V DC UPS systems located in separate rooms.
There is a dedicated 24V DC UPS system that supplies fixed VHF, aircraft radio and NDB.
In addition, there are two "Misc" UPS systems which, among other things, supply the telephones, MUX, radio link and UHF base station. It is somewhat unclear why the switchboard (PABX) and DECT remained operational during the incident, but not the UHF system, as these are all connected to the two "Misc" UPS systems.

As a result of the central UHF equipment being connected to only one of the UPS systems, it is a plausible theory that this one ran out of power before the other one. However, there is no verifiable information to confirm this.

In the event of the complete loss of UPS power on SLB, the principle will depend on portable radios/phones with lower power and antennae with lower self-amplification, in addition to being within coverage of the receiving station.
In other words, in this case, it would have been necessary to stand on the south side of the platform, rendering “live” reporting from the scene of the accident impossible. In this case, it would have been necessary to stand outdoors with a clear view of SLA in order to make contact. As regards the UHF radios, it would also have been necessary to change the radio channel in order to enable direct radio-to-radio "simplex" communication, which would then bypass the base stations.
To ensure robustness, there was, as noted during the interviews, a solution which used a handheld UHF radio connected to an external directional antenna pointing towards SLA. This radio has its own battery and was being charged continuously. Such a solution enables indoor direct communication between SLA and SLB with better signal strength.
We were told that this outdoor antenna was damaged during the flushing by the water monitors on the FIFI vessels, but the solution should have been available at the time of the first visit to SLB.
It was not clear whether this solution was actually used, or whether the crew were even aware of it at all.

During the first visit on board to inspect the damage and check whether the fire was still burning, communication with SLA took place via a DECT phone and the local base station on SLB. This communication solution relies on the local UPS on SLB being operational.
Using "Misc" UPS systems to supply safety-critical communications equipment, along with other equipment, can make the emergency power solution more complex and less robust with regard to faults. This can also cause the battery bank to “discharge” more rapidly. When it is not being used for transmissions, communication equipment normally has a relatively low power consumption, i.e. “idle power consumption”.

4.8.1 Communication during the incident

During the interviews, it became clear that there were challenges relating to communication between a number of operators involved during the incident. We were told that there is a known problem with radio coverage on SLB. As we understand the communication challenges which arose during the incident, it was problematic that it was not ensured that a UPS power supply would be available during the incident itself, and that there were no satisfactory solutions in place to safeguard communication. Most of the fixed communication equipment was located in the old living quarters area, which was a long way from the scene of the incident.

The On Scene Commander encountered problems communicating with both the SAR team and the emergency preparedness management team on SLA. Several of the fire helmets had no communication wire, and there was a lot of noise and interruptions on the fire team's channel from another facility nearby. There was also noise from the helicopter on the helicopter deck, as its engine was running, ready for possible rapid evacuation. To improve communication with SLA, the On Scene Commander used a phone. However, this resulted in many people losing access to information and communications. It was also difficult to communicate internally on SLB.

5 Maintenance

As part of the investigation, maintenance was discussed as a topic during a number of interviews. We also received an internal Synergi case on this dating from 23 February 2018 (Synergi no. 1534539). Equinor has completed a project called "Plant Integrity", which links maintenance concepts to equipment. These maintenance concepts were not linked to the VSD on SLB, which meant that the maintenance activities were not in SAP. In the case, it is stated that a lot of unnecessary text in preventive maintenance (FV) templates increases the risk of important maintenance not being performed, of there being a lot of text that is irrelevant to the job, and of it being difficult to know what to actually do on the FV. According to the case information, this issue has been raised and the case has been closed.

It emerged during the investigation that water has been added to the cooling system for the VSD every 14 days. Neither the task nor the volume of water added was logged in SAP, but the date, the pressure in the expansion tank before and after filling, the conductivity of the water, and the volume of water added were recorded on a sheet of paper pinned to the door on the VSD. The volume of water was only included in about half of the logs. The sheet of paper also stated that water would start to be added at a pressure of 1.5 bar, and that water would then be added to take the pressure up to 3 bar. In practice, water was added until a pressure of approximately 3 bar was reached each time there were personnel on board SLB. On the occasions when the volume of water was recorded, the average volume of water added was approximately 2 litres. It was stated on the sheet of paper that some water consumption was normal, although this was not quantified. No corrective maintenance orders or other activity reports are created in SAP in connection with the addition of water. We were informed that the expansion tank for the internal cooling water circuit was replaced in the summer of 2023 and that water consumption decreased after this. The data on the log sheet shows that water consumption then decreased from corresponding to a pressure drop in the expansion tank of 0.15 bar/day to 0.05 bar/day.

The Profibus link between SLA and SLB had not worked since the turnaround in August 2024. Our verification showed that there had not been a maintenance programme that checked or verified that this function worked after the turnaround. The latent failure was not known at the time of the incident.

Electrical switchboards, switchboard switches and the emergency power system all have different main functions and are classified differently in terms of both criticality and redundancy. Despite this, they are part of the same function chain, where the loss of components could result in the auxiliary function in its entirety being put out of action.

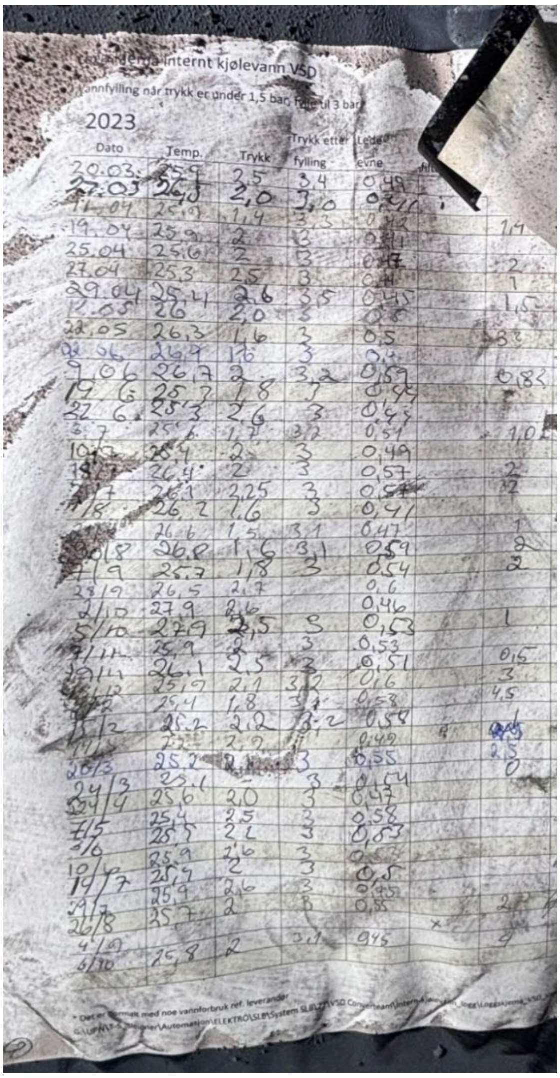


Figure 23 Log of water filling in the internal cooling system, VSD (Source: Norwegian Police)

6 Sequence of events

At 04:35:48 on 22 October 2024, the first of several smoke alarms was triggered in the high voltage room in the M40 module on SLB. The central control room (CCR) first called the Operations and Maintenance superintendant manager to discuss the alarms. They decided to reset the alarms, but the alarms continued to be triggered. The CCR sent a silent notification to the emergency preparedness management, which then mobilised in the emergency preparedness room. It was initially somewhat unclear to the emergency preparedness management what had happened, as the silent alert contained a report of a DSHA involving a radioactive source, but this was quickly clarified through a telephone call to the CCR. The CCR and the emergency preparedness room on SLA are located on different floors and all communication must take place by telephone.

At 04:50, the CCR began pressure relief on SLB. In accordance with the emergency preparedness plan, the CCR then notified the second line onshore, JRCC, the preparedness vessels and SAR helicopter. POB on SLB was 0. POB on SLA was 217. The area response vessels Skandi Mongstad and Esvagt Bergen both set course for SLB, with estimated arrival times at 06:20 and 08:30 respectively. The SAR helicopter from Johan Sverdrup (JS) circled SLB and reported to SLA at 05:58 that they could not see any external signs of a fire. They then landed on SLA.
SLB was shut down and depressurised. The SLB was de-energised and was now operating on UPS power. HVAC was shut off in connection with SLB being de-energised.

At 06:15, it was decided to send a team over to SLB to determine the conditions on the facility and to restore UPS charging. A team of seven persons were mobilised on SLA, which was to travel to SLB in order to obtain an overview of what had happened. They were to check the switchboard room and vent the smoke that had been observed on camera. This smoke was described by several people during the interviews as white "theatre smoke". It appears that there was a strong focus on the fact that the facility would lose power (UPS) shortly. The seven-person team consisted of electricians and personnel from the Search and Rescue (S&R) team. As SLB had been de-energised, the fire water system on the helicopter deck also did not work, and the helicopter was unable to land until an area response vessel with FIFI was in place. The team did not bring any equipment from SLA, nor were they wearing personal locator beacons on their immersion suits when they flew across from SLA to SLB. When the team landed on SLB at 07:02, the two electricians went to open the two doors into the room where smoke was being generated in order to ventilate the room, while two members of the S&R team went to put on smoke diving equipment with breathing apparatus. The S&R team had no thermal imaging camera or powerful torches. The S&R team only had normal torches when they entered the room. The fire helmets also had no lights. After the S&R team had completed its first sweep of the room, they each brought an electrician into the room to carry out an inspection. The On Scene Commander faced challenges communicating with both the S&R team who were in the module and SLA. He was then assisted by another person to take over the communication with S&R team in the high voltage room, and the On Scene Commander used the phone to communicate with SLA.

The team on SLB reported to SLA that they were unable to identify any obvious cause of the smoke. On this basis, the emergency preparedness management team began the process of normalising the situation. Esvagt Bergen was then demobilised and began the return sailing to the Utsira High.

On SLB, they attempted to restore the power supply during the period between 07:23 and 07:35. During the same period, further smoke development occurred. The main transformer was again disconnected at 07:47. There was black smoke inside the high voltage room. Electricians were followed out of the room by the S&R team, who then went back into the room to see whether they could find the source of the smoke. As they climbed the stairs towards the VSD, the smoke was so black and thick that they could only see clearly about half a metre in front of them right down on the floor. When they looked up, they could just about glimpse a glow coming from the VSD. The CCR on SLA saw the same flames on CCTV and the evacuation alarm on SLB was activated from the CCR 08:52. Everyone on board SLB withdrew to the helicopter deck and the SAR helicopter took off and headed for SLA at 08:57.

Due to the escalation, Esvagt Bergen was ordered to return to SLB. When the SAR helicopter had left the area, Skandi Mongstad began external cooling of the area at 09:15. About the same time that external cooling started, what was thought to be flames on SLB were observed from SLA. This turned out to be a reflection from the sun.

Some of the personnel in the S&R team were exposed to smoke, and were checked by the medic when they returned to SLA.
At 08:35, the navigation lights were out of operation. A 2 nm safety zone was created around SLB. There was no electricity or monitoring on SLB, so the emergency preparedness vessel Skandi Mongstad monitored the situation.

Esvagt Bergen arrived at SLB at 10:55 and began by dousing water onto SLB. The emergency preparedness management demobilised at 11:10 and the CCR on SLA took over management of the incident.

At approximately 12:00, FIFI was stopped to see whether any smoke was still visible. After a short time, Skandi Mongstad observed smoke again, and they resumed cooling using a FIFI vessel.
At around 12:50, SAR JS was sent to Sola to install FLIR, and SAR Oseberg went to Johan Sverdrup to cover emergency preparedness and to be at readiness for the incident on SLB.
At 14:14, the emergency preparedness vessels once again stopped dousing and no smoke was observed until 17:20. Cooling was then resumed by Skandi Mongstad,

while Esvagt Bergen observed. At 21:45, preventive cooling was terminated, and no smoke was subsequently observed.

At 08.00 on the following day, 23.10.2024, Esvagt Bergen was relieved by Skandi Iceman. At 09:15, SAR JS flew to SLB to observe. The purpose of this was:

- To record a video above and below the helicopter deck to verify that the helicopter deck was not damaged.
- To record a video with FLIR around the entire lowermost floor with a particular focus on doors in the area where smoke/fire was observed (In the area with blue containers)
- Record a video with FLIR around the risers to search for potential gas.
- Make a sweep around the entire platform
- To record a video from the top of platform with FLIR

22.10.2024 Time:	**Incident element**	**Additional Information**
04:35:48	First smoke detector alarm activated. The tag on the smoke detector refers to module M40 lower mezzanine and also contains the Tag no. for the VSD.	Alarm list
04:38:03	Fire and gas reset to see whether the detector is reactivated.	Alarm list
04:42:09	The same detector is reactivated and transmits a warning and two seconds later an alarm.	Alarm list
04:42:26	Another smoke detector transmits a warning, followed by an alarm 5 seconds later. The alarm text shows that the detector is in module M40, lower mezzanine, and also includes the text “höyspent” (high voltage).	Alarm list
04:43:00	Alarm W-27-ER01_102_ Driver alarm is received. The alarm text does not contain any additional information. The Tag no. in the text refers to the VSD. The alarm stops in the same second that it is received. The alarm is re-activated 2 seconds later and then ceases again at 04:47:46, and is then re-activated again 2 seconds later. The alarm is acknowledged by the CCR operator at 04:49:03.	Alarm list
04:43:00	Alarm W-71-US__102_ Br. Can. Syst, Error is received. This is an alarm that refers to the fire water system.	Alarm list

22.10.2024 Time:	Incident element	Additional Information
04:43:00	The alarm W-27-ER01_101_ Mv7000 driver error is received. The alarm text does not contain any additional information. The Tag no. in the text refers to the VSD.	Alarm list
04:43:00	An additional 17 alarms associated with VSD (W-27-ER01) are received: Insulation fault DC Link Low Volt DC Link Imbalance IGBT 1 V2+ IGBT 1 V1+ IGBT 1 W2+ IGBT 1 W1+ IGBT 2 W2+ IGBT 2 W1+ DC Link Over Volt - AC Inverter Over Current U AC Inverter Over Current V AC Inverter Over Current W Zero Seq. Over Volt PIB General Fault DC Link Too Low Start Prem These alarms indicate an electrical fault in the VSD or the motor operated by the export gas compressor (VSD). The IGBT alarms are from IGBTs, which are located in the lower and middle sections of the left inverter panel.	Alarm list Motor winding was subsequently checked through insulation measurements, with no faults being detected. The IGBTs that triggered an alarm are indicated in red in Figure 12.
04:43:00	Alarm from local control panel A (LCP A) and B (LCP B) for back-up generator.	Alarm list These back-up generator control panels were still receiving power at this time. We have not determined the reason why this alarm was activated at this time.

22.10.2024 Time:	Incident element	Additional Information
04:43:00	The 13.8kV switch which supplies the VSD (W-80-EF06) goes from status closed to not closed. The switch sequence does not continue to open. Data extracted from the protection system indicates that the fault current was interrupted. The fault current was due to a short circuit and ground fault in the DC part of the VSD.	Alarm list and data from overcurrent protection.
04:43:11	The third smoke detector triggers a warning, followed by an alarm 34 seconds later. The alarm text shows that the detector is located in module M40, lower mezzanine, and also includes the Tag no. for the VSD.	Alarm list
04:43:23	Manual pressure relief of the 27 system (gas compression) on SLB is activated from the CCR.	Alarm list
04:43:48	A fourth smoke detector triggers a warning, following by an alarm 2 seconds later. The alarm text indicates that the detector is located in module M40, lower mezzanine, local instrument room (LIR).	Alarm list It subsequently became apparent that this detector was actually located in the high voltage room. The error in the alarm text meant that the situational understanding was that smoke development was occurring in two rooms.
04:43:58	A fifth smoke detector triggers a warning. The alarm text indicates that the detector is located in module M40, main deck, in the high voltage room. Over the next ten minutes, alarms were received from a further five smoke detectors from the main deck in the high voltage room. These detectors consist of two on the 3kV switchboard and one for each of the transformers W-82-ET04, W-27-ET01B and W-27-ET01A.	Alarm list
04:47:42	Emergency shutdown of SLB is initiated from the CAP panel in the CCR.	Alarm list
04:47:45	Emergency shutdown also entails process shutdown PAS 3.0 on SLB.	Alarm list

22.10.2024 Time:	Incident element	Additional Information
04:47:45	Emergency shutdown involves isolating loads on the 440V switchboard in M40, including the circulation pumps for the internal cooling water circuit in the VSD.	Alarm list
04:48:00	The valves that isolate the fire water system from the seawater system are closed.	Alarm list
04:50	Pressure relief initiated	Main log
04:54:23	More new alarms from the VSD are received. These IGBTs are located in the upper part of the inverter cabinet of the VSD. IGBT 1 U2+ IGBT 1 U1+ IGBT 2 U2+ IGBT 2 U1+ IGBT 2 V2+ IGBT 2 V1+	Alarm list With these six alarms, all 12 IGBTs with a '+' at the end of the text in the alarm description have activated an alarm. These are all the IGBTs that are in the left inverter panel. The six IGBTs are marked in green in Figure 12.
04:54:32	Alarm from VSD indicating that the 230V power supply to W-27-ER01_074_T is off. LOP panel alarm with the text D162: 220V supply OFF Flt.	Alarm list and LOP panel We have used this alarm to adjust the time specification in the alarm list from the LOP panel, so that it was synchronised with the alarm list from the control room.
04:55	The CCR alerts the 2nd line	Main log
04:59:31	Eleven smoke detectors issue a warning. During the period up to 05:03:41 a further six detectors activate a warning and/or an alarm. These are all located in the high voltage room or in the LIR (05:00:53). One of these is located next to transformer W-82-ET05, while another is located next to 13.8kV switchboard W-80-EH02.	Alarm list
05:00:28	Manual pressure relief for the rest of SLB is initiated from the CAP panel.	Alarm list

22.10.2024 Time:	Incident element	Additional Information
05:01:14	Switch W-81-EF05 which runs from the 3kV switchboard to transformer W-82-ET05 is opened.	Alarm list
05:01:14	Switch W-82-EF06 switches to status not closed.	Alarm list
05:01:17	Alarm from transformer W-82-ET06 which is between 440V and 230V in M40. The transformer is physically located by the VSD in the high voltage room.	Alarm list
05:01:19	Alarm from switch W-82-EF06 with alarm text "Switch 440V In".	Alarm list
05:01:22	Alarm indicating that the back-up generator is not available.	Alarm list
05:01:28	Fire pump A is in operation. Supplied from SLA power cable. Two seconds later, an alarm is received indicating low pressure in the oil cooling system for fire pump A.	Alarm list Fire pump A is not in fire water mode.
05:02	Skandi Mongstad: ETA at SLB 06:30	Main log
05:03	Emergency preparedness vessel Esvagt Bergen: Sets course for SLB (ETA 08:30)	Main log
05:04	Area response vessel Skandi Mongstad ETA at SLB 06:20	Main log
05:04:43	Incoming switch (W-80-EF03) on SLB is opened. SLB now has no power supply and is only being supplied by UPS power. This also means that fire pump A stops. The back-up generator does not start up.	Alarm list
05:04:44	Switch W-80-EF04 opens. This supplies the main transformer in system W-82-ET04. The switch comes in a few seconds later with an alarm and notification of an electrical fault.	Alarm list
05:06:46	An eighth smoke detector triggers a warning for the air compressor on C30 weather deck.	Alarm list
05:07	The Platform Manager alerts the 2nd line	Main log
05:11	Havtil is notified by the 2nd line	Main log
05:15	Depressurised platform	
05:35:47	A ninth smoke detector triggers a warning and, during the period through to 06:08:58, five additional detectors come in with warnings and/or alarms. These are all located in M40 LIR.	Alarm list
05:45:19	An attempt is made to reconnect switch (W-80-EF03) on SLB again.	Alarm list and PI-Vision

22.10.2024 Time:	Incident element	Additional Information
	On the switchboard in the emergency preparedness room, it is stated that they attempted to close the switch, but without success. Both trends from PI-Vision and the alarm list indicate that the switch is closed.	There is uncertainty as to whether the switch was actually closed; see section 4.1.4.
05:45:50	Switch W-81-EF06 between main transformer and 3kV switchboard is opened.	Alarm list
05:48	The SAR coordinator reports that they cannot see any external signs of fire on SLB after circling the platform.	Main log
05:49:58	Switch W-81-EF05 between 3kV board and transformer W-82-ET05 is closed.	Alarm list
05:50:12	Switch W-81-EF06 between main transformer and 3kV switchboard is closed.	Alarm list
06:04:30	Switch W-81-EF06 between main transformer and 3kV switchboard is opened.	Alarm list
06:10:31	Smoke detector no. 25 triggers a warning. This detector is located in the M40 low voltage room. Two additional detectors in the low voltage room and two detectors in the LIR trigger a warning and/or alarm during the period through to 06:49:45.	Alarm list
06:15	The emergency response management team decides to send a team over to SLB	1st line log
06:52	The 2nd line is informed that the SAR helicopter is taking 7 pax (passengers) from SLA to SLB and that they are going to the switchboard room. There is a comment in the log which indicates that normalisation was now in progress and that the vessels were reducing speed as they approached the installation.	Main log
06:56	SAR Johan Sverdrup takes off in the direction of SLB	Panel
07:02	SAR helicopter landed on SLB	Main log
Approx. 07:10	The fire doors on both sides of the high voltage room are opened to vent smoke.	Interview
07:13	Emergency stop button pressed by response personnel on fire pump A. Done to avoid deluge when power is restored.	PI-Vision and interview

22.10.2024 Time:	Incident element	Additional Information
07:14	Emergency stop button pressed by response personnel on fire pump B. Done to avoid deluge when power is restored.	PI-Vision and interview
Approx. 07:15	The electricians in the response team are up in the open loft next to the VSD and observe water on the floor, which they conclude must be due to holes in the VSD cooling water circuit. They also see soot particles on the top of the pre-magnetisation transformer and in the surrounding area.	Interview
Approx. 07:20	The electricians in the response team come down from the loft and go to the 13.8kV high voltage switchboard. There, they check that the switches for the VSD are isolated.	Interview
Approx. 07:20	The switch on the 440V switchboard that supplies the pre-magnetisation transformer for the VSD is opened by the response team on SLB. This is to ensure that this will not supply power to the VSD when power is restored to the 440V switchboard in M40.	Interview
Approx. 07:23	Switch W-80-EF03 is closed and energises the 13.8kV switchboard on SLB.	Interview
07:23:22	Switch W-82-EF04 is closed by the response team that has now arrived. This supplies the main transformer in system W-82-ET04. The power supply has now been restored to the C30 module (switchboard W-82-EN01). The electricians note that charging of the UPS systems has been restored, and that lighting has returned to areas supplied by switchboard W-82-EN01.	Alarm log
07:26-07:29	The power supply to switchboard W-82-EN01 is lost again during these three minutes.	Alarm log with zero voltage alarm.
07:28	Esvagt Bergen is demobilised and returns to Utsira	Main log
07:32-07:47	Power supply to the 3kV switchboard in M40 is restored. In addition, switchboard W-82-EN03 (440V in M40) is energised for all or part of this time interval.	Alarm log and LOP panel
07:35:23	Alarm from LOP panel. D1179: Cooling Unit Low Pressure Alarm. Simultaneous alarm from VSD, W-27-ER01_102 Driver Alarm (07:35:24)	Alarm log and LOP panel

22.10.2024 Time:	**Incident element**	**Additional Information**
07:43:35	Alarm from LOP panel. D1164: Fan Supply OFF Alm. Simultaneous alarm from VSD, W-27-ER01_087_T Fan supply.	Alarm log and LOP panel
07:46:22	Multiple IGBT alarms from LOP panel and PCDA (07:46:23) There are 12 IGBT alarms, all of which concern the IGBTs located in the right-hand inverter panel. These are marked in yellow in Figure 12.	Alarm log and LOP panel
07:46:47	Alarm linked to tripping of external cooling water pump 2 for the VSD, Switch W-80-EF05 position error and available error. Simultaneously, several alarms in the alarm log linked to the VSD: Watchdog Relay Error Filter RTD d Kjölskid H2O Level Low Transformer A RTD Fault Transformer A RTD Fault Transformer A RTD Fault Transformer A RTD Fault Transformer B RTD Fault Transformer B RTD Fault Transformer B RTD Fault Transformer B RTD Fault Filter Temp RTD Fault Filter Temp RTD Fault Filter Temp RTD Fault	Alarm log and LOP panel
07:48:49	Aux supply off and precharge supply off. Also alarm for deionised water leak detected in the VSD. Leak detector is only in the panel where the internal cooling circuit pumps are located. Simultaneous alarms in alarm list linked to VSD: W-80-EF06_018_T Emergency stop W-27-ER01_073_T Aux Supply Off W-27-ER01_076_T Fuse blown W-27-ER01_104_ Motor RPM	Alarm log and LOP panel
07:48:50	D1163: 400V Supply OFF Alm Simultaneous W-27-ER01_102 Driver Alarm.	Alarm log and LOP panel

22.10.2024 Time:	Incident element	Additional Information
07:48:51	Alarm from cooling unit for VSD linked to high temperature and high conductivity of deionised water.	LOP panel
07:48:53	Alarm linked to position of ground switch for VSD.	LOP panel
07:50:46	Incoming switch (W-80-EF03) to the 13.8kV switchboard on SLB is isolated by the response personnel on SLB.	Alarm log and interview
07:50:51	Alarm concerning electrical fault from switch W-80-EF04.	Alarm log
07:52:20	UPS circuit series 31-46 from UPS distribution - W85-EL05A042 isolated by response personnel on SLB. This UPS distribution is located in the LIR room in M40.	Alarm log and interview
07:53:42	System filter Ramp Off Alarm. Simultaneous W-80-EY01_115_A Filt Spol Overtemp (07:53:41) and W-27-ER01_102 Driver Alarm (0753:43)	LOP panel
Approx. 07:54:30	Cable from SLA to SLB is isolated at outgoing switch on SLA.	PI-Vision and interview.
07:56	Info from PLS to 2nd line. When the response team on SLB attempted to restore the power supply, there was further smoke development. All power supplies shut down again.	Main log
08:34.50	UPS circuit series 31-46 for emergency lighting from UPS distribution W85-EL06A042 isolated by response personnel on SLB. This UPS distribution is located in the LIR room in M40.	Alarm log and interview
08:35	Navigation lights out of operation. Safety zone of 2 nm created.	Main log
08:50:49	Smoke detector no. 30 triggers a warning, followed by an alarm six seconds later. This detector is located in the M40 low voltage room.	Alarm list
08:52	Open flames are observed via a camera, which are shown on a screen in the CCR.	Screenshot
	Evacuation alarm on SLB	
08:53	Esvagt Bergen returns due to escalation, ETA 10.55	Main log
08:57:28	Evacuation shutdown (ENS/APS) for SLB is activated by the CCR personnel on SLA.	Alarm log and interview
08:57	SAR takes off from SLB to fly to SLA	Main log
09:15	They believe they can see flames from SLA	Main log

22.10.2024 Time:	**Incident element**	**Additional Information**
09:15	Skandi Mongstad starts cooling	Main log
09:25	Correction: not open flames, only reflections from the sun	Main log
09:26	Skandi Mongstad Cools using one FIFI cannon (up to 3,600m3 per hour)	Main log
10:55	Esvagt Bergen arrives	Main log
11:10	Emergency preparedness team on SLA demobilised. Control room on SLA takes over	Main log
Approx.12:00	FIFI stopped to see whether there was still smoke	Main log
Approx. 12:10	Skandi Mongstad saw smoke shortly after stopping FIFI. Restarted cooling 1 x FIFI.	Main log
12:15	Emergency preparedness vessels Skandi Mongstad and Esvagt Bergen preventive cooling	Main log
Approx. 12:48	SAR JSF flew to Sola to install FLIR, while SAR Oseberg flew to JSF to cover emergency preparedness and be at readiness for the incident	Main log
14:14	FiFi vessels stopped flushing. No smoke observed.	Main log
14:40	Skandi Iceman mobilised to relieve Esvagt Bergen	Main log
17:20	Skandi Mongstad once again observed smoke and resumed cooling.	Main log
	SAR JSF returns to Johan Sverdrup due to new smoke development at SLB	Main log
19:07	Skandi Mongstad cooled using 1x FIFI, Esvagt Bergen observed	Main log
21:45	Preventive cooling from emergency preparedness vessels discontinued. No observations of smoke after that.	Main log
23.10.2024 08:00	Skandi Iceman relieves Esvagt Bergen at SLB	Main log
09:15	SAR JSF went to SLB to observe	Main log

7 Relevant history

7.1 Smoke detection at the VSD 17.8.2024.

At 14:21 on 17.8.2024, smoke was detected by a total of six detectors in the high voltage room on SLB. Three of the smoke detectors were located by the VSD; two by the 3kV switchboard and the other one by the reactive compensation filter (system filter). The detector that first detected smoke was located by the VSD. SLB was shut down in a controlled manner and depressurised. No smoke was observed via the camera in the high voltage room.

The SLB was unmanned and a team of seven people flew across at approximately 19:00 on the same day for troubleshooting. The alarm panel on SLA, which displays alarms from the VSD (LOP panel), was checked before they departed. This displayed no alarms.

No abnormal smoke odours were known or observed during troubleshooting. The cabinet doors to the VSD were opened, and nothing abnormal was detected. Photographs were also taken, which were then sent to the electrical engineering manager. These photographs were then compared to previous photographs in a meeting in which the onshore organisation also took part. Discolouration was observed on a copper bar, but it was concluded that there was nothing abnormal. The supplier was not involved in the troubleshooting.

After troubleshooting, it was concluded that the smoke detection was probably due to a smoke detector fault or system failure. Production was resumed on the following day, at approximately 12:00, with follow-up measures to monitor relevant cabinets/switchboards through visual inspections and checks by an electrician when SLB is manned.

The Synergi case linked to the incident was closed on 1.9.2024.

The detectors that detected smoke on 17.8 were also among the first to detect smoke during the fire on 22.10.2024.

7.2 Fire incident in the VSD on 7.3.2019.

In 2019, excessive heat was being generated in the water-cooled resistors in the rectifier part of the VSD. It was concluded that the pre-magnetisation transformer had closed during restarting of the node. In turn, this causes cooling water hoses connected to the water-cooled resistors to melt and water then splashed around inside the rectifier and the DC link part of the VSD.

Prior to this event, the high voltage switch that suppliers the VSD was locked out, and the middle and internal cooling circuits were taken out of use.

The Synergi case linked to the incident was closed on 3.5.2021.

7.3 Failure of compressor motor in March 2022

The compressor motor failed in March 2022. After this failure, the stator was replaced, and the rotor was transferred across from the damaged motor. A complete new spare motor was also ordered for the storage facility. After stator replacement, compressor operation was resumed in October 2022.

During this period, the control system for the VSD was also upgraded to a newer version. In connection with this upgrade, a VISOR panel and LOP panel were also installed on SLA. These panels show the status of the VSD on SLB.

7.4 Reports of concern

During the investigation, we received a copy of a previous internal report of concern stating that the fire water system is a vulnerable system (ref. Synergy 2417643 Concern about major accident SLB). The weaknesses in the fire water system are described in detail in the report of concern, but the processing of the report did not lead to the identification/implementation of measures which reduced the likelihood of the loss of fire water in the event of fire in the high voltage room.

We have also received an internal report of concern regarding the lack of emergency preparedness drills on SLB. (Synergi 3265399 Failure to carry out emergency preparedness drills on SLB).

8 Potential of the incident

8.1 Actual consequences

The actual consequences of the incident were material damage and an extended production shutdown.

The material damage resulting from the fire was a completely destroyed VSD, smoke and soot damage in the rest of the high voltage room, in addition to some smoke and soot damage in nearby rooms. In addition, the thermal insulation in the ceiling above the VSD was damaged beyond repair. Judging from the damage, it appears that there has been a fire in the ceiling immediately above the VSD. Some light fittings and smoke detectors above the VSD had also fallen down as a result of the fire. Outside, the visible damage caused by the fire is limited to heat-exposed structures in the ceiling of the high voltage room above the VSD.

In addition to the damage caused by the fire, there was also substantial external material damage caused by the use of FIFI to cool the area, e.g. deformation of cable ladders and safety railings.

Production has been shut down for an extended period.
No persons were injured, nor did any discharges into the sea take place as a result of the incident.

Figure 24 Thermal insulation in the ceiling above the VSD (1 of 3) (Source: Havtil)

Figure 25 Thermal insulation in the ceiling above the VSD (2 of 3) (Source: Havtil)

Figure 26 Thermal insulation in the ceiling above the VSD (3 of 3) (Source: Norwegian Police)

Figure 27 Fire damage to the inverter part of the VSD (Source: Norwegian Police)

Figure 28 Fire damage to the VSD viewed from door no. 6 looking towards the DC link (Source: Norwegian Police)

Figure 29 Fire damage to the VSD viewed from door no. 7 looking towards the output filter (Source: Norwegian Police)

8.2 Potential consequences

During the investigation, we concluded that there was little risk of the fire spreading beyond the module in which it occurred.

There were no personnel on board SLB at the time the fire broke out, but a response team was sent there to assess the situation.
S&R personnel were inside the room while there was thick, black smoke.
Smoke from a fire is harmful to health and normally contains various carcinogenic components and other hazardous substances. Only personnel wearing smoke diving equipment entered the room. The personnel were checked by a medic when they returned to SLA, as the pilot of the SAR helicopter observed that some of them had

soot on their faces, which may have indicated that they had been exposed to smoke, although no smoke-related injuries were detected.

Our assessment is that if there had been personnel on board, the response team would have got into position sooner and they would have been better-placed to deal with the situation. They would quickly have seen where the smoke was coming from, and they would have had UPS capacity available for troubleshooting purposes.

9 Direct and underlying causes

Direct
Although it was the VSD that caught fire, it is uncertain what the direct cause of the fire was. We know that there was a leak in the cooling water system, but we are unsure whether this occurred before the fire, or as a consequence of the fire. Our assessment is that the most likely cause of the fire was an electrical fault in the VSD. However, based on investigations in the room and various logs, we cannot determine the direct cause of the fire with any certainty.

We assume that the fire developed because two fire doors into the high voltage room were opened for ventilation and/or because the power supply from SLA was restored.

Underlying
During the investigation, we were informed that there have been many challenges associated with the VSD. Given that there is uncertainty over the direct cause of the fire, there is also uncertainty relating to any underlying causes. Overheating and cooling system failures have previously been observed in the VSD, but there is uncertainty as to whether it was the failure of the cooling system that caused the fire.

The history of the VSD may have affected the pattern of action. It appears that the fire-related potential of the components that comprise the VSD was underestimated. The team that went to SLB did not open the cabinets, which might have helped to identify what was causing the smoke development, and they might have been able to stop the fire to develop further.

The incident where smoke was detected around the VSD on 17 August 2024 was inadequately followed up. The supplier was not involved when no cause for the smoke was identified during internal troubleshooting.

10 Emergency preparedness

When the alarms were received by the CCR, they sent a silent alert to the emergency preparedness management team. On the DSHA overview, there was no provision for silent alerts for the DSHA concerned, and they therefore chose a different DSHA. The

DSHA for radioactive source was used, but this had no further impact on the subsequent management of the incident, as the matter was clarified as soon as the emergency preparedness management team was able to speak to the CCR. The silent alert function was corrected while we were on board. A silent alert was issued because the incident did not affect SLA and the personnel there did not need to be mustered.
There is a joint emergency preparedness plan in place for the entire Sleipner field. The DSHA for fire is divided into fire/explosion in a process area and fire/explosion in living quarters.
The CCR reported the incident in accordance with the relevant plan, and both emergency preparedness vessels and SAR helicopter were summoned.

The emergency preparedness management decided to dispatch an S&R team to SLB to check and secure the scene, and possibly fight the fire if doing so was justifiable. It was also decided to send various personnel, including the switching responsible person and an electrician, to see whether it was possible to restore UPS charging. As SLB had no power supply at all, they did not have fire water or any other safety systems that were not supplied by UPS, and they had to wait to send the SAR helicopter with personnel over to SLB until the emergency preparedness vessel was in place.
When the team was mobilised, they were informed of the situation on SLB. It seems that there was a sense of urgency and this perception was reinforced by the SAR helicopter already standing on the helicopter deck while the rotor was turning. No equipment was taken on the flight from SLA. On the way to SLB, the team put on immersion suits, but they did not have any personal-locator beacons. Seven persons were on the flight across to SLB. The SAR helicopter remained on the helicopter deck on SLB while the team was on board.

When the team came on board SLB, the S&R team went to put on firefighting equipment, while others went to open the doors into the high voltage room in order to vent the smoke. Two persons entered the living quarters module in order to find some radios. They did not have any torches with them, but they did find some small electric lights which they used to find their way through the darkened living quarters module. These small electric lights were also used later when the emergency stop buttons on the fire pumps (A and B) were pressed in order to prevent the pumps from starting.

The S&R team inspected the room to make sure it was safe for the electricians to enter. They then observed what they called "theatre smoke" in the room. They each brought an electrician with them as they entered the room. They did not bring a thermal imaging camera with them. They did not have one in the S&R equipment cabinet on board SLB, nor had they brought one from SLA. The S&R team only had small torches, which produced little light in a completely darkened room.

The On Scene Commander had set up an incident command centre immediately outside the room.

The On Scene Commander encountered problems communicating with both the SAR team and the emergency preparedness management on board SLA. Some of the fire helmets did not have a communication wire, and there was a lot of noise and interruptions on the fire team's channel from another facility nearby. They were unable to make contact with this facility. To improve communication with SLA, the On Scene Commander used a phone. However, this resulted in many people losing access to information and communications. It was also difficult to communicate internally on SLB. The On Scene Commander was assisted by another member of the team, who took over responsibility for communications with the S&R team, which worked better.

Shortly after power was restored on SLB and the doors at both ends of the high voltage room were opened for ventilation, large amounts of smoke emerged. A search was approved by the accident scene manager and the S&R team re-entered the room. On the first floor, there was a good overview, but there was a lot of smoke on the second floor. It was completely dark on the second floor as a result of thick smoke. There was only visibility right down at floor level, and only then for about half a metre above and in front of the personnel. The S&R team did not have a lifeline which they could follow if the smoke had developed more rapidly. The S&R team withdrew from the room in order to change their air tanks, but the CCR on SLA then observed flames on the screen and triggered the evacuation alarm on SLB. Everyone then withdrew to the helicopter.

Poor communication was a recurring theme during several interviews conducted as part of the investigation. This applied not only internally on SLB and between SLB and SLA, but also internally on SLA. As the communication between SLA and SLB had to take place by phone, this meant that the line was often engaged, and it was sometimes difficult for the CCR to get hold of the emergency preparedness management team. On SLA, the emergency preparedness room and the CCR are on different floors, which means that all communication between these two locations must take place by phone.

11 Regulations and proposals for regulatory changes

Section 37, first paragraph of the Facilities Regulations on fixed fire-fighting systems states that *"Fixed fire-fighting systems shall be installed in explosion-hazard areas and in areas with a major risk of fire. The systems shall also cover equipment containing significant amounts of hydrocarbons. The systems shall be designed such that fire-fighting can be carried out quickly and efficiently at all times."* The guidelines state that: *"In order to fulfil the requirement for fixed systems as mentioned in the first* *subsection, the standards NS-EN ISO 13702 Chapter 12 and Appendix B.8 and NORSOK S-001 Chapter 21 should be used with the following additions (...)".*

NORSOK S-001 Technical Safety does not require a fixed firefighting system in switchboard rooms. The only requirements are for early smoke detection, secure isolation of the power supply (energy) and the maintenance of ventilation in the event of an incident where fire is detected in a switchboard room.

SLB is controlled remotely from SLA, with scheduled stays by personnel on board (2-3 days) every other week.

There is no fixed firefighting system in the high voltage switchboard room, which is in accordance with current regulations. The safety strategy for SLB (section 5.3.9 PS 9 Active fire protection) describes the following philosophy in the event of a fire in the electrical room: "*Electrical rooms are protected through early detection and isolation of the power supply (energy) to the room, and any additional manual response. Isolation of the power supply for personal safety reasons in connection with fire-extinguishing must be carried out for all voltage levels from 230V and above. This requirement is aimed at preventing any potential touch hazards for unprotected first-line personnel who are attempting to extinguish a fire using handheld equipment. Handheld CO_2 extinguishers are located near or in these rooms.)*"

When the fire broke out in the high voltage room, it was no longer appropriate for response personnel to start manual firefighting using handheld CO_2 extinguishers. The available firefighting equipment was also unsuitable for extinguishing a fire of such a size/magnitude.
In the case of a facility that is not permanently manned at all times, it takes time for response personnel to muster at the scene of an incident in order to commence manual firefighting. During this time, smoke/fire can develop and escalate, and firefighting by response personnel using handheld extinguishers may be inappropriate. Therefore, in such cases, the rapid and effective fighting of a fire will not be possible in switchboard rooms in which fixed firefighting systems are not installed.

The incident on SLB has led the investigation team to draw up a proposal to revise the guidelines for Section 37 of the Facilities Regulation on fixed firefighting systems on facilities that are not permanently manned.
In *order to meet the requirements for fixed facilities as mentioned in the first paragraph, the standards NS-EN ISO 13702, Chapter 12 and Annex B.8 and NORSOK S-001 Chapter 21 should be used with the following additions:*

...

x. The requirement for rapid and effective firefighting as mentioned in the first paragraph renders it necessary to install fixed firefighting systems in electrical *rooms/switchboard rooms where there is a major fire risk for facilities that are not permanently manned.*

...

12 Observations

Havtil’s observations are generally divided into two categories:

Non-conformity: Observations where we *prove* the existence of a breach/non-compliance with respect to the regulations.

Improvement point: Observations where we *believe we have seen a* breach/non-compliance with respect to the regulations, but do not have sufficient information to be able to prove it.

12.1.1 Inadequate risk management and choice of technical solutions

Non-conformity:

Equinor has not ensured that the safety management covers the activities and processes that are necessary to ensure that risks are reduced in line with applicable requirements. Technical solutions, including the evaluation of necessary barriers and the robustness of implemented barriers, are not designed to address relevant factors which impact on risk.

Equinor had not adopted technical solutions for fire water, emergency power, back-up power and main power for SLB that sufficiently reduce the likelihood of hazard and accident situations occurring.

Requirements:

Management Regulations, Section 4 concerning risk reduction, first paragraph
Management Regulations, Section 5 concerning barriers
Facilities Regulations, Section 5 on the design of facilities, fourth paragraph, cf. Section 4 on the choice of development concept (letter a)

Rationale:

Equipment in the high voltage room is supplied at several voltage levels. The 13.8kV switchboard is supplied via a cable from SLA. The 3kV switchboard is supplied via a transformer which is connected to the 13.8kV switchboard, or alternatively from the back-upgenerator, and supplies power to the fire pumps. There is also low voltage equipment in the room which is supplied from the 440V and 230V switchboards in the M40 module, as well as UPS circuits which are supplied from the M40 LIR. In the event of a fire in the high voltage room which requires the isolation of all energy supplies, critical safety systems such as HVAC, fire water and the ability to maintain UPS charging will be lost.

SLB has two electrically operated fire pumps (combined seawater pumps). The fire pumps receive their power via a supply from SLA (power cable between SLA and SLB).

The technical solution that has been described does not safeguard the fire water supply at all times. The philosophy in the event of smoke development/fire in the high voltage room includes isolating the power supply (energy) to the room. In such an event, the power supply will therefore be lost from both the 13.8kV switchboard and the 3kV switchboard, which will result in loss of the fire water supply on SLB.

Fire pumps A/B rely on several circuit breakers and transformers in order to operate (ref. section 4.7.2.4).

The SIL analysis conducted as part of the compressor module project only covered safety systems. The various components that supply power to the fire pumps (e.g. power cable, back-up generator) are not considered to be instrumented safety systems. Thus, the power supply to the fire pumps is not included in the SIL calculations. The analysis concluded that the fire water system complies with the SIL requirement, which is SIL 2.

The vulnerability analysis concluded that the technical solution, where the power supply to the fire pumps (power cable, back-upgenerator) passes through the high voltage room (all switchboards and relays are located in the same room), is the most vulnerable part of the safety system. This technical solution is assigned category C in the vulnerability analysis. Category C in the analysis is defined as: *"Large effect on the system or loss of redundancy. The system can most likely not perform its function"*. The vulnerability analysis goes on to provide the following recommendation: *"It should be considered whether the position of the main switchboard, including both opportunities for power to the firewater pumps, is safe enough"*. Based on this recommendation, the project conducted an internal assessment of the main switchboard room (high voltage room). The minutes from the internal assessment state that the purpose of the internal review was to look at whether the proposed design based on a switchboard with a bus-tie switch was a good solution. Furthermore, it is concluded in the minutes that the solution was satisfactory. Internal assessment is inadequate and does not include any assessment of the technical design of the main switchboard room, where both the switchboards for supplying power to the fire pumps are contained in the high voltage room. No new measures to improve the robustness of the fire water supply (with regard to an incident involving fire in the switchboard room) were identified during the internal assessment.

During the investigation, we obtained a Synergi case which identifies poor design of fire pumps, power supply (emergency power, back-upand main power) and firefighting. During the interviews, we were also informed that concerns regarding poor design have been communicated by offshore employees to the onshore management. The processing of these cases did not result in any measures to ensure the adequate robust design of safety functions.

During a previous incident involving the VSD, which occurred on 17.08.2024, a total of six smoke detectors detected smoke on SLB. The conclusion following the internal investigation was that the smoke detection was probably due to smoke detector or system failure.

12.1.2 Deficiencies in handling of hazard and accident situations

Non-conformity
Equinor had not implemented the necessary measures on SLB to prevent smoke development (hazard situation) in the high voltage room from developing into a fire (accident situation).

Requirements:
Activities Regulations, Section 77 on the handling of hazard and accident situations, letter b; cf. letter e.

Rationale
Sufficient measures were not implemented during smoke development, and the incident/condition was normalised before smoke development had been stopped. Despite several alarms indicating the presence of smoke, as well as observations of white “theatre smoke”, it was decided not to open the cabinets in order to search for the cause of the smoke. In addition, it was decided to restore the power supply to SLB without the cause of smoke being investigated thoroughly. This was not in accordance with the fire protection philosophy for the high voltage room (ref. section 4.7.1). The sequence of events and the handling of the incident (recorded actions/incidents in alarm log/interviews) indicate that:

- The first smoke detector in the high voltage room triggered an alarm at 04:35 and a fire was confirmed at 04:42. The action board in the emergency preparedness room on SLB includes action indicating that all power supplies in the high voltage room were isolated at 04:52. This was in accordance with the fire protection philosophy for the high voltage room.
- The action board in the emergency preparedness room on SLB includes the following action at 05:15: “Emergency generator is not starting up”. This refers to the back-upgenerator, as the back-up generator is not defined as an emergency generator. We have been informed that several attempts were made to start the back-up generator. The back-up generator supplies the 3kV

switchboard in the high voltage room. Energising of the 3kV switchboard was not in accordance with the firefighting philosophy for the high voltage room.
- At 06:52, a comment in the main log (CIM log) indicates that normalisation was now in progress, and that the vessel was reducing speed as it approached the facility. The incident is therefore considered to be under control and elevated preparedness can be terminated.
- At 07:20, the action board in the emergency preparedness room on SLA includes the following text: ""Commencing response with the SAR team. Energising SLB." This was not in accordance with the firefighting philosophy for the high voltage room.
- When personnel arrived in the high voltage room, there was white smoke in the room and the doors into the room had been opened to allow ventilation. Water was observed on the floor outside the VSD cabinet, but the locking mechanisms on the VSD doors made it time-consuming to open the VSD cabinets. As a result, no further investigations were conducted into the cause of smoke development in the VSD. The priority at this stage in the sequence of events was to restore charging of the UPS battery banks as a matter of urgency.
- A fire door (pneumatic sliding door in a fire division with rating A-0) into the high voltage room was left in the open position when the facility was evacuated.

<u>Assessment of the sequence of events and inadequate management of the hazard situation</u>
During the investigation, we also obtained confirmation that the supply of power (energy) to electrical equipment in the high voltage room was not isolated at any stage during the entire sequence of events (see Figure 3 to Figure 6). The following equipment was energised:

- At 07:23, the 13.8kV switchboard and main transformer in the high voltage room were operational.
- At 07:32, the 3kV switchboard and 3kV/440V transformer in the high voltage room were operational.
- At 07:35, a Cooling Unit Low Pressure Alarm was triggered on the LOP panel of the VSD, which may have indicated the start up of the pumps supplied from the 440 V switchboard in the high voltage room.

The alarm log in the control room (ref. Table 1) continuously showed new incidents ("events"), with smoke detectors triggering alarms during the period from the first smoke detector alarm to APS (the overview of the fire and gas detection system was then lost). The SAR team observed a lot of smoke in the high voltage room. This shows that the smoke development incident was not over at the time power was restored to the equipment on SLB.

During the incident, compromises were struck between completely isolating the room and limiting the consequences of such isolation. They therefore followed a step-by-step process of isolation where the 440V switchboard in M40 was isolated first. Rather than reducing the amount of smoke being generated, this approach resulted in an increase in smoke development, as observed by the camera in the room. When they saw this, they isolated the power supply via the cable from SLA. From this point onwards, the only power supply to the room was via UPS circuits. The back-up generator did not start up automatically and several attempts were made to start it from the control panel on SLA, without success. It was then decided that personnel should go to SLB as a matter of urgency in order to manage the situation further from there. As a result, the only energy source on SLB was the UPS systems, which had limited battery capacity. If the UPS battery banks ran out, fire and gas detection systems, among other things, would have been lost on SLB, and experience from previous incidents also indicates that they would probably have had to bring a generator out from land in order to recharge the battery banks.
The priority at this stage in the sequence of events was to restore charging of the UPS battery banks as a matter of urgency. This may have contributed to the failure to bring a thermal imaging camera with them, which could have proved a very useful aid in the manual response in the high voltage room. No thermal imaging camera was available at the fire station on SLB either.

The description of the sequence of events and actions carried out indicates that the firefighting philosophy for the high voltage room was not followed throughout the incident. Adequate measures were not implemented. Normalisation of the incident began before smoke development in the high voltage room had ceased.

12.1.3 Fire division deficiencies

Non-conformity:
The A-60 fire division between the high voltage room and LIR room did not prevent the spreading of smoke for at least 60 minutes.

Requirements:
Facilities Regulations, Section 82(4); cf. Facilities Regulations as of 2006, Section 29 on fire divisions, second paragraph; cf. Section 1 on definitions

Rationale:
<u>Fire division between the LIR room and high voltage room:</u>
There is an A-60 fire division between the high voltage room and the LIR room. Fire divisions with a rating of A-60 must prevent the spreading of smoke for at least 60 minutes. According to the alarm lists, the first smoke detector (W-DS-M40L-V216, high sensitivity) in the high voltage room triggered an alarm at 04:35:48 Smoke detector in the neighbouring room LIR (W-DS-M40L-V201 high sensitivity) received an alarm at 5.00.53. The performance requirement to prevent the spreading of smoke for one hour was thus not met.

12.1.4 Missing navigation lights

Non-conformity:
The auxiliary system for marking SLB with navigation lights did not provide lights for at least 96 hours

Requirements:
Facilities Regulations, Section 82(2); cf. Regulations of 28 June 1985 on safety, Section 15; cf. the Regulations of 1 December 1976 on the marking of facilities, Section 7.6

Rationale:
Logs from the emergency preparedness follow-up of the incident state that SLB was already completely dark and without navigation lights on the day of the incident. In Equinor's main log, this was logged at 13:14.
The absence of navigation lights is also cited as a justification in an application to Havtil for an extended safety zone from 09:53.
Skandi Mongstad was located adjacent to SLB as a measure to mitigate the absence of navigation lights.

The requirement in the Norwegian Coastal Administration's provisions stipulates that such lighting must continue to function for at least 96 hours using an emergency power source, even when no other power sources are available.

12.1.5 Outdated documentation

Non-conformity:
Technical operating documents for the power system on Sleipner B were not available in the updated version.
Requirements:
Activities Regulations, Section 20 on the start-up and operation of facilities, second paragraph (b)

Rationale:
The received single-line diagram for the electrical system on SLB was issued on 17.11.2008 (audit A5). On the single-line diagram, system filter W-80-EY01 is indicated as being 8,000 kVAr. In an e-mail received from Equinor on 18.12.2024, we were informed that the system filter had been modified to 4,000 kVAr around 2017. Sub-distribution board W-82-EL04 was also not shown on this diagram.

The document entitled "SLB variable speed drive train system hardware training manual" was only released in a draft version and had not been approved. Among other things, the document contains a chapter on troubleshooting and a description of error codes, where the content contains deficiencies.

12.1.6 Deficiencies in ventilation

Non-conformity:
Ventilation arrangements in the M40 module did not enable smoke from a fire to be controlled.

Requirements:
Facilities Regulations, Section 82(4); cf. Facilities Regulations as of 2006, Section 13 on ventilation and indoor climate, first paragraph

Rationale:
During the fire, the 440V switchboard W-82-EN03 was de-energised by opening switch W-81-EF05. This caused the HVAC fans to stop. As the only emergency power supply on SLB consists of two UPS systems, each of which have a capacity of 40kVA, there is no capacity to keep the HVAC fans operating on emergency power.

12.1.7 Inadequate facility-specific training and drills

Non-conformity:
Equinor has not ensured that the requisite training and drills are conducted to ensure that personnel are able to manage operational issues and hazard and accident situations in an effective manner at all times.

Requirements:
Activities Regulations, Section 23 on training and drills, first paragraph

Rationale:
During the investigation, it was confirmed to us during several interviews that training and drills had been carried out concerning the management of incidents on Sleipner B.
Despite this, the investigation has shown that there was a lack of knowledge regarding the equipment that is available and how to ensure that the type of incident that occurred is managed well. The training and drills that have been conducted have not covered this, and have thus not prepared the personnel to manage hazard and accident situations effectively.

- There was insufficient knowledge of internal and external communication during the incident. During the interviews, it emerged that there were challenges relating to communication between a number of operators during the incident. During one interview, we were also informed that a solution had been installed using a handheld UHF radio, which was connected to an external directional antenna pointing towards SLA. This radio has its own battery and was being charged continuously. This solution enables direct indoor communication between SLA and SLB with better signal strength. Ref. section 4.8, it is not known whether this solution was known to the response team, as it was not used. A phone was used to communicate with SLA instead. However, this resulted in many people losing access to information and communications.
- It was also difficult to communicate internally on SLB. Several of the fire helmets used by the response team lacked any provision for communication. This meant that the On Scene Commander encountered problems communicating with the S&R team.
- When the team from SLA (electricians and personnel from the S&R team) was sent on the first trip on the SAR helicopter across to SLB in order to obtain an overview of the incident and check the switchboard room where smoke development had been observed, they did not take any equipment with them from SLA. This equipment was also not available on SLB.
    - No one was wearing an personal-locator beacon. However, these were later placed in the heli-cabin for the other trips.
    - When the S&R team entered the darkened module where the fire was burning, they were only equipped with two small torches which gave off a limited amount of light. They also did not have a light mounted on their fire helmets, or a thermal imaging camera that could provide important information about heat generation in the VSD cabinets.

When the response team entered the darkened living quarters module in order to collect a phone and later examine the fire pumps, the only light sources they found were small electric lights, which made the work even more difficult.

- The S&R team did not have a lifeline between them and the exit to facilitate evacuation in the event of a rapid smoke development during the incident

- We have received an internal report of concern regarding the lack of implementation of emergency preparedness drills on SLB (Ref. section 7.4, Synergi 3265399 Failure to carry out emergency preparedness drills on SLB).

13 Barriers that did function

The following barriers worked as intended:

- Smoke detection
- Emergency shutdown
- Pressure relief
- Alerting and establishment of emergency preparedness management team and emergency preparedness resources

14 Discussion concerning uncertainties

There is still some uncertainty about what actually caused the fire. We know where the fire started, but the exact component of the VSD that triggered the fire is unknown. The response team stated that there was "theatre smoke" in the room when they opened the doors for the first time, which may indicate that one or more capacitors had failed. Fire in capacitors often produces white smoke. White smoke could also be caused by the overheating of components or cooling hoses due to failure of the cooling system. The smoke may also have been mixed with water vapour due to a cooling water leak. Such a fault could escalate and affect other components, which in turn could then start to emit black smoke, as described later in the development of the fire.

It is also uncertain whether previous incidents and alarms involving the VSD could have influenced the resultant pattern of action and the decisions made during this incident. It appears the main focus was placed on recharging the UPS systems when the response personnel arrived on SLB and discovered soot and water leakage in the VSD. It is uncertain whether a different focus could have prevented escalation of the fire, e.g. whether escalation could have been averted had the VSD cabinets been opened at this point in the sequence of events.

It is also uncertain whether the fact that they energised SLB caused the fire to intensify, or whether it was a smouldering fire inside the VSD cabinets which developed over time, with an increased supply of air.

Each cabinet in the VSDs has an extraction fan which receives its power supply from the UPS system. We have been informed that these fans will continue to operate after the VSD has been shut down in order to maintain cooling. The fans may have stopped at some point and then restarted due to the power supply being restored. The fans may have caused the airflow to increase when charging of the UPS system was restored. Certain parts of the control system for the VSD are supplied from switchboard W-82-EL05 (230V), which was isolated at 05:01:14. This applies for example to the PLC control of the VSD. This may have caused the cooling fans to stop. This panel was re-energised at 07:32, which may have caused the cooling fans to restart. This could be one explanation as to why the fire suddenly began to develop again after this time, as a result of the increased air flow in the VSD cabinets. These are questions that we have not found answers to in the documentation we have received, and we have also not succeeded in obtaining this information through interviews.

Following a maintenance turnaround in August, many signals from SLB were “frozen”. This mostly concerns analogue signals. For this reason, a lot of data relating to the time of the incident is unavailable. This means that the status of the system before and during the incident cannot be fully analysed.

As the central UHF equipment was only connected to one of the UPS systems, one possible theory is that it ran out of power before the other, but this information could not be verified.

15 Assessment of the company's investigation report

Equinor has conducted a corporateinvestigation at assignment level 2, with EVP Equinor EPN as the client. We received Equinor’s investigation report on 14 August 2025.
Equinor drew on external support for fire and smoke simulations as part of its investigation.
Equinor classifies the incident as falling under the highest severity Actual Red 2 – Failure of safety functions barriers, Actual Red 1 – loss of production, and Actual Red 1 – Costs and losses. No indications have been found to suggest that the incident could have developed into a major accident or caused serious injuries.

Equinor’s investigation has revealed the need for safety improvements on SLB. Equinor identified weaknesses in governance and management, VSD testing, verification, maintenance, risk assessments and design philosophy for SLB.

Weaknesses include insufficient segregation and redundancy, poor lines of communication and technical barriers which affected operational safety, particularly as regards radio communication and emergency power supplies. The recommendations include improved testing and maintenance, the ensuring of redundancy and segregation of critical components, as well as improvements to knowledge and training concerning the management of electrical fires in order to prevent future incidents. The purpose of these measures is to enhance safety through measures to improve robustness on SLB.

Equinor's investigation report is generally very consistent with our own report. Both reports refer to uncertainty linked to the triggering and underlying causes of the fire in the VSD.

In its report, Equinor referred to "clamp" capacitors of the thin film type in the inverter part of VSD as being the component where the fire probably began. This is justified by the fact that this type of capacitor does not have a safety barrier to protect against internal faults, and that the maintenance programme recommended by the VSD supplier regarding monitoring of these components has not been followed.
Equinor has also conducted technical material tests which showed that the components were exposed to temperatures in excess of 600°C during the fire. The CFD simulations that Equinor also had carried out indicated that the heat output of the fire must have been of the order of 1.2 MW inside the VSD in order to achieve this temperature.

16 Annexes

A: The following documents were used as a basis for the investigation:
B: List of interviewed personnel.

Annex A

Document ID/date	Document title
A 2024-17 EPN L1	Granskingsrapport Brann i VSD i høyspentrom på Sleipner B 22.10.2024
01.04.2025	TAG linked to the fire water system
26.02.2025	Trends PI-Vision
16.12.2024	Email from ABB_SLB DR and event list
11.02.2025	Disturbance recorder
Synergi #3655184	Fire in switchboard room on Sleipner B
38.2 2417643	Concern regarding major accident on SLB
C034-B-S-DY-M402	Fire protection data sheet
31.01.2025	Switchboard W-82-EL02 load list
C034-B-C30-EA-103-01	Arrangement UPS/battery room
31.01.2025	Switchboard W-82-EL05 load list
31.01.2025	SLB ELE load list W-82-EN03
11.02.2025	SLB HV room viewed from the west, dimensioned
03.02.2025	SLB HV room viewed from the south, dimensioned
13.11.2024	Accommodation history for SLB
13.11.2024	SLB A06 REG670 DR
20.01.2025	SLB A06 event list
C034-B-M40-MA-5028	System filter general arrangement
C034-B-E-DE-5001	System filter data sheet
08.11.2024	Time on LOP and Visor panel
13.12.2024	Trends PI-Vision
C034-B-S-RE-516	SIL analysis of firewater & watermist systems
SO04927-opr	Sleipner B system 27 Pre compressor & pipeline compressor operating procedures
54 SO04927	Sleipner B system 27 Pre compressor & pipeline compressor system description
08.01.2025	Switchboard W-82-EL04 load list
C034-B-M40-LP-505-01	Plot plan deck level M40L
C034-B-M40-LP-506-01	Plot plan deck level M40D
19.12.2024	W-27-ER01 signals
C034-B-M-KJ-5005	General MV7000 protection & diagnostics
12.05.2011	Sleipner B variable speed drive train system hardware training manual
09.09.2021	ABB report (1VC1AH00021341)
09.09.2021	ABB report (1VC1AH00021343)
08.09.2021	ABB report (1VC1AH00021662)
08.09.2021	ABB Test object – Device settings W-80-EH02 A02
08.09.2021	ABB Test object – Device settings W-80-EH02 A02
07.09.2021	ABB Test object – Device settings W-80-EH02 A04
09.09.2021	ABB Test object – Device settings W-81-EM01 A08
08.09.2021	ABB Test object – Device settings W-81-EM01 A03
15.09.2023	ABB Test object – Device settings W-81-EM01 A04
08.09.2021	ABB protection checklist for PM MV switchgear (W-82-ET02 A02)
08.09.2021	ABB protection checklist for PM MV switchgear (W-80-EH02 A02)
07.09.2021	ABB protection checklist for PM MV switchgear (W-80-EH02)
09.09.2021	ABB protection check list for PM MV switchgear (W-81-EM01 A08)
09.09.2021	ABB protection check list for PM MV switchgear (W-81-EM01)
14.09.2021	ABB Service report
14.09.2021	ABB Service report
14.09.2021	ABB Service report
27.11.2024	SLB TAG review
27.11.2024	Review of history in SAP
13.09.2024	ABB electrification service. Service report
13.09.2024	ABB Summary report preventive maintenance service

11.09.2024	ABB Test object - Device settings W-81-EH02 A02 RET670
11.09.2024	ABB Test object – Device settings W-81-EH02 A04
11.09.2024	ABB Test object – Device settings W-81-EH02 A02
11.09.2024	ABB Test object - Device settings W-81-EH02 A02 RET670
11.09.2024	ABB Test object – Device settings W-81-EH02 A04
11.09.2024	ABB Test object – Device settings W-81-EH02 A02
11.09.2024	ABB Test object – Device settings W-81-EH02 A04
11.09.2024	ABB Protection check list MV switchgear (W-81-EH02 A04)
11.09.2024	ABB Protection check list MV switchgear (W-81-EH02 A02)
11.09.2024	ABB Protection check list MV switchgear (W-81-EM01 A02)
10.09.2024	ABB Test object – Device settings W-81-EM01 A09
13.09.2024	ABB Test object – Device settings W-81-EM01 A07 REJ521
10.09.2024	ABB Test object – Device settings W-81-EM01 A07
12.09.2024	ABB Test object – Device settings W-81-EM01 A08
13.09.2024	ABB Test object – Device settings W-81-EM01 A03
13.09.2024	ABB Test object – Device settings W-81-EM01 A04
10.09.2024	ABB Protection check list MV switchgear (W-81-EM01) A09
12.09.2024	ABB Protection check list MV switchgear (W-81-EM01) A08
13.09.2024	ABB Protection check list MV switchgear (W-81-EM01) A07
13.09.2024	ABB Protection check list MV switchgear (W-81-EM01) A07
13.09.2024	ABB Protection check list MV switchgear (W-81-EM01)
13.09.2024	ABB Protection check list MV switchgear (W-81-EM01)
16.09.2023	ABB Report W-80-EH02 A07 (1VC1AH00021637)
15.09.2023	ABB Report W-80-EF06 A06 (1VC1AH00021700)
12.09.2023	ABB Report W-80-EF05 A05 (1VC1AH00021661)
16.09.2023	ABB Report W-80-EF03 A04 (1VC1AH00021642)
16.12.2021	ABB Report (1VC1AH00021642)
16.12.2022	ABB Report (1VC1AH00021642)
14.09.2021	ABB Test object. Device setting (TAG W-80-EH02)
15.09.2021	ABB Report (W-81-EF01)
14.09.2021	ABB Test object. Device setting (TAG W-80-EF06)
19.09.2021	ABB electrification service. Service report.
15.09.2021	ABB Protection check list MV switchgear circuit breaker testing/service (serial 1VC1AH00023291)
16.09.2021	ABB Protection check list MV switchgear circuit breaker testing/service (serial 1VC1AH00021637)
12.09.2021	ABB Protection check list MV switchgear circuit breaker testing/service (serial 1VC1AH00021700)
12.09.2021	ABB Protection check list MV switchgear circuit breaker testing/service (serial 1VC1AH00021661)
16.09.2021	ABB Protection check list MV switchgear circuit breaker testing/service (serial 1VC1AH00021642)
14.09.2021	ABB protection check list for PM MV switchgear (Serial 242365)
14.09.2021	ABB protection check list for PM MV switchgear (Serial 242370)
15.09.2021	ABB protection check list for PM MV switchgear (Serial 245771)
09.09.2021	ABB report (1VC1AH00021341)
09.09.2021	ABB report (1VC1AH00021343)
08.09.2021	ABB report (1VC1AH00021662)
08.09.2021	ABB protection check list for PM MV switchgear (Serial T0721008)
08.09.2021	ABB protection check list for PM MV switchgear (Serial 242364)
07.09.2021	ABB protection check list for PM MV switchgear (Serial 242367)
09.09.2021	ABB protection check list for PM MV switchgear (Serial 245769)
09.09.2021	ABB protection check list for PM MV switchgear
01.09.2021	ABB service report
03.09.2021	ABB service report
	Trends from PI-Vision

C034-B-M40-PW-500	P&ID diagram back up generator
C034-B-C30-PW-501	P&ID diagram cooling oil system A for firewater pump W-71-PS02A
C034-B-C30-PW-201-01	Firewater / Seawater service system pumps and risers
C034-B-C30-PW-202-01	Firewater / Seawater service system ring main west
C034-B-M40W-PW-5017.01	P&ID water mist system
	24 image files concerning Gransking av Sleipner B hendelse 22102024.pdf
C034-B-M40-ZR-5201.01	External pneumatic operated sliding door type HB-SWP A-60
C034-B-M40-ZP-500-01	Architectual general arrangement main deck M400
C034-B-C30-SL-103-01	Fire divisions weather deck
C034-B-C30-SL-102-01	Fire divisions mezz deck
C034-B-C30-SP-103-01	Safety plot plan & escape routes weather deck
1249352	Power outage SLB 29.09.2011
C034-B-C30-SP-102-01	Safety plot plan & escape routes mezzanine deck
C034-B-M40-GB-500	HVAC D&ID compression module main deck
C034-B-M40-GB-501	HVAC D&ID compression module main deck and lower mezz deck
C034-B-M40-MA-5014	MV7612 General Arrangement Drawings
PV1P01C01	Functional Design Specification
PV01P01C03S01	MV7612 drive PEC to PECE upgrade. Functional Design Specification
04.11.2024	5 screenshots from CCR for documentation
2733431	Power supply accident in connection with work on 13.8kV main switchboard SLT
2794935	Proposal to bring external expertise into the incident investigation.
1534539	Plant integrity Preventive maintenance templates
04.11.2024	23 images for documentation
CFO FCOE SSU GAR ASR-2021007	TTS final report SLP December 2021
30.10.2024	SLB PS7 – Fire Detection
01.11.2024	TIMP HVAC.pdf
01.11.2024	System 71.pdf
30.10.2024	SLB - TIMP Syst-85 and PS-11.pdf
22.10.2024	SLB callout 22.10.2024
C034-B-M40-MA-5029.01	Sleipner B project – MV 7000 Pre-charge Transformer
C034-B-M40-MA-5029.02	Sleipner B project – MV 7000 Pre-charge Transformer
C034-B-M40-MA-5029.03	Sleipner B project – MV 7000 Pre-charge Transformer
C034-B-M40-MA-5029.04	Sleipner B project – MV 7000 Pre-charge Transformer
C034-B-M40-MA-5029.05	Sleipner B project – MV 7000 Pre-charge Transformer
C034-B-M40-MA-5029.06	Sleipner B project – MV 7000 Pre-charge Transformer
C034-B-M40-MA-5030.01	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.02	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.03	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.04	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.05	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.06	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.07	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.08	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.09	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.10	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.11	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.12	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.13	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.14	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.15	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.16	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.17	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.18	Sleipner B project – MV 7000 converter transform
C034-B-M40-MA-5030.19	Sleipner B project – MV 7000 converter transform

C034-B-M40-MA-5030.20	Sleipner B project – MV 7000 converter transform
1573063	Short circuit I 1142-W-27-ER01 I VSD (Variable speed drive
3655184	Fire in switchboard room on Sleipner B
2417643	Concern regarding major accident on SLB
3265399	Failure to carry out emergency preparedness drill on Sleipner B
C034-B-M40-MA-5014	GA drawing W-27-ER01
27.10.2024	Photographs of switch W-80-EH01
27.10.2024	Photographs of panel 27-EC-02
27.10.2024	Photograph of panels 27-EC-02 and 27-EC-03
29.10.2024	SLP Events 00:00 to 04:45 22.10.2024
29.10.2024	SLP Events from 21.10.2024 00:00 to 22.10.2024 04:45
29.10.2024	SLP Events 00:00 to 04:4522.10.2024
C034-B-M40-EN-5008-25	Cooling unit flow diagram
C034-B-M40-EN-5008-25	Cooling unit flow diagram
C034-B-M40-EN-5008-32	Cooling unit auxiliaries
C034-B-M40-EN-5008-31	Cooling unit auxiliaries
C034-B-M40-EN-5008-30	Pumps & auxiliaries
C034-B-M40-EN-5008-29	Cooling unit flow diagram
C034-B-M40-EN-5008-28	Cooling unit flow diagram
C034-B-M40-EN-5008-27	Cooling unit flow diagram
C034-B-M40-EN-5008-26	Cooling unit flow diagram
C034-B-M40L-JB-0002-01	GE Power conversion VSD Circuit Diagrams
C034-B-M40L-JB-0003-01	GE Power Conversion VSD Controller Architecture
C034-B-M40-EN-5008	Sleipner B upgrade project MV7612 electrical drawings
C034-B-M40L-JB-0001-01	GE Power conversion VSD Circuit Diagrams
28.10.2024	Video of visible flames
22.10.2024	Copy of SL-EventLog-2024-10-22-0000-0445
C034-B-000-PE-106	P&I diagram gas compressor
C034-B-000-PU-116	Utility P&I diagram Utility services to gas compressor trafo and VSD
29.10.2024	Extract SAP notifications Systems 27 and 81
1640156	Block on manual switches for water mist system on back-upback-upgenerator SLB not reset after test
07.03.2019	Image 1 of VSD before the incident
07.03.2019	Image 2 of VSD before the incident
07.03.2019	Image 3 of VSD before the incident
07.03.2019	Image 4 of VSD before the incident
07.03.2019	Image 5 of VSD before the incident
07.03.2019	Image 6 of VSD before the incident
28.10.2024	Copy of SL-EventLog-2024-10-22-0000-0430
25.10.2024	Main log Sleipner B fire
23.10.2024	Copy of email. Availability of persons involved in the incident.
C034-B-000-JB-105-01	Process shutdown logic hierarchy
C034-B-000-JB-105-02	APS/ESD logic diagram
C034-B-000-JB-105-03	Process shutdown logic hierarchy
C034-B-000-JB-105-04	Process shutdown logic hierarchy
25.10.2024	Photographic report and copy of assignment document for first trip to SLB after fire
25.10.2024	TAG and AO List SLB_M40
3494771	Smoke detectors activated on SLB • Synergy Life.pdf
SO04971	Sleipner B - System 71 - Fire Water & Water Mist System - System Description
SO04980-Opr final ver. 2.02	Sleipner B - System 80 - Main Power Gen. and Distr. (13.8kV) - Operating Procedures
SO04980	Sleipner B - System 80 - Main Power Gen. and Distr. (13.8kV) - System Description
SO04980-Opr final ver. 1.01	Sleipner B - System 80 - Node no. A120-30 Energisation - Operating procedure
3494771	Smoke detectors activated on SLB

24.10.2024	SleipnerB-switchboard room-3
IMG_4179	Alarms event list
IMG_4180	Alarms event list
IMG_4181	Alarms event list
24.10.2024	Alarm list
24.10.2024	SleipnerB-switchroom-1
24.10.2024	SleipnerB-switchroom-2
24.10.2024	Screenshot of fire area M402 high voltage room lower level
24.10.2024	Screenshot of fire area M404 low voltage room
24.10.2024	Screenshot of fire area M404 LIR room
24.10.2024	Screenshot of fire area M402 high voltage room upper level
C034-B-S-DY-M402	Fire protection data sheet. Fire area M402
24.10.2024	Layout and VDU Images
C034-B-000-EE-101-01	Overall single line diagram AC power system / UPS
20241022_083124.pdf	Screenshot showing locations of smoke detectors in high voltage room on SLB
20241022_085303	Screenshot of camera from helipad on SLB
20241022_085807	Image of CAP panel for SLB
IMG_1970	Screenshot from surveillance camera on SLB
24.10.2024	3 screenshots from cameras on SLB
C034-B-S-DY-M404	Fire protection data sheet
C034-B-E-DE-5041	NORSOK TRANSFORMER DATA SHEET
24.10.2024	Sleipner B TIMP Facility assessment 23 August 2024
24.10.2024	Photograph of action board at 10:03 overview
24.10.2024	Photograph of action board at 10:03
24.10.2024	Photograph of action board at 09:08
24.10.2024	Photograph of action board at 09:08 overview
24.10.2024	Photograph of focus board
24.10.2024	Photograph of action board at 07:54 overview
24.10.2024	Photograph of action board at 07:54
24.10.2024	List of equipment in the room
C034-B-M40D-JA-501-01	FIRE AND GAS LAYOUT MAIN LEVEL M40D.pdf
C034-B-M40L-JA-501-01	FIRE AND GAS LAYOUT LOWER DECK LEVEL M40L.pdf
C9.3 034-B-M40-SL-500-01	FIRE DIVISIONS_ COMPRESSOR MODULE_ LOWER MEZZANINE DECK
C034-B-C30-SL-104-01	FIRE DIVISION ELEVATION LOOKING NORTH
C034-B-C30-SL-105-01	FIRE DIVISION ELEVATION LOOKING WEST
C034-B-000-JE-304-01	Cause & effect chart, ignition sources group ISI-1, ISI-2, ISI-3 and isolation of crane on SLB
C034-B-S-DY-M402	Fire protection data sheet compressor module M40D high voltage room
C034-B-M40-GB-500	HVAC D&ID compression module main deck
C034-B-M40-GB-501	HVAC D&ID compression module main deck and lower mezz deck
C034-B-M40-GA-500-01	HVAC layout M40D
C034-B-M40-GA-501-01	HVAC layout M40L
TR1055	Sleipner TR1055 addendum ver 6.03 -2023
22.10.2024	Alert and notification of hazard and accident situations - Equinor Energy AS - Sleipner - SLEIPNER B - 2024-10-22 04 45 00