PETROLEUMSTILSYNET

Investigation report

Report	
Report title Nyhamna - Investigation following incidents involving falling objects	Activity number 005921020

Classification

☑ Public ☐ Restricted ☐ Strictly confidential
☐ Exempt from publication ☐ Confidential

Summary

Based on the many incidents of falling objects reported to the Petroleum Safety Authority Norway in 2015, it was decided to undertake an investigation of the follow-up of these by A/S Norske Shell and the contractors. Our investigation emphasised the companies' own follow-up of the incidents in relation to established governing documents in the project. The investigation at the facility was performed from 9 to 11 November 2015. In the main, the impression is that Shell and its contractors have performed good investigations of the individual incidents. No non-conformities with the regulations were identified in connection with our investigation. We did however detect some improvement points as shown in chapter 6. These relate primarily to deficient requirements in the governing documents.

Parties involved	
Main group T-Land	Approved by / date Kjell Arild Anfinsen / 28.01.2016
Investigation group participants Bjarte Rødne, Trond Sigurd Eskedal and Sigmund Andreassen	Investigation leader Sigmund Andreassen

Figure 1: Overview of Nyhamna

Contents

1 Summary

Based on the many incidents of falling objects reported to the Petroleum Safety Authority Norway in 2015, it was decided to undertake an investigation of the follow-up of these by A/S Norske Shell (Shell) and the contractors. We performed the investigation by interviewing key personnel and personnel who had participated in, or had knowledge of, incident follow-up in the project. We also talked with safety service representatives from the affected companies: Shell Project: Kværner Stord (KST), AF-Gruppen (AF) and Beerenberg Gruppen (BBC) at Nyhamna. A review of governing documents in the project was performed, which emphasised incident follow-up and investigation procedures in the above-mentioned companies. The investigation at the facility was performed from 9 to 11 November 2015.

In the main, the impression is that Shell and its contractors have performed good investigations of the individual incidents. Based on the identified findings, appropriate measures have been implemented.

It is our assessment that Shell, KST and KST's subcontractors have taken the individual falling-object incidents at Nyhamna seriously. The companies have worked in a targeted manner to learn from the incidents, so as to avoid similar incidents in the future. The companies have jointly arranged the implementation of various measures that were identified by the investigations.

No non-conformities with the regulations were identified in connection with our investigation. We did however detect some improvement points as shown in chapter 6. These relate primarily to deficient requirements in the governing documents. There follows a summary of the observations made during the investigation.

Observations:

1. Shell, KST, BBC and AF had not established coordinated project-specific requirements for which investigation procedure should be used for following up undesirable incidents in the project. No clear criteria were issued for which incidents should be investigated and which investigation method should be used depending on which company contributed to the undesirable incident and the project's choice of investigation leader.

2. There were no coordinated project-specific requirements for the organisation and composition of investigation teams in the Nyhamna expansion project in order to ensure participation from all relevant stakeholders, as well as the necessary competence.

3. BBC and AF could not point to company requirements that described the scope and content of investigations and inspections of incidents with a lower level of criticality.

4. For some of the investigated incidents, we found that the investigation team could have beneficially performed a more thorough analysis of the underlying causes of the incidents. This can help promote better learning and more effective measures for preventing similar incidents in the future.

5. KST uses a height deduction of 1.75 m (height of a person) in calculating the fall energy of falling objects for the risk classification of incidents. This deviates from the

applicable manual ("Best Practice - Dropped Objects Prevention", rev. 03 2012) from SfS (Samarbeid for Sikkerhet), which is used as a standard in the Norwegian petroleum industry, and may result in fewer incidents being reported.

6. We note that some of the incidents associated with falling objects have not been the subject of further reporting to the PSA.

2 Introduction

In 2015, there were a number of falling objects in connection with the development project at Nyhamna. The PSA has previously followed this up in some of our audits at the facility, and in a video conference in June 2015.

It was decided to undertake an investigation after incident number 16 in 2015 was notified to us on 2.11.2015. Based on internally reported incidents at Shell, in 2015, there were a total of 21 incidents of the falling-object type. Some of these incidents, with minor changes in the circumstances, could have resulted in serious personal injury.

The investigation group comprised the following people:

Sigmund Andreassen, investigation leader
Bjarte Rødne
Trond Sigurd Eskedal

Mandate:

1. To provide a brief overview of the falling-object incidents at Nyhamna in 2015 and select 2-4 of these incidents for more thorough review.
   To assess the companies':
   a. Planning of works and safety assessments made in advance of actual incidents.
   b. Description of actual and potential consequences.
   c. Assessments made of proximate and underlying causes, with an emphasis on human, technical, operational and organisational factors (depending on the investigation level).
   d. Preparation of investigation reports and communication of investigation results.
2. To assess the participants' own follow-up of the incidents individually and overall, as well as measures implemented in relation to falling objects at the facility.
3. To assess the companies' supervisory activities in respect of contractors and subcontractors.
4. To discuss and describe any uncertainties/confusions in the PSA's investigation work.
5. To identify any regulatory breaches, to recommend further follow-up and to propose the use of tools.
6. To prepare a report and accompanying letter.

2.1 Abbreviations

Abbreviations used in the report.

A/S Norske Shell	(Shell)
Kværner Stord	(KST)
Beerenberg	(BBC)
AF Gruppen	(AF)
Johny Birkeland Transport	(JBT)
SEC AS	(SEC)
Risk Assessment Matrix	(RAM)
Safety representatives	(VO)
Work permit	(AT)
Petroleum Safety Authority Norway	(PSA)
Samarbeid for Sikkerhet	(SfS)

2.2 Description of the Nyhamna Expansion Project

The Shell Nyhamna expansion project is an upgrade being performed in order to connect up a new pipeline, Polarled, to the facility at Nyhamna. In the first instance, this pipeline will transport gas from the Statoil-operated Aasta Hansteen field to Nyhamna, but subsequently Polarled will also be able to enable other fields to connect to the processing and export facility at Nyhamna.

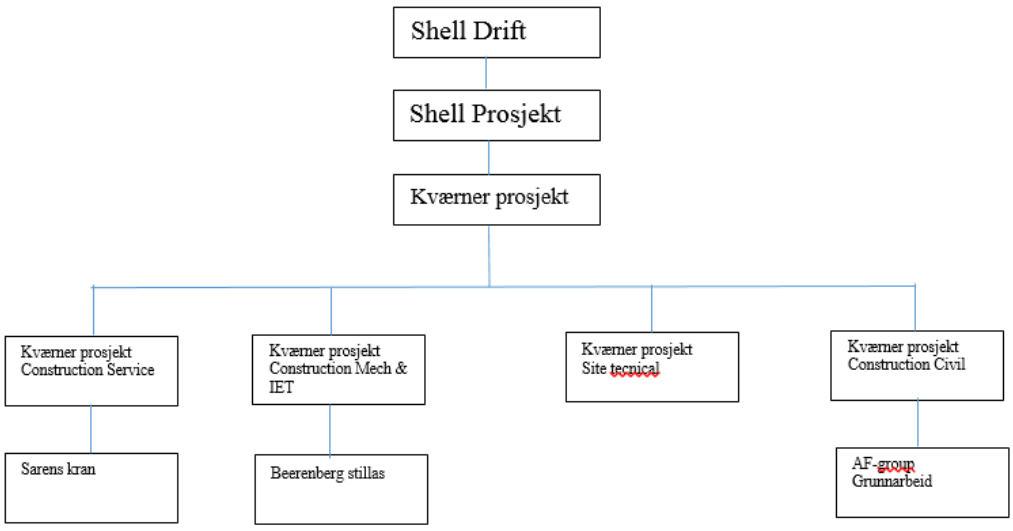

Figure 2 Lines of responsibility and reporting lines in the Nyhamna expansion project

Kværner Stord (KST) is Shell's main contractor for the project. KST's contract covers all projects for and modifications to the Ormen Lange/Nyhamna facility.

Description of each individual company's connection with the project:

- Shell Operations owns the project.

- Shell Project exercises the supervisory duty and follow-up of the project on behalf of Shell Operations.
- Kværner Stord holds the EPC contract with regard to Shell Operations and the project is managed by Kværner Project.
- Kværner Project Construction Service performs materials handling and coordinates cranes and lifting operations by hiring mobile crane firms.
- Kværner Project Construction Mech & IET follows up and manages the contract with Beerenberg for scaffolding work.
- Kværner Project Site Technical is responsible for technical follow-up.
- Kværner Project Construction Civil follows up ground works and manages the contract with AF Gruppen.

Figure 3 Overview of sections of the Nyhamna expansion project. Source: Shell's website

Shell's expansion project at Nyhamna started in 2014. The work involves preparing for the installation of two new compressors. These compressors are to assist the wellstream from Ormen Lange at a depth of 850 metres up onto land, which is an initial phase in Ormen Lange's future compression requirements, before compression is installed on the field itself. This will assist in increasing the production of Ormen Lange gas.

The project has been divided into four phases of activity.

- One phase for foundation work and organising construction, named "Civil". This phase is being performed by AF Gruppen, as subcontractor to KST.
- A phase for module handling, named "Module", for transporting on-site the plant's individual prefabricated modules.
- A phase named "ME&I" for installation and mechanical completion.
- A phase for testing and trialling the plant.

At the time of the investigation, there were approx. 700 people engaged in the project and it was expected to increase this total at year-end, peaking at around 830 in February 2016, with activity then tailing off towards summer 2016.

The project work has proceeded while the rest of the facility has been fully operational with the processing and supply of gas, apart from one month in the summer of 2015.

3 The companies' governing documents for incident follow-up and classification of risk potential

As part of our investigation, we examined the companies' governing documents in the project for following up undesirable incidents, including their investigations. The objective was to investigate whether established requirements ensured proper follow-up and learning following incidents, and whether established requirements were complied with in the project.

This was done by focusing on three of the reported incidents in order to follow the chain of events and investigation/follow-up by the different companies in the wake of the incidents. These three incidents are described in table 4.1.

It was explained that Shell's contract with KST entails the use of KST's procedures in the project. The subcontractors' procedures are used in specialist areas where KST's procedures are not adequate. During the investigation, it was not however possible to get this in writing. In particular, there is uncertainty as to which investigation procedures apply in investigating incidents where several companies are participating jointly in the investigation work. We noted that investigations had been performed based on the investigation procedures of KST, BBC and AF.

3.1.1 A/S Norske Shell (Shell)

For the operating company Shell, incident follow-up and investigation is described in the procedure (UIE-17.PR4) "Incident Reporting and Follow-up". Shell registers and follows up the incidents in its Fountain incident follow-up system. Much of the information in Fountain is based on the Synergi reports received from KST and its subcontractors.

The degree/level of incident investigation in Shell will depend on the specific factors relating to the incident, and the initial risk assessment the incident is assigned.

In our investigation, we did not see examples of incidents of the falling-object type where Shell had the investigation leader role or where Shell's investigation methodology was used. Instead, at Nyhamna, Shell has chosen to participate through a representative in the investigation work headed by KST or KST's subcontractors. This practice is not clearly reflected in Shell's "Incident Reporting and Follow-up" document or in other documents presented to us by Shell. See chap. 6.2.2 of the report.

Shell's risk assessment matrix for risk classification of undesirable incidents is shown below.

1. **Use the Risk Assessment Matrix (RAM), see Figure 1 below, for performing HSSE Risk Assessments.**

SEVERITY	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A	B	C	D	E
					Never heard of in the Industry	Heard of in the Industry	Has happened in the Organisation or more than once per year in the Industry	Has happened at the Location or more than once per year in the Organisation	Has happened more than once per year at the Location
0	No injury or health effect	No damage	No effect	No impact					
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact					
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact					
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact					
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact					
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact					

Light Blue
Dark Blue
Yellow
Red

Figure 1: The Group Risk Assessment Matrix

2. **Assure the competence of people applying the RAM to HSSE Management processes.**

Figure 4 Shell's risk assessment matrix

3.1.2 **Kværner Stord (KST)**

For KST, incident follow-up is described in procedure P0001ENYX "Processing of HSSE Incidents/oppfølging av HSSE saker".

Incidents are classified in the following categories:
Green incident: Undesirable incident with a low risk potential (green field in the risk matrix), or actual consequence level 5.
Yellow incident: Undesirable incident with medium risk potential (yellow field in the risk matrix), or actual consequence level 4.
Red incident: Undesirable incident with high risk potential (red field in the risk matrix), or actual consequence level 3.
Black incident: Undesirable incident with extreme risk potential (black field in the risk matrix), or actual consequence level 1 or 2.

Risikopotensialet

Risikopotensialet bestemmes ved først å gradere den sannsynlige konsekvensen av en hendelse for mennesker, miljø eller materielle verdier (grad 1 – 5).

Merk: Hvis hendelsen ikke har noen potensiell konsekvens for mennesker eller miljø, skal den registreres som en kvalitetshendelse.

Deretter vurderes sannsynligheten for at en hendelse med den definerte konsekvensen skal inntreffe i bedriften (grad A – E).

I den grad dette er tilgjengelig, bør man bruke erfaringsdata fra bedriften, eventuelt fra søsterbedrifter eller bransjen for øvrig.

Consequence		Injury / illness	Environment	Reputation	Economic/ material/ production	Probability (probable recurrence rate in the Kvaerner): E > 5 years	D 1 - 5 years	C 6 months - 1 year	B 14 days – 6 months	A < 14 days
	1	Fatality	Serious off-site impact, significant remediation required	International media coverage	USD > 1 mill				Extreme	
	2	Serious with permanent disablement	Significant off-site impact, some remediation required	National media coverage	USD 250k-1mill			High		
	3	Serious injury / illness	Release significantly above reportable limit or some local impact	Regional media coverage	USD 50k-250k		Medium			
	4	Medical treatment	Release above reportable limit or minor impact	Local media coverage	USD 10k-50 k					
	5	First Aid	Small release contained onsite and no impact	No media coverage	USD < 10 k	Low				

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Figure 5 KST's risk assessment matrix

Klassifisering av fallende gjenstand

Mulig konsekvens av en fallende gjenstand bestemmes ut fra bevegelsesenergien:

Masse (kg) x Fallhøyde (m) x Tyngdeakselerasjonen (g=9,81 m/s^2)

Dersom bevegelsesenergien er over 20 Joule settes mulig konsekvens til grad 3 (alvorlig personskade). Er energien over 40 Joule settes mulig konsekvens til grad 1 eller 2 (død eller skade med varige men).

Deretter vurderes sannsynligheten for at noen kunne blitt skadet ut fra hvor og eventuelt når gjenstanden har falt ned.

Forhold av betydning er:
- type gjenstand?
- området åpent for ferdsel?
- personell i nærheten av fallstedet?
- verneutstyr benyttet?
- området avsperret?
- personell innenfor sperringer?
- område der personell sjelden ferdes?
- tidspunkt med liten/stor trafikk?

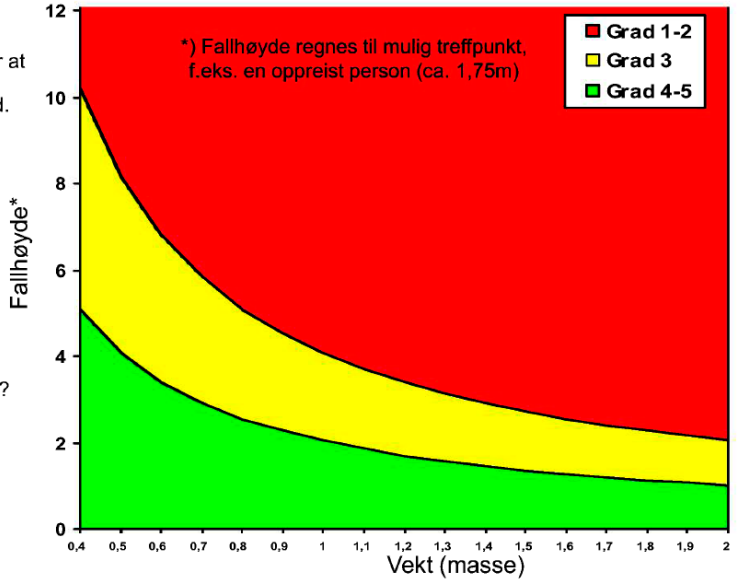

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Figure 6 KST's classification of falling objects

In the case of a **green incident**, a simple gathering of facts concerning the chain of events is made, including proximate causes, consequences/losses and measures implemented. The incident is followed up in Synergi.

In the case of a **yellow incident**, an assessment is made of whether to perform a simplified investigation (doc no. P0001-04) of the incident. Such an investigation covers gathering of facts, descriptions of risk potential, actual consequences/losses, proximate causes, underlying causes, breaches of barriers and measures implemented to prevent similar incidents. See separate annex to this report, annex "KST template for simplified investigations". An investigation group must be established within 48 hours and the leader of the investigation should have received investigation training. A simplified investigation report must be appended to the Synergi case. If an investigation is not assessed to be necessary, the incident is followed up as normal in Synergi.

In the case of a **red incident** or actual harm at level 2 or 3, the need for a more comprehensive investigation is assessed against the company's Incident Investigation Standard. An investigation is to be initiated within 48 hours. A mandate for the investigation group must be prepared. An investigation report must be submitted, which is appended to the Synergi case. The leader of the investigation should have received investigation training.

In the case of a **black incident** or actual harm at level 1, an investigation must be initiated within 24 hours, with a mandate and an investigation in accordance with the company's investigation standard.

A typical mandate for an incident investigation in KST comprises the following factors:
1. Gather, record and analyse all information in order to determine how the incident could occur.
2. Describe the chain of events. Establish a timeline and gather known facts and findings leading up to the incident, including notification of the incident.
3. Identify and analyse causal factors, management system failures and root causes.
4. Describe and assess actual and potential consequences.
5. Compile a report with recommendations and lessons learned and ensure that measures are prepared in order to prevent similar incidents and to promote greater awareness and communication of lessons learned.
6. Examine roles and responsibilities of management functions at different levels. Reflect at previous experiences and determine whether similarities have arisen in terms of causal factors linked to incidents/near-misses in the project or Kværner in the last year.

It further appeared from the mandates for the various investigation groups that they should, as a minimum, make an assessment of:
- technical conditions
- organisational conditions
- management
- use of and adherence to procedures, risk assessments (e.g. Care talks, SJAs)
- communications factors
- relevant training
- any other relevant factors.

It further appeared from the mandate that the investigation should be performed in accordance with a man, technology, organisation (MTO) model and in compliance with the company's

procedure for investigation of incidents. The findings identified in the investigation must be registered in Synergi with associated deadlines and responsibilities for measures/actions. For **yellow, red and black incidents**, immediately after the incident has been investigated, a presentation in Norwegian and English of lessons learned is to be prepared. A fixed template is used for this in KST; see document P0001ENYX-03. Such a presentation may also be produced for **green incidents**, if this is judged to be appropriate

The incidents we have followed up are shown in the list in chap. 4.1. Based on KST's risk classification of the different incidents, our general impression is that KST has performed investigations and prepared investigation reports in compliance with the company's requirements. Specific improvement points are discussed later on.

3.1.3 **Beerenberg (BBC)**

It is stated in Beerenberg's document "HSE programme (Contract: KST-DUL-12-0047)" chap. 4.9.3 that the classification of incidents at Nyhamna will be assessed in partnership between KST and BBC for registration in KST's non-conformity follow-up system (Synergi). The classification of the incidents will proceed in accordance with KST's risk assessment matrix (RAM).

However, BBC gave the impression that they also classified the incidents in a separate Synergi system based on BBC's own incident classification requirements; see GOV-WI-17-00197 "Definition of HMS parameters". The same incident could therefore have different classifications in the different companies.

BBC's risk assessment matrix is shown below.

Sannsynlighet		
Faktor	Sannsynlighet	Kriterier
5	**Svært sannsynlig**	Kan skje 1 gang pr. mnd.
4	**Meget sannsynlig**	Kan skje 1 – 5 ganger pr. år
3	**Sannsynlig**	Kan skje 1 gang pr. år eller sjeldnere
2	**Mindre sannsynlig**	Kan skje 1 gang pr. 10 år
1	**Veldig lite sannsynlig**	Kan skje 1 gang pr. 50 år

Konsekvenser				
Faktor	Person	Materiell	Ytre miljø	Omdømme
5	**Katastrofe** Dødsfall	**Katastrofe** Fullstendig materiellødeleggelse med alvorlige økonomiske konsekvenser for selskapet.	**Katastrofe** Alvorlige langtidsskader på ytre miljø	**Katastrofe**
4	**Særdeles kritisk** Livstruende, meget alvorlig personskade, varig men. Arbeidsuførhet	**Særdeles kritisk** Alvorlig økonomisk tap. Lengre driftsstans.	**Særdeles kritisk** Moderat langtidsskade på ytre miljø.	**Særdeles kritisk**
3	**Kritisk** Kritisk personskade som resulterer i langtidsfravær. Stort potensial.	**Kritisk** Betydelig økonomisk tap over 50.000,- Driftsstans opp til en uke.	**Kritisk** Moderat korttidsskade på ytre miljø.	**Kritisk**
2	**Alvorlig** Personskade, medisinsk behandling. Fraværsskade.	**Liten** Mindre økonomisk tap (1 – 50.000) Kort driftsstans	**Liten** Noe, men ubetydelig skade på ytre miljø.	**Liten**
1	**Uønsket hendelse** Førstehjelpsskade	**Ubetydelig** Ubetydelig økonomisk tap. Ingen driftsstans	**Ubetydelig** Ubetydelig til ingen skade på ytre miljø	**Ubetydelig** Ubetydelig tap av omdømme.

10-25	Høy risiko	5-9	Middels risiko	1-4	Lav risiko

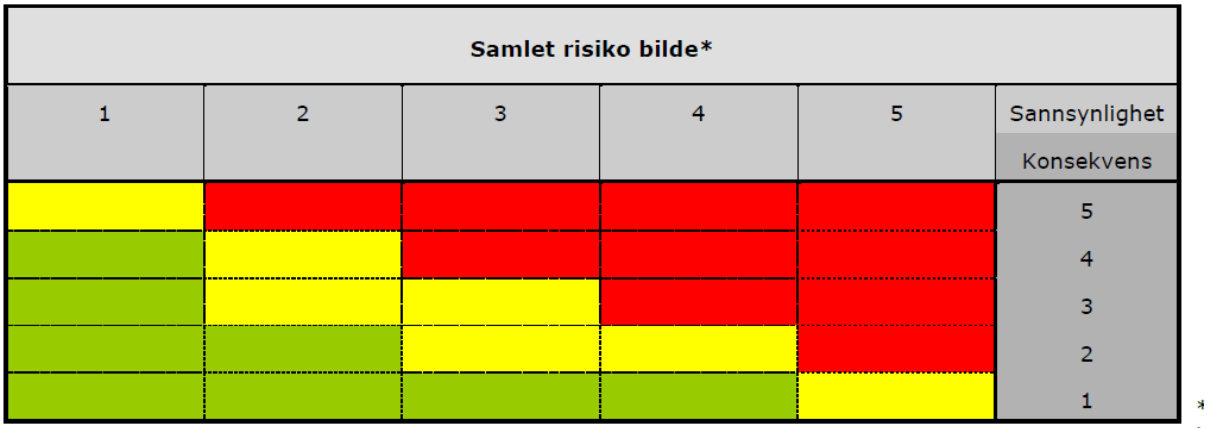


Figure 7 BBC Risk matrix

Classification of falling objects in BBC:

For the classification of falling objects, the following requirements are given in the BBC document GOV-WI-17-00197 "Definition of HMS parameters"; see chapter 4.4.

By falling object is meant an object falling freely in air between two levels. A falling object is classified in accordance with the amount of energy it represents. The kinetic energy of a falling object is calculated using the following formula:

Fall energy (joules) = mass (kg) x height x 9.81m/s2

The incident must be classified in one of **two categories** – objects with a fall energy **above or below 40 joules**. In addition, a further classification must be made based on an assessment of the potential for personal injury or damage to safety-critical equipment. The potential for harm will not depend on the fall energy alone, but also factors such as the object's hardness, shape, where it hits or could have hit under slightly different circumstances, etc. This entails that the potential must be assessed and if necessary adjusted in relation to which object has fallen and how.

The following criteria apply to the classification of falling objects in BBC:

1. Objects with a fall energy above 40 joules

   By definition, falling objects above 40 joules are classified as **red**. The classification must be nuanced on the basis of actual hazard potential, where hazard potential means possible harm to safety-critical equipment and personnel.

   Fall within a cordoned-off area:
   Falling objects above 40 joules which fall within a cordoned-off area are classified as **yellow** if there is no risk to personnel or safety-critical equipment. The basis for classifying the incident as **yellow** is that there will always be a theoretical chance that the barrier (cordon) may have failed (e.g. a break in the barrier, area inadequately cordoned-off etc.). By classifying falling objects as **yellow**, this uncertainty is taken in account.

2. Objects with a fall energy below 40 joules

   If the object's shape or specific weight is of such a nature as to have a potential for personal injury (such as pointed objects, sharp edges), the incident must be classified as **red** if, in the given circumstances, personnel could have been hit by it.

As indicated above in point 2, for objects with a fall energy below 40 joules, no specific requirements have been stated as to when these should be assigned to risk category **yellow** (medium risk) or risk category **green** (low risk).

Follow-up of incidents in BBC

For BBC, follow-up of incidents is described in the document GOV-WI17-00194, "Investigation of undesirable incidents". These different levels of incident are identified. The need for investigation will depend on the incident's classification level. In BBC, the term *investigation* is used for level 1 and level 2 incidents. The term *inspection* is used for all level 3 incidents.

Level 1: Highly critical incidents. Incidents that have caused death, serious personal injury, very extensive pollution and/or substantial harm to material assets. Level 1 investigations must be initiated immediately following an incident.

Level 2: Critical incidents. Incidents with a large potential for loss (**red incidents** in Synergi). An investigation must be initiated no later than the first working day following the incident and before the area is cleared for clean-up.

Level 3: Other incidents. Incidents which it is wished to *investigate* or *inspect* for other reasons. Level 3 *inspections* will be undertaken if the incident in question affects group statistics (TRIF). For incidents included in group statistics, the project involved will undertake its own inspection of the incident. We interpret level 3 incidents as incidents classified as **yellow** or **green** in the risk matrix, without BBC having specifically differentiated between these two categories.

It was not clear from BBC's document "Investigation of undesirable incidents" which requirements were imposed for inspecting incidents categorised as level 3 and which were not subject to an investigation. We note that some incidents were followed up by performing a simplified investigation with regard to the principal's (in this case KST's) formula for such simplified investigations. We do not find this practice reflected in BBC's established management systems for on-going project work at Nyhamna. This circumstance was not pointed out by Shell or KST who had both had BBC's corporate procedures for review and comment. See chap. 6.2.3 of the report.

A standard mandate for investigating incidents is given in the company's document GOV-AP17-00195 "Mandate for investigating incidents" and a template for preparing an investigation report is given in document GOV-AP17-00257.DOCX "Investigation report".

A typical mandate for incident investigation in BBC consists of:

- Mapping the chain of events
- Identifying proximate and underlying causes
- Identifying the backgrounds, training, experience and so forth of personnel involved
- Assessing notification and emergency response factors
- Assessing the incident's overall potential
- Checking for similar incidents, transfer of experience from these and the effect of the measures taken
- Making recommendations and proposing measures
- Preparing a report following the investigation
- Preparing a presentation (short version) of the incident for experience transfer.

We note that BBC was involved in many of the 21 incidents of the falling-object type reported in 2015. None of these were investigated in accordance with BBC's own investigation requirements. In order to obtain a picture of BBC's own investigation work, in relation to its own investigation procedures, we therefore decided to look at the incident which occurred on 8.3.2015 - "Scaffolding which toppled over in strong winds at accommodation facility, ref. BBC Synergi no. 14426". This incident was not notified and reported to the PSA, since the incident occurred "outside the plant perimeter" and thus does not come under our authority. We mention it here nonetheless since it provides an insight into BBC's methods for incident investigation at Nyhamna. This incident was classified by BBC as a level 3 incident, where investigation was considered desirable.

Our main impression is that the investigation report produced following this specific incident on 8.3.2015 was executed in a structured and systematic way. The report was prepared in accordance with the company's requirements for the content of such reports.

3.1.4 **AF Gruppen**

For AF Gruppen, the company's requirements for follow-up of undesirable incidents are described in the procedure (9811-324168) "Reporting and handling of undesirable incidents" All reports of undesirable incidents are registered in Synergi.

Undesirable incidents are classified in the following categories:

Red incidents: Undesirable incident that may cause very serious personal injury or death. Major harm to the external environment or major material damage.

Yellow incidents: Undesirable incident that may cause serious personal injury, harm to the external environment or to material assets to a lesser extent than red incidents.

Green incidents: Undesirable incident than may cause minor personal injury, or minor damage to the external environment or material assets.

Personskade	Materiell skade	Utslipp til ytre miljø	Produksjons-tap	Mest sannsynlig gjentakelsesfrekvens				
				> 10 år	1-10 år	3mnd. – 1 år	14 d – 3 mnd	1 – 14 dager
Død	Over 1 mill	Betydelig utslipp	Over 1 mill					
Alvorlig p.skade m/mulig mèn	Inntil 1 mill	Utslipp < 1000 l	Inntil 1 mill					
Alvorlig personskade	Inntil 500.000,-	Utslipp < 500 l	Inntil 500.00,-					
Medisinsk behandling	Inntil 100.000,-	Utslipp < 100 l	Inntil 100.000,-					
Førstehjelpsskade	Inntil 50.000,-	Utslipp < 10 l	Inntil 50.000,-					

Figure 8 AF's classification of incidents

For incidents which result in lost time injuries and incidents with large risk potential (red incidents), under AF Gruppen's procedures an investigation must be initiated. Reference is made to procedure (1007-ADMPAF-00008) "Investigation and follow-up of serious incidents".

The investigation procedure listed the STEP method as a possible method for describing the chain of events with the involvement of the parties. The incidents must be analysed to detect proximate and underlying causes, as a basis for implementing measures to prevent similar incidents in the future. Use of the 'causes of loss' model and a barrier analysis are proposed for identifying proximate and underlying causes of the incident.

In this context, we followed up the (red-classified) incident of 2.8.2015 "Concrete hose breakage". Our main impression is that the investigation report produced following this incident was executed in a structured and systematic way. The report was prepared in accordance with the company's requirements for the content of such reports.

In the received governing documents from AF Gruppen, no requirements were defined for how incidents in categories lower than **red** are expected to be investigated or reviewed. The above-mentioned omission in AF's investigation and follow-up procedure was not pointed out by Shell or KST who had both had AF's corporate procedures for review and comment. See chap. 6.2.3 of the report.

We subsequently received information describing that, in practice, at Nyhamna, AF also tries to find the underlying causes of incidents classified as yellow and green, by using the 'causes of loss' model. An assessment must also be made of whether risk-reducing barriers were in place and of the reason why these were insufficient or weakened. We note that, to a large extent, this corresponds with the content of KST's formula for simplified investigation which we note is actively used in the Nyhamna project by KST's subcontractors.

3.1.5 **Choice of investigation method and composition of investigation team**

We cannot see that coordinated requirements have been established between Shell, KST, BBC and AF to describe which investigation method should be used at Nyhamna for following up

undesirable incidents. This concerns requirements for investigation depending on the incident's risk classification and which company contributed to the undesirable incident. We were told that the choice of investigation method and the appointment of the investigation leader were decided by KST in consultation with Shell. We do not find this process described in governing project documents. We note that investigations have been performed based on the investigation procedures of KST, AF and BBC. In several cases, KST led the investigation work for incidents caused by the subcontractors BBC and AF. KST has then used its own investigation routines and involved the subcontractor and Shell in the investigation work. We also see examples of BBC and AF having used KST's tools for simplified incident investigation for following up undesirable incidents, where they have led the investigation work.

There were no coordinated project-specific requirements for the organisation and composition of investigation teams for the follow-up of undesirable incidents. Such requirements may help ensure the necessary participation of all companies involved, and to fulfil the companies' supervisory duty, as well as ensuring necessary technical competence and expertise in the investigation methodology employed. We noted that the individual companies have established requirements for the composition of investigation teams, but these requirements do not clearly describe how investigation teams are to be established at Nyhamna.

Based on our discussions with personnel from the different companies, it emerged that potential conflicts of interest and responsibilities of appointed investigation members were not widely assessed and discussed in relation to the composition of an investigation team. Such factors can affect the investigation work and, under KST's investigation procedure, must be assessed in each individual case. See chap. 2.2 of the procedure. Corresponding requirements are described in AF's procedure for investigation and follow-up of serious incidents. See chap. 3 of the procedure. In BBC's procedure for inspecting undesirable incidents, it is recommended that a representative of line management participates in the investigation work. If this line responsibility is linked to the actual incident, this can be problematical.

3.1.6 **Use of language**

There were no requirements concerning which language must be used in compiling investigation reports. We noted that the companies' investigation reports (according to the highest classified incidents) were all written in English, except for the investigation report produced by JBT, "Vacuum tanker caught up in scaffolding", and the investigation of "Scaffolding which toppled over in strong winds" led by BBC. We received information that some employees and safety representatives failed to read the investigation reports because they were only available in English. We found it positive that a brief summary of the investigation findings was prepared for learning and experience transfer purposes. We were told that these summaries (lessons learned) should exist in Norwegian and English.

4 Falling objects Nyhamna 2015

Our investigation at Nyhamna was based on the 16 incidents involving falling objects notified to the PSA in 2015 up to 4.11.2015. A separate table appears below, arranged by when the incidents occurred. The descriptions of the incidents in the table are the same as received in the notification from Shell to the PSA, with reference to the description in the Management

Regulations (Regulations relating to management and the duty to provide information in the petroleum activities and at certain onshore facilities), chap. VIII.

The table contains columns for date, companies involved, brief description of the incident, fall energy derived from Shell's calculation of the incidents, type of investigation, name of the company which led the investigation and classification of the incidents by Shell, KST and any subcontractor.

The KST column also gives the fall energy used in their reports and classifications. In the subcontractor column, for incidents involving BBC, BBC's own classification of the incidents is given, without a deduction of 1.75 m from the fall height as used by KST in its classification.

During interviews with personnel at Nyhamna we chose to focus on three of the reported incidents in order to follow the chain of events and investigation/follow-up by the different companies in the wake of the incidents. These three incidents are the incident dated 2.8.15 with AF Gruppen responsible for the investigation, the incident dated 9.10.15 with Beerenberg responsible and the incident dated 2.11.15 with Kværner responsible.

We also received investigation and follow-up reports from the other incidents relating to falling objects at Nyhamna, which we reviewed as part of our mandate.

4.1 List of falling objects Nyhamna 2015

Date in 2015	Company involved	Brief description of incident	Fall Energy (Ef) in (J) *	Type of investigation	Company heading the investigation	Classification		
						Shell	Kværner (J)-1.75 m	Subcontractor
23.2	BBC	During erection of scaffolding, a scaffolding tube fell approx. 5 metres. The weight of the tube was 3.6 kg. The area under the scaffolding was cordoned off.	172	None		C4 (Yellow)	115	Green
7.3	JBT	Incident on Saturday morning on the road/underpass between the water treatment plant and turboexpander (U43-U53). The inlet connector on a vacuum tanker caught up in the scaffolding under a pipe support tray as it passed by. This caused several scaffolding planks to fall onto the road. The driver stopped the lorry and the damage site was quickly secured and cordoned off. Drops of hydraulic oil spilled from the lorry, but the driver quickly got Absol sand spread out. The scaffolders blocked the road on both sides of the underpass and scaffolding. 5 scaffolding planks of approx. 10 kg fell from a height of approx. 5.5 metres. There was no-one on the scaffolding or in the immediate vicinity when the incident occurred except the driver of the vacuum tanker.	540	Investigation	JBT	B4 (Yellow)	Yellow 368	"Could have had fatal consequences"
11.03	BBC	During erection of scaffolding in P44, a scaffolding clamp fell from a height of 3 metres. The weight of the clamp was 1.5 kg.	44	None		C1 (Dark blue)	18	Green
104.	BBC	A scaffolding plank fell to the ground during erection. Weight 11.3 kg, height approx. 2.5 m.	277	None		Dark blue	Green 83	Yellow
06.05	BBC	During erection of scaffolding, the IP dropped a 0.5 m large ledger of 1.1 kg which fell 5 metres. The area below was cordoned off.	54	Internal investigation	BBC	C3 (Yellow)	Green 35	Yellow

14.05	AF Gruppen	When dismantling some formwork, a wooden board was used to remove a piece of plywood. When the piece loosened, the person dropped the board and it fell approx. 10 m. Its size was 48 mm x 98 mm x 600 mm and weight approx. 1.5 kg.	147	Investigation	Kværner	B4 (Yellow)	Red 121	Yellow
16.05 ****	BBC	An aluminium tube of 2.3 kg fell in the drop zone from 2.4 m when a scaffolder stretched to pass the tube to a colleague on a 3.3 m deck.	54	None				Yellow
17.05	AF Gruppen	A person was descending a ladder carrying a scaffolding element. The person slipped and dropped the element off the scaffolding tower. Weight 3 kg and fall height around 10 m. The area was cordoned off.	294	Investigation	Kværner	B4 (Yellow)	Red 243	Yellow
31.05	SEC	During splitting of a DN600 flange, a seal ring fell approx. 4 metres and landed on a scaffold. Seal ring weighed 7.55 kg. No personal injury or damage to equipment. Everyone working on the job was at a higher elevation. No-one was in the area where the object landed. The area below was cordoned off by chain and signage.	296	Simplified investigation	Kværner	B4 (Yellow)	Green 167	
8.6	BBC	During work on a scaffold (in area P35 east), an aluminium plate fell approx. 10 metres and landed on the concrete deck on the ground. The plate weighed 4.18 kg. No personal injury or damage to equipment. Those working on the job were at a higher elevation. No-one was in the area where the object landed. The area below was not cordoned off.	410	Investigation	Kværner	C4 (Yellow)	Red 340	Red
24.7	BBC	During dismantling work on scaffolding in area P44, a scaffolding clamp fell 7.7 m. Weight 1.3 kg. The area below was cordoned off.	98	Simplified investigation	BBC	D3 (Yellow)	Green 76	Green Yellow
2.8 **	**AF Gruppen**	**In connection with concrete pouring at Nyhamna area S70, a concrete hose came off a concrete lorry and fell 12 metres. The hose was 13 m long and fell in a cordoned-off**	**29430**	**Investigation**	**AF Gruppen**	**B4 (Yellow)**	**Red**	**Yellow**

		area. The weight of the hose with concrete was around 250 kg. Only the operator was present. There was only concrete spillage which was gathered up, and no personal injuries.					**25138**	
5.8	BBC	During modification of a scaffold, a scaffolding plate (weight: 3.2 kg) was to be moved from one place to another at the same level. The plate was temporarily stored in an upright position and supported on the railing. Meanwhile, the person involved went to get a rope a few metres away. Due to movement on the scaffold from other team members, the plate was "shaken" loose and fell 3 metres to the ground. The area was cordoned off and no-one was within the cordoned area.	94	Simplified investigation	BBC	D3 (Yellow)	Green 39	Green Yellow
13.8 ****	Unknown	A scaffolding plank fell during removal of formwork.	78	None		Dark blue	Green	
24.8	BBC	During dismantling of scaffolding, a scaffolding ledger fell in area L46 (landfall). The ledger weighed 4.1 kg and fell 2.5 metres. The area underneath was cordoned off and no-one was within the cordoned area.	101	Simplified investigation	BBC	D2 (Yellow)	Green 18	Green Yellow
28.8 ****	AF Gruppen	During work to remove precut paving close to a manhole in L46, a paving piece fell through the manhole cover down into the manhole and damaged a firewater pipe.		Simplified investigation		Dark blue	Green	
07.10	AF Gruppen	During installation of a stair tower, a crowbar of 0.5 kg fell about 20 m. The tool slipped out of its safety holder down into a cordoned-off area. The area was monitored by a guard.	98	Simplified investigation	AF Gruppen	A4 (Dark blue)	Green 89	Green
9.10 **	**BBC**	**During dismantling of scaffolding, a scaffolding tube of 4.7 kg fell approx. 3 m. The tube got stuck in a cable tray and then fell down. The area below was cordoned off.**	**138**	**Simplified investigation**	**BBC**	**B4 (Yellow)**	**Green 58**	**Green Yellow**
24.10	Sarens	During dismantling of support material for module transport, a bolt of 2 kg fell about 4 metres. The bolt was not secured	78	Investigation	Sarens	B4 (Yellow	Yellow	

		during the work. The area below was not cordoned off and there were personnel in the area.				)	44	
02.11 **	**Kværner**	**An aluminium plate of 100 X 15 cm, 1.5 kg fell 16 metres during installation work. The area below was not cordoned off. There were 4 people in the area, but no injuries.**	**235**	**Investigation**	**Kværner**	**B4 (Yellow)**	**Red 210**	
08.11 ***	Kværner	During installation of a railing module for the new Piperack in P45, a piece 29 cm long, weighing 0.8 kg, broke off. It fell through the piperack and ended up in freefall for approx. 6 m. The area below was cordoned off during the installation.	47				33	
08.03 *****	BBC	A scaffolding tower toppled over due to strong winds		Investigation	BBC			

Figure 9 List of falling objects Nyhamna 2015

* Fall energy (E) is calculated as E=mhg, where m = the mass of the object in kg, h = the fall height in metres and g=acceleration due to gravity (9.81 m/s^2). The definition is taken from SfS (Samarbeid for Sikkerhet) "Best Practice - Dropped Objects Prevention, rev. 03-2012.

**Incident used as an example in our investigation.

*** Falling object that occurred after the PSA decided to investigate falling objects at Nyhamna.

**** Incidents that were not reported to the PSA

***** Incident that was not reportable to the PSA, but is used as an example in the investigation, ref. chapter 3.1.3 above.

Beyond the incidents listed in the table above, there were a further 5 falling objects at Nyhamna in 2015, that were either not reportable to the PSA due to being small falling objects (low risk potential) or not coming under the PSA's responsibility (e.g. occurred outside the plant's perimeter).

4.2 Planning of works and safety assessments made in advance of actual incidents

As part of our investigation we examined what planning and safety clearances were enacted in advance of the individual work assignments that result in falling objects.

Shell's "Procedure for work management" imposes a requirement for a system of work permits and applies to "all work performed within the perimeter of Nyhamna". The work permits (ATs) reviewed in connection with our investigation had different levels, as described in the same Shell procedure. The procedure describes when AT level 1 is required, when AT level 2 is required and when these ATs are not required. Below is a sample AT level 1.

ARBEIDSTILLATELSE NIVÅ 1 NR.: 9500273029 (Released)

☐ Varmt arbeid kl. A ☐ Varmt arbeid kl. B ☐ Entring ☐ Utkopling av sikkerhetssystem ☐ Trykktesting ☐ Arbeid over sjø ☐ Farlige kjemikalier ☐ Radioaktive stoffer ☐ Graving ☐ Eksplosiver ☐ Kritisk løfteoperasjon ☒ Annet/Kritisk operasjon ☐ Arbeid på hydrokarbonførende system ☐ Spesiell transport

Søker navn: Roar Solås Disiplin: NYH-CO-A Telefonnr: 97075609
Utførende kontraktør: AP/KVÆRNER
Arbeidsbeskivelse: Støping av fundament/vegg 5070 P35.El. utstyr tagget og-godkjent..Oppstilling av pumpe på eksisterende veg..utstyr:vibrator,-pumpebil og betongbiler
Utstyr/verktøy: håndverktøy,kompressor el.verktøy gysegumpe
Prod. enhet: N004 Område/Anlegg: NYHP35
Nr. utstyr, rørlinje o.l.: Sone: Unclass.
Vedlegg: JP: LQ1LP35U020

☐ SIKKER JOBB ANALYSE: NR:
ARBEIDSORDRE NR.:
OPERASJON NR.:
ISOLASJON NR.:
☒ Dag ☐ Natt ☐ Pågående arbeid
Dato fra: 02.08.2015 Kl. fra: 07:00:00
Dato til: 02.08.2015 Kl. til: 19:00:00
Forlengelse til kl:
Leder Sign:
Kontrollrom Sign:
Områdetekniker Sign:

DRIFTS- OG SIKKERHETSFORBEREDELSER A B

Påkrevet Utføres av områdetekniker — Signatur
☐ Avfasting av trykk
☐ Drenering/tømming
☐ Rengjøring/gassfriing
☐ Avstengning med: enkel ventil/to ventiler og avblødning
☐ Blinding/isoleringsplan
☐ Merking/avlåsing
☐ Utluftning/ekstra ventilasjon
☒ Forebygge utslipp av olje/gass i området
☐ Tiltak mot radioaktiv stråling
☐ Inspeksjon av arbeidsstedet hver ____ time
☐ Annet

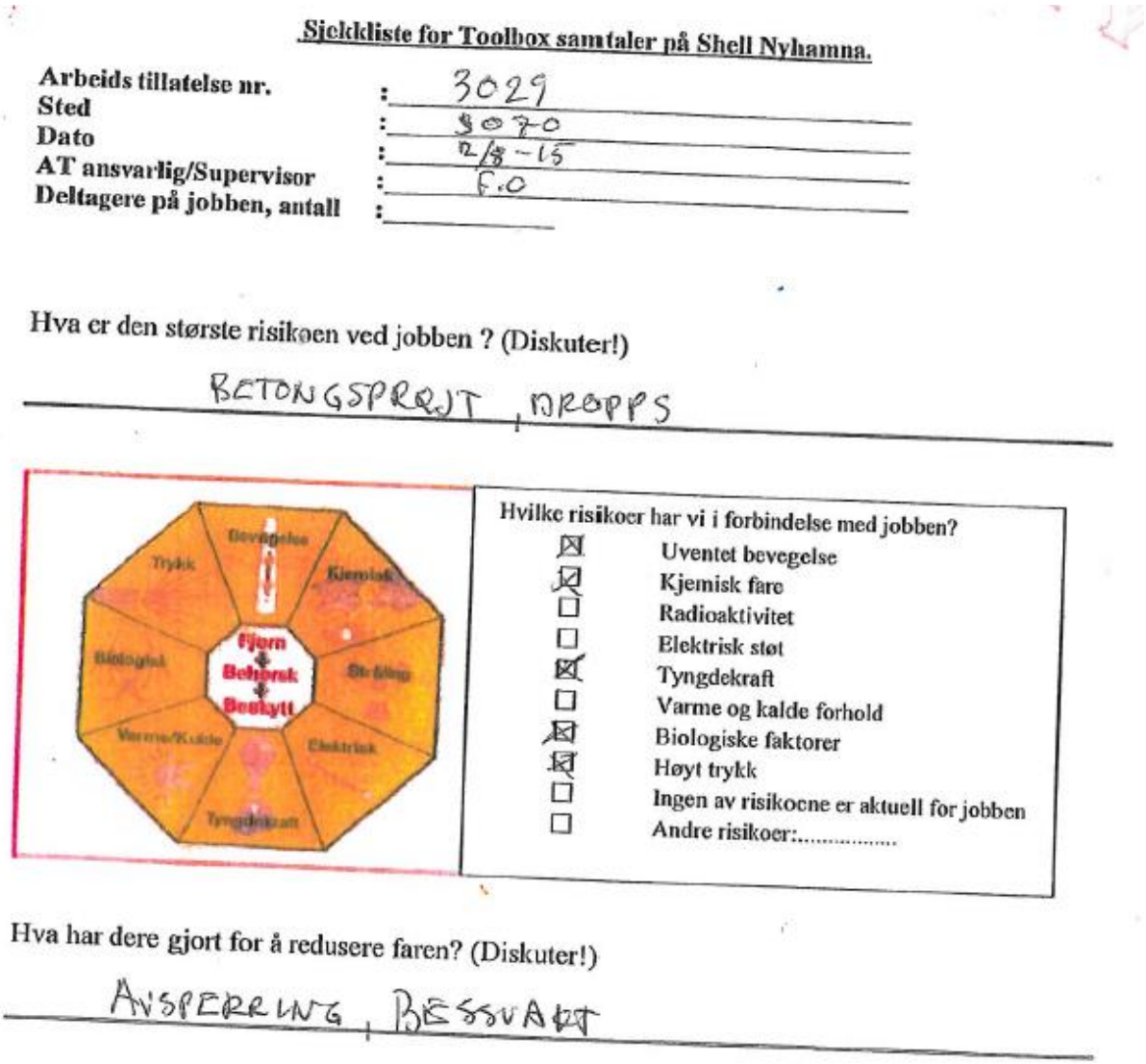
GASSMÅLINGER FØR/UNDER ARBEIDET
☐ Hydrokarboner hver 0,0 time ☐ H_2S hver 0,0 time
☐ Oksygen hver 0,0 time ☐ hver 0,0 time

UTKOPLING AV SIKKERHETSSYSTEM ☐ Lokalt ☐ Kontrollrom
System:
Sted/område:
Kompenserende tiltak:

Påkrevet Utføres av utførende fagperson — Signatur
☒ Gassmåler nr: [illegible] på arbeidsstedet F.O
☐ Verifisere mekanisk isolering
☐ Elektrisk utkopling/låsing
Nr. Utstyr:
☒ Brannapparat/tiltak mot brann F.O
☐ Sveiseapparat plasseres sikkert og jordes
☒ Kontinuerlig vakt/radioforbindelse F.O
☐ Drenering/sluk i området plugges/tildekkes
☒ Avsperring/skilting/[illegible] F.O
☒ Koordinering med [illegible]/områdetekniker F.O
☐ Følge krav til arbeid over sjøen høyden
☒ HMS-datablad lest og tilgjengelig F.O
☒ Prosedyrer/sjekklister for operasjon kjent F.O
Ref. Nr.: STØY PROSEDYRE
☐ Kontroll av midlertidig oppstilt løfteinnretning
☐ Følge krav til entring
☐ Spesielt verneutstyr for operasjonen
Dobbelt hørselvern ved behov
☐ Tiltak mot arbeidsbetinget sykdom
☒ Andre krav/forberedelser F.O
Toolbox (care talk)

Figure 10 Sample work permit

In the work permits we reviewed, there are checkboxes for which other requirements and preparations must be completed before the work is permitted to start. Here, without exception, the box requiring completion of a "toolbox talk" was checked. A toolbox talk is performed and documented using a form, as shown below.



Sjekkliste for Toolbox samtaler på Shell Nyhamna.

Arbeids tillatelse nr. : 3029
Sted : 8070
Dato : 2/8-15
AT ansvarlig/Supervisor : F.O
Deltagere på jobben, antall :

Hva er den største risikoen ved jobben ? (Diskuter!)

BETONGSPRØYT, DROPPS

Hvilke risikoer har vi i forbindelse med jobben?

- [x] Uventet bevegelse
- [x] Kjemisk fare
- [ ] Radioaktivitet
- [ ] Elektrisk støt
- [x] Tyngdekraft
- [ ] Varme og kalde forhold
- [x] Biologiske faktorer
- [x] Høyt trykk
- [ ] Ingen av risikoene er aktuell for jobben
- [ ] Andre risikoer:.....

Hva har dere gjort for å redusere faren? (Diskuter!)

ANSPERRING, BESSVAKT

Figure 11 Example of a toolbox talk form

These forms provide a brief checklist describing the greatest risks in the job to be done. Common to AT levels 1 and 2 is that a toolbox talk is performed at the start of the work and the AT must be approved before the work begins.

It is our impression that the ATs were approved before the work started and that the toolbox talks were completed. Based on the reviewed toolbox talk form, the largest risks associated with the planned work do appear to have been identified.

However, clear requirements were not established for where at the worksite a toolbox talk should be held or how authorisation of an AT should proceed in the field. Shell's "Procedure for work management" rev. 20M, dated 20.10.2015 describes, in chapter 3.4.6, that "a toolbox talk must be performed in addition to (an SJA), as a team talk in the field, in order to clarify assumptions and potential risk factors that the work might entail". The usual practice at Nyhamna is not for a toolbox talk and AT to be authorised at the worksite.

What makes toolbox talks and authorisation of ATs not occur at the worksite itself is difficult for us to assess. Several factors relating to this were commented on by people during the

investigation. Time pressure and the need to make progress were among the reasons mentioned.

The incident dated 2.1.2015 related to the installation/modification of railing/grating in an area called P45. The worksite was at a level of about 16 metres above ground level. Both the toolbox talk and authorisation of AT were performed at ground level. In the toolbox talk checklist for the work in question, falling objects were listed as one of the greatest risks in the job and cordoning-off of the area was mentioned as one of the measures for reducing the risk to personnel.

Following the toolbox talk and authorisation of the AT, the work team itself decided, after a new assessment of the worksite (around 16 metres above ground level), not to cordon off the underlying areas. Subsequently, however, an aluminium plate of 1.5 kg fell around 16 metres into an area that had free passage. Authorisation of the AT was hence given on false premises, since implementation of all the measures described in the toolbox talk form was not performed.

4.3 Description of actual and potential consequences by the companies involved

In the 21 incidents covered by our investigation, minimal actual losses/consequences were registered. Material and equipment fell, but no personal injuries were recorded. Only minimal material damage was described in the different incidents.

The companies involved in the incidents had themselves reported that some of the incidents had the potential to cause serious personal injuries in the event of minor changes in the circumstances.

What can be observed from the different investigation reports and different classifications of the incidents is that the companies involved in the follow-up of the incidents classify their potential consequences very differently. This is because the different companies have individual procedures with different requirements for the classification of undesirable incidents, as mentioned in chapter 3.

Some of the companies, for instance, subtract the height of a person (1.75 m) in calculating fall energy.

This can be exemplified by an extract from KST's procedure for "Processing of HSSE Incidents" which describes the classification of falling objects. Here it is stated that 1.75 metres, the height of a person, is to be deducted in the case of falling objects. In the incident dated 16.5.205, the height of the person involved in the incident was measured in order to justify deducting that person's actual height of 1.92 metres.

In incident reporting to the PSA, the authority assumes that the maximum potential height of fall is stated without any deduction for the height of individuals.

The figure below is taken from KST's procedure for "Processing of HSSE Incidents", where there are "Guidelines for the classification of risk potential", rev. 17, for "Classification of falling objects". The height of fall is here calculated with a deduction for the height of a standing person.

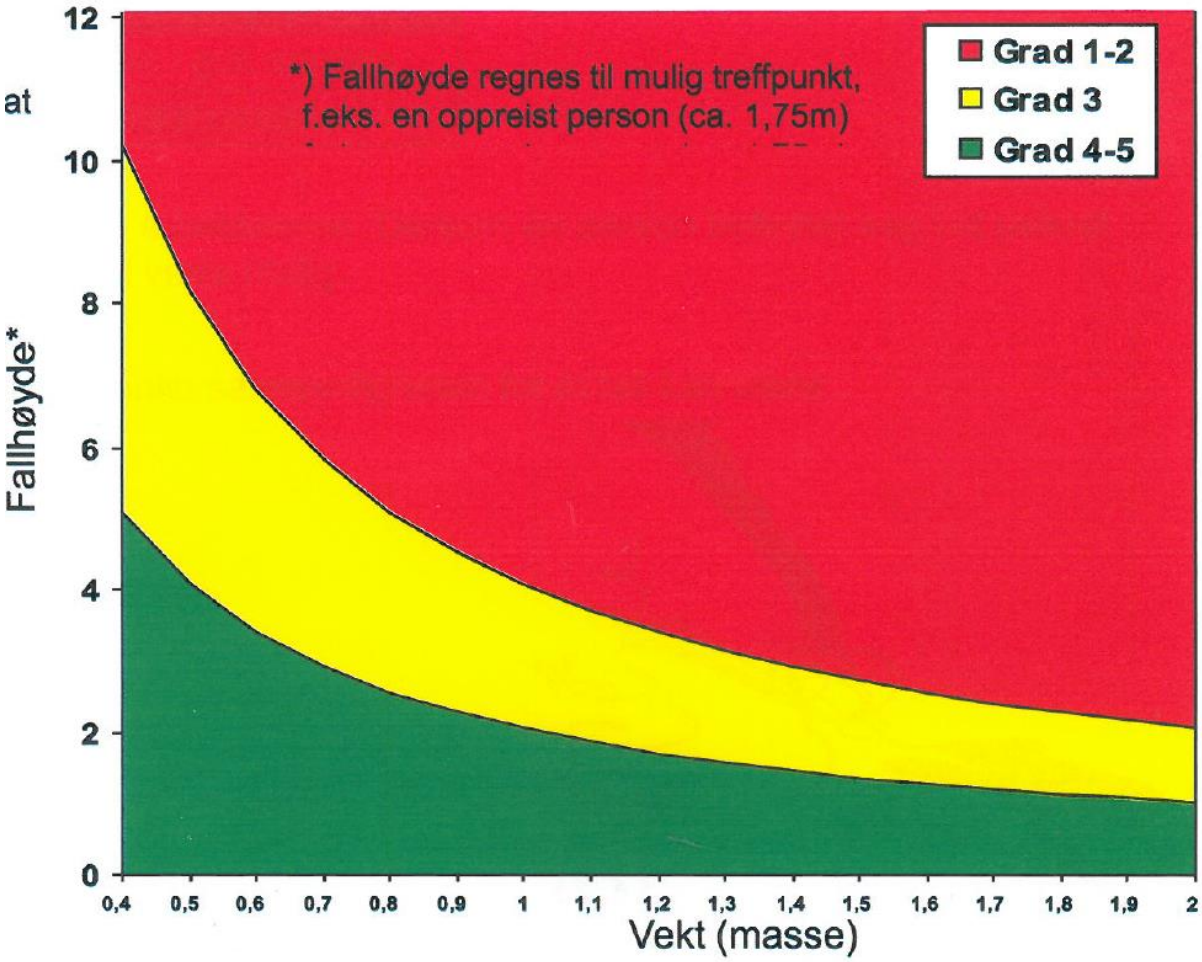


Figure 12 KST's classification of falling objects

4.4 The companies' assessments of proximate and underlying causes, with an emphasis on human, technical, operational and organisational factors

It is our impression that the different investigation reports provide a good picture of the different chains of events. The proximate causes have largely been identified and accounted for in the different investigations that the companies involved have performed. The underlying causes of the incidents have not been equally thoroughly analysed and processed in some of the investigation reports.

The thoroughness of the investigations in terms of how far back in time the causal analyses reach, and in finding underlying causes for the incidents occurring, appears to be generally somewhat deficient. Examples here might be the incident with the concrete hose which fell on 2.8.2015 and the scaffolding tube which fell during erection on 9.10.2015.

In the incident with the falling scaffolding tube, a missing tube bolt was found to be one of the main causes of the incident. In the investigation report, the analysis stops here, without going further into the subject by asking why the tube bolt was missing. Missing tube bolts are a common challenge for scaffolders in the field and this is normally corrected/resolved by scaffolders on-site. If the investigation had gone further into identifying the underlying causes of the missing tube bolt, a measure to obviate this problem could most likely have been identified.

In the incident with the falling concrete hose, an incorrect hose clamp on the concrete hose was identified as the proximate cause of the hose falling. AF Gruppen had previously verbally agreed with its supplier that only standard hoses and couplings should be used for this type of work. The actual hose that fell was fitted with a non-standard coupling. The investigation following this incident did not go further in order to find the underlying causes of the incident. Why did the concrete lorry's driver not receive information about using standard hoses and standard couplings?

4.5 The companies' preparation of reports and communication of investigation reports.

In collaboration with Shell, KST normally sets up an investigation team and invites a representative of Shell and representatives of subcontractors involved to participate in the investigations. Findings identified in the investigation will as a rule be followed up in KST's Synergi software. In addition, the individual subcontractors have their own incident reporting systems. AF Gruppen and BBC use their own versions of Synergi.

4.5.1 Use of timelines in the reports.

In KST's investigation procedure, section 2.3 "Investigation of serious incidents" mentions that a timeline of the incidents must be established. AF Gruppen's procedure mentions use of a STEP diagram for presenting the chain of events and a timeline will normally have a role in such a diagram. BBC does not have specifically defined requirements for the use of a timeline in its investigation methodology.

Establishment of a timeline is described in several of the companies' investigation mandates, but only in a few of the reports do we find such timelines documented. Examples where timelines are documented in the investigation reports are the incidents with falling scaffolding planks of 7.3.2015, the falling concrete hose of 2.8.2015 and the aluminium plate which fell on 2.11.2015.

It can be useful to illustrate the chain of events along a temporal axis, not least for visualising actions and incidents in context and investigating the causes of why certain actions, for example, took longer than expected to perform. As an example, we may refer to the incident of 14.5.2015 (Wooden beam and plug fell 14 metres to ground level), where it emerges in the investigation report that notification of the incident was made late to different people at KST and Shell. The causes of the late notification were not analysed and commented on in the investigation report.

4.5.2 Preparation of investigation reports

Based on KST, BBC and AF's risk classification of the different incidents, our general impression is that in the main the companies performed investigations and prepared investigation reports in compliance with their requirements. Individual improvements points are indicated in chapter 6 of the report.

4.5.3 Communication of investigation results

We were told that lessons learned from the investigations performed were communicated in the start-up meetings for the individual work shifts when starting a new period at the facility. This is normally performed for all three shifts present in the facility.

Results from the investigations were also in some cases displayed as "One Page" on the TV monitors located around the facility.

Some of the investigation results have also resulted in updates to procedures, where changes to the procedures have been communicated at the start-up meetings before new shifts commence work.

For the creation of PowerPoints/lessons learned, we noted that KST has defined a requirement for these to be in both Norwegian and English versions. Of the documents received post-investigation from the different companies, we noted that these were sometimes in Norwegian versions, sometimes in English and sometimes in both languages. We are uncertain as to whether this reflects the actual conditions in the project. If such lessons learned from incidents are available in both languages, in accordance with KST's requirement, this will help ensure that all employees at the facility take the lessons learned on board.

4.6 Assessment of the participants' own follow-up of the incidents individually and overall, as well as measures implemented in relation to falling objects at the facility

The following discusses the participants' individual and overall follow-up of incidents linked to falling objects at Nyhamna.

4.6.1 The participant's follow-up of the individual incident

As shown in chapters 3.1.1-3.1.4 and 4.1 of the report, the same incident is classified somewhat differently between the different companies. This is judged by us not to have had any significance for the follow-up of the individual incidents that we monitored at Nyhamna. We were also informed that, if investigation work had been started and then indicated a need for a more through incident investigation, the investigation method would be able to be altered as a result.

Each incident has been followed up. For yellow and red incidents, investigation has been implemented whereby Shell, KST and the subcontractors involved have participated actively in the investigation work. Through such participation, Shell has fulfilled its supervisory duty in respect of KST and KST's subcontractors. The same applies to KST where the incident involves a subcontractor. The companies have jointly arranged the execution of various measures that were identified through the investigation work. A more thorough analysis of underlying causes of the individual incidents could possibly have resulted in a need to undertake further measures. Print-outs from KST's Synergi measures following the 21 incidents show that identified measures were essentially followed up in compliance with established deadlines.

It is our general assessment that Shell, KST and KST's subcontractors have taken a serious approach to the individual falling-object incidents, and have worked in a targeted way to learn from the incidents and avoid similar incidents in the future.

4.6.2 **Overall follow-up and analysis of common traits among the incidents**

KST, BBC and AF were not able to show that systematic analyses of self-reported incidents had been performed in order to identify possible common causes for these and potential barrier failures. We were told that Shell had not largely disclosed such analyses to its contractors.

As a result of a series of falling objects at Nyhamna, Shell decided to set up a separate group named the Dropped Object Task Force. This was established in June 2015. Originally Kværner was intended to take the leadership role in the group, but due to problems with progress and workloads, Shell decided to head up this work itself. In addition to Shell and KST, a representative from BBC participated in the group. AF and other subcontractors did not take part in this work. No explanation was made as to why AF did not participate in the work.

Based on discussions with representatives for the different companies, we registered little awareness of this group's mandate and work among leading personnel at both BBC and AF.

This group was to clarify and strengthen the framework for working at heights at Nyhamna. The procedure for working at heights was to be revised as part of this activity. Part of the group's mandate was to review all recorded falling objects at Nyhamna, Stord and Verdal. The group decided to analyse 43 falling objects at Nyhamna since 2010 with a view to identifying common causes and possible measures for preventing similar incidents in the future.

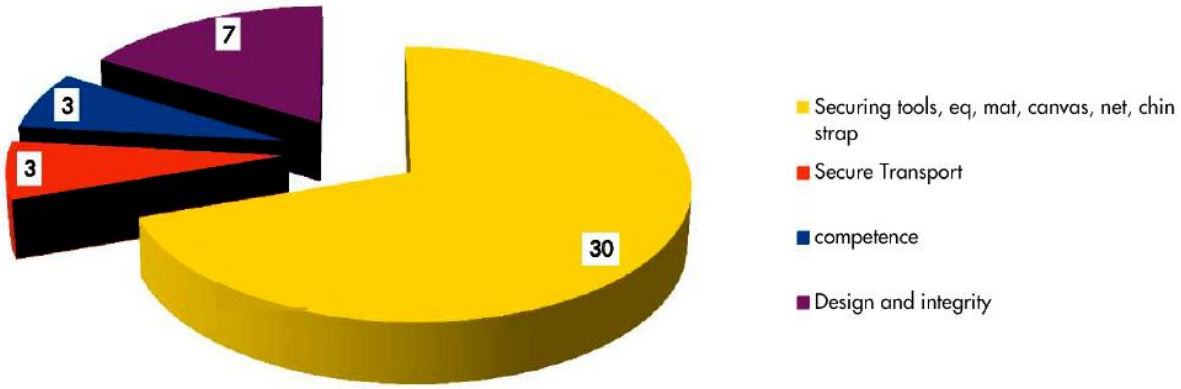


Figure 13 Barriers that could have prevented the 43 falling objects

The group has put forward several recommended measures for barriers in order to prevent falling objects and recommends that at least two barriers are established in order to prevent falling objects. A best practice document has also been prepared with a visualisation of what the **two barrier principle** means in practice. Examples of some of these measures are the use of hardhats with chinstraps, the securing of radios and loose tools, barrier covering to be used on gratings where many tools, parts and pieces of equipment are present. Blue cloth is to be used to ensure that objects do not fall through openings in railings.

At the time of our investigation at Nyhamna, the procedure for working at height had not been updated but these recommendations have now been implemented in Shell's procedure for working at height.

It is our general impression that the Dropped Object Task Force's work has resulted in practical requirements and measures for preventing falling objects. It was explained to us that the outcome of this work was to be incorporated into the companies' procedures for working at height.

We note that SfS's own "Handbook (Best Practice) for the prevention of falling objects" has not been put forward as a useful tool in the work to prevent falling objects in spite of this sectoral standard having existed for several years.

4.6.3 **Other forums where the potential for falling objects has been examined as a theme:**

Following discussions with personnel and presentations, we were made aware of further measures implemented in order to increase awareness of the problems of falling objects in the project. Among such initiatives, the following are noteworthy:

- **Time-out for safety** Such time-outs were held after some of the falling-object incidents in 2015. The time is then used to discuss the challenges of individual incidents with the different work teams at Nyhamna.
- **Use of HSE-Safety Coaches** Individuals were appointed with special responsibility for performing inspection rounds and talking with personnel at the facility to identify potential risk factors and prevent falling objects.
- **Use of Safety Moments** Performed daily at the facility. Special safety topics are dealt with. For instance, falling objects, use of PPE, cycling, HSE datasheets, etc.
- **Safety Lunches** These are lunch meetings for Shell personnel, KST and subcontractors' safety personnel and foremen. This entails two-way communication on specified safety topics, including falling objects.
- Publication of a separate **Working at heights – Best Practices** presentation in August 2015.

Below is a figure that was presented by Shell. It shows the individual incidents in a time axis with Shell's colour coding for each incident. The risk potential of the incidents in the figure is represented by dark blue, green and red circle at the top of the figure. Implemented preventive actions are shown at the bottom of the figure.

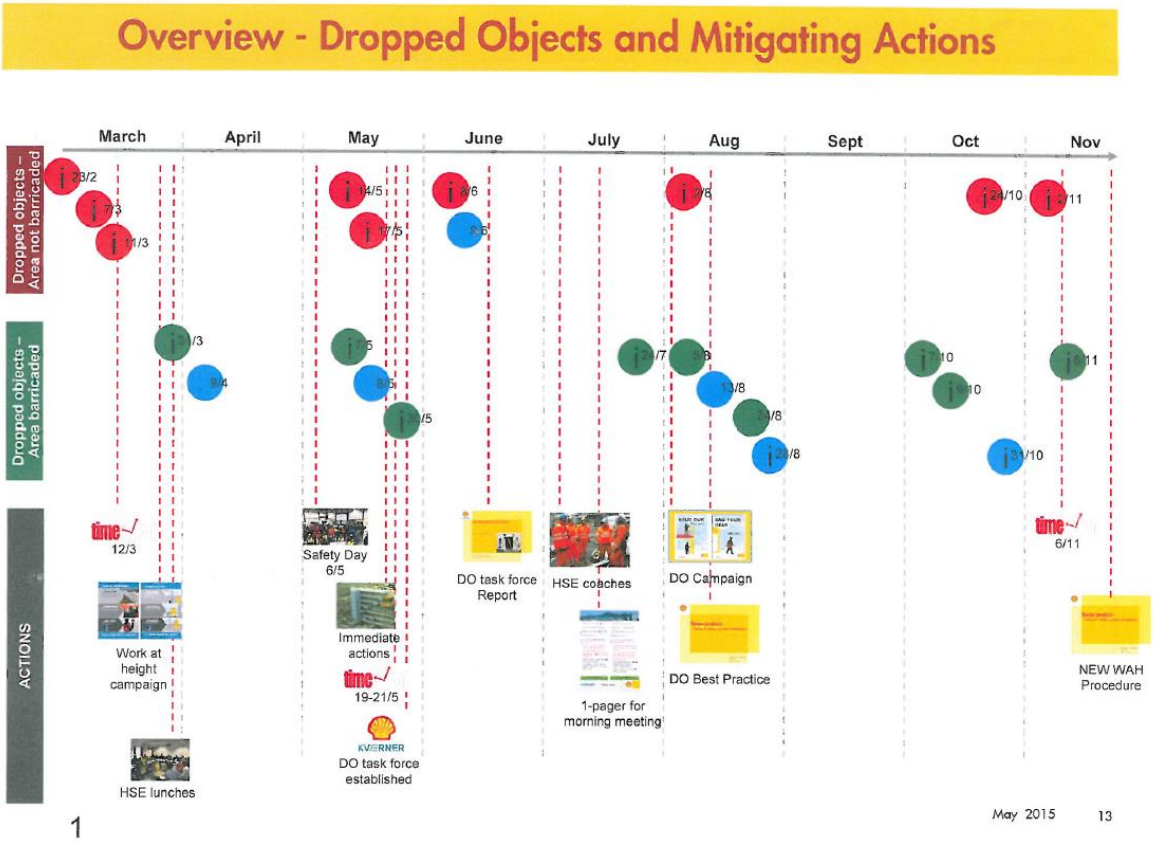


Figure 14 Overview of falling objects and measures at Shell

5 Other factors

The investigation teams did not have the opportunity to examine in depth the factors mentioned below, but would nonetheless like to point them out.

Based on a review of the incidents, we see examples of a work team having caused an undesirable incident and then having wanted to continue working without performing the expected notification of the undesirable incident. This was pointed out in some investigation reports, without a more detailed analysis of what the causes of this behaviour might be.

Comments emerged from interviews that there could be personal consequences for the individual employee, in the worst case exclusion from the facility, if the person was caught breaking the rules; see Shell's Consequence Management Procedure for HSSE Rule-breaking.

At the same time, it was stated that the employees feared the consequences of not reporting incidents, since this could have personal consequences if it was discovered. We see from investigation reports that, in some cases, it was other personnel working in the same area who notified the incident, since they or others at the facility could have potentially been injured.

By its nature, an investigation will require resources and time to complete, which can be disruptive to the progress of the project. From interviews, it emerged that an employee might find it difficult to comply with the notification requirements out of fear of being seen as a

stickler or someone who causes trouble for a project or actually stalls progress on the job. Possible underreporting of incidents cannot therefore be excluded.

It was also expressed that, for some employees, there may be problems in interpreting messages issued in Norwegian or English due to a lack of language proficiency. Such problems will not normally be indicated by the individual on-site, for fear of appearing less linguistically competent. We were informed that this problem still exists at the facility, but less so now than during the planned shutdown in summer.

6 Observations

The PSA's observations are generally divided into two categories:

- *Non-conformity:* In this category are observations where the PSA believes the regulations have been breached.
- *Improvement point:* Concerns observations where we see deficiencies, but do not have sufficient information to be able to identify a breach of the regulations.

6.1 Non-conformities

No non-conformities with the regulations were detected.

6.2 Improvement points

6.2.1 Coordinated project-specific requirements

Improvement point
Shell, KST, BBC and AF had not established coordinated project-specific requirements for which investigation procedure should be used for following up undesirable incidents in the project. No clear criteria were issued for which incidents should be investigated and which investigation method should be used depending on which company contributed to the undesirable incident and the project's choice of investigation leader.

Reasons:

- Investigations of falling objects at Nyhamna have been performed based on the investigation procedures of KST, BBC and AF. In several cases, KST led the investigation work for incidents caused by the subcontractors BBC and AF. KST has then used its own investigation routines and involved the subcontractor and Shell in the investigation work. We also see examples of BBC and AF having used KST's tools for simplified incident investigation for following up undesirable incidents.
- Based on a review of the governing documents, no clear criteria have been issued for which incidents should be investigated in the project.
- The choice of investigation method and the investigation leader were decided by KST in consultation with Shell. This process is not described in governing project documents.
- In interviews with personnel during the investigation, no-one was able to point to coordinated requirements concerning which investigation methodology to use. This concerns requirements for investigation depending on the incident's risk classification and which company contributed to the undesirable incident.
- Nor did we receive references to such requirements in subsequent documentation from the project.

Requirements:
The Management Regulations, Section 6 on the management of health, safety and the environment
The Management Regulations, Section 8 on internal requirements

6.2.2 Organisation and composition of investigation teams

Improvement point:
There were no coordinated project-specific requirements for the organisation and composition of investigation teams in the Nyhamna expansion project to ensure participation from all relevant stakeholders, as well as the necessary competence.

Reasons:
- It could not be shown that project-specific requirements that ensured necessary participation from all companies involved, in order to provide for the companies' supervisory duties, guaranteed the necessary technical competence, competence in the investigation methodology in use and the requirement to ensure necessary independence in the investigation work.
- We noted that the individual companies had established requirements for the composition of investigation teams, but these requirements do not clearly describe how investigation teams are to be established at the Nyhamna expansion project.
- Reference is made in this context to the requirement in the Management Regulations, Section 20 concerning the registration, review and investigation of hazard and accident situations, notably the third subsection: *Criteria shall be set for which situations that must be registered, examined and investigated, and requirements shall be set for scope and organisation. The guidelines to the third subsection expand on this: The requirement for organisation as mentioned in the third subsection, should e.g. indicate when contractors and suppliers shall participate.*

Requirements:
The Management Regulations, Section 6 on the management of health, safety and the environment
The Management Regulations, Section 20 on registration, review and investigation of hazard and accident situations, with reference to the last sentence of the guidelines

6.2.3 Investigation and follow-up methodology for incidents with medium and low criticality levels

Improvement point:
BBC and AF could not point to company requirements that described the scope and content of investigations and inspections of incidents with a lower level of criticality.

Reasons:
- It was not clear from BBC's document "Investigation of undesirable incidents" which requirements were imposed for inspecting incidents categorised as level 3 and which were not subject to an investigation. We note that some incidents were followed up by performing a simplified investigation with regard to the principal's (in this case KST's) formula for such simplified investigations. We do not find this practice reflected in BBC's established management systems for on-going project work at Nyhamna. Reference is

made in this context to the requirement in the Management Regulations, Section 20 concerning the registration, review and investigation of hazard and accident situations, notably the third paragraph: *Criteria shall be set for which situations that must be registered, examined and investigated, and requirements shall be set for scope and organisation.*

- In the received governing company documents from AF Gruppen, no requirements were defined for how incidents in categories lower than red are expected to be investigated or surveyed.
- This circumstance was not pointed out by Shell or KST who had both had the corporate procedures for review and comment.

Requirements
The Management Regulations, Section 20 on registration, review and investigation of hazard and accident situations, with reference to the third subsection
The Management Regulations, Section 21 on follow-up

6.2.4 **Deficient causal analysis**

Improvement point:
For some of the investigated incidents, we noted that the analysis of the underlying causes of the incidents appeared to be somewhat deficient. A more thorough analysis could have promoted more learning and more effective measures for preventing similar incidents in the future.

Reasons:
- In the incident of 9.10.2015 with the falling scaffolding tube, a missing tube bolt was found to be one of the main causes of the incident. In the investigation report, the analysis stops here, without going further into the subject by asking why the tube bolt was missing. Missing tube bolts are a common challenge for scaffolders in the field and this is normally corrected/resolved by scaffolders on-site. If the investigation had gone further into identifying the underlying causes of the missing tube bolt, a measure to obviate this problem could most likely have been identified.
- In the incident of 2.8.2015 with the falling concrete hose, an incorrect hose clamp on the concrete hose was identified as the proximate cause of the hose falling. AF Gruppen had previously verbally agreed with its supplier that only standard hoses and couplings should be used for this type of work. The actual hose that fell was fitted with a non-standard coupling. The investigation following this incident did not analyse further why standard hoses and couplings had not been used. Why did the concrete lorry's driver not receive information about the use of standard hoses and couplings?
- We also refer to the incident of 14.5.2015 (Wooden beam and plug fell 14 metres to ground level), where it emerges in the investigation report that notification of the incident was made late to different people at KST and Shell. The causes of the late notification were not analysed and commented on in the investigation report.

Requirements:
The Management Regulations, Section 19 letter e) on the collection, processing and use of data
The Management Regulations, Section 20 on registration, review and investigation of hazard and accident situations.

6.2.5 KST's risk classification for falling objects

Improvement point:
KST uses a height deduction of 1.75 m (height of a person) in calculating the fall energy of falling objects for the risk classification of incidents. This deviates from the applicable manual ("Best Practice - Dropped Objects Prevention", rev. 03 2012) from SfS (Samarbeid for Sikkerhet), which is used as a standard in the Norwegian petroleum industry, and may result in fewer incidents being reported.

Reasons:
KST uses its own procedure "Processing of HSSE Incidents" with its "Guidelines for the classification of risk potential" for classifying falling objects. In this, it is described that 1.75 m must be deducted when calculating fall energy in the risk classification of falling-object incidents.

Requirements:
The Management Regulations, Section 8 on internal requirements

6.2.6 Reporting of falling objects to the PSA

Improvement point:
We note that some of the incidents associated with falling objects have not been the subject of further reporting to the PSA.

Reasons:
The incidents dated 10.4, 16.5, 13.8 and 28.8 were reported internally at Nyhamna, but not reported to the PSA. It appears that Shell may not have a consistent reporting practice for falling objects.

Requirements:
The Management Regulations, Section 29 on the notification and reporting of hazard and accident situations to the supervisory authorities

7 Discussion concerning uncertainties

Based on our investigation mandate, in our investigation we did not have the opportunity to go into depth on the individual incidents in order to determine whether the existing investigation reports provide a true and full picture of the actual circumstances. Such an investigation on our part would be very time-consuming and difficult to perform, considering the number of incidents and persons involved, and the time that has elapsed since the incidents occurred. We therefore made an assumption that the chains of events described in the individual reports are correct. In our discussion with different personnel, we did not receive information to erode our confidence in the work that had been done.

Another uncertainty in our investigation is whether we have been supplied with all relevant governing documents. Our investigation report and our observations are consequently based on the project documents received.

8 Appendix

A: The following documents were used as a basis for the investigation:

Shell

- 37-1A-NS-J03-00044 Procedure for work management, rev 17M, 16.11.2015
- 37-1A-NS-J03-00053 Procedure for Working at Heights, rev 01M, 16.11.2015
- NSEP-17.PR.10 Incident reporting and follow-up, rev 1, 10.07.2014
- Start-up presentation
- Material presented by the Dropped Object Task Force
- Guide Risk Assessment Matrix (RAM) Guide, version 1, April 2010
- 37-1A-NS-F03-66002 Nyhamna Expansion Project, Consequence Management Procedure for HSSE Rule Breaking, rev 03M 19.01.2015
    - CMP meeting log
- Existing investigation report following incident involving falling objects, see list chapter 4

KST

- Incident Investigation Standard, part of HSE Policy, rev 02, 10.01.2009
- (37-1A-KST-FO3-00011) (P0031-ENYX) Working at Heights
- (37-1A-KST-FO3-00003) (P001-ENYX) Processing of HSSE incidents, rev 03M, 26.03.2015
- P0001 Follow-up of HSSE cases, approved 9.10.2015
- Draft Incident Investigation report "Aluminium plate fell down in P45 at Nyhamna site 02.11.2015"

BBC

- GOV-WI17-00197 Definition of HMS parameters
- GOV-WI17-00193 Registration in Synergi
- GOV-WI17-00191 Reporting of personal injuries and MAS
- GOV-AP17-00243 Cause of loss analysis
- GOV-WI17-00194 Investigation of undesirable incident (rev 03, 02.10.2015)
- (WI-17128.02) 18 Point Incident Report, rev04, 12.06.2014
- KST-DUL-12-0047 HSE Programme contract KST-DUL-12-0047, rev 04, 09.02.2015
- Investigation of incident "Scaffolding which toppled over in strong winds", BBC Synergi 14426, KST Synergi 398777

AF

- 1007-ADMPAF-00008 Investigation and follow-up of serious incidents, rev 01, 10.10.2010
- 9811-324168 Procedure - Reporting and processing of undesirable incidents, rev 03. 09.11.2013
- Investigation Report, Breakage of concrete hose incident, rev 03, 27.08.2015

B: Figures

C: List of interviewed personnel.

D: Appendix – Template for simplified investigation report