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Assessment of environmental implications of mooring the Hutton TLP in Vatsfjorden

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Preface

The Hutton Tension Leg Platform (TLP) operated by Kerr-McGee will be towed to Vatsfjorden for mooring in early July 2002. The TLP will be released from its tethers and towed to Vatsfjorden for temporary storage prior to handover to a new owner. The storage and mooring project will be handled by Maritime GMC.

The current work assesses the environmental implications of the mooring and storage process, and is commissioned by Maritime GMC AS to RF-Rogalandsforskning.

The project group will like to thank Egil Berge Nising for assistance and boating facilities during field work and crab fishing during the active period. Thanks also to Vidar Høivangli for providing information and updates on the Maureen decommissioning operations and Aker, and Sigmund Låte for information about the activities related to the cod hatchery.

The field work was carried out by Stig Westerlund, Anne Bjørsntad and Endre Aas. Analysis have been carried our by Miljøkjemi AS and RF-Miljølab.

Data from Amundsen Diving has been incorporated into the report as agreed upon with Maritime GMC and Amundsen Diving.

Stavanger, 01. October 2002

Grethe Kjeilen, project leader

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Summary

The environmental implications of mooring the Hutton TLP platform in Vatsfjorden have been assessed. As part of this assessment, a baseline survey examining the conditions prior to the planned activities has been conducted. The baseline survey has included sampling and analysis of sediments (metals, THC, PAH, PCB) from the mooring site at Grønavika and representative references locations, and analysis of biological stress in local crabs (PAH-metabolites in crab urine) and caged blue mussels (Lysosomal response) in the same area. Analysis of metals and organic parameters (PAH, PCB) in marine growth from the TLP columns has also been undertaken. An ROV survey was carried out by Amundsen Diving, surveying the seabed at the mooring site and tow route. Objects on the seabed were identified on maps.

The results from the baseline survey showed that, in general, the environmental conditions of the mooring site along the quay in Grønavika are good. The mooring site sediment and water column is considered to be little polluted, and there are no differences between the stations at the quay and the reference stations. No specific contamination of concern (metals, PAH, PCB, THC) is seen in the sediments. When comparing levels of single components to SFT classification for coastal waters and fjords (Molvær, 1997), the site is considered to be mainly unpolluted (SFT class 1). There is no evidence of stress in blue mussels exposed to the seawater in the mooring area, and also no indications of PAH contamination in local crabs from the same location. Metal levels in marine growth were low, and no PAH or PCB were detected in the samples.

A range of objects were identified on the seabed during the ROV survey, reflecting the use of the quay as a former platform construction site. The seabed littering identified by the ROV-survey apparently does not cause chemical contamination of the area.

The overall conclusion of the assessment is that the environmental implications from removal of marine growth from the TLP in Yrkjefjorden, transport of the TLP from Yrkjefjorden into Vatsfjorden and mooring in Vatsfjorden with the planned activities and safety measures related to these operations are minor and overall short-term.

The influence from the platform mooring in Vatsfjorden is considered to be minor and acceptable if the activities on the platform during mooring are kept at a minimum, as is planned. Noise related to the activities is not considered a major negative element. The operations are assumed not to have unacceptable implications for the local population or other uses of the area such as fishing and recreational use.

It is concluded that it is acceptable to discharge marine growth into the sea in Yrkjefjorden with the proposed gentle methods of flushing that will reduce the outfall of surface coating associated with the marine growth. Although the presence of marine growth on the seabed in Yrkjefjorden may add to the organic load and hence increase anoxic conditions on the seabed and cause smoothering, this is not considered to be of a severity that calls for other actions. Although such effects may be more long-term, these will be reversible and confined to a limited area, and will have few implications for the overall environmental status of the

location. Natural fall out due to drying of marine growth from the parts of the TLP still being covered when moved from Yrkjefjorden to Vatsfjorden is considered to be within acceptable limits and does not require containment. If continued removal of marine growth in Vatsfjorden proves necessary (due to nasty odours being a nuisance to the workforce and local residents), measures should be taken to reduce the load to the seabed. Extended seabed and water column monitoring during and after operations is then suggested.

The most severe environmental effects foreseen are such related to accidental spills. The risk of such incidents are however considered to be minor and within acceptable limits. Major operations currently not planned need to be assessed separately to establish whether the environmental implications are acceptable. In case of operations on board involving removal or emptying of oil tanks etc., special considerations of the risk of spilling and need for contingency equipment must be addressed.

It is recommended to carry out a survey after the TLP has been removed from Vatsfjorden in order to confirm that the environmental stress has been limited. With the limited activities planned in Vatsfjorden, such a post-survey is however not crucial. If, however, the activities on the platform when moored in Vatsfjorden become more extensive than currently planned, if the mooring period exceeds the initially suggested 6 months, or if considerable fall out of marine growth at the mooring site in Grønavika occurs, such a post-survey should be initiated.

Introduction

The Hutton Tension Leg Platform (TLP) operated by Kerr-McGee will be towed to Vatsfjorden for mooring in early July 2002. The TLP will be released from its tethers and towed to Vatsfjorden for temporary storage prior to handover to a new owner.

The current work assesses the implications to the environment from the TLP during temporary anchoring in Yrkjefjorden while removing marine growth, and further towing, anchoring and storage of the TLP at its designated location along the deep-water quay in Grønavika, Vatsfjorden.

The former dismantling of the Brent Spar buoy was carried out in the Yrkjefjorden in 1998-1999. Environmental assessments and monitoring were carried out during this phase, and thus provide important background data for the current assessment.

Background and project description

An evaluation of the environmental status of the area and possible impacts that may arise from operations such as transport into place, mooring and operations on the structure once in place, is given, focusing mainly on the marine environment.

The assessment includes a baseline survey of chemical and biological parameters in the sea before placement of the structure, an evaluation of how the planned operations may influence the environment based on input on planned and estimated discharges from the worksite, and suggestions on how to mitigate potential negative impacts. Data from the ROV-survey undertaken by Amundsen Diving (18 June 2002) is presented and the findings are included in the overall assessment.

Suggestions for further evaluation and surveys during the mooring period and after the structure is removed from the site are given. This is especially applicable if work is carried out on the platform during the storage period and in the case of any accidental discharges. The basis for the current evaluation is that the TLP will not be subject to any major workover/reconstruction during the mooring period.

Hutton TLP description

The Hutton TLP is a semisubmersible platform with 6 columns, which has been operating at a water depth of 148m. The structure has an operating weight of 47,300 tonnes and each of the 6 columns is 65m high (Figure 1).

The platform has the following storage capabilities of fluids on board (Table 1), which will not be emptied prior to storage (the indicated numbers are maximum capacities):

Table 1. Storage capabilities of fluids onboard the Hutton TLP

Pot Water	D-3712A - 268 m^3 D-3712B - 268 m^3 D-3712C - 268 m^3	These are maximum capacities
Drill Water	D 3711 – 268 m^3	These are maximum capacities
Diesel Storage Tanks: Diesel Fire Pump Day Tanks:	D-4101A & B G-2801A/D1 - 2.62 m^3 G-2801B/D1 - 2.62 m^3 G-2801C/D1 – 2.62 m^3 G-2801D/D1 – 2.62 m^3	- Total Capacity 920 m^3
Drilling MTU Day Tanks	D7202A – 1 m^3 D7202B – 1 m^3 D7202C – 1 m^3 D7202D – 1 m^3	
Emergency Gen, Day Tank	V- 5201/D1 – 7 m^3	
Helifuel	V-4501/D1A – 4.55 m^3 V-4501/D1B – 4.55 m^3 V-4501/D1C – 4.55 m^3 V-4501/D1D – 4.55 m^3	Minimum 2 tanks on board at any time
Lube oil stores	Approximately 2000 litres total in 25 & 200 litre drums	
Lube oil sumps	The following drives (8 off) hold about 3000 litres each of lube oil in their sumps: Gas Compressor - K 2001 Pipeline pumps - G 1501A & B W.I. Booster pumps - G 2701A & B "Q" Pump - G 2706 W.I. HP Booster pump - G 2704 Refrig Compressor - V-4201/E3	
Waste oil	Tote tank on deck for waste oil (capacity 2000 litres) will be removed prior to the tow	
Chemicals, various	Maintenance/preservation and cleaning	

There will be no quantities of production chemicals onboard the installation, only chemicals for maintenance and cleaning activities. These shall be found in small volumes in tins, bottles aerosols and will be stored in work areas e.g. D1 workshop, accommodation, D4 deck and mezz drilling power generation and power generation on weatherdeck.

Figure 1. Illustration of Hutton TLP (from www.hutton-tlp.com)

Environmental monitoring: Baseline survey

A baseline survey to assess the environmental status of the mooring area prior to towing in the platform has been carried out. This survey includes the following elements:

- Chemical parameters in sediment; metals, LoI, THC, PAH and PCB,
- Biological parameters; lysosomal stability in mussels (caged, two weeks) and PAH metabolites in urine samples in crabs (local)

A map of Vatsfjorden is given in Figure 2. The mooring area is to the south of Raudnesholmen in the outer part of the fjord.

Method

The chemical parameters were analysed on sediment samples from 4 locations along the quay in the area where the platform will be situated and at a reference location further out (Figure 3). The sediment were analysed for a blend of metals, total organic matter (TOM, measured as Loss of Ignition - LoI), and the organic parameters; THC, PAH and PCB. Metals were analysed according to RF methods RF-2.1-401 (metals in sediment) and RF-2.1-408 (Hg(CVAAS)). Reference to accredited analytical procedures for organic parameters is included in Appendix.

The sediment samples were retrieved by grab (van Veen, 225 cm^2), and treated according to normal procedures prior to analysis (see Appendix). Metal analyses were conducted by means of ICP-MS, THC analysis by GC-FID, while PAH and PCB were quantified by means of GC-MS.

Mussels were analysed for a biomarker (neutral-red retention time) that measures sub-lethal responses to environmental pollution. Measurements of lysosomal stability in blue mussels were carried out on caged specimens from 4 locations, two in the mooring area, one in the Yrkjefjorden and one at a references location in Vatsfjorden. The samples were placed in the sea for a period of 13 days, at a depth of about 5-10 m (deployed 13 June, collected 25 June).

Approximate positions of the sampling locations are given by the following:

	N	E
S1	59 26.3068	5 44.9481
S2	59 26.3041	5 44.9739
S3	59 26.2837	5 44.9947
S5	59 26.2889	5 44.9639
S6	59 26.6007	5 45.3934
B1	59 27.9269	5 44.5786
B2	59 26.2945	5 44.8692
B3	59 26.2467	5 44.9975
B4	59 25.9137	5 45.2098

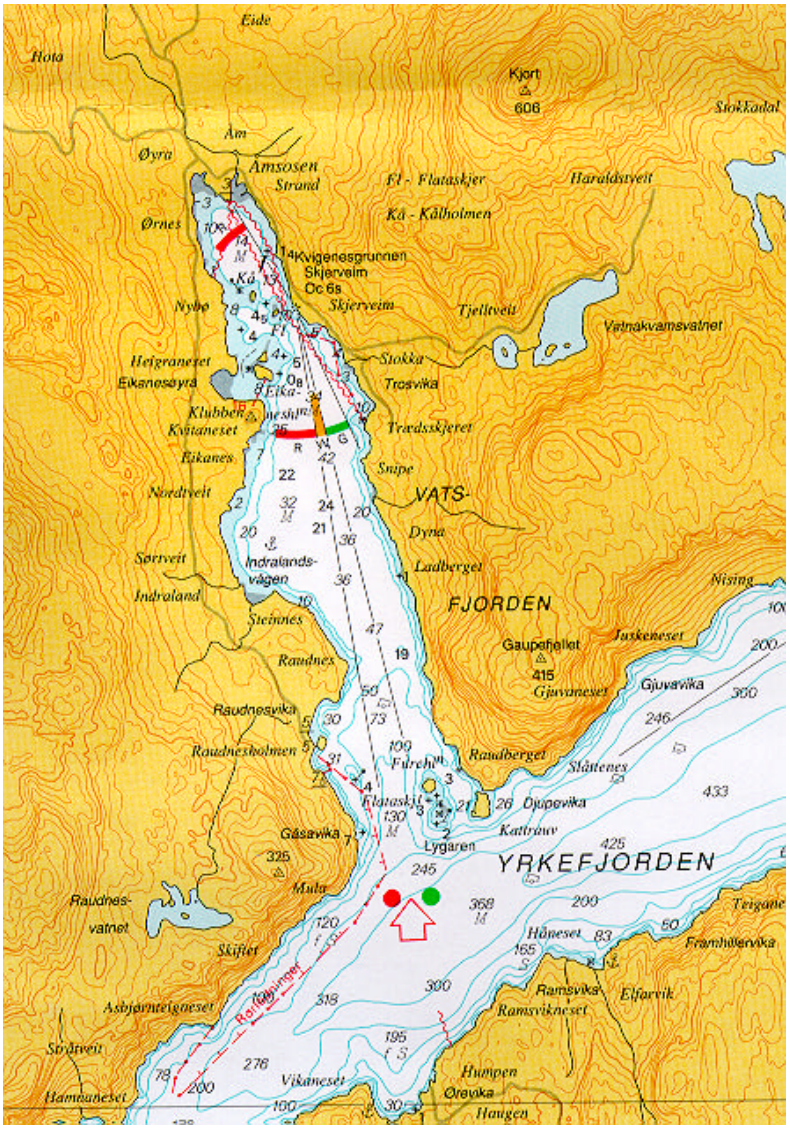
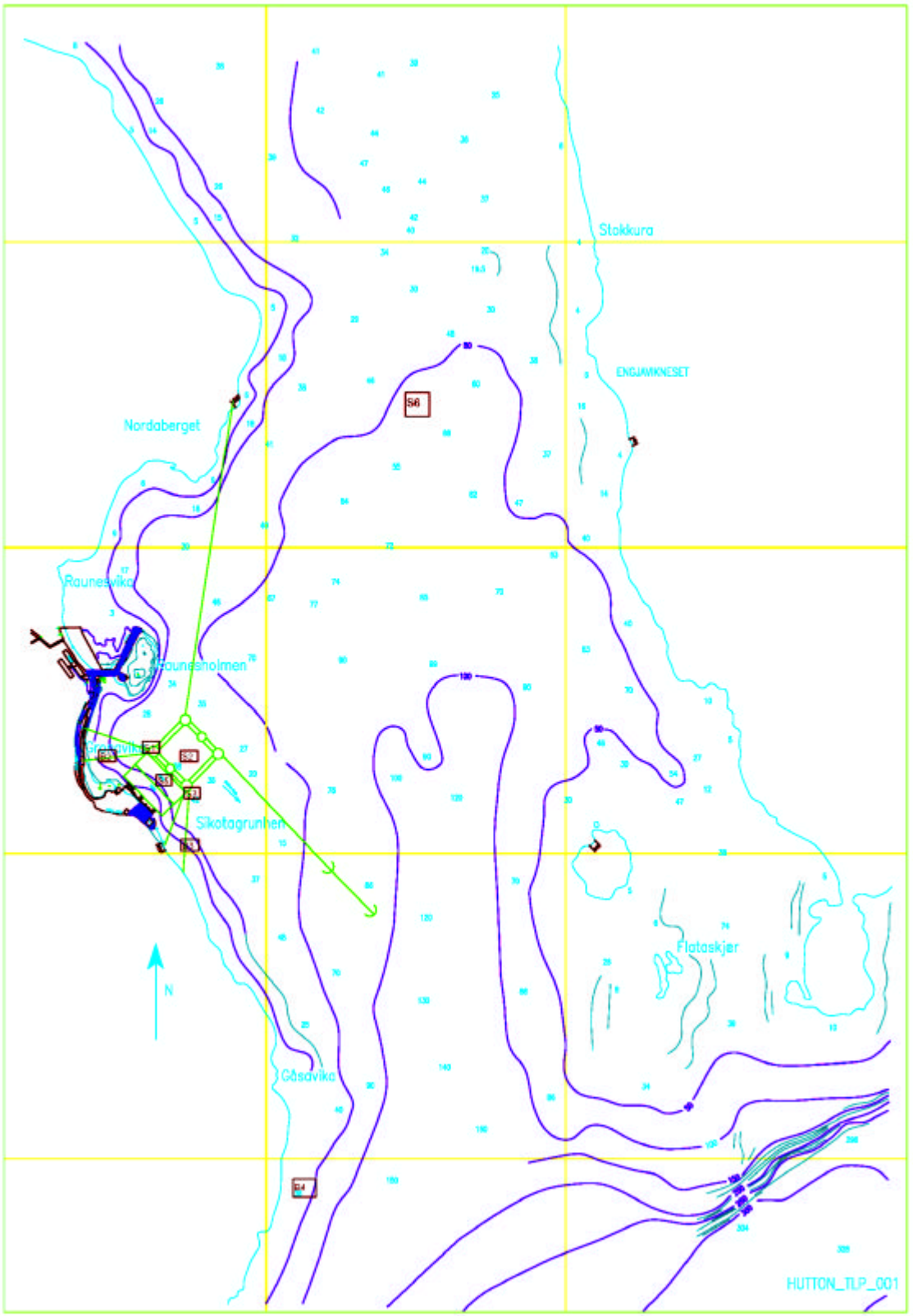


Figure 2. Map of Vatsfjorden and Yrkjefjorden.

Polycyclic aromatic hydrocarbons (PAH) compounds possess inherent fluorescence, and this can be utilized for measurements of PAH levels in organisms. It has mostly been applied for the detection of PAH metabolites in fish bile, but urine from crab can also be used as an analytical matrix. Fluorescence is measured either at certain wavelength pairs characteristic for types of PAH compounds (fixed wavelength fluorescence-FF) or by fluorescence scanning



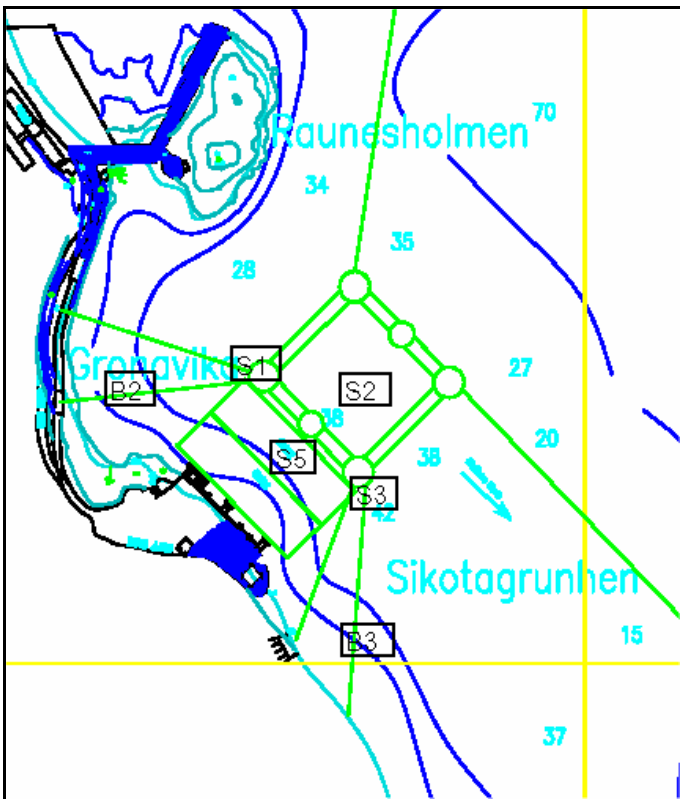


Figure 3a and b. Map showing locations of sampling sites (close up and distance view). B1-4 represents points for caging of mussels and fishing for crabs, while S1-6 represents sediment sampling locations. B2 is located further in at Vatsfjorden, and is thus not included here.

over a range of wavelengths (synchronous fluorescence spectrography-SFS). Detection of PAH compounds/metabolites in urine is regarded as an indication that a PAH is taken up, metabolised and thereby may cause negative effect on the organism. Local crabs, edible crab (*Cancer pagurus*), to be analysed for PAH metabolites in urine were sought for at the same stations where mussels were deployed (at the same dates), but only a limited number of crabs could be found. The crab specimens were hence treated as representatives for the whole mooring area.

Urine from crab was removed by use of a bodkin and a 1 ml pipette and transferred to a cryo vial. The vial was put on ice during transport to laboratory and put in -80°C freezer until analysis. The blue mussels were transported back to the lab, stored on ice, placed overnight in running seawater (sand filtered), and then analysed the consecutive day (see Appendix). After measuring lysosomal stability, the blue mussels were frozen and stored for possible later analysis of PAH in tissue.

Results and discussion

Sediment: Metals

The metal levels measured are presented in Table 2. Three replicate samples were taken at each station. The sediment on the stations closest to shore and the reference station is sandy in texture and grain size, with tendencies of more silty particles in the top surface. A low content of iron (Fe) is also indicative of a high sand content. At the sampling locations at the longest

distance from the quay-side, a hard bottom substrate was found. No samples were hence collected from this area (i.e. station S4 was not sampled).

The sandy sediment was low in organic matter as can be seen from the TOM/LoI measurements. In general, the levels of metals were low, and according to SFT (State Pollution Authorities) classification of coastal areas (Molvær et al., 1997), most metal levels measured were within SFT class 1, representative of an unpolluted location. There were only minor differences between stations, the reference station S6 (at a forthcoming sludge discharge outlet) and the S1 station in general showing the lowest levels. The levels of copper vary somewhat between stations, elevated levels were found at stations 2, 3 and 5, but with considerable variations between replicate samples at each station. Similar trends were seen with zinc, arsenic, cadmium, tin, barium and lead which was higher in stations 2 and 5. Distinct contamination was only seen for zinc and lead for which replicates with levels exceeding SFT class 1 was seen.

At the previous surveys in Yrkjefjorden and Vatsfjorden (Cordah, 1999), the sediment sampled were of a more silty nature. It is hence not possible to compare such low metal levels directly since the natural metal content differs between sediment types with varying grain size characteristics.

Table 2. Metals and TOM/LoI in sediment samples from Vatsfjorden (measured by ICP-MS).

Station		Chromium	Iron	Nickel	Copper	Zinc	Arsenic	Silver	Cadmium	Tin	Barium	Lead	Hg	LOI
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%
S1	Repl1	7.80	8503	4.50	3.58	32.0	2.11	0.011	0.023	0.7	38.7	6.09	<0.02	1.8
	Repl2	10.7	10909	6.79	5.99	46.5	2.42	<0.01	0.028	1.8	42.9	8.96	<0.02	2.5
	Repl3	10.6	10445	7.44	6.30	48.9	2.54	0.092	0.044	1.4	34.3	9.56	<0.02	2.8
S2	Repl1	10.9	12303	9.51	9.45	76.0	3.51	<0.01	0.042	2.0	42.2	14.4	<0.02	3.2
	Repl2	21.1	15978	13.7	21.9	267	5.46	0.024	0.105	13.6	45.3	47.0	<0.02	5.3
	Repl3	14.8	13753	12.4	25.9	209	10.0	0.019	0.057	9.3	118	33.5	0.1	4.0
S3	Repl1	14.0	16720	13.6	9.26	57.5	4.61	<0.01	0.052	1.6	36.0	15.2	<0.02	5.1
	Repl2	14.7	17273	15.2	11.7	68.6	4.52	<0.01	0.068	2.1	65.8	20.7	<0.02	5.6
	Repl3	13.8	10609	11.7	17.2	88.2	3.55	<0.01	0.040	3.6	44.0	16.8	<0.02	4.2
S5	Repl1	15.9	15651	13.1	30.5	188	5.53	0.012	0.082	5.7	72.6	38.7	<0.02	3.9
	Repl2	13.5	17986	13.4	13.7	157	5.46	0.038	0.086	5.7	82.2	24.2	<0.02	4.3
	Repl3	15.4	16051	18.8	17.0	96.2	7.28	0.030	0.094	2.9	150	24.2	<0.02	4.5
S6	Repl1	11.1	11474	8.89	5.42	38.3	3.33	0.040	0.039	0.5	15.8	7.66	<0.02	3.2
	Repl2	10.5	12445	7.13	5.71	40.0	3.09	0.021	0.032	0.8	17.6	8.54	<0.02	3.0
	Repl3	9.87	10056	7.07	5.26	34.7	3.59	0.016	0.039	0.8	17.3	8.18	<0.02	4.0
STF Class1		70.0		30.0		150.0	20.0	0.300	0.3			30.0	0.15	

Station location

S1	At location for plattform mooring SE
S2	At location for plattform mooring MID
S3	At location for plattform mooring NE
S5	At location for Barge MID
S6	Vatsfjord sludge discharge point

Sediment: Organic parameters

Details from the organic parameter analysis are presented in Appendix. Average concentration (three replicates) of the main groups from each station is presented in Table 3. Two samples (station S2, sample 5 and station S3, sample 8) exhibited higher PAH levels than the rest. Otherwise, values were similar and low, with some, but small, differences between stations (S1 being lowest). PCB was detected in some samples (congener 28 and in

one case 52), but at levels at or below the detection limit. The THC levels measured in the sediment samples were low in all samples (detection limit 5-25mg/kg).

Table 3. Average levels of PAH, PCB and THC (i.p: not detected at levels above detection limit)

station	Sum PAH_{16} k	Sum PCB_7 k	THC
S1	0,21	i.p	19
S2	0,87	i.p	20
S3	0,76	i.p	36
S5	0,50	i.p	32
S6	0,54	0	i.p

Mussel monitoring: Lysosomal stability

Lysosomal stability was measured on 15 mussels from each station. 4 stations were selected, two at the mooring site, one further in Vatsfjorden and one in Yrkjefjorden close to the inlet to Vatsfjorden (see map in Figure 2). The Yrkjefjord station is close to the location where the marine growth will be removed. The background level in the mussels prior to field exposure was measured on mussels from the same batch the day when the mussels were put out.

Mean neutral-red retention times as measured in the 15 mussels from each location is presented in Table 4. Healthy, unstressed, cells should be able to retain the probe for between 150-180 minutes, while stressed cells exhibit shorter retention times. As can be seen from the table, the mean values for all stations are in the range typical for healthy unstressed cells. There are further no apparent differences between stations. It can hence be concluded that the mussels have not been exposed to considerable contamination during the two week period of inclubation.

Table 4. Mean neutral-red retention times (NRRT) in mussels from the 4 stations (B1-B4) and the background level reference (blank).

	BLANK	**SITE B1**	**SITE B2**	**SITE B3**	**SITE B4**
Slide	**13.06.2002**	**26.06.200.**	**26.06.2002**	**27.06.2002**	27.06.2002
1	120	180	150	120	180
2	150	120	150	180	120
3	60	180	150	150	180
4	120	180	150	150	150
5	180	150	150	180	180
6	150	120	90	120	90
7	180	150	150	180	180
8	180	180	120	120	150
9	90	120	90	180	180
10	180	180	150	180	120
11	120	180	90	120	90
12	180	180	180	180	180
13	60	180	180	150	180
14	120	180	120	120	120
15	150	150	150	150	180
Average	**136**	**162**	**138**	**152**	**152**
Median	**150**	**180**	**150**	**150**	**180**
St.dev.	**42**	**25**	**30**	**27**	**35**

PAH metabolites in crab urine

In total 12 crabs were sampled, 7 when deploying the blue mussels and 5 when collecting the mussels, 13 days later.

Generally the results revealed fluorescence levels as could be expected from a clean site (Table 5). There are some fluorescence peaks around the 290/335 wavelength pair. The origin of this peak has also been detected in other expected clean sites, and it may be caused by natural constituents in the crab urine. A SFS-scan is shown in Figure 4.

Table 5. Fluorescence data for crab urine from local crabs in Vatsfjorden. The station name (B1 – 4) and individual number at each station is given in the first column.

Ind/Location	Sampling time	$PFE_{290/335}$ ng/g	$PFE_{341/383}$ ng/g	$PFE_{380/430}$ ng/g	SFS scan
Solvent		21	7	5	x
B1 - 1	25.June 2002	207	26	21	x
B1 - 2	25.June 2002	78	21	15	x
B1 - 3	25.June 2002	60	21	14	
B1 - 4	25.June 2002	195	61	38	x
B2 - 1	12.June 2002	176	26	13	
B3 - 1	12.June 2002	189	32	16	
B3 - 2	12.June 2002	49	29	16	x
B3 - 3	12.June 2002	529	31	24	x
B3 - 4	12.June 2002	815	39	27	
B4 - 1	12.June 2002	120	36	21	
B4 - 2	12.June 2002	359	29	18	x
B4 - 3	25.June 2002	130	29	18	
	Mean-PFE ng/g:	225	30	19	
	Stdev-PFE ng/g:	225	12	8	

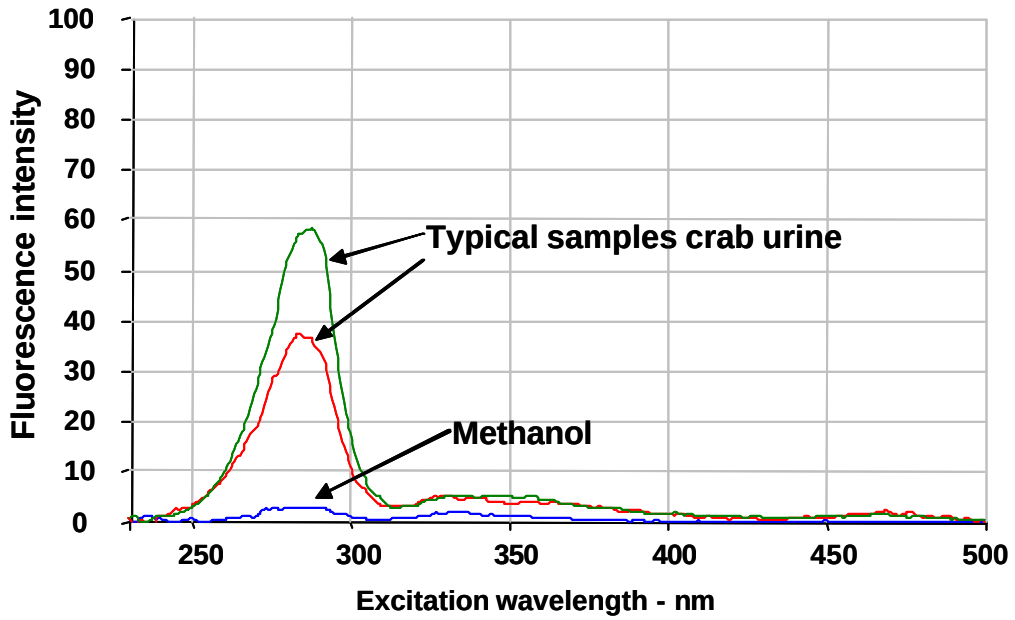


Figure 4. SFS-scan showing typical output from crab urine from unpolluted site.

Debris and seabed irregularities: ROV-survey

A survey to identify debris and irregularities on the seabed in the area where the TLP will be moored was carried out by Amundsen Diving on the 18th June 2002, using ROV.

Method

The seabed at the mooring site of the TLP was investigated by means of an ROV (Argus Mariner) that was run along preset grids. The ROV followed 10 transects at 20m distance, the grid covering in total 200m x 200m. Other grids were also included. Larger objects on the seabed was identified and marked on the map (standard UTM coordinates), as can be seen in Appendix.

Results and discussion

30 larger objects were identified, as outlined in the following (Table 6):

Table 6. Identified larger objects (with position) from ROV survey undertaken by Amundsen Diving.

No.	Position	Object	No.	Position	Object
1	59º 26. 278 05º 44. 924	Wire	16	59º 26. 298 05º 44. 952	Wire
2	59º 26. 275 05º 44. 943	Wire	17	59º 26. 288 05º 44. 961	Stillas plank
3	59º 26. 264 05º 44. 954	H-bjelke	18	59º 26. 331 05º 44. 920	Sunken moring
4	59º 26. 303 05º 44. 904	Dekk til kjøretøy	19	59º 26. 305 05º 44. 959	Oljefat el.
5	59º 26. 289 05º 44. 918	Rekkverk	20	59º 26. 302 05º 44. 966	Ledning
6	59º 26. 287 05º 44. 924	Takplate	21	59º 26. 306 05º 44. 972	Ledning
7	59º 26. 290 05º 44. 934	Takplate	22	59º 26. 334 05º 44. 936	Ledning
8	59º 26. 281 05º 44. 940	Dekk til kjøretøy	23	59º 26. 333 05º 44. 960	Presenning
9	59º 26. 259 05º 45. 000	Presenning	24	59º 26. 296 05º 45. 038	Dekk til kjøretøy
10	59º 26. 249 05º 45. 002	Rør stomp	25	59º 26. 345 05º 44. 976	Ledning
11	59º 26. 311 05º 44. 919	Takplate	26	59º 26. 342 05º 44. 996	Sunken moring
12	59º 26. 304 05º 44. 926	Takplate	27	59º 26. 345 05º 45. 013	Presenning
13	59º 26. 300 05º 44. 929	Rør stomp	28	59º 26. 353 05º 45. 002	Ledning
14	59º 26. 302 05º 44. 950	Dekk til kjøretøy	29	59º 26. 361 05º 45. 015	Ledning
15	59º 26. 302 05º 44. 951	Oljefat el.	30	59º 26. 362 05º 45. 024	Sunken moring

Only the larger objects were identified in the table. In general, the seabed was loaded with many objects reflecting the former use of the area for platform construction etc. None of the larger objects are considered harmful to planned operations. Maps identifying the depth profile of the area and objects identified are presented in Appendix. A video report form the survey was also prepared and issued to Maritime GMC.

Marine growth

Marine growth is a term used to describe the macroscopic plants and animals that colonise man-made structures in the sea. Prior to mooring in Vatsfjorden, marine growth from the parts of the TLP that are above sea level is planned removed. This operation will be carried out in Yrkjefjorden, at the same location where the Brent Spar buoy were dismantled previously (Cordah, 1998). The marine growth will be removed by means of flushing into the sea using the water cannons of the tug boat 'Bison'. The water stream will have a pressure of 13 bars and a volume of 500 m^3/h. The effective water pressure at the platform will be about 8-10 bars, considering the pressure drop between the nozzle and the platform. The tug boat will not be able to access the part of the column legs situated underneath the deck. As a result, about 25% of the total area from the zone being exposed to air will be left to air dry directly (no flushing).

The area of the structure from which marine growth will be removed is about 2800 m^2 (raising the TLP about 12-15m above the former splash-zone). Assuming a similar marine growth structure and density as was estimated for the Maureen platform storage cylinders (Cordah, 2000) the following quantities are estimated:

- 2 800 m^2 x 0.26 kg/m^2 = 728 kg, or 0.73 tonnes (sea water)

(based on a value of average mass per unit are in sea water (kg/m_2) of 0.26)

- 2 800 m^2 x 15.39 kg/m^2 = 43092 kg, or 43 tonnes (air)

(based on a value of average mass per unit are in air (kg/m_2) of 15.39)

The calculated masses are only rough calculations since they are based upon monitored densities and estimated volumes of marine growth for a different structure, the Maureen (Cordah, 2000). The estimated marine growth masses of the Maureen structure was about 1700 tonnes (in air). In comparison, the marine growth estimates of the Brent Spar buoy was 20.8 tonnes (in air). It should also be noted that the experiences made when removing the Maureen marine growth was that the actual masses removed (dry weight) was considerable less than the estimated (V. Høyvangli, Pers. Comm.). The masses that will be removed from the TLP in Yrkjefjorden will lay somewhere between the air weight and the seawater weight, since drying and evaporation processes will start immediately when the structure is raised from its former position in the water column before towing.

The seawater depth at the location for marine growth removal is about 300m.

Method

To examine potential contamination associated with the marine growth and surface coatings to which it adheres, analysis of metals and PAH in biota tissue were carried out. Samples of marine growth were collected from 4 locations on the structure (one from each of the four

main columns). The samples were collected by use of ROV (by the operator). The four samples were analysed separately for metals, and blended into two batches for organic parameters (THC, PAH and PCB). Analysis was carried out by the analytical procedures described in Appendix.

Results and discussion

The marine growth samples were dominated by Acidians.

The results of the metals analysis are presented in Table 7. No PAH or PCB were identified in the marine growth samples, at detection limits 20 µg/kg DS for PAH and 5 µg/kg DS for PCB.

The levels of metal are similar in all four samples, and also reflect the findings of marine growth from other locations (Frigg area, TotalFinaElf, as reported in amongst others Westerlund 2002). For the metal components enlisted in SFTs classification system, most values are within SFT class 1 (Molvær et al. 1997). The differences in dry weight measured are a result of using tap water to wash the material prior to sample processing. It does thus not reflect different characteristics of the sampled biota.

Table 7. Metal levels in marine growth samples.

Sample ref nr	02231-1	02231-2	02231-3	02231-4	Mussels	Sea-Weed
Sampling location:	C1	C2	C3	C4	SFT Class 1	
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
Vanadium	3,89	5,98	2,96	4,46		
Chromium	1,27	1,10	0,96	0,91	3	1
Manganese	2,17	3,23	2,65	2,47		
Iron	78,2	139,6	259,7	77,3		
Cobalt	0,140	0,113	0,130	0,092		
Nickel	0,73	1,39	1,45	0,79	5	5
Copper	7,26	6,00	5,03	5,16	10	5
Zinc	146	115	107	113	200	150
Arsenic	16,8	21,9	18,7	20,8	10	50
Silver	0,064	0,121	0,068	0,079	0,3	0,5
Cadmium	0,358	0,706	1,924	0,548	2	1,5
Barium	9,28	24,07	12,05	9,35		
Lead	0,26	0,23	0,18	0,14	3	1
Dry weigt (%)	13,2	18,1	14,9	18,4		

Environmental assessment

Description of Vatsfjorden

Typically, the fjords of Ryfylke (Rogaland County) are long and narrow, deeper in their middle and upper reaches than at their seaward ends, and with mostly steep and rocky shorelines with occasional shingle and coarse sediment shores found in small pockets. Vatsfjorden is a small spur off the north side of Yrkjefjorden. Vatsfjorden is 5km long and just over 1km wide in its central portion. Vatsfjorden is relatively shallow, about 100m at its

entrance and less than 40m for most of its length. There is no sill towards the much deeper Yrkjefjorden (Tvedten 1999).

A string of small habitations are present from Vats at the head of the fjord to Raudnes near the exit to Yrkjefjorden. The area is quite undeveloped with only limited industrial and agricultural activities. There is a large electronics factory at the head of Vatsfjorden. The mooring site at the quay close to Raudnes is surrounded by steep forested hills (200-400m high) and is effectively hidden from the few local populated areas.

(1) Biological resources

Some fishing by local fishermen takes place in Vatsfjorden. Different types of fishing gear are used, and fishing takes place both from small "sjarks" and larger purse seines. The number of boats engaged in fishing varies from just a couple to 10-15 at the maximum during the summer months (Cordah, 1998).

There is no fish-farming activity in Vatsfjorden, except one land-based facility for hatching of cod. The cod hatchery holds a brood of about 40-50 000 individuals and plans to increase the capacity. The activities are continuous year round. The water inlet for the hatchery is placed at 70m depth to the south-east of Raudnesholmen. The water inlet runs through a 6 inch pipe, the estimated consumption being about 200 l/min (Sigmund Låte, pers. comm.).

There are no designated conservation sites in Vatsfjorden. There is one recognised site of importance for seabirds in the fjord, in the inner part of the fjord, where small colonies of gulls and terns breed and roost during the summer months.

(2) Other use

Although Vatsfjorden is not an important recreational area for tourists, it is used by the locals for recreational fishing and other recreational use. There are two recognised public beaches at Vassendvik and Stratveitbukta further in and on the opposite side of the fjord to the mooring site.

Mooring outline

The platform will be moored along the deep-water quay in Grønavika (Vatsfjorden) as shown in Figure 3. Two barges will be aligned along the quay, and the platform will be placed along these, some 70m from the quay-side. Six lines will stabilise the TLP, four connected to land at the quay-side, one at Nordaberget (about 600m long line) and one that will be anchored to the seabed with a double anchor in a south-eastern direction. The line attached at Nordaberget will be equipped with two ten-tonne buoys to ensure there will not be any conflict with existing seabed pipes. It is ensured that mooring does not conflict with the seawater pipe feeding the onshore cod hatchery.

Environmental risk

This section identifies environmental effects than can potentially occur as a result of the planned activities in connection to the mooring and associated operations, and suggests

actions that should be taken to reduce negative impacts if any are identified. The issues are divided into the type of operation involved.

Removal of marine growth

The marine growth will be removed in the deep Yrkjefjorden prior to towing in to Vatsfjorden. The operation as such, e.g. the removal by use of water cannons, have no significant environmental impacts except for the emissions related to the vessel, which are negligible in this context.

The concerns of the marine growth are mostly related to the following aspects:

- The organic load to the recipient, and
- Possible content of harmful substances

There are several ways that the organic load can affect the recipient. For one, partly dried material may float on the surface with the potential of being spread and reach shores in more populated areas, causing unpleasant odours as it is degraded. This was a concern with the removal of marine growth from the Maureen platform (Tvedten, 2001). However, the experience from the Maureen marine growth removal was that floating particles was not a major issue (Vidar Høivangli, Pers. Comm.). The TLP platform will be raised from its current location in the water column to the planned position for mooring, but this process will take place only a short time before flushing of marine growth is started. It is thus not likely that considerable amounts of marine growth will have dried to such an extent that floating particles will be considerable.

The effects to the water column as the marine growth settles are expected to be minor, although some degradation processes requiring oxygen will occur. Decaying organic material on the seabed can lead to oxygen deficiency in the sediment and will most likely affect benthic animals. The degree of oxygen deficiency will be a result both of organic load, which is also reflected by the spread of the material, and of the water renewal. In addition, the benthic fauna will also be subject to a smothering effect from the settling material. Such impacts are however believed to be moderate and confined to a limited area. Normal conditions can be expected within a couple of years when a "natural" benthic fauna is assumed to have re-established. The benthic smothering is not expected to have considerable effects on other biological sources such as fish.

The TLP surface has been treated with glass flake epoxy (e-mail: David Sinclair, Kerr-McGee). The glass flake epoxy is not expected to have major negative impacts to the environment. Also, with the gentle flushing planned, fall-out of TLP surface coating is expected to be minimal. The load of contamination to the seabed, except for that of organic enrichment, is thus expected to be reflected in the composition of the marine growth. No significant metal enrichment was observed in the marine growth dominated by Ascidians. Further, no PAH or PCB was detected in the marine growth samples analysed. This is in agreement with the other observations which also give no indications that elevated levels can be expected. Hence, based on the current knowledge, no considerable load of harmful substances on the seabed is foreseen.

Towing and mooring process in Vatsfjorden

The towing of the TLP into Vatsfjorden will not cause any significant disturbance to the environment. There is a risk of collisions and other incidents related to vessel movement and also pollution incidents from vessels. The risk is however limited. The marine operations will be carried out according to established routines and safeguard measures associated with offshore marine operations around platforms.

Potential conflicts with local fishermen and other recreational use is possible. The public domain is informed about the pending operations through regional and local press. The exclusion of other users will also be of short duration. With regard to the mooring process/anchoring activity itself, the operator has planned the operations and mooring locations to avoid interference with new sludge pipe and water intake for cod hatchery.

In case of collisions or accidents during tow in and mooring, leakages and spills from storage tanks onboard and supporting vessels can occur. Safety and contingency measures are however taken to reduce the risk of such operational incidents.

Physical presence of structure

There will be only limited maintenance activities onboard the TLP during the storage period according to the current plans, and mostly connected to the mooring and preparation phase in the start. No considerable environmental implications are expected from this. The presence of the TLP in the fjord will also have limited influence on other users (e.g. recreational fishing), as it covers a considerable area thus inaccessible for other users. The access to the quay will also be limited.

The residues of the marine growth on the TLP will deteriorate (degrade) on the structure and may cause unwanted odours. This can affect both workers on the site and nearby users of the sea. It is believed that these processes will not be long-lasting. This need however to be considered, and actions should be initiated if conditions are found to be unacceptable. Such actions can include scraping or further flushing of the internal structure members or temporary halt in the work onboard. If further scraping or flushing is initiated, measures to reduce fall-out to the quay locations must be considered (such as containment). It is then also highly recommended to carry out a monitoring survey at the location during and after operations.

Possible discharges at mooring site

With the current planned activities and safety and management procedures incorporated, the risk of accidental spills to the sea or land-based facilities are considered to be minor. Contingency equipment is available at location in case of oil-based spills. Vindafjord municipality has, as part of their contingency plan, 300m oil booms stored at the quay at Raunes. The nearby municipality Ølen also have 300m oil booms available in the vicinity.

A separate source of point pollution is run-off of rain water from the TLP. Considerable volumes of water will wash off pollutants associated with the deck unit surface during rain periods. With the limited operations planned onboard, re-introduction of polluting substances onto the platform deck will be minimal. The concentration of polluting substances in the run-off will therefore be reduced with time. It is assumed that the potential contamination from

run-off water is limited and within acceptable limits, so that no containment of water will be necessary. If activities onboard is expanded this must be re-evaluated, based on the potential sources and amounts of pollution that may enter the water column.

Nuisance

Since the mooring site in Vatsfjorden and the site for removal of marine growth in the Yrkjefjorden are in areas with low population and at a distance of more than 1km from the nearest residents (Cordah, 1998), nuisance such as noise and odours are not considered to be a major concern.

The operations on the platform at the mooring site will be limited and hence should not cause considerable noise that could be of disturbance to the local population. After arrival of the platform at the mooring location, the Ruston gas turbine will be run while commissioning and connecting for the onshore services. This phase is expected to last for maximum one month. During this period, 25-30 tonnes of diesel are required per day. In case of failure of onshore power supply or equipment in later phases, the gas turbines will be put into use again. No special considerations towards the local population are suggested since the TLP are located at a distance from the residents and the period in which the turbine will be run is relatively short-term.

No other major source of noise pollution is identified.

Conclusions and recommendations

Main conclusion

The overall conclusion is that the environmental implications from removal of marine growth from the TLP in Yrkjefjorden, transport of the TLP from Yrkjefjorden into Vatsfjorden and mooring in Vatsfjorden with the planned activities and safety measures related to these operations are minor and overall short-term.

Decaying of marine growth on the seabed in Yrkjefjorden may give more long-term effects, but these will be reversible and confined to a limited area, and will have few implications for the overall environmental status of the location. The most severe environmental effects that can occur are such related to accidental spills. The risk of such incidents are however considered to be minor and within acceptable limits.

More specific sub-conclusions are drawn in the following. These have been divided into two sets, one related to the baseline survey, and the other related to the environmental risk judgements.

Baseline survey conclusions

- In general, the environmental conditions of the mooring site along the quay in Grønavika are good. The mooring site sediment and water column is considered to be little polluted, and there are only minor differences between the stations at the quay and the reference stations.

- No specific contamination of concern (metals, PAH, PCB, THC) is seen in the sediments.
- No specific contamination of concern (metals, PAH, PCB) were seen in the marine growth from the platform.
- There is no evidence of stress in blue mussels exposed to the seawater in the mooring area, and also no indications of PAH contamination in local crabs from the same location.
- A range of objects were identified on the seabed during the ROV survey, reflecting the use of the quay as a former platform construction site.The seabed littering identified by the ROV-survey apparently does not cause chemical contamination of the area.

Environmental assessment conclusions

- The influence from the platform mooring in Vatsfjorden is considered to be minor and acceptable if the activities on the platform during mooring are kept at a minimum, as is planned.
- The risk of accidental discharges or releases of oil or other contaminants to the sea is presumed to be minor. The risk increases if workover operations are initiated, but will still be small and in general within acceptable limits with the contingency equipment (oil booms) that are in place.
- Major operations currently not planned need separate assessments of their environmental implications. In case of operations on board involving removal or emptying of oil tanks etc., special considerations of the risk of spilling and need for contingency equipment must be addressed.
- It is concluded that it is acceptable to discharge marine growth into the sea in Yrkjefjorden with the proposed gentle methods of flushing that will reduce the outfall of surface coating associated with the marine growth. Although the presence of marine growth on the seabed in Yrkjefjorden may add to the organic load and hence increase anoxic conditions on the seabed and cause smoothering, this is not considered to be of a severity that calls for other actions.
- Natural fall out due to drying of marine growth from the parts of the TLP still being covered when moved from Yrkjefjorden to Vatsfjorden is considered to be within acceptable limits and does not require containment. If continued removal of marine growth in Vatsfjorden proves necessary (due to nasty odours being a nuisance to the workforce and local resident), measure should be taken to reduce the load to the seabed. Extended seabed and water column monitoring during and after operations is then suggested.
- Noise related to the activities in not considered a major negative element.
- The operations in Vatsfjorden and Yrkjefjorden are assumed not to have unacceptable implications for the local population or other users of the area such as fishermen and recreational use.

Recommendations

It is recommended to carry out a survey after the TLP has been removed from Vatsfjorden in order to confirm that the environmental stress has been limited. With the limited activities planned in Vatsfjorden, such a post-survey is however not crucial.

If the activities on the platform when moored in Vatsfjorden become more extensive than currently planned, if the mooring period exceeds the initially suggested 6 months, or if considerable fall out of marine growth at the mooring site in Grønavika occurs, such a post-survey should be initiated.

Status as of September 25th 2002

A decision has been made on reuse of the Hutton TLP. The TLP is therefore planned removed from the mooring site on October 6th, after about 3 months mooring in Vatsfjorden.

Activities have been as planned during the mooring period, except the power turbines has been run all the time. Most of the period, the smaller turbine have been used, reducing noise as well as diesel usage and concurrent emissions. No complaints have been received regarding noise from the operations. A minor oil spill onboard the platform/barges was also reported, the volume was however not documented. No oil sheen was observed on the seawater surface, but there are small accumulations of oil in the small enclosure between the two barges which will be removed when towing the TLP away.

Given the short duration of the mooring period and the anticipated small volumes of oil spilled to the sea during the minor spill onboard the TLP, no post-operation surveys are deemed necessary, although it is recommended on a general basis as a confirmation of absence of negative environmental impacts.

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