Goliat – Leak detection and monitoring from template to satellite

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www.goliatinfo.no
Content

- Goliat development project
- Requirements and expectations from authorities
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PL 229 Goliat – Location and partners

- License awarded in 1997
- Partners:
  - Eni Norge AS (op) 65 %
  - Statoil Petroleum AS 35 %
- Start production Q4 2013
Goliat design and operation

- **Drivers**
  - **BAT** - Best Available Techniques
  - **ALARP** - As Low As Reasonably Practicable

- **Implementation**
  - “zero” discharge to sea during normal operations
  - Reduced emissions to air
  - Environmental friendly chemicals
  - Energy efficiency
  - Winterization
  - Use of multiple barriers
  - Oil spill preparedness
Practical use of BAT

**Eni Norge HSE Goals**
No harm to personnel or the environment  
Ref: DM # 320939 (HSE 4 year plan)

**Eni Norge RISK REDUCTION PRINCIPLES**
- Use of Risk Acceptance Criteria
- Use of ALARP & BAT principle  
  Ref: DM # 223748

**Goliath HSE Goals**
- Sound technical solutions, low risk level, meet environmental framework for the Barents Sea
- Good working environment  
  Ref: DM # 200761 (Goliath HSE Program)

**GOLIAT OVERALL DETECTION, MONITORING AND MEASUREMENT PHILOSOPHY:**
- Monitor possible environmental leak points according to BAT (i.e. early detection)
- Monitor process flows continuously
- Monitor and measure planned discharge
- Forecast and monitor metrological and oceanographic parameters
- Detect and monitor ship and drifting objects on collision course
- Detect, monitor and locate any oil spill in the sea. Predict the trajectory. Share information in real-time between oil spill response resources
- Detect and locate any personnel in the sea (i.e. search and rescue). Share information in real-time between response resources and organisations
- Detect mustered personnel
- Seek to use state of the art technology for detection, monitoring and measuring

**REQUIREMENTS (functional & specific)**

**Solutions & measures (detail design)**
(How to meet the requirements)
Goliat development solution

- Geostationary FPSO
- 8 templates
- 22 wells
  - 11 producers
  - 9 water injectors
  - 2 gas injectors
- Electrical cable from shore
- Export of oil by the use of tankers
- Reinjection of produced water
- Reinjection of associated gas. Gas export is being evaluated.

22 wells in 8 of 4-slot templates
350-400 meter water depth
Oljevernberedskap for Goliat – målsetting og eksterne vilkår

- Eni Norges aim for the oil spill preparedness:
  - Robust
  - Effective
  - Well adapted to local conditions

- St.prp. nr. 64 (2008-2009) Utbygging og drift av Goliatfeltet – vilkår nr. 6 – Goliat proposition to the Storting requirement no. 6:
  - The oil spill preparedness is to be highly prioritized
  - The operator shall conduct a detailed mapping of the infrastructure within the influence area for acute pollution
  - The operator shall strengthen the oil spill preparedness in the affected municipalities, such as Måsøy, Hasvik and Nordkapp with basis in the hearing comments from the Norwegian Coastal Administration to the Goliat PDO.

- Final oil spill preparedness solution will be specified by Klif in the discharge permit.
Requirements in the HSE regulations

- The operators are required to cooperate

- The operator shall establish a monitoring system. This means a system that can detect and map position, area, volume and properties of acute pollution regardless of visibility, light and weather conditions.

- There are requirements on how acute discharges shall be described in the emergency preparedness plans:
  - Aim
  - Description of the emergency preparedness measures and decision criteria
  - Response time for emergency preparedness measures
  - Remote sensing
  - ..

- It is a requirement that the emergency preparedness measure starts as early as possible.

Klif will in further work following up the petroleum industry among others prioritize requirements to and audits on effective remote sensing, that means that acute spills are detected as early as possible.
Sensors

- Process sensors
  - Process sensors are sensors that measure the state inside the process stream. The sensors have as primary function as process monitoring, but do also have capacity to detect spills.

- External sensors
  - External sensors are sensors that measure outside the well/process stream. The sensors have as primary function to detect and monitor acute discharges and to give operational decision support during an incident.

- Goliat will utilize both process and external sensors for leak detection.
Goliat remote sensing strategy

Goliat remote sensing system shall:

1. Provide early detection of acute spills of significance according to regulation and requirements in discharge permit

2. Be able to classify and to track the movement of acute spills

3. Give decision support during spill combating (no action/mechanical recovery/dispersion)
Detection and monitoring - production phase

**SPACE**
KSAT: Radarsat-1, Radarsat-2, ENVISAT, AIS & weather data.

**AIRBORNE**
SURVEILLANCE AIRCRAFT/SUNDT AIR B350: SLAR, IR, AIS, photo, video, visual, drifters, downlink
ENI HELICOPTERS HAMMERFEST/BRISTOW EC225: IR, visual, downlink

**OFF-SHORE**

**ON-SHORE**
ENI Hammerfest/Stavanger + Other

**GOLIAT FPSO**
- OSD
- IR
- Downlink
- TCMS

Safety Stand-by
- OSD
- IR
- AIS buoys
- Downlink
- ROV

Template sensors:
- Acoustic
- Capacitance

Meteorological data incl. ocean currents profile

Riser leak sensors

Prosess sensors

Bridge to traditional GIS systems

Support Data

GOLIAT OIL SPILL REMOTE SENSING SYSTEM
- Sensors and dataflow
Requirements for template leak detection

- The system for leak detection is to have two independent sensor types
- Robust design (25 years)
- Shall be based on tested and reliable detection methods
- BAT shall be used for sensor selection
- Identification of leak “hot spots”
- Optimization of placement and number of sensors
- “Tuning” of sensors based on operational experience
- Possible to change sensors through “wet mating”
Selected sensors

Capacitance:
- Proven technology
- Extensive field experience
- Tested by SINTEF
- Can be changed
- Leak need to be collected in front of sensor
- Not a direct measurement of leak
- Complex installation

Passive acoustic sensor
- Proven technology
- Tested by SINTEF
- Easy to install
- Independent of template design
- Can be changed
- Background noise and distance affect the sensor
- Limited field experience
Installation analysis – leak “hot spots”
Installation analysis
Proposed solution
Field internal pipelines

Monitoring of field internal pipelines with:
- Process sensors
- Regular pipeline inspection with ROV from safety stand-by vessel
- Sensors monitoring the sea surface

www.seaeye.com
Riser monitoring

- Goliat will have a system that monitors the annulus in risers containing hydrocarbons.
- The primary function is to detect water entering the annulus, i.e. a riser breach and hence the system can detect leakage of hydrocarbons.
- The system continuously monitors the gas dissipation in annulus.
- The system can give automatic alarms.
- The system can provide samples that can be analysed in a laboratory.
Goliat FPSO

- The FPSO is designed to reduce the probability of acute pollution
- The FPSO will have process monitoring detectors
- FPSO will have sensors (OiW) and flow meters monitoring the discharge points
  - Produced water
  - Ballast water
- FPSO will have IR-cameras and oil detecting radar
Offloading of oil from FPSO to tanker

- Goliat will have a new offloading system resulting in lower risk for collision and spills than traditional NCS offloading systems.
- Optimization of offloading sector, close to 360° with one station
- New hose based on API 17K-requirements
- In case of hose damage, sections can be replaced on the FPSO
- The offloading station will give good working conditions for operation, inspection and maintenance.
- "Green line" – a number of criteria must be fulfilled before pumping starts
Offloading from FPSO to shuttle tanker

- Requirement to distance between tanker and FPSO (normal 250 m, min. 150 m)

- Requirement to tanker heading in relation to FPSO in case of drive off

- Requirement to distance between bow on tanker and anchor lines (min. 20 m)

- "Online" video communication between FPSO and tanker

- Monitoring with oil detecting radar and IR-camera from FPSO and vessels

- Tanker with DP2 positioning system
Stand-by vessel and supply vessels

Eni Norge will for the operation of the Goliat field have modern support vessels. Eni Norge have entered into a long term contract with Esvagt for the delivery of the safety stand-by vessel for Goliat.

- Both vessel will have IR-camera and oil detecting radar
- Both vessels will be NOFO approved and the requirements to crew will be so that they can operate the equipment without NOFO support.
- At least one of the vessels will have AIS-boys
- One of the vessels will have an observation ROV (Esvagt Eurora)
Helicopter

Eni Norge will have two helicopters available in Hammerfest.

- **Helicopter 1 – Transport helicopter EC225:**
  - Visual methods and procedures

- **Helicopter 2 - AWSAR EC225**
  - Visual methods and procedures
  - FLIR camera
  - Downlink (can send live pictures to vessels)
National surveillance plane

- The Norwegian Coastal Administration is responsible for the service and a new modern aircraft has just been put into service.

- Sundt Air AS is responsible for the service and two planes is part of the contract.

- The plane has the following equipment:
  - Visual (video and photo)
  - FLIR- (only primary aircraft)
  - SLAR
  - GIS with AIS
  - NOFO Downlink-system

- NOFO has 60 flight hours pr. year.
Satellite

- Satellites do not directly detect oil, but detect the dampening effect the oil have on the sea surface. That means that detections need to be verified in order to confirm that it is oil.

- With existing coverage, it can be expected to get an average of 2-3 “scenes” pr. day.
  - Assuming that the FPSO is 20 km from edge of area covered (about 12 hours drift time for oil).
  - Satellites alone, will today be expected to give an detection time of 12 hours,

- From 2013 it is expected that there will be 3-4 scenes pr. day.

*Theoretical max coverage by satellites for a 24 hour period, 1. August 2011 (5 scenes). (KSAT)*
Conclusion I

- Significant development of leak detection and remote sensing since 2003

- Eni Norge will use a number of platforms with different sensors in order for detection of acute spills and for the monitoring of the movement and characteristics of a spill:
  - Satellite
  - Plane and helicopter (SAR, SLAR, IR)
  - FPSO (radar, IR)
  - Safety stand-by and supply vessel (radar, IR, AIS-boys)
  - ROV on safety stand-by vessel
  - Sensors on the templates
  - Land based Hi Frequency radar that can measure surface currents? Pilot is being evaluated

- In total more than 80 sensors
Conclusion II

- Goliat will have state of the art leak detection and remote sensing

- Goliat will integrate information from different sensors placed on different platforms

- Goliat will have a situation awareness picture that can be shared with relevant parties both on shore and off-shore (requires internet access)

- Eni Norge will continue to have oil spill preparedness high on the R&D agenda.
Thanks for your attention

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