Upgrade of Gas Detection Technology Eliminates False Alarms and Improves Safety Performance
Introduction and background

- Terra Nova is the second largest offshore oilfield in Canada.
- Total recoverable reserves are estimated at 419 million barrels.
- Production began in 2002, through the use of a Floating, Production, Storage and Offloading (FPSO) vessel.

<table>
<thead>
<tr>
<th>Owners of the Terra Nova oilfield</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Suncor Energy</td>
<td>38%</td>
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<tr>
<td>Husky Energy</td>
<td>10%</td>
</tr>
<tr>
<td>ExxonMobil</td>
<td>19%</td>
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<tr>
<td>Statoil</td>
<td>15%</td>
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<tr>
<td>MURPHY OIL CORPORATION</td>
<td>13%</td>
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<tr>
<td>CMR Gexcon</td>
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<tr>
<td>Senscient</td>
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Location of the Terra Nova field
The Terra Nova FPSO on a sunny day
The Terra Nova FPSO on a normal day
The Terra Nova FPSO on a foggy day
Gas detection upgrade project

- 2002 – original gas detectors used infrared (IR) technology (predominately LOS)
- Issues with reliability → during fog or snow IR detectors would report a fault condition and some would falsely detect gas
- Executive Action triggered by gas detection → complete ESD
- 2010 – advent of sour gas
- Based on IR performance issues and need to detect H$_2$S, two projects were initiated:
  1. To build a gas dispersion model and perform consequence analysis to benchmark and optimize the safety performance of the gas detection system
  2. To investigate technologies that addressed problems with the existing system and could detect both flammable and toxic gas releases
Gas dispersion simulation modeling

CFD was used to simulate 1,480 leak scenarios and optimize the design of the upgrade:

• A diverse set of leak scenarios was simulated
• Leaks that yielded challenging clouds were chosen to “test the system”

Safety criteria for flammable gas:

• A confirmed gas alarm must be triggered before a leak reaches a hazardous level
Hazardous cloud size varies by module

<table>
<thead>
<tr>
<th>Module</th>
<th>Cloud Size</th>
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<tbody>
<tr>
<td>Main Deck</td>
<td>88 m³</td>
</tr>
<tr>
<td>Separation</td>
<td>332 m³</td>
</tr>
<tr>
<td>Prod. Water</td>
<td>406 m³</td>
</tr>
<tr>
<td>Water Inj.</td>
<td>604 m³</td>
</tr>
<tr>
<td>Power Gen.</td>
<td>695 m³</td>
</tr>
</tbody>
</table>
Geometry model of the FPSO
Geometry model of the FPSO
Geometry model of the FPSO with gas leak simulation
Dispersion simulation of a gas leak scenario
Simulation of a gas leak – power generation module
Simulation of a gas leak scenario – main deck
Gas detector technology selection

- In February 2011, a trial ELDS™ unit was tested at the onshore DCS simulator
- Over a period of two weeks, stringent performance tests were conducted on the device, under a variety of conditions that were known to generate problems

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulated fog using water mist</td>
<td>No issue with performance</td>
</tr>
<tr>
<td>Direct water spray on the device lenses</td>
<td>No issue with performance</td>
</tr>
<tr>
<td>Plastic of various types placed in the beam path</td>
<td>No issue with performance</td>
</tr>
<tr>
<td>Snow placed over the lens (approx. 1 inch thick)</td>
<td>No issue with performance</td>
</tr>
</tbody>
</table>

- Following an offshore trial (2011-13), a decision was made to replace all existing IR LOS gas detectors with ELDS™ technology
Installation of an ELDS™ system on the FPSO
Installation of an ELDS™ system on the FPSO
Detector layout on main process deck
Detector layout on process deck
Undetected scenario (using IR technology)
Same scenario detected using laser technology

- Detector is (barely) impinged
- With increased sensitivity of laser detector cloud is detected
Exposure curve for scenario shown on previous slides

- With IR no alarm is given
- Increased sensitivity of laser provides detection
Results – impact on safety

Data from the Terra Nova data historian, maintenance management system and lost production tracking register was analyzed to quantify performance.

1. Sour gas detection:

   Addressed by utilizing Senscient’s dual Methane-H$_2$S sensors
   This minimized installation, retrofit and wiring costs

   Alarm triggered within 30 seconds for any leak where:
   - H$_2$S > 10ppm for 100m$^3$
   or
   - H$_2$S > 100ppm exceeds 10m$^3$
Results – impact on safety

2. Five-fold increase in sensitivity
   • IR detection – old threshold set at 1 LELm / 2.5 LELm (low / high alarm) to avoid drifting and false alarms
   • Laser detectors set at 0.2 LELm / 0.5 LELm (low / high alarm)

3. Elimination of unrevealed gas detector failures
   • IR had an average of 21 unrevealed failures per year
   • Laser detectors have not recorded a single unrevealed failure

4. Increased availability of detection safeguards
   • Adverse weather conditions have no impact on laser detectors
1. Average of 234 maintenance work orders per year generated relating to IR LOS detectors being in fault

   Note – excludes maintenance calls during conditions of limited visibility (rain, fog, mist, snow) to clean detectors as these calls were not tracked

2. Over comparable period 13 maintenance work orders for laser-based devices (minor re-alignment issues).

3. Automated calibration and daily testing
   - no sensor replacement
   - eliminates need for gas cylinders and hazardous calibration operations
   - operating cost reductions of 90%

4. Bluetooth connectivity eliminates need for scaffolding or ladders to make physical connections
Results – impact on production

1. Production trips:
   – With IR technology, 3 – 4 production trips per year due to false gas detection. (Note: This is after inhibits were placed on IR sensors due to bad weather).
   – During a trip, ESVs are closed, shutdown and inventory is sent to the flare.
   – These type of shutdowns have damaging effects on plant equipment

2. Financial impact:
   – Trips resulted in production deferments of 50 – 100kbpa
   – Annual financial impact at $100/bbl = $5 – 10 million
     • At $30/bbl = $1.5 – 3 million

There has not been a single instance of false gas detection with the laser-based gas detection technology.
“The performance of the upgraded system has been exceptional.”
• Jason Schexnayder
  – holds a degree in Electrical Engineering
  – spent the first decade of career as a Plant Engineer for Gerdau Ameristeel and BASF
  – spent 5 years before joining Senscient working in sales and application engineering of fire and gas detection systems
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