Hendelser med stabilitet og ballastering av flytende innretninger på norsk sokkel

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I forbindelse med RNNP gjøres det en årlig gjennomgang av hendelser som er rapportert til Petroleumstilsynet. Av hendelser som gjennomgås er de knyttet til stabilitet og ballastering. Gjennomgangen danner grunnlag for teksten i de årlige RNNP-rapportene. Samtidig danner lista også grunnlaget for presentasjoner til næringen i ulike fora.

Hendelser med DP som medfører krengning, stamping eller rulling er ikke med her; de rapporteres i RNNP under DP-hendelser. Se sammenstillingen her. Tilsvarende behandles bølger som slår inn i dekk, som etterlater seg mye vann og bidrar negativt til stabilitet (COSLInnovator og liknende), er dekket under konstruksjonsskader. Se sammenstillingen her.

Eldre hendelser med stabilitet og ballastering er beskrevet i en artikkel fra 2013. Artikkelen inneholder detaljer om hendelsene og drøftinger.

Gjøa production semi in 2010
The Gjøa semi experienced two incidents before it was due to be towed to the field. Owing to a fault involving short circuiting in the ballast control system in the safety automation system (the SAS I/O cabinet) at the top of a column, the facility listed three degrees. This fault caused all the valves between ballast tanks in one of the quadrants to open, which in turn led to a shift in the ballast water and thereby also in the unit's centre of gravity. Valves in the ballast water intake from the sea remained shut. The fault in the electrical supply spread to other equipment. Input boards malfunctioned and required manual resetting after the loss of power. The software controlling the input boards had wrong parameters. The software opened all the valves because of the fault in the input boards. The interlock designed to prevent multiple valves from opening simultaneously failed to once after the valves had already been opened incorrectly. The applicable ballasting procedure did not include the use of an emergency stop during a crisis (Aker Solutions, 2010, and PSA, 23 August 2010).

One week before the tow out, an error was found in the stability calculations. Physical changes had to be made in the hull compartmentation and caused a five-week delay. The intact stability with small angles of floating units is determined by the metacentric height GM – the distance between the centre of gravity (G) and the metacentre (M) – as follows: GM = KB + Iw / V – KG. When collision damage occurs at the water line, the water-line area is reduced. The moment of inertia of the water-line area (Iw) is reduced as a result, causing an equivalent reduction in GM. The effect of this is that listing with minimum potential energy will occur around a system of axes which rotates in relation to intact symmetry axes. This condition was not identified (PSA, 23 August 2010). Kvitrud, 2013

Veslefrikk B production semi in 2011
21.7. 2011 på Veslefrikk B var 60 kubikkmeter vann lakk ut. Lekkasje av drillvann i sementrom. Operatør forlot område med vanntilførsel åpen mens vannfylling av tank i sement pumperom pågikk. Dumpeventil i dørk var i tillegg stengt. Dette førte til vannfylling i rom, samt tilstøtende områder. Påfølgende trimforandring av installasjonen ble raskt oppdaget i Maritimt kontrollrom (<1 grad). Alarm reaksjonslag ble sendt til området. Basert på tilbakemelding fra ARL, ble det valgt å initiere generell alarm. Beredskapsorganisasjonen

mønstret. Årsaksforholdet ble raskt brakt på det rene, vannfylling stoppet og situasjonen normalisert. Alt dette før man rakk å varsle 2 linje. Elements: 2011/871.

Åsgard A FPSO – leakage in 2011
Corrosion on an internal 10-inch drainage tube (in a return flow of central fresh cooling water to the main generators) 2.3metresbelow the water line caused seawater to flood into a pump room at the stern of the Åsgard A FPSO on 4 October 2011 (Statoil, 2011). The room's volume was 3800 cubic metres. Two gauges showed less than 30 per cent water fill. An operator also discovered water in the stairwell. The bilge pumps were started, but had insufficient capacity. A ballast pump was activated, but experienced start-up problems. Starting the ballast pumps had no effect on the water level in the ballast pump room. Three gas-powered fire pumps and repair clamps were flown in from Åsgard B. After some trouble shooting, the leak was identified. The tube was immediately sealed with a wooden plug, and secured with cargo straps. The water intrusion was limited to the thruster room and the adjacent stairwell. The leak was stopped after about two hours. Kvitrud, 2013 med referanse til Statoil: Dybdestudie av vannlekkasje i akterskipet Åsgard A, 13.12.2011.

Transocean Winner semi in 2011
25.11.2011 Void space har et volum 75m3 fylt med vann pga. manglende lukking av mannlokk. RNNP-rapporten for 2011.

Scarabeo 8 semi – list in 2012
The Scarabeo 8 semi suffered a seven-degree list on 4 September 2012 (Eni, 2012 and Dybvig et al, 2012). Around 14.40, the control room operator (COOP) noticed a movement in the unit indicating that the rig was listing in the aft direction. The COOP started to operate the ballast control system to counter the effect. A sea chest valve and a ballast valve were opened. This was done 14.49. His actions had no effect, and the list continued to develop. The COOP tried several measures to no effect. He had not understood the situation, and became more and more stressed. The stability section leader and the offshore installation manager arrived shortly afterwards, and started to work the ballast control system together. The "close all valves" function in the ballast control system was activated at 15.12. By that time, the rig had an aft list of seven degrees. The situation was then stabilised. Eni's conclusion was that the COOP in question was not fully qualified to be alone in the control room. Two valves had been opened from the sea to an aft ballast tank with a volume of 1186 cubic metres in a pontoon. If the tank had been filled, the unit would have developed a list of 12.3 degrees (Eni, 2012). Elements 2012/25.

Floatel Superior semi – list in 2012
The night between 6 and 7 November 2012 an anchor caused eight holes, flooding of two ballast tanks and a list of approximately 5.8 degrees on Floatel Superior (Andersen et al, 2013). The direct cause of seven of the holes, were penetrating strokes of a loose anchor. The last hole occurred when a damaged part of the anchor bolster, failed due to fatigue. The bolster lost three members to the sea floor. The damage had occurred over time. After the failures, the remaining parts of the bolster did not prevent the anchor to hit directly into the hull. The anchor was hanging freely, and hit repeatedly into and damaged the hull in rough weather. The damage occurred after all eight anchors had moved with repeated blows to structural components of the bolster. Damages in different stages of development have been observed on all four bolsters. The incident was mainly caused by choices made in the design, and linked to the decision that Floatel Superior could keep position both with mooring and

dynamic positioning with the anchors placed in weather rough positions in the bolsters. The design resulted in several unfortunate choices:
• The anchors could not be securely attached to bolster,
• The bolster was not designed for the actual loads,
• Doubling plates used as weak links failed due to fatigue.
• The hull was not designed to withstand direct hit of the anchors. (Andersen et al, 2014 + Elements 2012/1727)

Songa Encourage semi – krengning i 2017
2.1.2017: Pumperom 8P i babord pontong ble fylt med sjøvann pga. en lekkasje på en kompensatorbelg. Vann inntrenging i pumpe rom (P8) Babord forut, Vann ble også observert i trusterrom i tilknytting til pumpe rommet. Riggen krenget og ble de-ballasted i motsatt retning. Mønstring av beredskaps organisasjon om bord og på land (Statoil og Songa). SAR helikopter mobilisert fra Heidrun; 8 personer midlertidig evakuert til Heidrun, disse er senere fløyet tilbake til Encourage når situasjonen var avklart. Truster # 6 ble stoppet kl. 14:30 pga. vann inntrenging via luftekanaler fra pumpe rom P8. Luftekanal ble stengt ned, lekkasje rate til thrusterrom # 6, ca. 3 – 4 liter/min. Riggen var allerede koblet fra brønnen pga. dårlig vær Riser hengt av på rigg. BOP på brønnen er stengt. Fokus videre for å tømme pumpe rom P8 og omkringliggende seksjoner for vann. Årsak til vann inntrenging er ikke kjent. De hadde 5 grader slagside og vanninntrengningen var estimert til mellom 600 og 1000 m3. Det ble fortløpende vurdert under hendelsen om riggen skulle gå til land. Avstand til land er 130 nautiske mil og det vil ta riggen 26 timer dersom den går for egen maskin. Riggen var 60 meter fra brønntemplate når hendelsen inntraff. Kl. 1639 mottok vi informasjon fra Songa om at lekkasjen var observert på videokamera. Det så som den var i tilknytning til en brannpumpe (flens eller belg). Alle sjøkisteventiler er stengt. Riggen tar ikke inn mer vann og forholdene er delvis normalisert på riggen. Kl. 1900 mottok vi informasjon fra Songa om pumperommet er fylt med vann og at rommet er isolert med vanntette dører og spjeld. Det er en forhøyet beredskap ombord hvor en gjennomfører vaktrunder for å bekrefte at en ikke har videre spredning av vann. En vurderer alternative løsninger for å tømme pumperommet for vann. En aktuell løsning innebærer å snu en sjekkventil. En vil deretter kunne få pumpet ut vann fra rommet. Elements: 2017/10.

Norne FPSO - negativ stabilitet i 2016 og 2019
02.05.2016: Det ble erfart negativ initialstabilitet på Norneskipet. Etter utlossing til tankbåt ble det lastes 4000 m^3 olje på cargotank 4 wing styrbord (sb) og babord (bb), for å kunne tømme ballasttank 4 sb og bb for vedlikehold. Det oppsto problemer med å få tømt 4bb/sb-ballasttankene, lensingen stoppet på ugunstig punkt ift. fri væskeoverflate. Samtidig var flere U-tanker under 98% fyllingsgrad. SKR justerte ballast for å holde rett kjøl, men skipet krenget 4-5° over til hver side – dette pga. negativ initialstabilitet. Ballasttankene ble fylt opp til over dobbelbunnsnivå/98% for å gjenopprette initialstabilitet. Periode ca. 3 timer. Synergi 1473084 ble etablert, og Equinor jobber med tilhørende aksjoner, hvor to fremdeles pågår på hhv lettskipsvekt og stabilitetsberegning. Elements: 2018/ 1609.

In 2016 negative stability was experienced on an FPSO causing the vessel to incline 4-5 degrees fourth and back to each side. The vessel was in a ballast condition and had just transferred 4000 cubic meters of oil to two cargo tanks. Simultaneously, the unit was in the process of preparing two ballast tanks for discharging and preparation for tank maintenance when the discharge operation accidentally stopped, and the inclining started. The cause of the negative stability was a large amount of partly filled tanks (slack tanks). The condition was brought back to normal by filling several of the ballast tanks full to reduce the free surface

effect. However, it took about three hours to get the situation under control. A procedure was later prepared stating that all tanks shall either be full or totally empty to avoid any free surfaces. Further, only one ballast tank shall be discharged at any given time. One of the reasons why the vessel became more sensitive towards free surface effects is an increase in the VCG through the years, in combination with a large negative contribution to the GM value from free surface effects specially from U-shaped ballast tanks. Fra Halsne et al (2020).

Reparasjonsarbeid pågår i ballasttank 4 styrbord, og tanken ble ikke fylt som normalt ved siste olje-lossing 17/7-2019. Skadestabilitetskravene ved en evt. punktering av ballasttank (17 grader) var i dette tilfellet ikke oppfylt i ballastkondisjon. Stabilitet i normalkondisjon er iht. kravene. Etter at forholdet ble identifisert er det innført operative tiltak for å hindre punktering eller annen utilsiktet fylling av tanken. Tiltakene er bl.a. stopp i båtanløp og arbeider som kan påvirke stabilitet eller ballastsystem. Skadestabilitetskravet ble igjen oppfylt 23/7, pga. oljeproduksjonen til sentertankene etter lossing. Elements: 2019/ 955.

Transocean Spitsbergen semi - i 2018
10.10.2018 på 6706/12-E-1 HT2 Snefrid North. Fylling av styrbord aktre søyle. General alarm sounded at 12:16 from C4S (column no. 4 starboard aft). Full mustering on the rig. Initial response team immediate acted and get a view of the on scene and reported back to command centre. It was reported back that there were light smoke and approximately 0,4 meters with water in the compartment. Leakage from a valve on a 4" seawater cooling line. The water had caused a short circuit in an UPS and operation station for ballast system and caused smoke in the compartment, and trigged the fire alarm. Elements: 2015/1266.

COSLPromoter semi - i 2020
14.10.2020 all remote operated ballast valves on port side of the COSLPromoter started to open, which led to an uncontrolled heel to port side. The crew closed the ballast valves on port side. By then the COSLPromoter had obtained a 6.1° heel to port side. Immediate causes:
• Valve on port side HPU insufficiently closed. Pressure activated from port side HPU. Other valves closed, pressure build-up in hydraulic system
• Internal leakage caused by pressure build-up in solenoid valve manifold pushed all port side ballast valves to open position. Elements: 2020/ 1940.