VORTEX SHEDDING IN CORRUGATED FLEXIBLES
With the recent increase in demand for offshore gas, a new phenomenon has been observed on floating production platforms that export or inject gas through flexibles (risers). As the gas flow is increased, high levels of distinctive tonal noise and vibration occur in the associated piping. The problem can be attributed to flow induced pulsations (FIP) that are generated on the inner corrugated layer of the flexible. When the vortex shedding frequency is able to excite acoustic natural frequencies of topside piping or subsea manifolds, a resonance phenomenon known as lock-in occurs. This lock-in can cause excessive pulsation, vibration and noise levels in the topside and subsea piping. With the problem evident for gas flow velocities as low as 3 m/s, production capacity may be severely limited.

OBJECTIVE
The objective of the acoustic assessment of flexibles (risers) is to avoid the lock-in behaviour within the normal operating conditions, or in other words, provide an on-set flow rate above the maximum required flow rate of the flexibles. The on-set flow rate is the minimum flow rate at which the unwanted ‘singing’ behaviour occurs.

ACOUSTIC ASSESSMENT
The acoustic assessment makes use of our so-called FIP-lock-in source model. This model is based on the knowledge generated within the ‘Flexible Riser’ JIP (see inlay) and field measurements on Statoil’s Åsgard B, one of the major gas exporting platforms in the Norwegian sea (see photo). The FIP-lock-in model predicts onset-flow rates based on carcass geometry, operating conditions and the acoustic properties of the topside piping and subsea manifold. Field measurements on an export gas system have proven that the interaction between these three components play an important role in the determination of the actual on-set flow rate. The model is presently integrated within our PULSIM (PULsation SIMulation) software.

DELIVERABLES
Ideally the analysis is carried out during the conceptual design phase. In that case the analysis provides recommendations in respect to:
− the selection of a suitable riser (carcass geometry);
− the installation direction of the flexibles;
− the layout of the topside piping and subsea manifold.
In case of existing flexibles, solutions to the problem can either be:
− installation of acoustic block(s) that shield the topside and subsea piping from the source; or
− increasing on-set flow rates by lowering reflected energy.

The reflected energy from the topside piping and subsea manifold(s) can significantly be reduced by:
− the relocation of (control) valves, reducers, and header tie-in points;
− the adjustment of side branches;
− the omission of dead-legs.

The last stage of the analysis is the execution of a mechanical scan. The objective of this scan is to identify the areas that are most vulnerable to dynamic loads (and subsequent high-cycle fatigue). The scan can lead to recommendations regarding the supporting and bracing of these lines.

Participants to the ‘Flexible Riser’ JIP are: BP, BV, Chevron, ExxonMobil, HSE, Shell, Statoil and TNO.