Rijkswaterstaat, which is part of the Dutch Ministry of Infrastructure and the Environment, asked MARIN to investigate the possibility of allowing larger ships into the Scheldt estuary.

Full-scale squat measurements

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Squat measurements on bulk carrier

The Scheldt estuary provides an important shipping route to North-West Europe but the waterways and the area are restricted both in horizontal dimensions and in water depth.
MARIN investigated the minimal safe under keel clearance and the tidal windows for different ports. The keel clearance is affected by squat, so to predict the squat behaviour of ships, empirical relationships are used. However, it was unknown how accurate these are. Therefore, full-scale measurements were carried out on 6 bulkers and 2 container vessels visiting Antwerp, Ghent and Flushing. Vessels selected for the campaign stretched the current limits; i.e. 14,000TEU container vessels calling Antwerp, Kamsarmax bulk carriers (230x37x12.5 m) transiting the locks of Terneuzen, (measured minimum keel clearance 1.0 m, with 1.0 m space between hull and lock fenders) and bulkers (289 x 45 x 16.5 m) approaching Flushing with a measured minimum of 2.02 m keel clearance while sailing (12.2% of draught).

Accurate Squat measurements were done using Real Time Kinematic GPS systems in combination with optical gyro motion sensors to get accuracies of 2.5cm in height and 0.01degree in trim and roll angle. Tides were also taken into account. Moored buoys measuring water height can be used but the interpolation between the height given by two buoys to get the water height at the position of the ship introduces large uncertainties. In shallow water areas and in narrow rivers, tide does not follow a perfect sinusoidal, so other methods were required.

The solution was found by using a small displacement boat closely following the test vessel, with an additional RKT-GPS onboard measuring the height of the water level relative to a fixed land-based reference point. This boat was unaffected by shallow water effects and squat, hence giving a reliable water height figure at the test vessel's position. Accurate figures of squat and draught deviations due to ship motions could then be calculated. This validated desk studies and model test results on sinkage and minimal keel clearance allowances.