# "Turning moment" – specification of the conditions of full-scale tests, model tests or calculations), as given in CESNI/PT/Pax (20)m 23

In response to the inquiry put forward by the Secretariat on the matter of evaluation the need of an ESI to specify further the conditions of full-scale tests, model tests or calculations, Sea Europe, CEMT and Croatia provide the following recommendations, based on ITTC recommended procedures and guidelines[1]:

**Introduction**:

Checking the formula for turning moment of passenger vessels in 2008 IMO Code (which is analogue to existing formula in ES-TRIN), nowhere is it stated that the formula refers exclusively to displacement vessels, so it can be concluded that it can be applied to non-displacement vessels also. Problem could be that this formula is, in general, too conservative for non-displacement vessels, as it does not include any positive effects which are usually present when manoeuvring in non-displacement mode (transverse component of rudder force, for instance, which rights the vessel, etc.).

By our opinion, if existing formula gives satisfactory result, further investigation would not be necessary, but if formula gives too high moment values, than tests or more detailed calculations can be done, as it is further described.

**Proposal**:

The most convenient way, from the perspective of organisation and implementation of test and reliability of results (as negative scale effects are excluded), would be full-scale test of vessel behaviour when turning on the range of advanced speeds (non-displacement speeds). If vessel incline towards the centre of the turning circle, it is stable, with no negative effects of turning, so turning moment can be neglected when calculating overall heeling moment of the vessel.

On the contrary, if vessel heels outward when turning on the advanced speed (non-displacement speed), this is unwanted and atypical situation which indicates possible inadequate stability of non-displacement vessel, so further analyses of vessel behaviour, or further modification of hull form or weight characteristics, should be carried out.

If full scale test is impractical for some reason (as confirmation of vessel's behaviour comes at the latest stage, which might be especially inacceptable if construction of series of sister-ships is in progress), free running model test can be applied. The procedure is used for surface vessels only, with Froude scaling law applied, where the smaller the model, the higher are the negative scale effects and the bigger is the challenge to create a realistic model with its own propulsion and steering. On the other hand, for larger models, negative scale effects decrease, so from the perspective of accuracy of results, the scale should be chosen as large as possible, meaning the model size should be as large as possible, but keeping in mind that the size of the actual test basin in relation to the required area for the tests to be carried out, as well as the capability of the test equipment are governing factors, which can make test impractical or too expensive to perform.

A simpler alternative could be towing test of the model (without its own propulsion) free to move in the relevant degrees of freedom in calm water, which is commonly carried out to find the inception of or the region of advanced velocities, as well as conditions of vessel weight and location of centre of

gravity, where vessel motions due to dynamic instability occur. An oblique towing test, with model inclined by applying the additional weights on one side, may provide dynamic (in)stability information on the model in calm water. Namely, if heeling of the model increases with increasing of speed, it indicates transverse instability of the vessel inherent in hull form (for specific conditions of vessel weight and location of centre of gravity), so further analyses of vessel behaviour, or further modification of hull form or weight characteristics, should be carried out. On the other hand, if heeling of the model decreases with increasing of speed, it indicates that there is no negative dynamic effects on transverse stability of the vessel, which should be confirmed by full-scale test or corresponding calculations (computer simulations). Also, the influence of the propulsor and appendages on the vessel motion due to dynamic instabilities can be significant, so the model used in the experiment should be with scaled propulsors and appendages or with suitably adapted towing procedures.

Furthermore, the effects of cavitation and ventilation, which may be significant for small models, cannot be avoided in tests at atmospheric pressure. Experiments in cavitation facilities may be required when the effect is expected to be significant. If such effects cannot be avoided in experiments, a computer simulation using measured or predicted hydrodynamic coefficients would be more reliable than the experiments.

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[1] INTERNATIONAL TOWING TANK CONFERENCE (ITTC) – Recommended Procedures and Guidelines