**Model Test Specification**

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| **Hull** | **KVLCC2** |
| **Test type** | **Captive (PMM)** |
| **Water depth** | **Deep** |
| **Appendages** | **Appended** |

**SUMMARY**

Captive PMM tests shall be conducted in **deep water** with a model of the KVLCC2 tanker. The data will be used as basis for simulation models for use in the SIMMAN 2013 Workshop.

NOTE: Please fill in fields marked with yellow and return the document to cds@force.dk.

**MODEL GEOMETRY**

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| --- | --- |
| **Identification:** | HMRI model no. T530 |
| **Scale:** | 1:46.426 |
| **Hull:** | Dimensions of the KVLCC2 hull in this scale are as follows:   |  |  |  | | --- | --- | --- | |  | [m] | 6.8279 | | B | [m] | 1.249 | | T | [m] | 0.448 | |  | [m3] | 3.1242 | | S | [m2] | 12.6168 | |  | [-] | 0.8098 | | LCG | [%Lpp] | 3.50 |   W/O rudder  (LCG positive forward of midships) |
| **Propeller:** | The KVLCC2 model is equipped with stock propeller no. HP801, righthanded, with following particulars:   |  |  | | --- | --- | | Type | FPP | | Blades | 4 | | d [m] | 0.2124 | | P/D at 0.7R | 0.721 | | Ae/A0 | 0.431 | | hub ratio | 0.1550 | | Rotation | righthanded |   + |
| **Rudder:** | The KVLCC2 is equipped with one semi balanced horn rudder. Rudder particulars:   |  |  |  | | --- | --- | --- | | Srudder | [m2] | 0.1268 | | lat. area | [m2] | 0.0523 | | lat. area movable | [m2] | 0.0634 | |
| **Bilge keels:** | None. |
| **Turbulence stimulation:** | Turbulence stimulation is provided by studs |
| **Comment:** | Note that values of full scale parameters can be seen on www.simman2013.dk |
|  |  |

**Model photos**

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| --- | --- |
| R529, R530_사진.jpg  Rudder arrangement side view | T530_사진 261.jpg  Hull view |
|  |  |

**TEST CONDITIONS**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Loading condition** | The model shall be tested on even keel at model draught corresponding to 20.8 m full scale. The mass and moment of inertia in yaw must be measured. Nominal values are as follows:   |  |  |  | | --- | --- | --- | | m | [kg] | 3123 | | ixx/B | [-] | n.a. | | izz/Lpp | [-] | 0.253 | | GM | [m] | 5.71 | |
| **Water depths:** | The tests shall be performed at deep water |
| **Nominal speeds and RPM:** | The nominal approach speed will be the same for all water depths:   |  |  |  |  | | --- | --- | --- | --- | | Nom. speed ship | [kn] | | 15.50 (\*1) | | Nominal model speed U0 | | [m/s] | 1.1702 | | Froude no. Fn | | [-] | 0.142 | | Nominal revs. N0 | | [RPM] | 465/594(\*2) |   (\*1) Speed chosen to match free model tests at BSHC.  (\*2) RPM shall be set **to ship self-propulsion point and model self-propulsion point** at nominal speed U0 |
| **Self-propulsion point:** | Ship and Model (No friction deduction force applied) |
| **RPM strategy:** | Constant RPM |
| **Degrees of “freedom”:** | 3 DOF, i.e. measure longitudinal force X, transverse force Y and yaw moment N |
| **Set-up:** | Free to trim and sink, otherwise constrained.  Roll is free for static test and fixed for Dynamic test. |

**TEST PROGRAM**

PLEASE PROVIDE APPLIED TEST PROGRAM ACCORDING TO ACTUAL TEST including applied amplitudes and frequencies of PMM motion for dynamic conditions.

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| Test kind | U/U0  (non-dim.) | Prop. Revs(\*)  (non-dims) | Rud. Angle  (deg.) | Drift Angle  (deg.) | Sway Acc.  (non-dim.) | Yaw Vel.  (non-dim.) |
| Static  Rudder | 1.0 | 1.0  1.277 | -15~25, +5 | 0 | 0 | 0 |
| 0.8571 | -10~20, +10 | 0 | 0 | 0 |
| 0.7143 | -10~20, +10 | 0 | 0 | 0 |
| 0.5714 | -10~20, +10 | 0 | 0 | 0 |
| 0.4286 | -10~20, +10 | 0 | 0 | 0 |
| 0.2857 | -10~20, +10 | 0 | 0 | 0 |
| Static  Drift | 1.0 | 1.0  1.277 | 0.0 | ±30~±20,5 | 0 | 0 |
| Drift &  Rudder | 1.0 | 1.0  1.277 | 0.0, 25 | -30 | 0 | 0 |
| 0.0, 23 | -25 | 0 | 0 |
| 0.0, 20 | -20 | 0 | 0 |
| 0.0, 18 | -16 | 0 | 0 |
| 0.0, 16 | -12 | 0 | 0 |
| 0.0, 14 | -9 | 0 | 0 |
| 0.0, 12 | -6 | 0 | 0 |
| 0.0, 10 | -4 | 0 | 0 |
| 0.0, 7 | -2 | 0 | 0 |
| 0.0 | - | 0 | 0 |
| 0.0, -7.0 | 2 | 0 | 0 |
| 0.0, -10.0 | 4 | 0 | 0 |
| 0.0, -12.0 | 6 | 0 | 0 |
| 0.0, -14.0 | 9 | 0 | 0 |
| 0.0, -16.0 | 12 | 0 | 0 |
| 0.0, -18.0 | 16 | 0 | 0 |
| 0.0, -20.0 | 20 | 0 | 0 |
| 0.0, -23.0 | 25 | 0 | 0 |
| 0.0, -25.0 | 30 | 0 | 0 |
| Pure  Sway | 1.0 | 1.0  1.277 | 0.0 | 0.0 | 0.05, 0.10,  0.15, 0.20 |  |
| Pure  Yaw | 1.0 | 1.0  1.277 | 0.0 | 0.0 | 0 | 0.1, 0.2,  0.3, 0.4,  0.5, 0.6 |
| Yaw with  Drift | 1.0 | 1.0  1.277 | 0.0 | 4,8,12,16 | 0 | 0.1, 0.2,  0.3, 0.4,  0.5, 0.6 |

(\*) Propeller revolution 1.0 means ship self propulsion point and 1.277 means model self propulsion point.

**MEASUREMENT SYSTEM**

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| **Facility:** | The tests were done in Planar Motion Mechanism set-up in HMRI’s deep water  towing tank with dimension 210 m X 14 m X 6 m |
| **Water temperature:** | 18.6 deg C for KVLCC 2 |
| **Measurements:** | The following quantities shall be measured (at least):  X and Y forces were measured by one X gauges located at LCG and two Y-gauges located 1.0 meter forward and after the LCG.  Propeller thrust and torque were measured on each propeller shaft.  Rudder forces were measured by 3-component gauge on the rudder stock.  Captive tests: X- and Y-forces, N-moment, sinkage fore and aft, carriage speed, rudder angle, drift angle, amplitudes and frequencies of PMM motion, propeller thrust, torque and RPM, rudder forces (if possible). |
| **Sampling frequency:** | 20 Hz |

**DATA PROCESSING**

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| --- | --- |
| **Coordinate system:** | The coordinate system is fixed in the ship model. Origin for captive motion: intersection between the water line plane and the centre line plane at amidships. The x-axis is positive in the forward direction, the y-axis is positive towards starboard side and the z-axis is positive downwards. Angles, moments and directions of rotation follow the general right hand rule. |

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| **Filtering of raw data:** | All raw signals should be filtered to remove measurement noise.  After filtering, two total forces and moment are found by combining the  raw data: measured forces from each of the gauges:  Xtotal = Xmean  Ytotal = Ymean, fore + Ymean, aft  Ntotal = 1fore · Ymean, fore - 1aft · Ymean, aft |
| **Inertia forces:** | The inertial forces originating from the mass of the model and the moving part of the measurement system have been subtracted to give the pure hydrodynamic forces:  Fhydro = Ftotal - Finertia |
| **Total hydrodynamic forces:** | After filtering, the total forces and moments shall be derived by combining the measured forces from each of the gauges and the inertial forces originating from the mass of the model and the moving part of the measurement system should be subtracted to give the pure hydrodynamic forces. Alternatively the total forces can be given along with sufficient information to derive the hydrodynamic forces. |
| **Motion variables:** | The definition of the independent motion variables (x0, y0, psi, beta, u, v, r, udot, vdot, rdot) in relation to the PMM motion should be given.  The independent variables (x0, y0, psi, beta, u, v, r, udot, vdot, rdot) are derived from the PMM setting and the carriage speed using the expressions defining the PMM motions.  Heading:  *ψ= ψ*max sin(*ωt + φ*)[rad]  Sway:  *vsway= y*max *ω cos ωt* [rad]  where  *y*max and *ψ*max are sway and yaw amplitudes, respectively  *ω* is the circular frequency of PMM motion |

**OUTPUT DATA**

The resulting output files from the PMM tests contain the channels listed below.

All tests have same output files

|  |  |  |  |
| --- | --- | --- | --- |
| Number | Designation | Dimension | Description |
| 0 | Time | sec | Run time |
| 1 | Sway amp. | m | Sway displacement |
| 2 | Y1 | kg | Hydrodynamic transverse force |
| 3 | Y2 | kg | Hydrodynamic transverse force |
| 4 | X | kg | Hydrodynamic longitudinal force |
| 5 | Yaw | deg | Yaw angle |
| 6 | Rx | Kg | Rudder X force of movable part |
| 7 | Ry | Kg | Rudder Y force of movable part |
| 8 | RM | Kg-m | Rudder torque of movable part |
| 9 | Tr | Kg | Thrust force |
| 10 | Tq | Kg-m | Thrust torque |

1. Static rudder tests (mean values, model scale)
2. Static drift tests (mean values, model scale)
3. Static drift and rudder tests (mean values, model scale)
4. Pure sway tests (mean and phase component values, model scale)
5. Pure yaw tests (mean and phase component values, model scale)
6. Yaw and drift tests (mean and phase component values, model scale)

**UNCERTAINTY ANALYSIS**

The model test facility is encouraged to carry out uncertainty analysis on the measurements.