#  Supplementary Material

**Sensitivity analysis**

The results of the sensitivity study on grid points for a normal propeller with SST model showed that the lift force remained almost the same in all models while the drag force of the coarse model changes more than 10% compared to the normal mesh (Table S1). Based on these results, a mesh was regenerated for LES model, taking into account the sensitivity of the boundary layer and Courant number, and then an unsteady analysis was carried out with the operating condition in Table S2. Unsteady analysis with LES model is very time consuming and our computational resources are limited. Therefore, a sensitivity analysis using LES model was not carried out. However, the resultant forces obtained from LES model were considered reasonable compared to the experimental results to discuss the flow feather by using this computational results.

TABLE S1. Sensitivity analysis on grid points of a normal propeller with SST turbulence model.

|  |  |  |  |
| --- | --- | --- | --- |
| Model | Coarse | Basic | Fine |
| Upper/Lower surface mesh size (mm) | 0.60 | 0.40 | 0.30 |
| Height of first layer (mm) | 0.016 | 0.012 | 0.008 |
| Total element number in all domain (×106) | 2.17 | 4.75 | 9.46 |
| Lift force (N) | 3.82 (-1.2%) | 3.87 | 3.79 (-2.1%) |
| Drag force (N) | 0.72 (+14.3%) | 0.63 | 0.66 (+4.7%) |

TABLE S2. The operating condition of the tested propeller models for an unsteady analysis.

|  |  |  |  |
| --- | --- | --- | --- |
| Parameters | Normal | Plate | Cylinder |
| Upper/Lower surface mesh size (mm) | 0.40 | 0.40 | 0.40 |
| Plate/Cylinder surface mesh size (mm) | - | 0.04 | 0.01 |
| Total element number in all domain (×107) | 2.31 | 2.37 | 2.55 |
| Rotational speed (rpm) | 4100 | 3650 | 3900 |
| Time step per rotation | 7200 | 8640 | 7920 |
| RMS courant number | 0.77 | 0.66 | 0.83 |

**Standard deviations of sound pressure levels**

TABLE S3. The standard deviations of the sound pressure levels.

|  |  |  |
| --- | --- | --- |
| Measurement locations | Normal | Serration (H3\_G1) |
| *x*v and *x*h = 0.5 m | 0.6643 dB | 0.2646 dB |
| *x*v = 0.5 m and *x*h = 1.0 m | 0.4423 dB | 0.2219 dB |
| *x*v and *x*h = 1.0 m | 0.3105 dB | 0.3084 dB |