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Calm water CFD for Rhino 3D users

SUMMARY

This document contains information related to the calm water resistance CFD simulation service provided by Cloud Towing Tank (CTT) to customers that use Rhino 3D for hull modelling. The service terms and conditions assume that the CAD preparation will be conducted by the customer. Prepared 3D geometry files in STL format will then be used by CTT to conduct the study.

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2 GENERAL CONDITIONS: PRICE, TIME OF DELIVERY, OUTPUT

2.1 Price

Prices are:

1. 100 EUR per simulation,
2. 0 EUR per hull geometry.

The unit price per simulation that will be applied is 100 EUR. One simulation can be used to predict resistance for one speed, one draught, one trim/LCG, and one hull geometry. For example, if a customer wants to calculate resistance at three speeds, one draught, for two different hull geometries, the total cost will be 600 EUR.

2.2 Time of delivery

Results of the analysis will typically be delivered within 2 working days. For simple geometries without complex and numerous appendages results will often be delivered within one working day. In no circumstances should time of delivery exceed 5 working days.

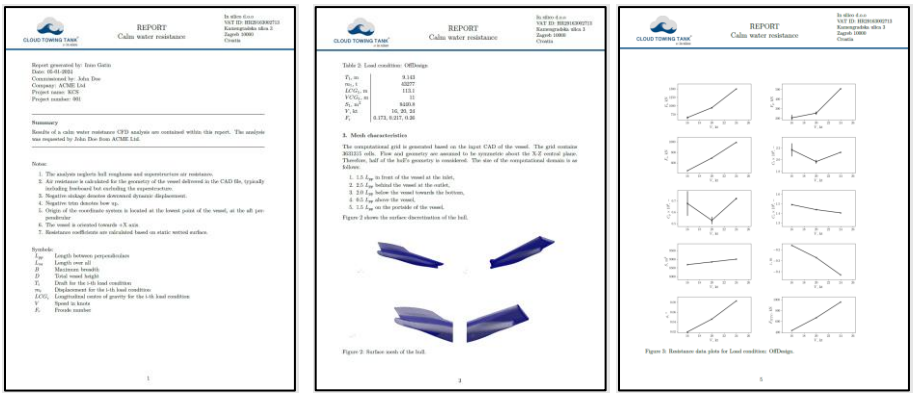
2.3 Output

Output of the CFD study will be comprised of the following:

1. PDF report,
2. Flow images,
3. .csv table files with results.

Examples of the above output can be found accompanying this document.

The PDF report will include basic information about the vessel, loading conditions, speeds, numerical grid, and all relevant resistance results.



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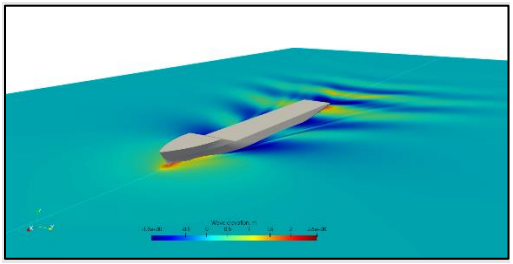
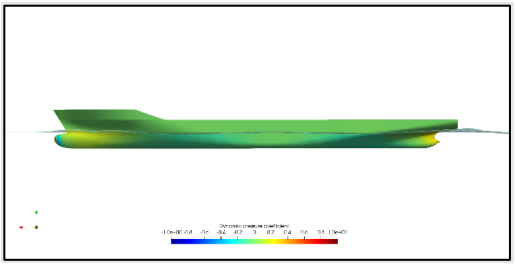
Flow images show the free surface elevation around the hull in several perspective views, and in bird's view. Pressure distribution along the hull is also shown in side, bottom, front and rear view.





To simplify further integration of our results into the design process, .csv tables are also delivered so that all results can be copy-pasted into Excel or similar.

Load condition name	OffDesign	OffDesign	OffDesign
Velocity [kt]	16	20	24
Displacement [t]	43276.85	43276.85	43276.85
LCG [m]	113.115	113.115	113.115
F_t [kN]	653.76	943.55	1495.12
F_p [kN]	204.19	253.25	506.77
F_v [kN]	449.57	690.3	988.35
$C_t\times10^3$ [-]	2.17	1.97	2.13
$C_p\times10^3$ [-]	0.68	0.53	0.72
$C_v\times10^3$ [-]	1.49	1.44	1.4
S [m^2]	8684.69	8844.36	9005.34
z [m]	-0.16	-0.27	-0.43
ϕ [^o]	0.02	0.05	0.08
F_{ITTC} [kN]	429.76	665.94	955.71

Additionally, the following optional output can be delivered **on request, without additional fees:**

1. Individual surface resistance, such as appendage resistance,
2. Hull resistance distribution along X axis (additional input needed),
3. Propeller plane wake fields (additional input needed),
4. 3D flow fields.

3 INPUT

3.1 Input Geometry and Data

The minimum input that we require to perform the analysis is:

1. Geometry of the vessel and appendages in STL format,
2. Main ship characteristics:
    a. Length between perpendiculars, L_{PP},
    b. Length overall, L_{OA},
    c. Breadth, maximum, B,
    d. Height of the STL geometry,H. . Note that this differs from the ship depth or height, and represents the vertical distance between the lowest and highest point in the STL geometry that you delivered.

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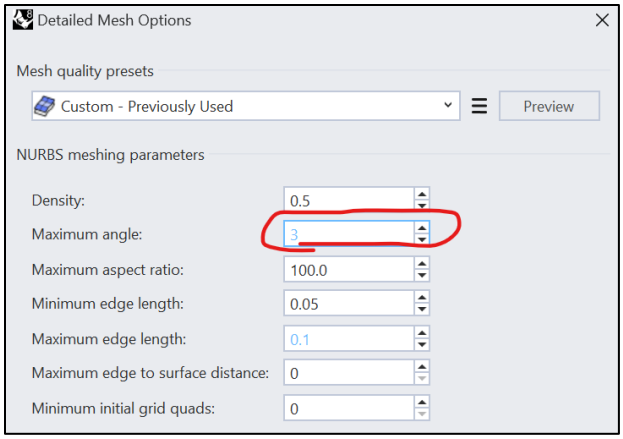
3. Load condition information:
    a. Draught and/or displacement,
    b. LCG and/or static trim
    c. List of speeds.

The STL files need to be prepared following our instruction video. The quality of the STL files will determine if we can conduct the study. We will warn the customer if we estimate that the STL quality may affect result accuracy.

We recommend the following STL export settings:

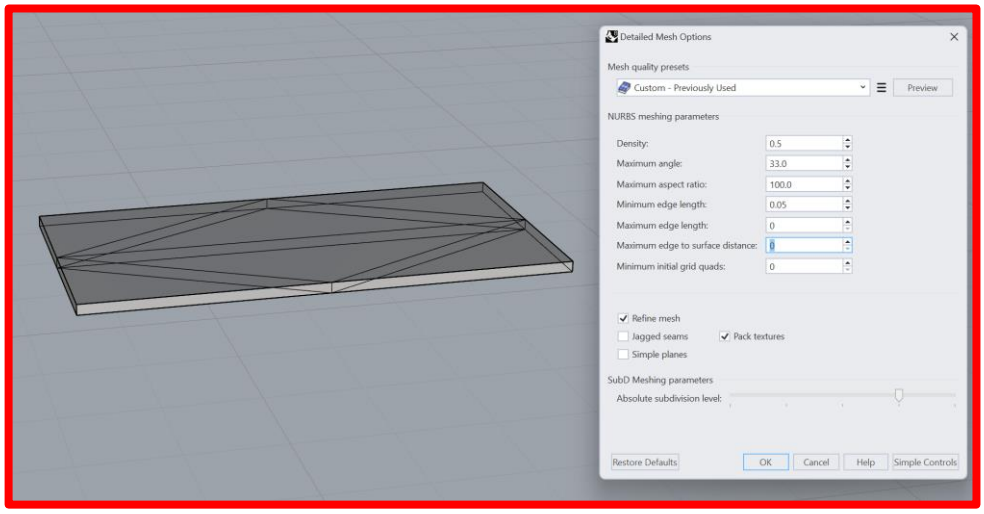
1. Displacement and semi-displacement vessels: **angle tolerance below 8 degrees,**
2. Planning hulls: **angle tolerance below 3 degrees.**

See image below for reference:



Maximum edge length should be limited to avoid larger triangles on low-curvature geometry features. Please see the example below:

Incorrect:



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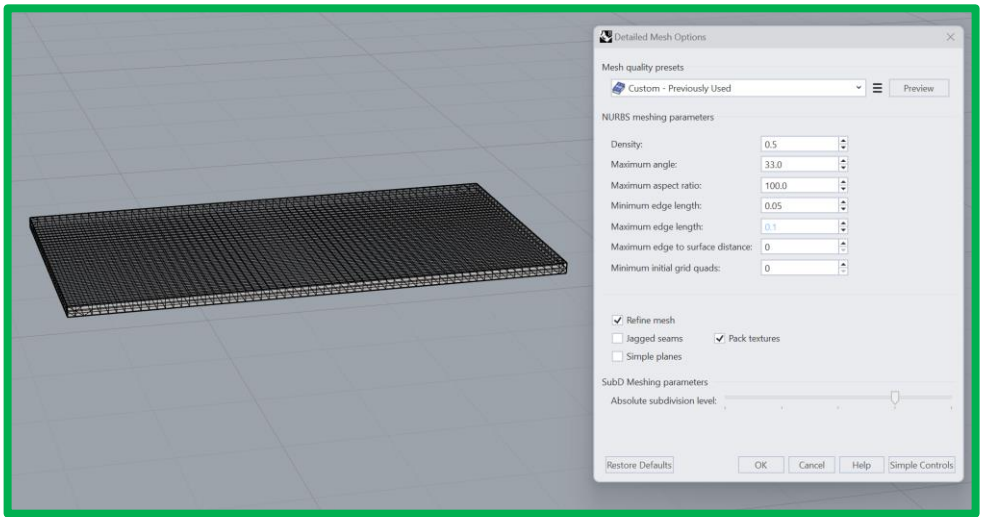
Correct:



Additional input required for optional output:

1. Hull frame spacing used to calculate hull resistance distribution.
2. Propeller(s) diameter, position and inclination angle, used to calculate the wake field.

3.2 Input File Exchange

We have prepared an Excel sheet file with the required data input, so that you do not have to worry about forgetting something. The Excel file can be downloaded from our website.

Hull name		
Length between perpendiculars	Lpp, m	
Length overall	Loa, m	
Maximum breadth	B, m	
Height of the STL geometry	H, m	

Load condition name		
Draught	T, m	
Displacement	Δ, tons	
Longitudinal centre of gravity	LCG, m	
Vertial centre of gravity*	VCG, m	
List of speeds	V, kt	
*optional		

STL files can be sent through e-mail or uploaded to a dedicated SharePoint location.