

Part II:
MAAT Hydro's Quick Hydrostatic Modelling Guide
Rev. 6.4

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1 Solid Based Hydrostatic Calculation:

MAAT Hydro is a solid based hydrostatic calculator designed to be the marine oriented companion of your favourite 3D modeller.

"Solid based" means that MAAT Hydro directly operates on the 3D surfaces describing ship's geometry, without needing any tedious sectioning.

Thanks to an IGES file, solids and can be directly imported from your 3D modeller or created in MAAT Hydro from the imported faces.

See "MAAT Hydro Solid Based Hydrostatic Reference Guide" for more details.

This short guide will explain you:

- How to export your ship model from your 3D modeller.
- How to import it in MAAT Hydro.
- Which data are necessary and why.
- How to make MAAT Hydro solids from the imported data.
- How to define compartments and tanks if necessary.
- How to manage ship's solid and liquid loads.

2 Exporting your Ship Model to MAAT Hydro:

2.1 Checking Solids:

If your 3D modeller is able to define solids, the most direct data transfer is obtained by exporting ship parts as solids (IGES entity 186). See «Part IV: Advanced Solid and Buoyancy Management" for further details on MAAT Hydro solids.

If not, watertight solids will have to be defined in MAAT Hydro by joining the imported faces together, as explained in this guide.

2.2 Checking Faces:

It is a good habit to check the following points before exporting your ship project to MAAT Hydro:

- The exported faces must be trimmed NURBS surfaces (See «MAAT Hydro Solid Based Hydrostatic References Guide" for further details).

- The exported faces must be as contiguous as possible, in order to allow defining watertight solid(s).

- Avoid duplicated faces: Like missing faces, multiple identical faces cannot be detected visually, but may seriously alter solid operations and hydrostatic calculations.

- Avoid surface singularities like degenerated or triangular faces.

2.3 Checking Lines:

Depending on the expected MAAT Hydro calculations, certain lines may also have to be exported. Don't forget to export the following lines with the ship faces whenever necessary:

- Ship's silhouette for windage calculations (closed lines only).
- Sheer line(s) for freeboard calculations.
- Opening line(s) for downflooding calculations.
- Overflowing / Downflooding lines for dredge.
- Evacuation routes for probabilistic damage stability.
- Ship's sail area for sail calculations (closed lines only).
- …

2.4 Setting the appropriate IGES Export Options:

As soon as ship's 3D model complies with these requirements in your 3D modeller, it can be exported in an IGES file, provided that the IGES Export options are correctly set. The following points must be kept in mind:

- Exported file must comply with IGES 5.2 specifications.

- The following IGES entities are the only accepted ones:

  100: Circular Arc
  102: Composite Curve
  110: Line (segment)
  120: Surface of Revolution
  122: Tabulated Cylinder
  124: Transformation Matrix
  126: "Rational B-Spline" Curve
  128: "Rational B-Spline" Surface
  141: Boundary / Outline
  142: Curve on Parametric Surface
  144: Trimmed (Parametric) Surface
  186: Manifold Solid B-Rep Object
  504: Edge
  508: Loop
  510: Face
  514: Shell

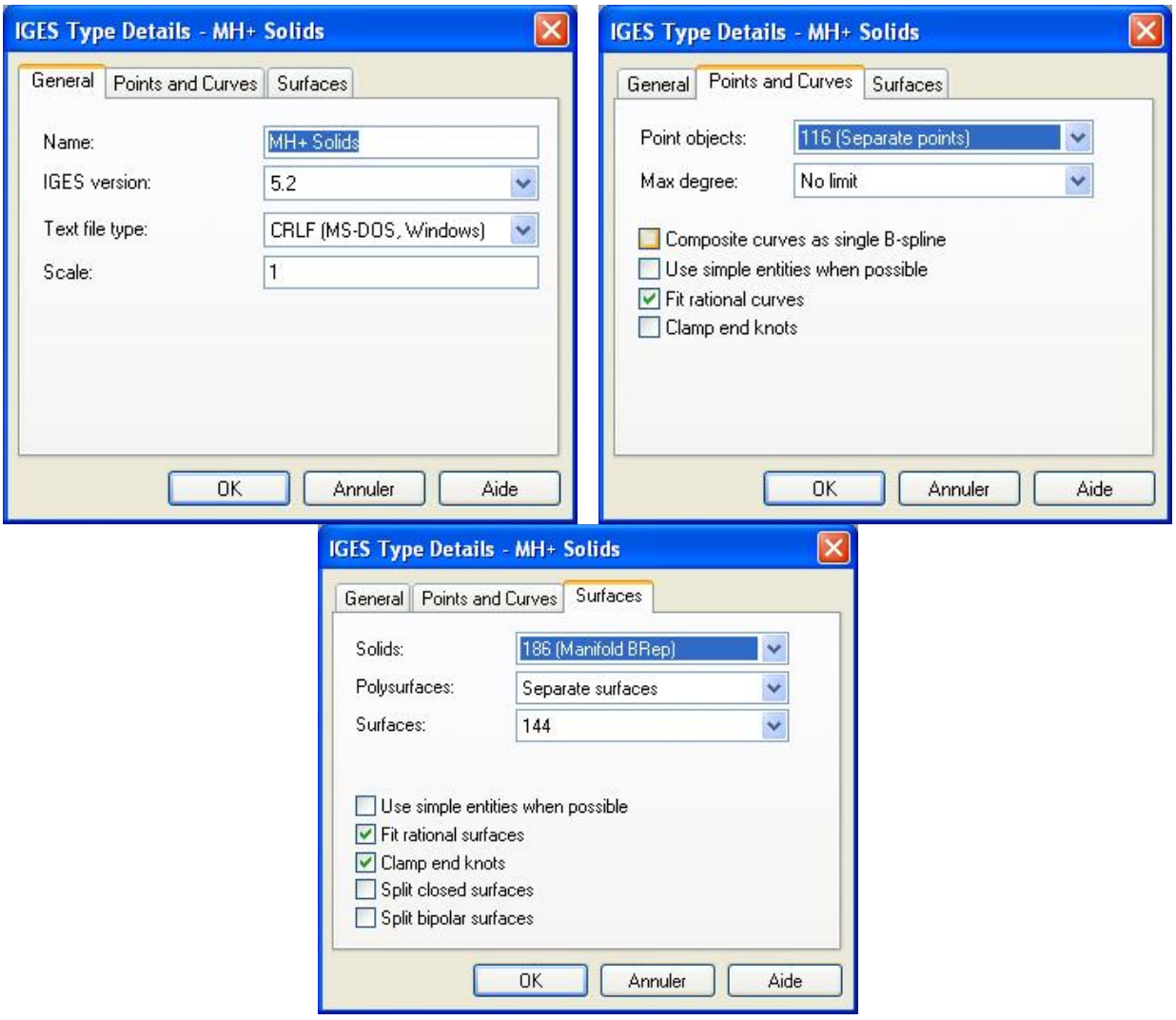
- Lines must be exported as NURBS (avoid Splines).

- Faces must unconditionally be exported as trimmed NURBS.

- If possible, convert rational NURBS to non-rational ones.

2.5 Example: Suggested Rhino's IGES Export Settings:

In order to illustrate this general information, let us suggest the Rhino users to try the following settings in order to create a MAAT Hydro Export Profile (Rhino solids will be exported when present, and only separate faces when not present):



3 Importing a Ship Model:

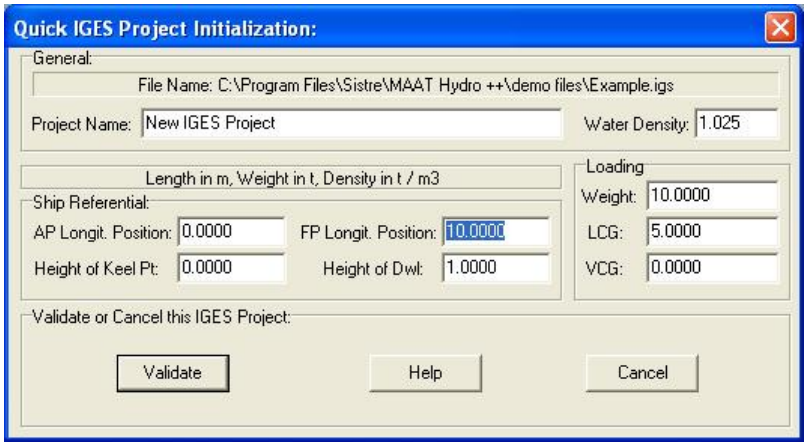
As seen above, Ship's surfaces, solids and lines coming from other 3D modellers must be supplied to MAAT Hydro by an IGES file.

Moreover, the MAAT 2000 files can also be opened directly, and automatically converted into MAAT Hydro data.

3.1 Importing an IGES Model in MAAT Hydro:

As soon as Ship's 3D model is exported in an appropriate IGES file, MAAT Hydro can import it as follows:

- From the menu bar:
  - Select "/File/**Open**" in the menu bar.
  - A File Selection dialog box pops up, allowing to select the IGES file and path («igs» extension must be selected).
  - The "Quick IGES Project Initialization" dialog box then pops up, allowing entering the main project data (project name, water density, default loading case...). Click on the [Validate] button to import the IGES File after setting these parameters.

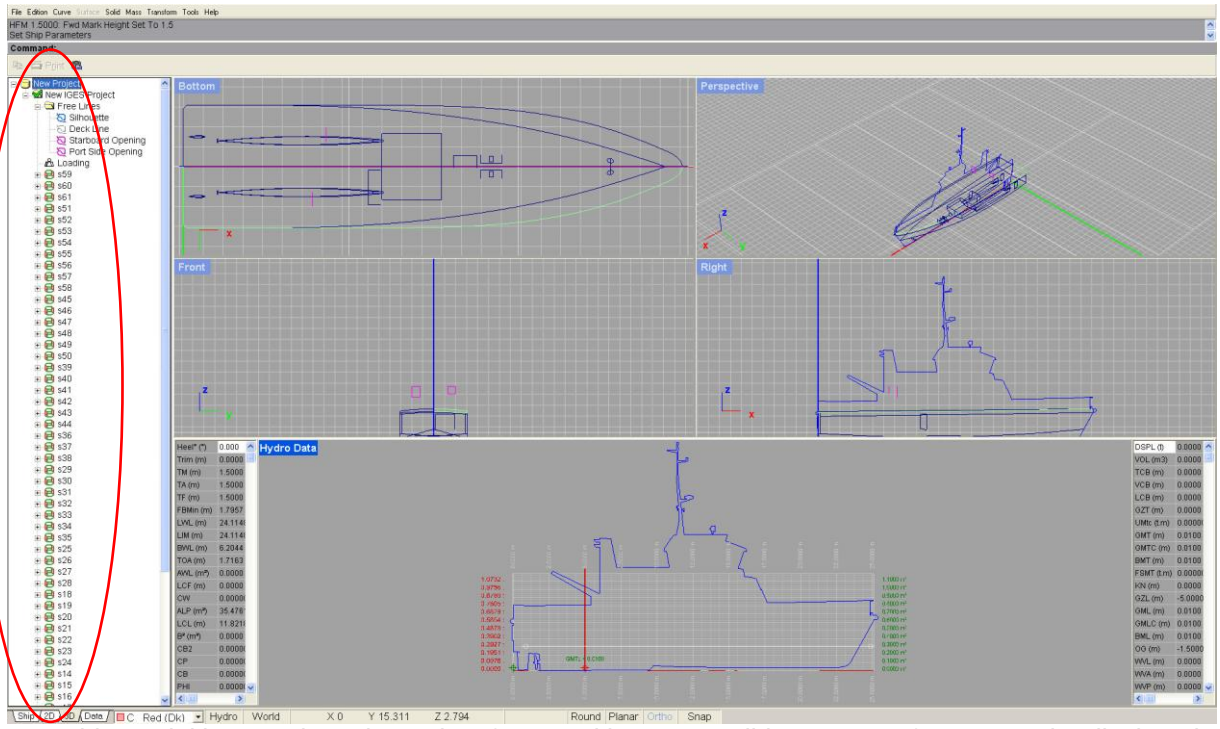


  - As soon as the 3D model is loaded, expand the 3D browser to check the imported items; Ship's lines, surfaces and solids must normally be listed and displayed.

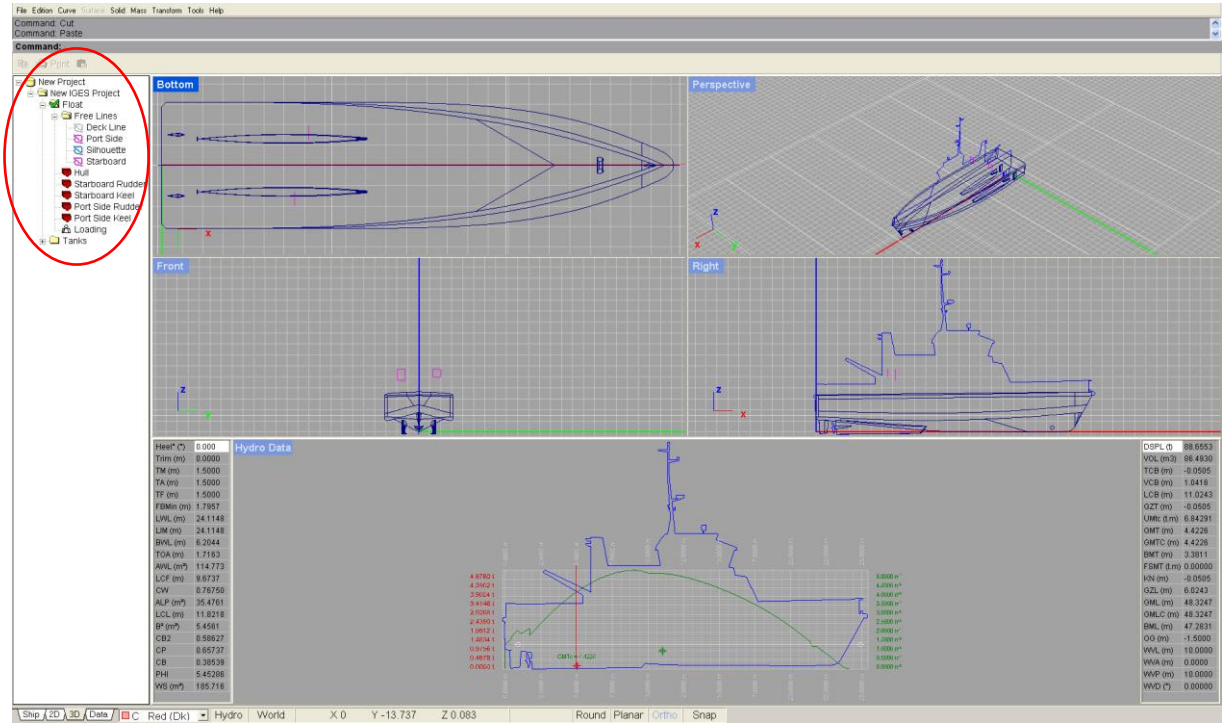
- From the 3D browser:
  - Select a destination folder in the 3D Browser, in which the IGES data will be imported.
  - Select "Import" in 3D browser's right-click menu.

- A File Selection dialog box pops up, allowing to select the imported IGES file and path («igs» extension must be selected).

- No project initialization dialog box is necessary in this case, IGES file's content being simply imported in the selected destination without changing the [Ship] page settings.



3D Ship model imported as trimmed surfaces: Without any solid, no curve of areas can be displayed.



3D Ship model imported as solids: Solids being buoyant objects, allow direct hydrostatic calculations.

3.2 Importing a MAAT 2000 Model in MAAT Hydro:

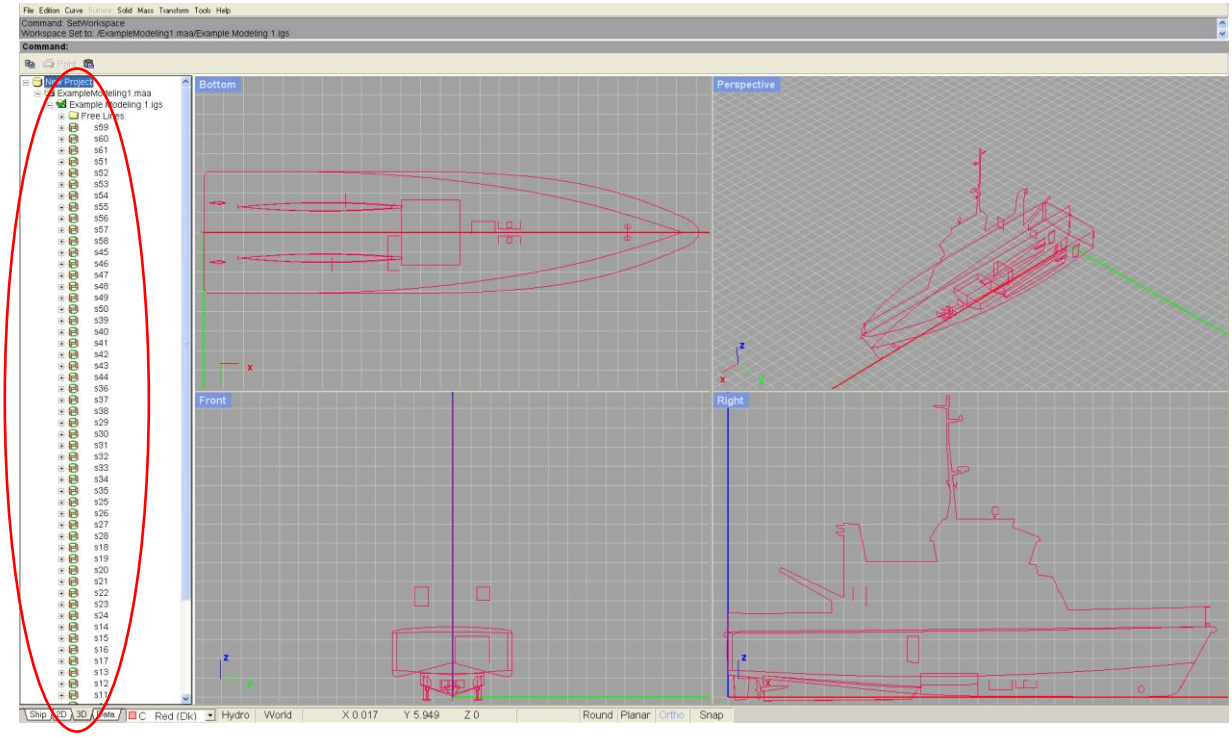
A MAAT 2000 file can also be directly imported by MAAT Hydro as follows:

- From the menu bar:

  - Select "/File/**Import**" in the menu bar.

  - A File Selection dialog box pops up, allowing to select the MAAT 2000 file and path («maa» extension must be selected).

  - As soon as the 3D model is loaded, expand the 3D browser to check the imported items; Ship's lines and surfaces are imported as well as most of the project settings (layers, etc…) and MAAT 2000 Loading Cases are converted into masses if present.



- From the 3D browser:

  - Select a destination folder in the 3D Browser, in which the MAAT 2000 data will be imported.

  - Select "**Import**" in 3D browser's right-click menu.

  - A File Selection dialog box pops up, allowing to select the MAAT 2000 file and path («maa» extension must be selected).

  - MAAT 2000 file's content is then imported in the selected destination without changing the [Ship] page settings.

4 Building a MAAT Hydro Model from Imported Data:

When no Manifold B-Rep Solid (IGES entity 186) has been directly imported from an IGES file, separate faces are then the only available data, having to be sorted and identified before being gathered in solids representing ship's buoyant components.

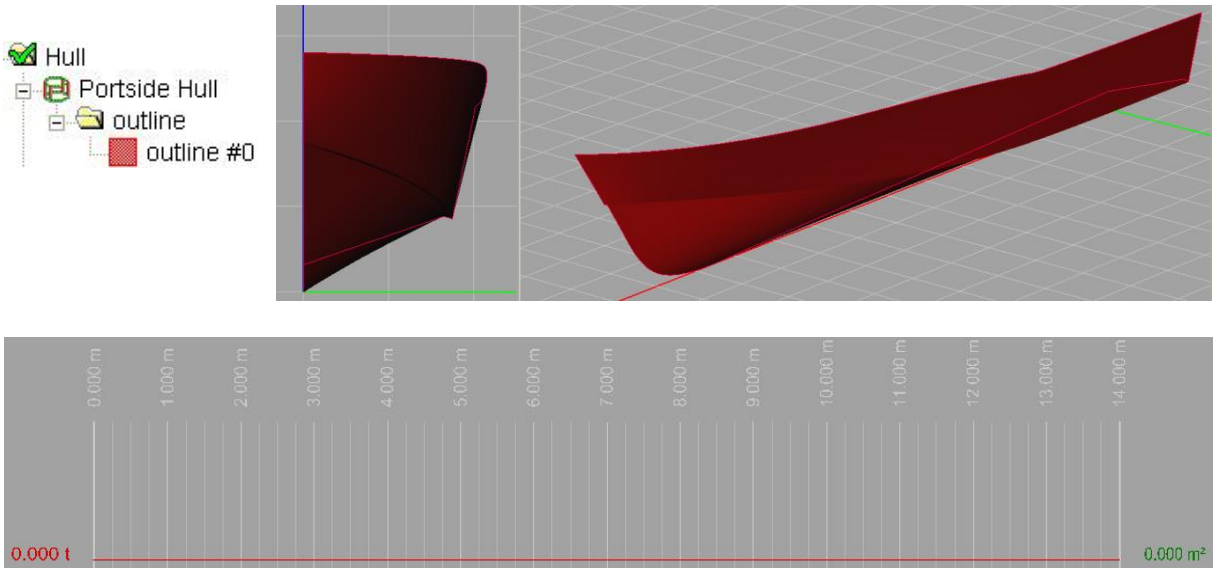
Such faces must be joined into watertight MAAT Hydro solids, as seen above, in order to become buoyant objects.

Remark: MAAT Hydro's "Layer" is a key concept allowing controlling solids and lines behaviour during the hydrostatic calculations. More information about MAAT Hydro layers is provided in Parts I and IV, which provides various examples of layer's advanced use.

4.1 Creating a Solid Directly from One Single Face:

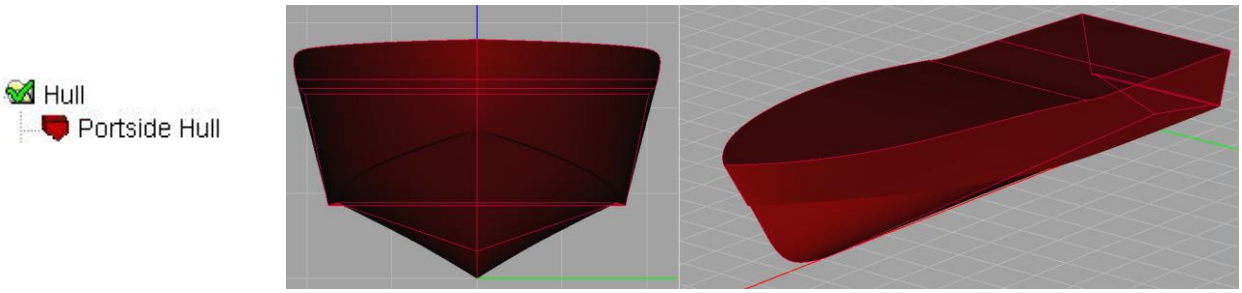
When ship's half-hull is simply represented by a single 3D surface, which is generally the case at early design stages, a few clicks allow transforming it into a buoyant solid, in order to start its hydrostatic analysis almost instantly:

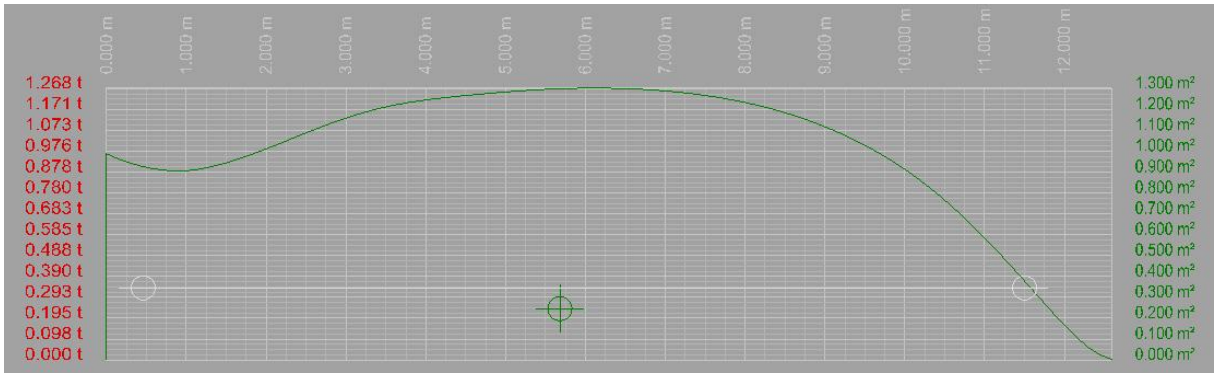
- Double click on the folder containing the face in order to activate it.
- Click on the [Hydro] lower left pane to open the hydrostatic viewport:



- Select "Solid/**Mirror Surface**" in the menu bar;
- Select the half hull surface to mirror in the 3D browser or in a 3D viewport ("Portside Hull" in this example);

- The selected half hull is then symmetrized and replaced by the corresponding solid descriptor (default flat transom and deck are automatically created). Ship solid's curve of areas is then displayed in the hydrostatic viewport:





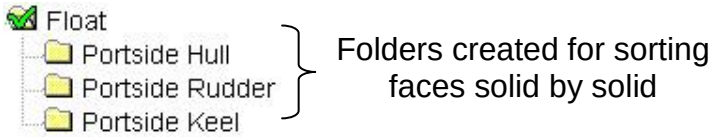
4.2 Creating Solids from Faces:

When more than one face is used for describing ship's hull or half-hull, the solid generation procedure is the following:

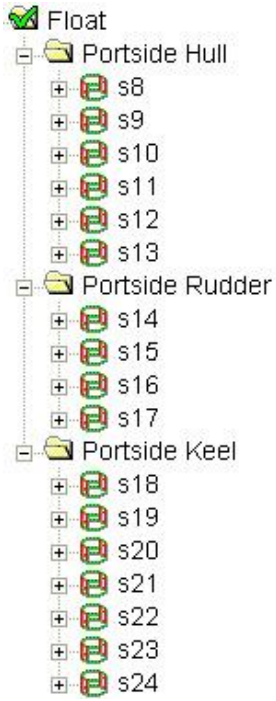
4.2.1 Sorting the Imported Data:

When the imported faces are numerous, it is often convenient to sort and identify them first before building ship's solids.

Creating preliminary folders in which the imported faces can be sorted solid by solid may then be helpful:



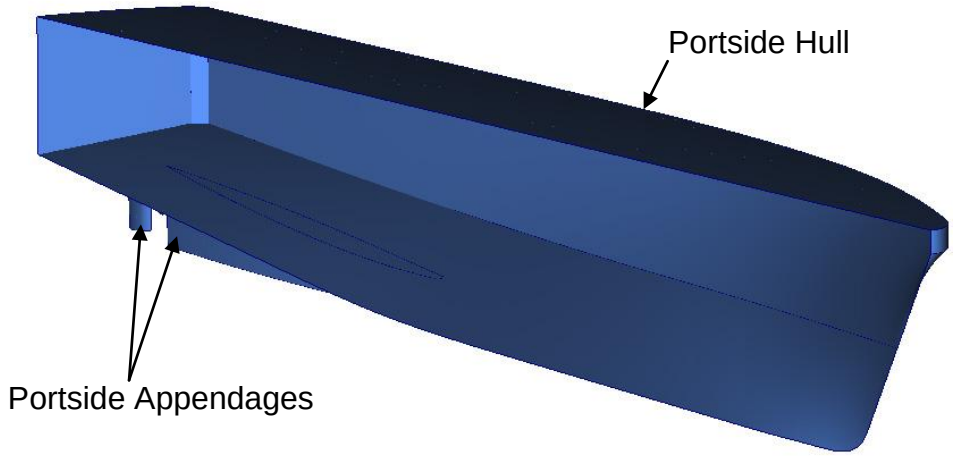
MAAT Hydro's 3D browser then allows identifying, renaming, dragging and dropping the imported faces in their appropriate destination folder:



A double click on any of these subfolders allows controlling its faces easily before creating the corresponding solid, therefore avoiding any face confusion.

4.2.2 Symmetrizing Imported Faces:

When ship's faces have not been symmetrized in your 3D modeller, this can be done easily in MAAT Hydro.



In our example, only the portside faces have been imported and must therefore be symmetrized to form a watertight solid as follows:

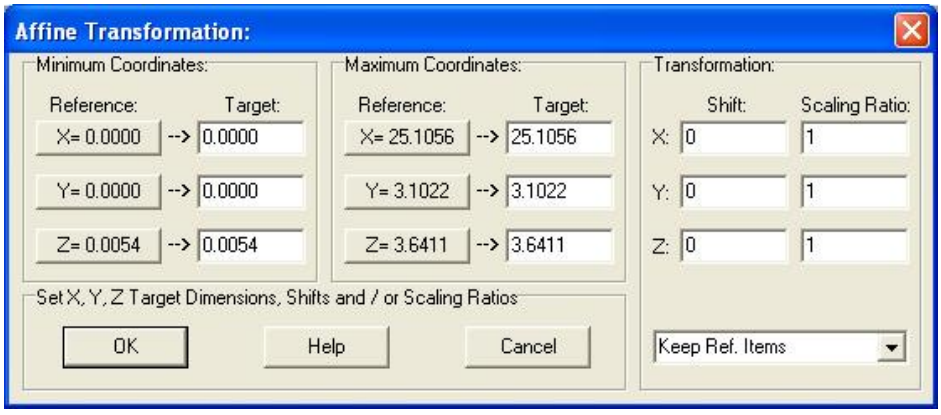
- <u>From the menu bar:</u>

  - Double click on the folder containing faces to symmetrize to activate it ("Portside Hull" in our example).

  - Select "Transform/Resize-Shift-Scale" in the menu bar;

  - A dialog box pops up, allowing to enter the transformation parameters in a "Min – Max" as well as in a "Shift – Scale" form.

    The "Reference" minimum and maximum X, Y, Z coordinate buttons allow resetting the target coordinates to their reference value. The "Target" minimum and maximum X, Y, Z coordinates are directly modifiable or automatically updated according to the specified x, y, z shifts and scaling ratios. By default, scaling ratios are fixed to 1 and shift factors to 0 (identity).



- Enter -1 in the “Y scaling ratio” field to define the Portside->Starboard transformation;

- Select “Keep Ref. Items” in the lower right selector in order to conserve the initial portside hull faces;

- Click on [OK] to Validate;

- Starboard hull faces are then created by symmetry and added to the initial portside faces.

- Rename the folder containing portside and starboard faces to avoid any confusion (“Hull” in our example).



The faces needed for creating a watertight hull solid are now present and can therefore be joined.

Remark: Portside appendage faces already bind a watertight object and can therefore be directly joined into a “Port side Keel” solid, which will then be symmetrized in order to create the “Starboard Keel” solid, as detailed below.

- From the 3D browser:

  - Select the items to transform in the 3D Browser.

  - Select **“Transform/Resize-Shift-Scale”** in 3D browser’s right-click menu.

  - Follow the same procedure than previously.

4.2.3 Joining Solid’s faces together:

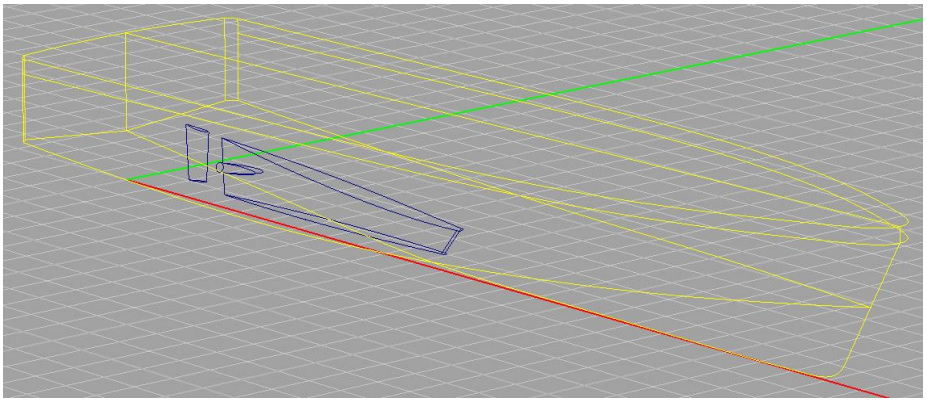
As soon as the faces form a closed / watertight solid, without any duplication, the following procedure allows joining them together in order to replace them by their equivalent solid:

- As the solid will be created in the active folder, you can first double click on it in order to activate it, if not done yet.

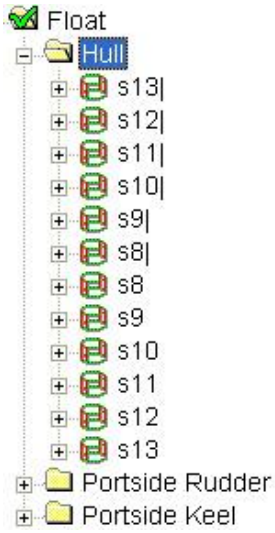


- Select "/Solid/**Join**" in the menu bar.

- Select solid's faces in the 3D viewports or with the 3D browser - [Ctrl] and/or [Shift] keys can be used - and check your selection on 3D viewports.

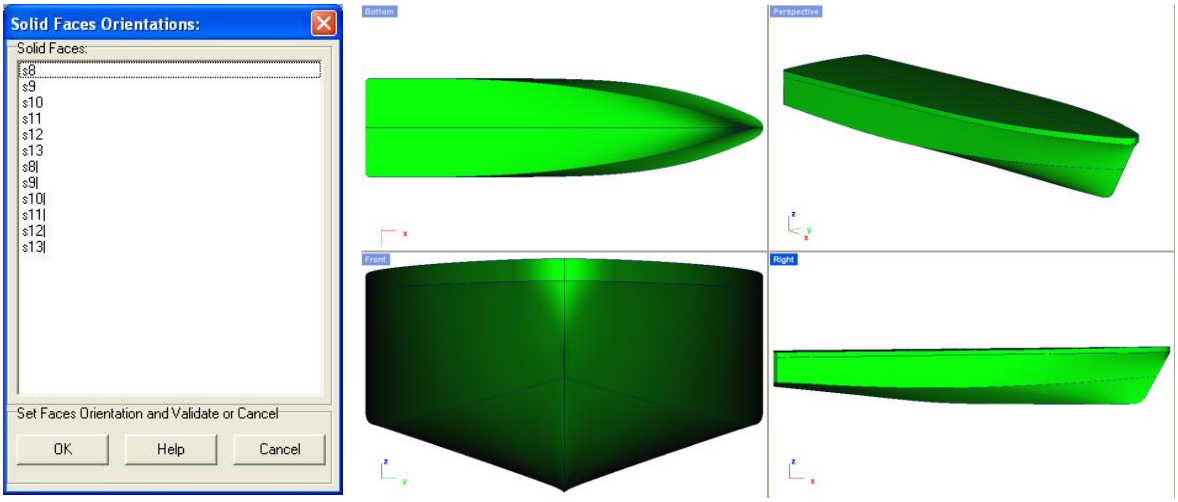


Alternatively, you can also directly click on faces parent folder to select all of them in a single click.



- Press [Enter] to build the solid when all the faces are selected and highlighted.

- The "**Solid Faces Orientations**" dialog box pops up while the 3D display turns to the "Red-Dry / Green-Wet" display mode;

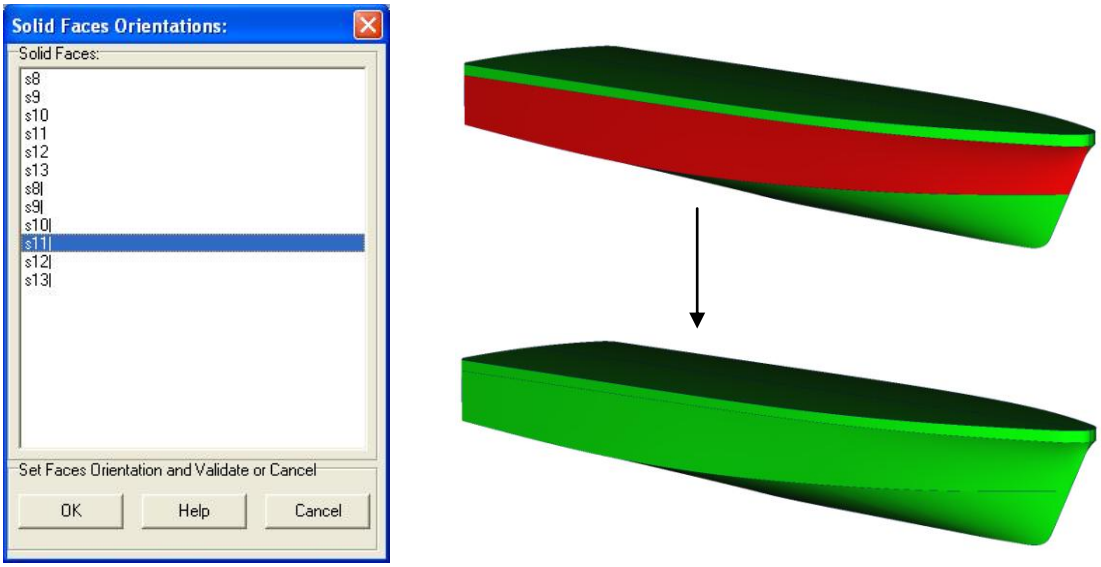


This quick but important stage allows controlling (and, if necessary, correcting) face's hydrostatic pressure orientation before creating the solid (see Part IV for more information on this topic):

Green represents the "Wet" face side
Red represents the "Dry" face side
and therfore:
Wet face sides must normally be the only visible ones from outside, no red side therefore having to appear on any view.

The "Solid Faces Orientation" dialog box allows checking and modifying faces orientation if necessary. See «Part IV: Advanced Solid and Buoyancy Management" for further details on face orientation's importance.

Selecting a face in the list highlights it in the 3D viewports and a double click allows reversing it:

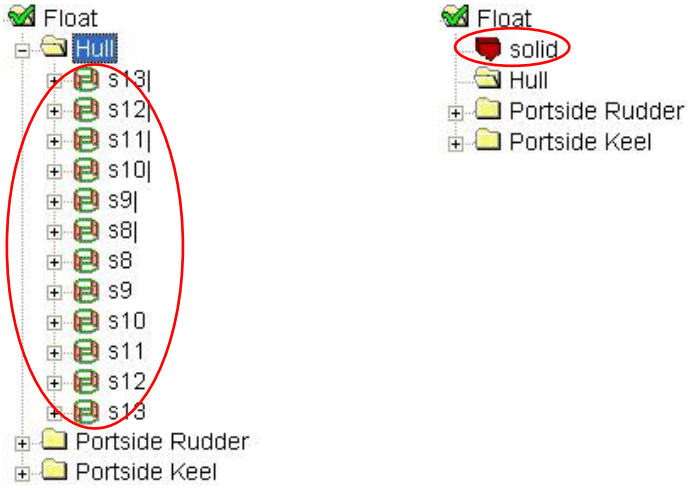


Validate faces orientation as soon as no red side can be seen on any viewport.

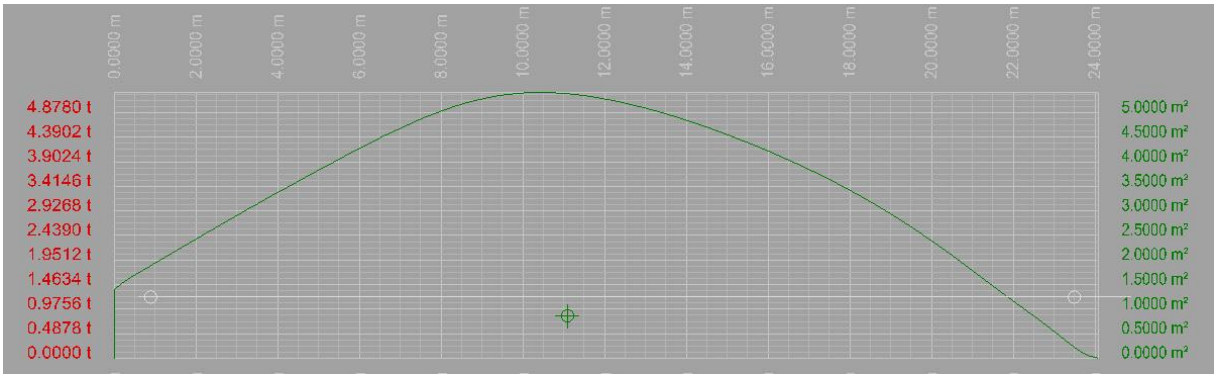
Remarks about the “Red-Dry / Green-Wet” mode:

- The “Solid Faces Orientations” dialog box can be recalled whenever necessary after validation, by selecting the solid in the 3D browser and then “**Set Solid Faces**” in the right-click menu.
- For any further control, you can toggle the “Red-Dry / Green-Wet” display mode at any time thanks to:
  - Viewport menu’s “Show / Hide Faces Orientation” option.
  - [Alt] [/] shortcut.

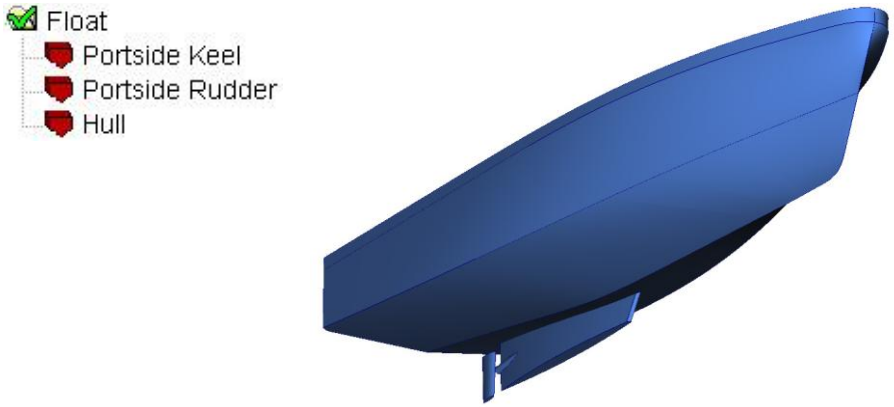
A solid is then created, replacing its parent faces. Its default name is “solid”.



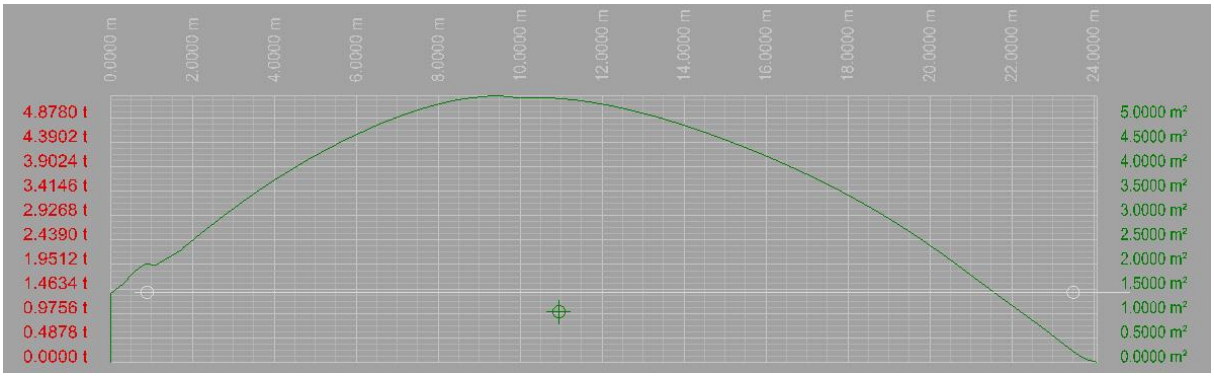
As soon as a the active folder contains an immersed solid, its hydrostatic features and curve of areas is displayed in real time in the Hydrostatic viewport (click on the lower left [Hydro] pane to open / close it):



Repeat this procedure for creating the portside appendages and rename them as soon as they are created:



Like previously, the incidence of each of these new solids on ship's hydrostatic features is displayed in the hydrostatic viewport as soon as they are created (click on the lower left [Hydro] pane to open / close it):

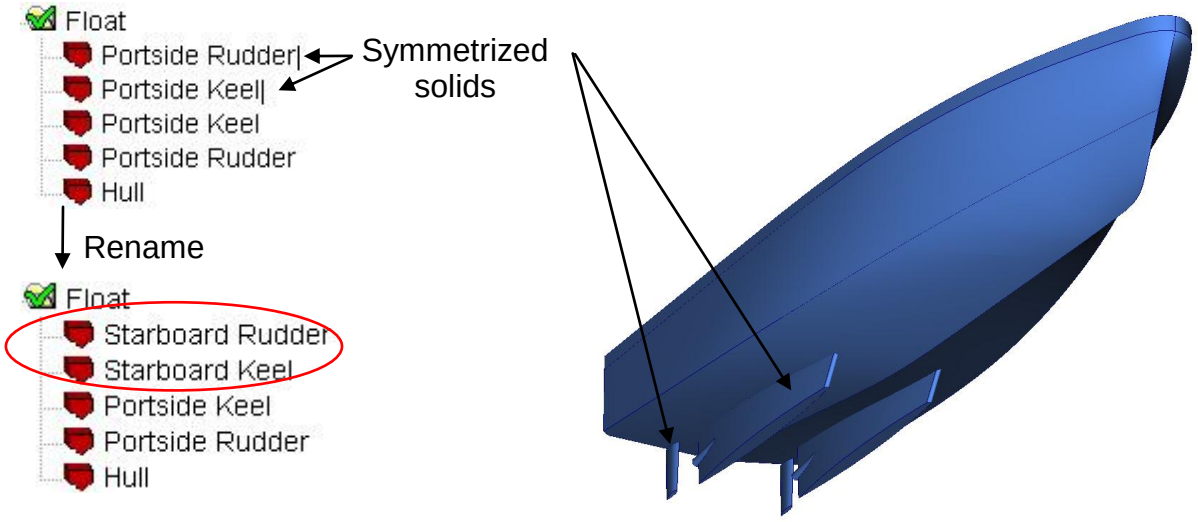


4.2.4 Symmetrizing Solids:

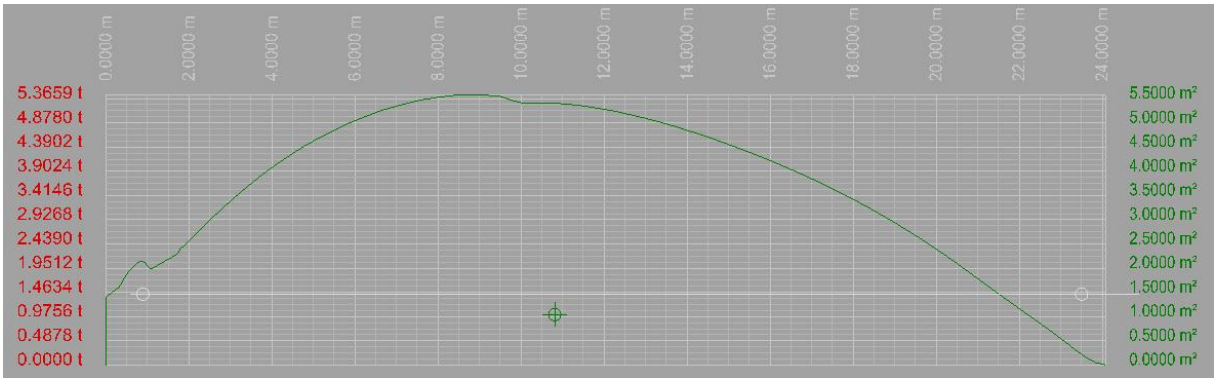
The portside appendage solids can then be directly symmetrized as follows, in order to create the starboard appendage solids:

- As the symmetrized solid will be created in the active folder, you can first double click on it;
- Select "/Transform/**Mirror**" in the menu bar;
- Select solid to mirror in the 3D browser or in any 3D viewport;
- The selected solid is then symmetrized, according to the longitudinal plane;

Starboard keels and rudders can then be created in this way by a few clicks:



Like previously, the incidence of each of these new solids on ship's hydrostatic features is displayed in the hydrostatic viewport as soon as they are created (click on the lower left [Hydro] pane to open / close it):

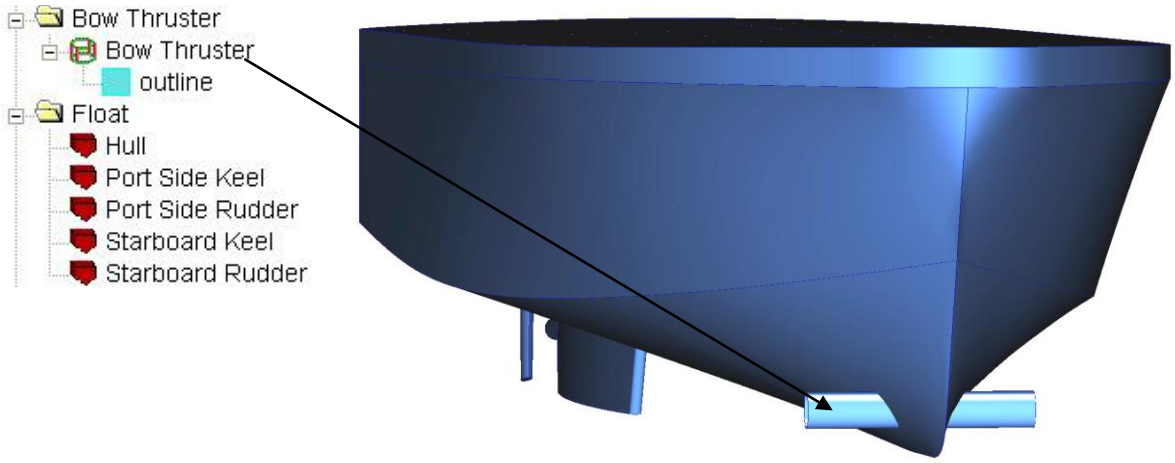


5 Creating Bow Thruster's Tunnel:

MAAT Hydro allows splitting solids by any orthogonal or oblique cutting plane.

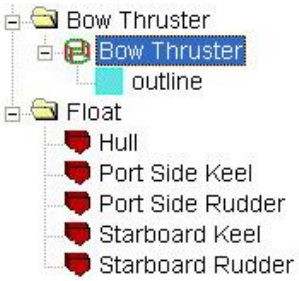
Moreover, MAAT Hydro also allows splitting / punching solids by any random face, provided that it exceeds the solid to split sufficiently.

In our case, bow thruster tunnel's parent cylinder has to be created first in the modeller and imported in the project in order to be available for cutting the hull solid. As told above, this cylinder must sufficiently exceed hull's knuckle plating in order to allow the cutting:

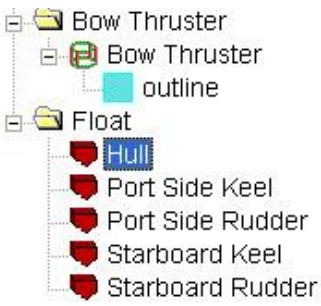


- Select "/**Solid/Split / Surface**" in the menu bar;

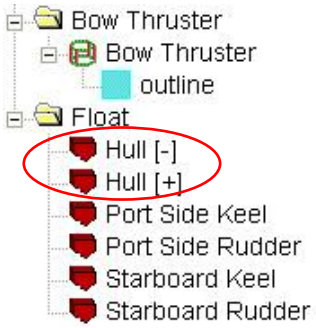
- Select the cutting surface;



- Select the solid to split;



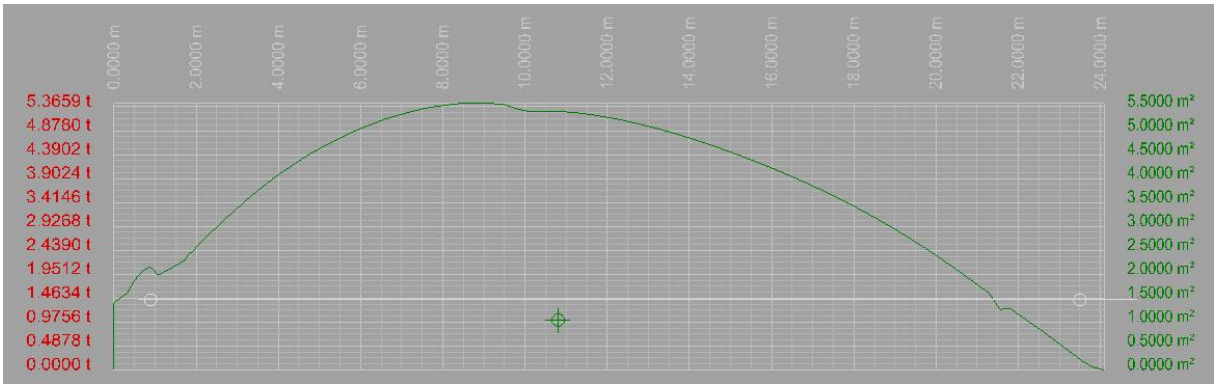
- The original solid is then intersected by the surface and split in 2 complementary parts: “Hull [+]” and “Hull [-]”, replacing the initial solid;



- Delete “Hull [-]” (tunnel’s inner solid) and the “Bow Thruster” cutting cylinder in the 3D browser, in order to remove it and punch the hull:



Like previously, the incidence of these operations on ship’s hydrostatic features can be followed in real time in the hydrostatic viewport (click on the lower left [Hydro] pane to open / close it):



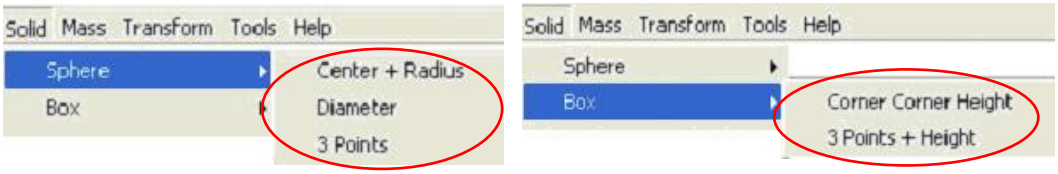
6 Modelling Additional Volumes:

As seen above, MAAT Hydro allows combining as many solids as necessary for describing ship's buoyancy accurately.

Moreover, certain small buoyant items generally don't require an accurate model, as their incidence on ship's hydrostatic mostly depend on their volume / location and not on their exact geometry.

These items are therefore usually simply represented by simple volumes like spheres and boxes, in order to save both modelling and response times.

Such spheres and boxes can therefore be directly created by MAAT Hydro according to different modes:



Such boxes can be used for creating simplified rudder or keel models, spheres for simplified propeller models, etc...

⚠ Before creating these additional volumes, their layer has to be selected as the current one in the lower left layer selector.

In our example, propellers will be modelized as spheres:

- If not done yet, activate spheres parent folder by a double click on it;
- Select "Wetted Surface" as the current layer in the lower left layer selector, in order to account sphere's immersed surface as wetted surface;
- Select "/Solid/Sphere/Center + Radius" in the menu bar;
- Sphere's center can be located dynamically by clicking in the 3D viewports, but you can also directly type sphere's center x, y, z coordinates separated by commas whenever necessary (press [Enter] to validate your inputs):

X (longitudinal), Y (transversal), Z (vertical)

Enter Sphere Center: 1.59,1.3,0.37

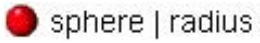
- Sphere's radius can be set dynamically by moving the cursor in the 3D viewports, but it can also be directly typed when its value is known:

Set Sphere Radius <0.2000>(Diameter, Volume): 0.2

Remark: Simply type ‘d’ (for Diameter) or ‘v’ (for Volume) before your input and it will automatically be considered as sphere’s diameter or volume. For example, type ‘d0.4’ to create an r=0.2 sphere or v1.5 to create a v=1.5 sphere (in current length / volume units).

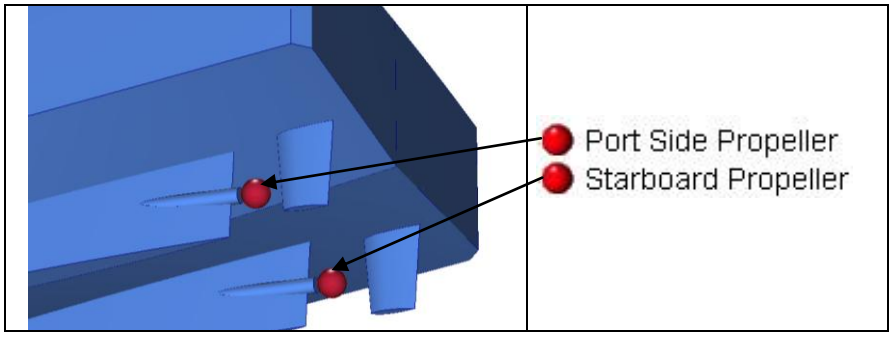
- Press [Enter] to validate;

- A sphere is then created, according to your inputs. Its default name is “sphere | radius”;

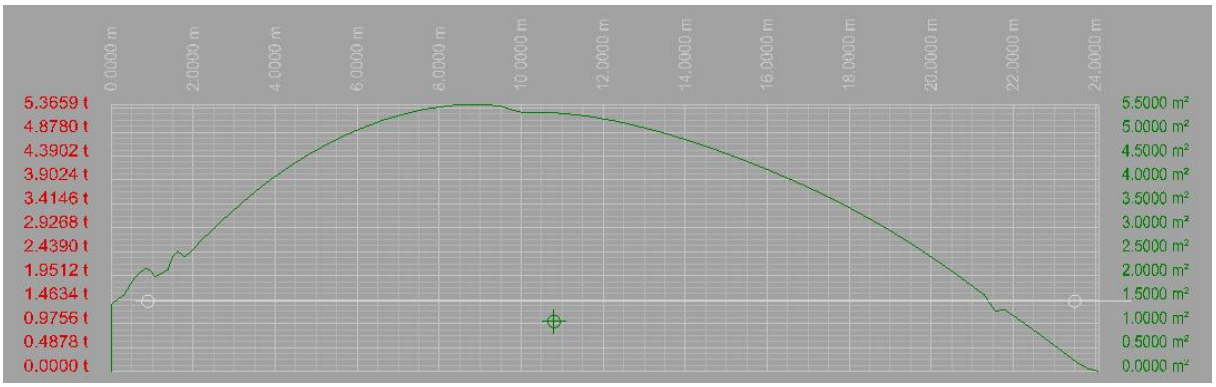


- Rename it;

- Repeat this procedure for the other propeller.



Like previously, ship’s hydrostatic features changes can be followed in real time in the hydrostatic viewport (click on the lower left [Hydro] pane to open / close it):



It is now time to introduce the two kinds of solids managed by MAAT Hydro, depending on their properties:

- **Compartments**, which are ship parts whose buoyancy depend on their permeability and flooding percentage.

- **Tanks**, which can be ship parts or compartment children, can contain a certain amount of liquid, depending on tank’s inner permeability and filling. Tank’s buoyancy depends on its parent compartment flooding status when present, but is always full in other cases (tank cannot be flooded while containing a fluid).

7 Tanks Modelling:

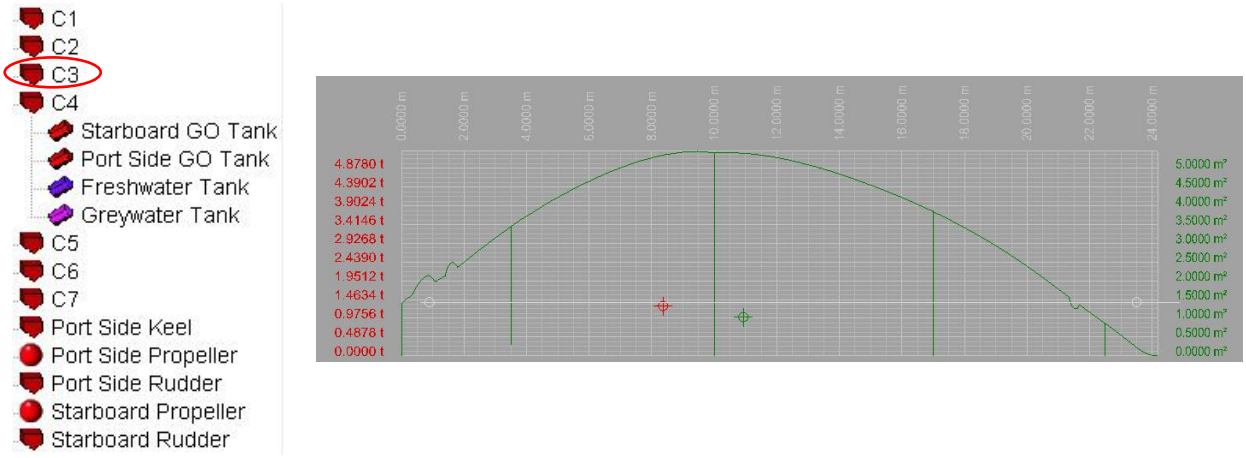
Usually, tanks have to be modelized in order to take their weight and free surface effect into account.

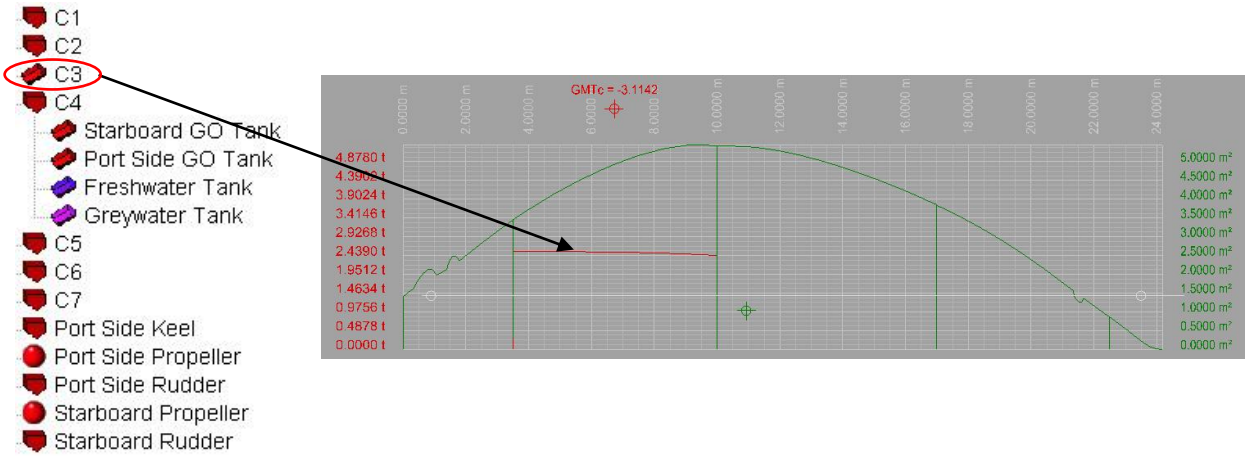
Tank models can be directly imported as solids (built by joining their imported faces like for creating compartments), or directly created in MAAT Hydro.

7.1 Case 1: Tanks Imported as Solids:

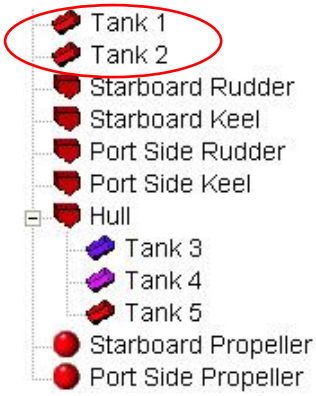
If tanks have been modelized in your 3D modeller and exported as solids, they just have to be transformed into tanks on the [Data] page and then dragged and dropped in their appropriate location, according to the expected behaviour:

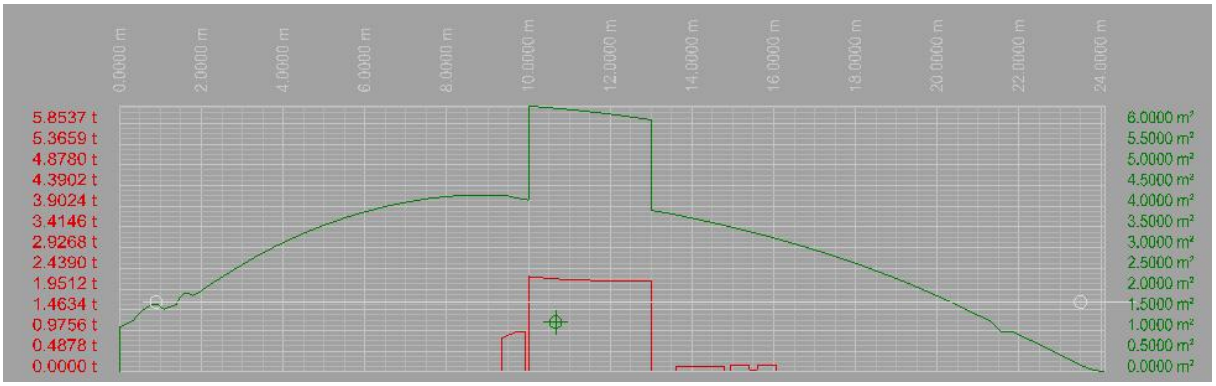
1°) When tanks have no parent compartment, they are considered as compartments in terms of buoyancy, except that their content's weight and free surface effect will be automatically updated and taken into account depending on current heel and trim. When tanks have no parent compartment, their buoyancy is accounted unconditionally, which allows modelling the incidence of liquid effect in compartments (compartment C3 is transformed below into a 50% filled tank):





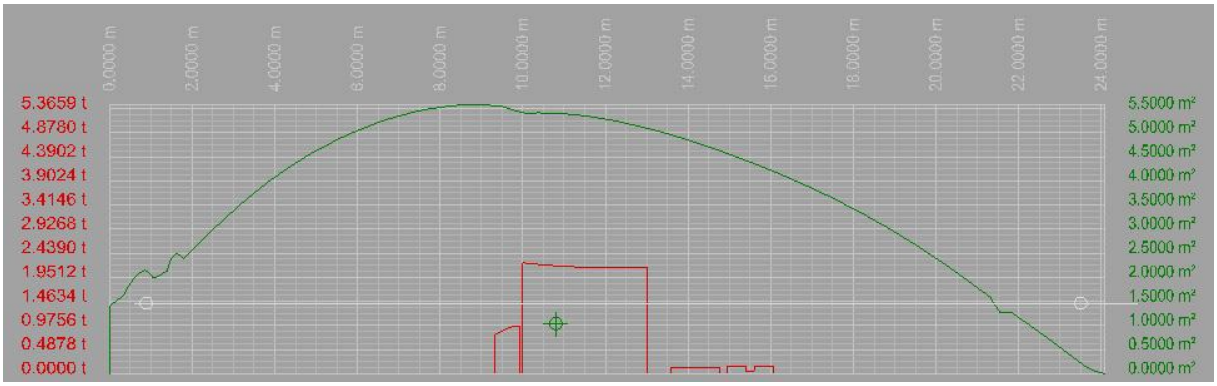
Nevertheless, when tanks are not representing compartments with a liquid effect / added mass, they have to be dragged and dropped in a parent compartment in order to avoid adding their buoyancy to compartment's buoyancy, as explained below (and more deeply discussed in Part IV):





2°) When tanks are children of a parent compartment, their buoyancy will depend on parent compartment's flooding state (i.e. will be weighed by parent's flooding state and permeability – See Part IV "MAAT Hydro's Advanced Solid and Buoyancy Management" for further details.





Additionally, tank's properties must also be set in the [Data] page:

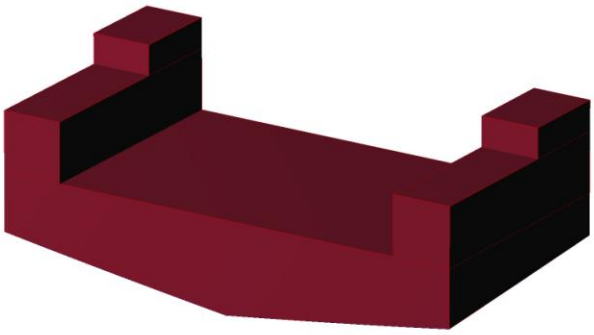
- The "Layer" field allows controlling tank's content (fresh water, grey water, oil, gasoil, etc…);

- The "Property" field allows setting tanks apart from compartments (notice the icon changes) and specifying their permeability;

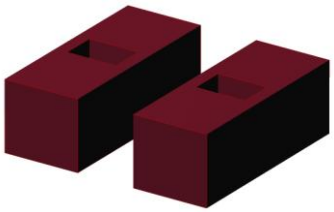
- The "Quantity" field allows setting tank's filling from 0% to 100%.

Name	Layer	Property	Quantity
|__ Float			
|__ Starboard Rudder	C_Red (Dk)	Compartment (µ=95%)	Intact (0%)
|__ Starboard Keel	C_Red (Dk)	Compartment (µ=95%)	Intact (0%)
|__ Port Side Rudder	C_Red (Dk)	Compartment (µ=95%)	Intact (0%)
|__ Port Side Keel	C_Red (Dk)	Compartment (µ=95%)	Intact (0%)
|__ Hull	C_Red (Dk)	Compartment (µ=95%)	Intact (0%)
| |__ Tank 3	Freshwater	Tank (µin=95%)	50 % Filled
| |__ Tank 4	Greywater	Tank (µin=95%)	50 % Filled
| |__ Tank 5	Gasoil	Tank (µin=95%)	50 % Filled
| |__ Tank 2	Gasoil	Tank (µin=95%)	50 % Filled
| |__ Tank 1	Gasoil	Tank 95	50 % Filled
|		Compartment	
|__ Starboard Propeller	C_Red (Dk)	Tank 95%)	Intact (0%)
|__ Port Side Propeller	C_Red (Dk)	Compartment (µ=95%)	Intact (0%)

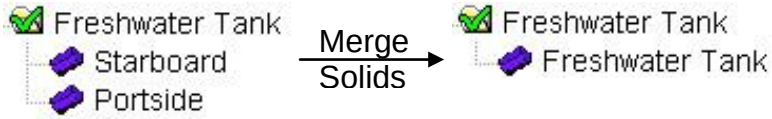
Menu bar's "/Solid/Merge Solids" function allows creating complex composite tanks by concatenating a selection of tanks into a single one.



In our example, ship's freshwater tanks being connected together, therefore have to be merged:



- Select "Solid/**Merge Solids**" in the menu bar.
- Select tanks to merge using [Ctrl]/[Alt] keys in the 3D viewports or in the 3D browser.
- Press [Enter] to validate current selection.
- The selected tanks are then merged:



Conversely, composite tank's original solids can be recovered thanks to menu bar's "/Solid/**Unmerge Solid**" function.

7.2 Case 2: Tanks Imported as Surfaces:

When tanks are imported as surfaces from your 3D modeller, you have to join them in order to build the tank solids first, like for creating compartments, according to the procedure described in 4.2.4.

Such imported tanks may have to be affiliated to their parent compartments, depending on their expected behaviour; their properties may also have to be set in the [Data] page, like for compartments.

7.3 Case 3: Tanks directly Created in MAAT Hydro:

7.3.1 Orthogonal Cutting Planes:

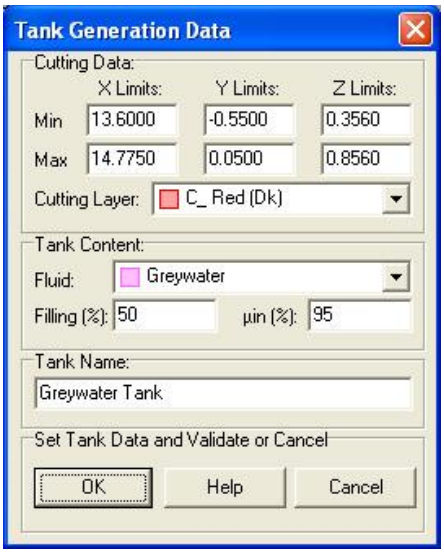
If no tank has been imported from your 3D modeller, you can, of course, also create them directly in MAAT Hydro:

- Select "/**Solid/Cut out Tank**" in the menu bar;

- Select tank's parent compartment (See "Advanced Buoyancy Management" for further details on tank's affilation);



- The short "Tank Generation Data" dialog box then pops up, allowing to input the orthogonal cutting planes coordinates necessary for creating the child tank by intersection with its selected parent compartment;



The "Cutting Layer" selector allows controlling tank's intersected faces layer.

The "Fluid Layer" selector allows controlling tank's content by its layer.

The "Filling" input field allows controlling tank's filling.

The "µin" input field allows controlling tank's inner permeability.

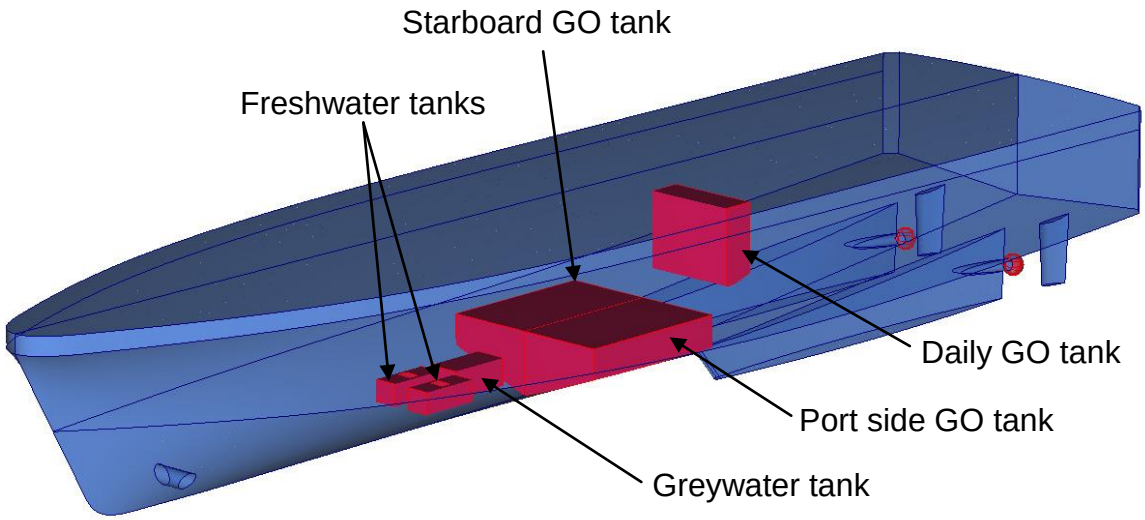
The "Tank Name" input field allows naming the tank.

- Validate tank's data when entered;

- The tank is created as child of the selected parent compartment:



Repeat this procedure for creating the other tanks and rename them as soon as they are created:



7.3.2 Oblique Cutting Planes:

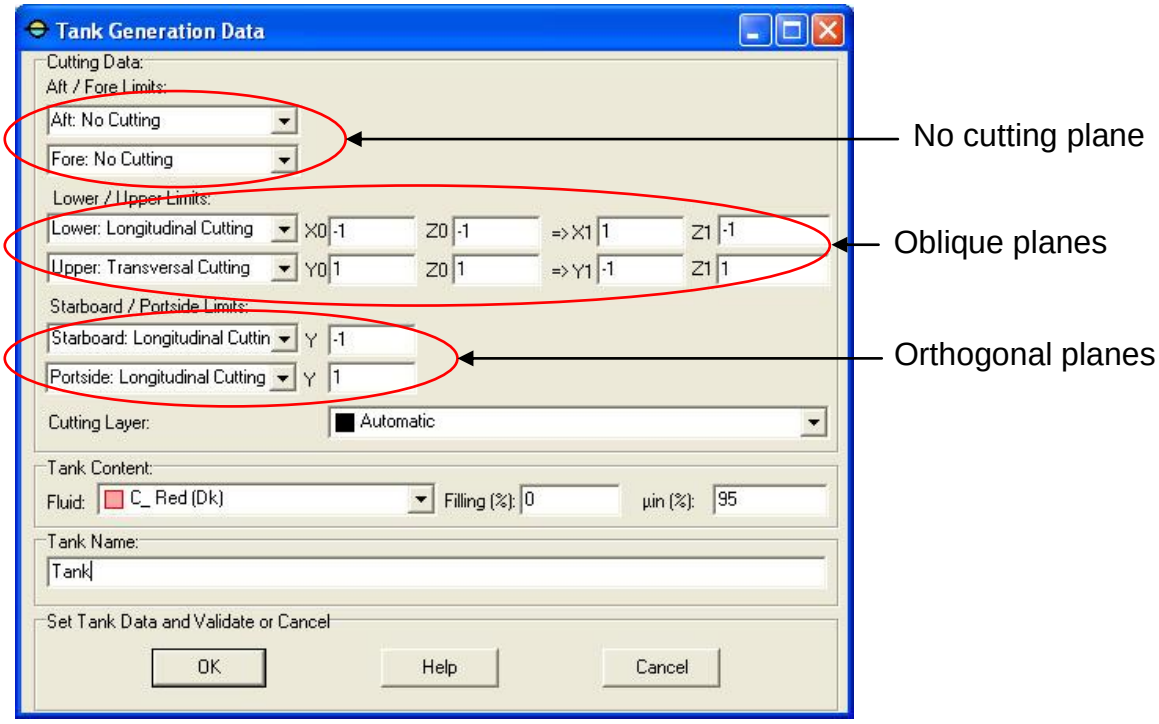
Tanks with oblique faces can be created similarly:

- Select "/**Solid/Cut out Oblique Tank**" in the menu bar;

- Select tank's parent compartment (See Part IV: "Advanced Solid and Buoyancy Management" for further details on tank's affilation);



- The full "Tank Generation Data" dialog box then pops up, allowing to input the oblique cutting planes coordinates necessary for creating the child tank by intersection with its selected parent compartment:



Three plane pairs allow cutting the tank out of its parent solid:

- Aft / Fore plane;
- Lower / Upper plane;
- Starboard / Portside plane.

Each of these planes can be:

- Ignored when the first option is selected (“No Cutting”);

- Orthogonal when the second option is selected (Transversal / Longitudinal/Horizontal Cuttings);

- Oblique when any of the other options is selected (Transversal / Longitudinal/Horizontal Cuttings).

A single coordinate is sufficient for locating the orthogonal planes, but 2 pairs of coordinates are needed for defining the oblique ones.

Like previously, menu bar’s “/Solid/Merge Solids” function allows creating complex composite tanks by concatenating a selection of tanks into a single one. Conversely, composite tank’s original solids can be recovered thanks to menu bar’s “/Solid/Unmerge Solid” function.

8 Compartments Modelling:

Damage stability calculations depending on ship's subdivision into compartments, a distinct damaged model must be created apart of the intact one. It is therefore a good habit to locate them in distinct folders, as the intact model is usually different and much simpler than the damaged one.

You have then usually to duplicate ship's intact components first, in a new workspace in which the different compartments needed by damage stability calculations will be created, the intact model remaining in its initial folder.



- MAAT Hydro allows dividing the float by the classical orthogonal planes:

  - Select "**/Solid/Split / Ortho Plane**" in the menu bar.

  - Select plane's type if necessary by typing the corresponding letter ('t' for Transversal, 'l' for Longitudinal, 'h' for Horizontal or "d" for a watertight horizontal deck) and enter plane's coordinate.

    For example, entering "t3.5" for a transversal plane located at 3.5 or l1.5 for a longitudinal plane located at 1.5.

    Notice that solid's intersected faces are created in the following layers:

    "t": Transversal intersection in the Transversal Bulkhead layer.

    "l": Longitudinal intersection in the Longitudinal Bulkhead layer.

    "d": Horizontal intersection in the Horizontal Bulkhead layer.

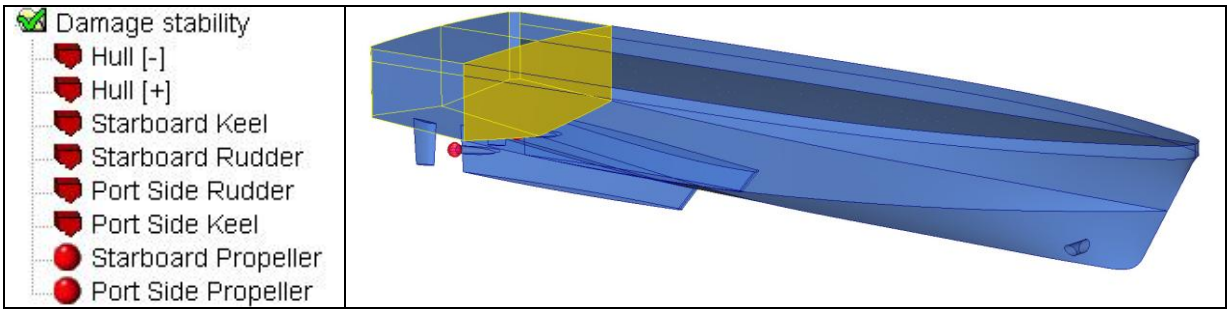
    "h": Horizontal intersection in the Current layer.

    The last plane type is used by default when no letter precedes plane's coordinate.

  - Press [Enter] to validate.

  - Select solid to split ("Hull" in our example).

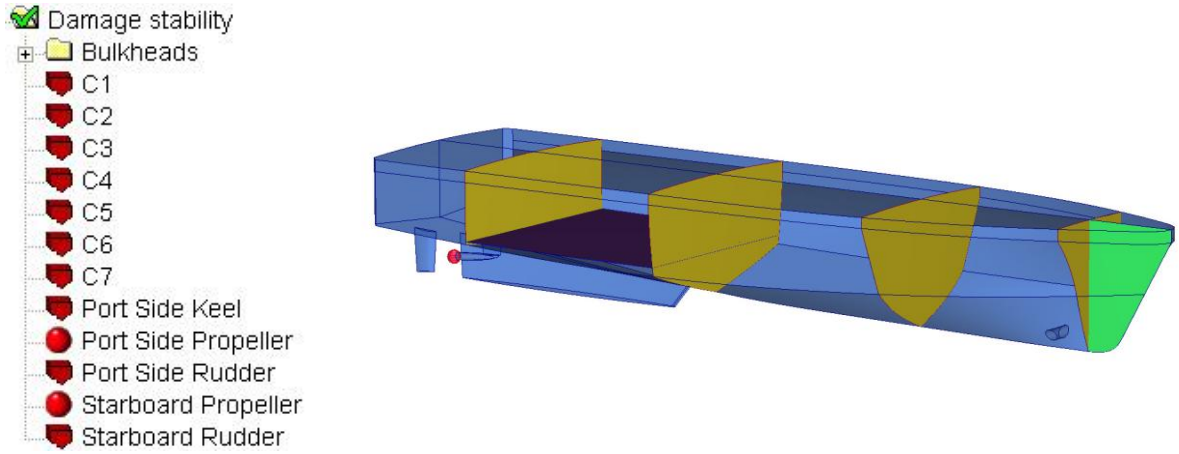
- The selected solid is then split in 2 compartments (“Hull [+]” and “Hull [-]” in our example).



- You can rename the first created compartment (and the other ones as soon as they will be created).

- Repeat this procedure for creating other compartments if necessary and rename them like previously.

- As this function operates in looped mode in order to allow chained solid splittings, don’t forget to press the [Esc] key to exit this solid splitting mode.



- MAAT Hydro also allows splitting the float by any oblique plane:

  - Select “**/Solid/Split / Oblique Plane**” in the menu bar.

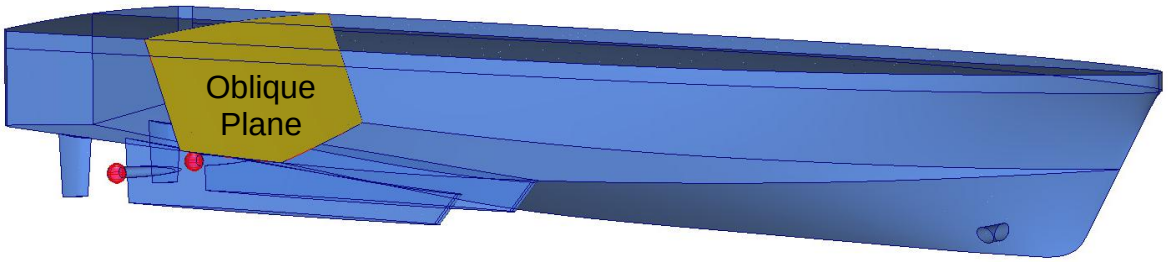
  - Type first cutting plane point’s x y, z coordinates and press [Enter] to validate, or enter them dynamically in 3D viewports.

  - Type second cutting plane point’s x y, z coordinates and press [Enter] to validate, or enter them dynamically in 3D viewports.

  - Type third cutting plane point’s x y, z coordinates and press [Enter] to validate, or enter them dynamically in 3D viewports, or directly type the extrusion axis (‘t’ for Transversal, ‘l’ for Longitudinal, ‘v’ for Vertical) and press [Enter] to validate.

- Select solid to split (“Hull” in our example).

- The selected solid is then split in 2 distinct compartments by the defined oblique plane.



Like for tanks, menu bar’s “/Solid/Merge Solids” function allows creating complex composite compartments by concatenating a selection of compartments into a single one. Conversely, composite compartment’s original solids can be recovered thanks to menu bar’s “/Solid/Unmerge Solid” function.

- When ship compartments are created, tanks can be directly copied and pasted in their appropriate parents from the intact ship model created previously, instead of re-creating them in ship’s subdivided model.

9 Mass Modelling:

Ship's balance being obtained by equalling weight and buoyancy, MAAT Hydro's accurate buoyancy modelling calls for an accurate mass modelling. Mass objects can therefore be easily created and modified in MAAT Hydro for reaching this goal.

9.1 Creating a Mass:

A new mass can be created by selecting "**New Mass**" in 3D browser or [Data] page's right-click menu.

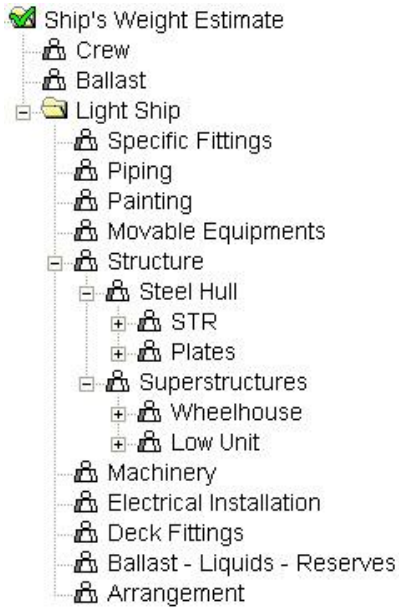
When the [Data] page is displayed, the new mass is added to the displayed list and its name, layer, weight, coordinates and longitudinal extent can be specified directly in the corresponding input fields.

The "Quantity" setting also allows weighing the incidence of any mass on the total weight.

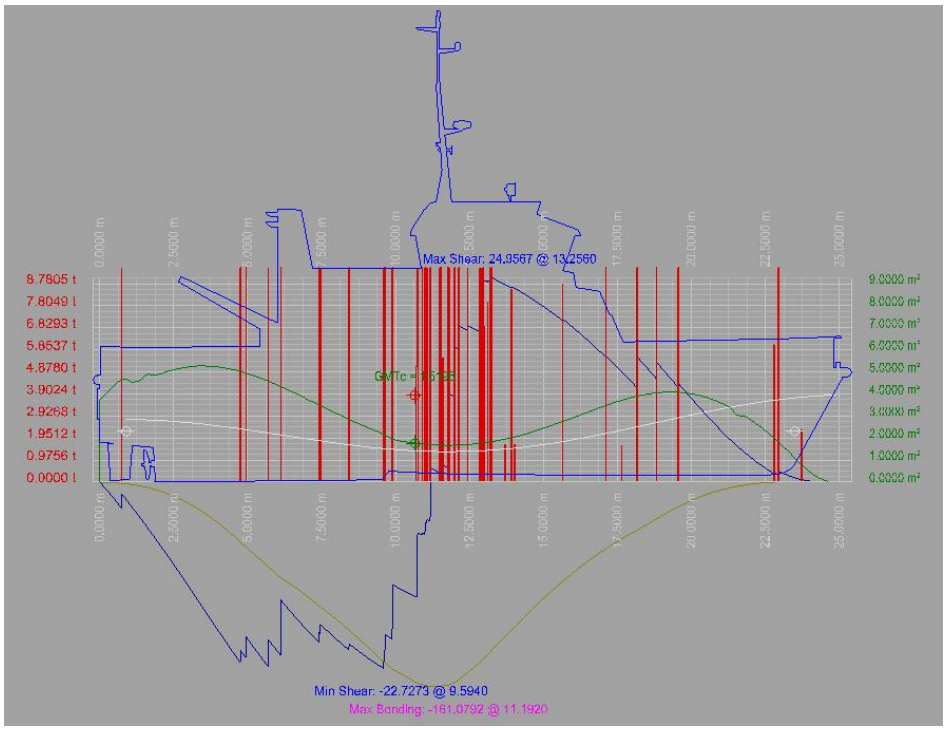
9.2 Organizing Masses:

Usually, ship's weight estimate contains all the items to be taken into account for C.G. calculation, except fluids which, as tank's content, need a separate process, depending on current heel and trim. MAAT Hydro's "Mass" objects can be used to represent all these items, the resulting C.G. being calculated in real time.

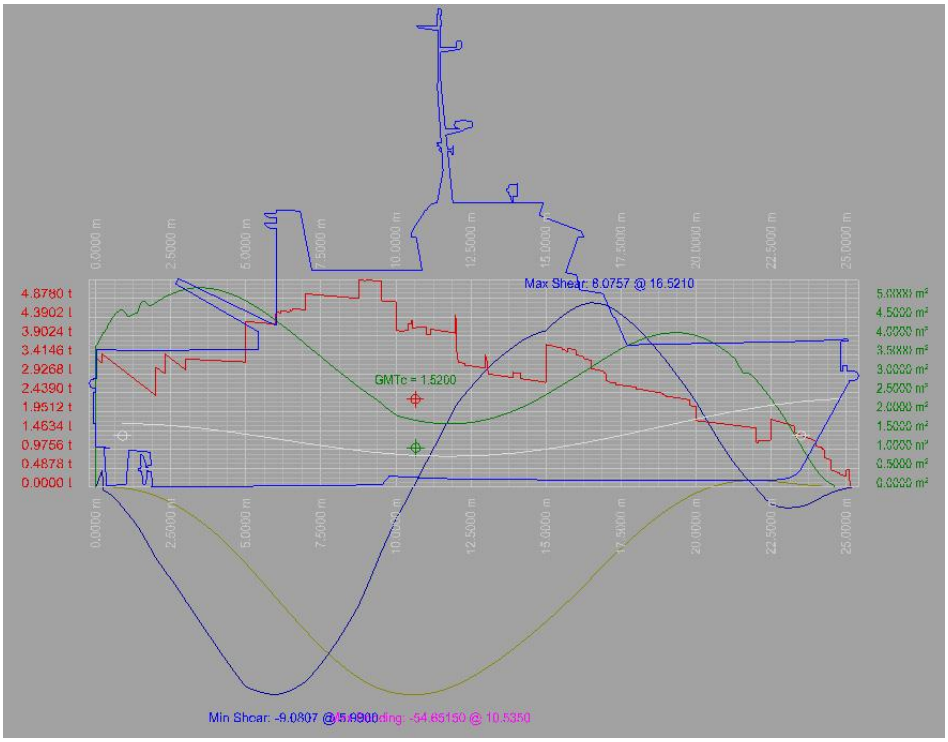
In order to allow a more synthetic work, the MAAT Hydro masses can include submasses. If necessary, this recursive mass management therefore allows encapsulating the complete mass distribution in one single recursive mass object:



By default, masses have no longitudinal extent, as this information is only needed for longitudinal strength calculations. As a consequence, such masses appear like “local” loads (i.e. with a locally infinite load density) on hydrostatic viewport’s weight curve (red), being unusable for shear forces and bending moments calculations.



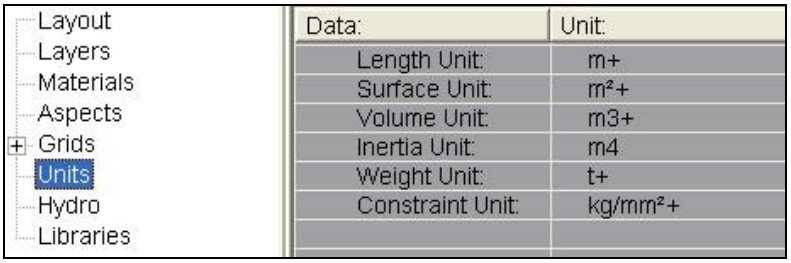
Mass extensions ([Ship] tab’s “Xmin” / “Xmax” fields) must therefore be defined whenever longitudinal strength calculations are needed, but can be neglected in all other cases, except when a realistic weight curve is expected.



10 Project Data:

Before any hydrostatic calculations, it is a good habit to check the hydrostatic calculation parameters (units, calculation accuracy, calculation layers, etc…).

These project data can be checked and modified in [Ship] tab's [Hydro] and [Unit] pages:



Data:	Unit:
Length Unit:	m+
Surface Unit:	m²+
Volume Unit:	m3+
Inertia Unit:	m4
Weight Unit:	t+
Constraint Unit:	kg/mm²+



Hydrostatic Parameter:	Value:
AP Position (X):	0.0000
FP Position (X):	10.0000
Dwl Height (Z):	1.0000
Keel Point Height (Z):	0.0000
Water Density:	1.025
Aft Mark Position (X):	0.0000
Aft Mark Height: (Z)	1.0000
Fwd Mark Position (X):	10.0000
Fwd Mark Height (Z):	1.0000
Marks Radius:	0.1500
Min Subdivision Length:	0.0000
Max Subdivision Length:	0.0000
Additional Plate Thickness:	0.0000
Computation Accuracy:	Const. (Medium Res.)
Downflooding Range:	0.1000
Max Hull Dimensions:	/ All Immersed Hull
Wetted Surface Layer:	Wetted Surface
Silhouette Layer:	Silhouette
Sail Layer:	Sail
Freeboard Layer:	Freeboard
Downfloodable Opening Layer 1:	Downfloodable Opening 1
Downfloodable Opening Layer 2:	Downfloodable Opening 2
Downfloodable Opening Layer 3:	Downfloodable Opening 3
Overflow Layer:	Overflow
Tank Gauge Layer:	Tank Gauge
Waterplane Trace Layer:	Waterplane
Transverse Bulkhead Layer:	Bulkhead (Trnsv.)
Lonitudinal Bulkhead Layer:	Bulkhead (Longt.)
Horiz. Bulkhead / Deck Layer:	Bulkhead (Horiz.)
Marking Line Layer:	Marking
Unwettable Line Layer:	Unwettable
Fatal Compartment Layer:	Fatal
Intermediary Flooding Layer:	Intermediary Flood.
Interm. Flood. Stages Number:	2

11 Hydrostatic Calculations:

As soon as ship's hydrostatic model is done and checked, hydrostatic calculations can be obtained immediately.

Most of the available stability calculation functions are proposed in menu bar's "/Tools" submenu, and presented in Part III: "MAAT Hydro's Quick Hydrostatic / Stability Calculation Guide".

All the available functions are, moreover, described in "MAAT Hydro's Reference Manual".

12 Warnings:

12.1 Wetted Surface Calculation:

Only solid's «Wetted» faces are taken into account in the wetted surface calculation, which allows excluding any «non wetted» face (like transom or compartment's bulkheads) from this calculation.

If not done yet, it is therefore important to set solid's faces outline in the wetted surface layer before joining them into solids, in order to allow a correct wetted surface calculation (and, consequently, a correct plate thickness correction).

For quick solid face's layer settings, it is recalled that you can select the wetted surface layer as target layer in the lower left selector, select the solids to convert in the 3D browser, and then select "/Force to Current Layer/Solid Faces" in the right click menu in order to convert selected solid's faces in the wetted surface layer.

12.2 Mean Draft Calculation:

In MAAT Hydro, the Mean Draft corresponds to keel point / floatation vertical distance and is generally different of the average draft (i.e. (aft draft + forward draft)/2).

As Keel point / K point locates the origin of the vertical offsets, it must therefore be controlled among the hydrostatic data to make sure that the output heights will refer to the appropriate origin.

12.3 Max Draft and Bwl Calculation:

The Max Draft / Bwl calculation operates on lines. It is therefore important that the 3D model includes at least 1 line (midship station for example) to allow an accurate calculation of these data and the depending parameters.