



WHEN TRUST MATTERS

Nauticus Hull

Highlights deployed in 2023 and 2024

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18 December 2024

DNV's calculation tools deployed in 2023 and 2024

Nauticus Hull and GeniE deployed in 2023 and 2024

Nauticus Hull release document: Summary of enhancements and corrections

DNV's calculation tools deployed in 2023

Nauticus Hull and GeniE

- Nauticus Hull V20.24 January 2023, with DNV July 2022 Rule updates (entering into force January 2023)
- Nauticus Hull V20.29 September 2023, with CSR BC &OT January 2023 Rule updates (entering into force July 2023)
- GeniE V8.5 January 2023
- GeniE V8.6 May 2023
- GeniE V8.7 June 2023
- GeniE V8.8 December 2023

Nauticus Hull V20.24 with DNV July 2022 Rule updates

Applicable rules

- ☒ DNV rules
- ☐ DNV offshore rules
- ☐ DNV HSLC rules
- ☐ DNV RU-NAV rules (only usable in Analyses->Rules)
- ☐ DNV RU-YACHT rules (only usable in Analyses->Rules)
- ☐ IACS CSR for bulk carriers and oil tankers

Rule version:

July 2022 ▼

Nauticus Hull V20.29 with CSR January 2023 Rule updates

Applicable rules

- ☐ DNV rules
- ☐ DNV offshore rules
- ☐ DNV HSLC rules
- ☐ DNV RU-NAV rules (only usable in Analyses->Rules)
- ☐ DNV RU-YACHT rules (only usable in Analyses->Rules)
- ☒ IACS CSR for bulk carriers and oil tankers

Rule version:

January 2023 ▼

DNV's calculation tools deployed in 2024

Nauticus Hull and GeniE

- Nauticus Hull V20.30 January 2024, with DNV July 2023 Rule updates (entering into force January 2024)
- Nauticus Hull V20.31 July 2024, with CSR BC & OT January 2024 Rule updates (entering into force July 2024)
- GeniE V8.9 Feb 2024
- GeniE V8.10 June 2024
- GeniE V8.11 Nov 2024

Nauticus Hull V20.30 with DNV July 2023 Rule updates

Applicable rules

- ☒ DNV rules
- ☐ DNV offshore rules
- ☐ DNV HSLC rules
- ☐ DNV RU-NAV rules (only usable in Analyses->Rules)
- ☐ DNV RU-YACHT rules (only usable in Analyses->Rules)
- ☐ IACS CSR for bulk carriers and oil tankers

Rule version:

July 2023 ▼

Nauticus Hull V20.31 with CSR January 2024 Rule updates

Applicable rules

- ☐ DNV rules
- ☐ DNV offshore rules
- ☐ DNV HSLC rules
- ☐ DNV RU-NAV rules (only usable in Analyses->Rules)
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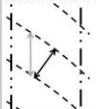
Rule version:

January 2024 ▼

Nauticus Hull's release document

Summary of enhancements and corrections, with reference to support case

Nauticus Hull V20.24 (January 2023) – Summary of enhancements and corrections

3.1 Enhancements and other modifications			
Area	Case #	Description	ID
Rules/DNV	375676, 424704	Ice - boundary condition factor, m1, for longitudinals can now be overridden when auto-detection based on applied end connections/spans does not give desired m1 factor.	317434
Section Scantlings		Determination of spacing between longons when a hull form is present was based on an intersection in Y2-plane giving conservative stiffener spacing and EPP breadth in curved area of hull, typically fore ship. Corrected. Spacing calculation now consider true distance between stiffeners.	307496
Section Scantlings			
Section Scantlings		Floors - switching between floor and transverse stiffener now possible from stiffener property grid without need for redefinition. Material and profile type shall be specified when switching to transverse stiffener.	93202
Transverse Bulkhead		Transverse bulkhead - control of the viewing of stiffener spans now moved outside the context of a selected stiffener and instead accessed through the context menu of the 2D view.	386993
Compartments and Loads	398120, 331133	CSR Tank - compartment loads, ballast condition - create standard now includes Fuel oil tanks, Lube oil tanks and Fresh water tanks.	349067
Compartments and Loads	385906	Compartments and loads - UDL - added vertical tolerance for the deck height to prevent application of UDL on adjacent decks.	333046
FE		FE Fatigue tool - Additional intermediate stress for Crack propagation and Fracture mechanics	360886
FE		Liquefied gas carriers with independent cylindrical tanks of type C - FE Fatigue loading conditions introduced in the FE manager	381670
3D Model		3D model - screen clipping dialog - default unit changed from [m] to [mm] to be consistent with other dialogs.	179246
Analysis Tools		DNV OSV - transverse bulkhead analysis - check of minimum thickness for superstructure front bulkhead and deckhouse front bulkhead implemented.	382555
Analysis Tools		In Section Scantlings Results grid, the user can open the EPP design iteration tool, where the user can iterate on lengths/yield strength, and get the required thickness (DNV Rules only).	340593
Analysis Tools		In Transverse Bulkheads Results grid, the user can open the EPP design iteration tool, where the user can iterate on lengths/yield strength, and get the required thickness (DNV Rules only).	382044
Analysis Tools		Minimum thickness list introduced for DNV and CSR rules. Access from Analysis - Rule calculation tools / New and select Minimum thickness list spreadsheet.	160546
Analysis Tools		In Section Scantlings Results grid, the user can open the Stiffener design iteration tool, where the user can iterate on scantlings/yield strength/spacing, and check local requirements (DNV Rules only).	382041
Analysis Tools		In Transverse Bulkheads Results grid, the user can open the Stiffener design iteration tool, where the user can iterate on scantlings/yield strength/spacing, and check local requirements (DNV Rules only).	382042
3D-Beam		3D-Beam - quality check of model - diagnostics functions introduced: 1) Select beams with free ends, 2) Select beams without profile.	373941

3.2 Corrections			
Area	Case #	Description	ID
Rules	361412	Stiffeners - section modulus - Zact did not consider web angle to plate between 75 and 105 degrees. Corrected.	293743
Rules/DNV	401584	No loads were calculated for tanks defined as type "Other" even though liquid load was specified as content. Corrected.	355014
Rules/DNV		Baltic Ice Class Excel spreadsheet updated to latest rule edition.	374826
Rules/DNV	415448	Corrected error in calculation of minimum power requirements for ICE class.	376238
Section Scantlings	306154	Bulk Carrier - span of side frames was not determined based on the definition in BC rules and could give wrong span in areas with shell curvature (typ. fore ship). Corrected.	172616
Section Scantlings	393180	HSLC - Result from cross-section analysis revealed erroneous allowable stresses in certain situations. Corrected.	341841
Section Scantlings		HSLC - Pitch slamming zone was determined incorrectly causing pitch slamming pressure to be applied where it should not. Corrected.	410219
Section Scantlings	297441	Transversely stiffened plate was not calculated if the width of plate was shorter than transverse stiffener spacing. Corrected.	156830
Section Scantlings	424229	Bow impact - pressure was set to 0 when flare angle alpha was 0 degree. Corrected.	391315
Section Scantlings		Bulk Carrier - steel coil loads. When floor spacing was '0', cross-section analysis returned a system error and stopped abruptly. Analysis now stops with a proper message if spacing is not set.	393973
Section Scantlings		Connection strength/welding for deck loads, CSR and DNV, x-position when calculating additional position.	350745
Section Scantlings		Renummer stiffener IDs was based on stiffener definition sequence, not distance from start of panel. This could lead to ID's out of sequence. Corrected, now uses distance from start of panel.	186452
Section Scantlings	426381	CSR - connection area involving tripping bracket. Calculation used wrong Reh (235) rather than the specified Reh.	396045
Section Scantlings	341068	CSR BC - Modification of side frame bracket width did not have any effect on the results, width was always calculated based on the stiffener web height. Side frame definition now extended to allow for override of bracket width for upper and lower brackets.	264480
Section Scantlings	429074	Transverse stiffeners in a cross-section covering both sides - span for starboard stiffener were different from port side stiffener even though starboard stiffener had identical geometry definition. Corrected.	402057
Section Scantlings		Cross-section analysis - segments with "Undefined" position codes will cause unpredictable analysis results or lack of results. A warning is now given prior to the analysis if there are any.	407079
Section Scantlings	417188	FE Mean mode	
Section Scantlings	434612	Conta panel 'Ouje corre	
Section Scantlings	432768	Defini cause longe possi	
Section Scantlings	431374	DNV i midst and ship d FE	
Transverse Bulkhead	415717	Trans could	
Transverse Bulkhead	435777	Trans surri panel hand impro	
Analysis Tools	420123	Analysis Tools	
Analysis Tools	419362	Analysis Tools	
3D-Beam	432694	3D-Beam	

Nauticus Hull V20.29 (September 2023) – Summary of enhancements and corrections

3.1 Enhancements and other modifications			
Area	Case #	Description	ID
Rules/DNV		DNV - Gas - Added possibility to specify design vapour pressure for liquefied gas tanks type A/B that shall be used for static design load scenarios. Available from DNV rule edition July 2022.	249518
Rules/DNV		Plate slenderness requirements when more than three continuous decks - now considers given Number of continuous decks above 0.7D. In addition, in case detection of continuous decks returns unexpected number, a checkbox is available when Number of continuous decks above 0.7D is less than three. The state of this checkbox will then be considered when determining the slenderness coefficient C. The detected number of decks is now also included in the report.	424518
Section Scantlings		Number of continuous decks above 0.7 D from baseline Vessel has more than three continuous decks	6
Section Scantlings		In Section Scantlings, for DNV Rules, proposed scantlings are now shown in the result grid for stiffeners where buckling fails. Implementation is now same for DNV Rules as for CSR BC and OT.	93184
Section Scantlings		Grouping principle for longitudinal stiffeners introduced. This can be activated by an option in the Run dialog of Section Scantlings. The groups are detected based comparison of multiple stiffener parameters, loads and panel geometry.	123472
Section Scantlings		Added plotting of general waterlines and ice-waterlines with indication of upper and lower extension of ice belt. Display can be turned on/off from context menu.	128997
Section Scantlings		In Section Scantlings, for DNV Rules, plates and stiffeners with a bending effectiveness less than 10%, were always considered as Other members when determining permissible bending stress coefficient for plate and stiffener. Now, all plates and stiffeners in Section Scantlings are considered as Longitudinal member, independent of the assigned bending effectiveness.	409117
Section Scantlings	445984	Torsional characteristics was shown in result tree only for limited ship types. Now shown in general, irrespective of rule set or ship type.	435583
Section Scantlings	445984	CSR and DNV - torsion characteristics - increased number of decimals for torsion constant.	435584
Section Scantlings		Color plot properties - "Construction type" added to the list of properties that can be plotted.	475549
Section Scantlings		Display of capacity curves for local Eigenvalue and Global eigenvalue are now implemented in PULS 64-bit version.	372029
Analysis Tools		In the PULS buckling code was previously depending on the 32-bit version of Nauticus Hull (V18.15 January 2018). Now GeniE can use this 64-bit version of Nauticus Hull when running PULS.	373287
3D-Beam		3D-Beam - functionality for auto-save of model extended. Five (5) backups of the model representing the last five stages will be maintained. This will improve the possibility to re-establish the model after an abnormal termination of 3D-Beam.	449704
Other	459623	If selecting worst load case in GeniE and opening SPBT (Single Panel Buckling Tool), then the LC giving the highest total utilization factor was always shown. Now SPBT can show the worst load case for stiffener buckling if UT_stiffenerbuckling is selected in GeniE.	460076
Other	461954	In the Rule Calculator, for DNV Rules, envelope accelerations for FLs are now provided.	463923
Ship Data		Frame table definition - value for spacings now accepts decimals.	483735

3.2 Corrections - highlights			
Area	Case #	Description	ID
Rules/DNV	461713	Ice - data transfer from Ship Data to spreadsheet "Ice Class; Baltic" - wrong data transferred for shaft and forward.	462691
Rules/DNV	464873	P_h_4 pressure was not considered in design load set Tk-2 when freshwater tanks. Error revealed in Rule Calculator - Corrugated Bulkhead and 3D-Beam - Get rule loads. Corrected.	467696
Rules/DNV		DNV Rules - bow impact calculation for bulk carriers (non-CSR) and dry cargo ships. Full load loading conditions, like "Homogenous", were not considered as the "Full load" loading condition required by the rules. Corrected, full load loading conditions now considered for bow impact pressure calculation even though name of loading condition type differ from "Full load" in Compartments and Loads.	469205
Rules/DNV	0013693	For stiffeners with flange thickness not in accordance DNV Rules Pt 3 Ch 8 Sec 2 (3.1.1.1 b), the effective free flange outstand was not correctly implemented. Corrected.	479738
Rules/DNV	00139200	Ice-C, ice frame web thickness minimum requirement 9mm was applied as for higher ice class. Corrected, 9mm minimum requirement omitted for ice-C.	479741
Rules/CSR	447954	CSR slenderness result plot indicated plates below requirement even though requirements were met and was OK in grid. Corrected.	440174
Rules/CSR		CSR BC - Rule Calculator - Plates and Stiffeners - corrosion addition for transverse bulkhead in dry cargo hold incorrect. Corrected.	466835
Rules/CSR	00141336	CSR BC - reduced hull girder shear capacity for longitudinal corrugated bulkhead shown too low effective plate thickness. This was due to F3 factor resulted in 0 as no long bhd was found. Corrected, detection of long bhd improved.	481223
Section Scantlings	444642	In Section Scantlings, for both DNV Rules and CSR BC and OT, the program wrongly used web stiffener thickness to calculate connection area where it should have been using aft and fwd	433064
Section Scantlings	446570	For a line load applied to a beam in a global model, the LMLA (Local Model Load Applier) tool did not correctly distribute the loads to the sub-model. Now fixed.	417453
FE	438099	For a Nauticus Hull cross section with rounded deck corner, export of boundary conditions to GeniE failed. Corrected.	423610
FE	453910	In the FE manager, envelope accelerations according to DNV Rules for heavy unit loads were wrongly calculated. Now fixed.	450520
FE	455028	In Niv V20.24 wrong static heeled pressure for Crye LNG carriers was introduced in Nauticus Hull V20.24. Now fixed.	451582
FE	462649	For buckling in way of openings modelled with the hole concept in GeniE, there was a limitation in the SPBT (Single Panel Buckling Tool). Fixed now so SPBT can correctly show different reference stresses for sub-panel and stiffener.	465264
FE		For FE cargo hold models with independent tanks, if excluding one load case in the analysis, the TSCF (Tank Support Coupling Force) tool did not distribute any friction force. Now fixed.	467369
3D-Beam	448918	For Pillar buckling in 3D-Beam, buckling curve 'a', as defined in DNV-CG-0128 [5.4], was wrongly assigned to some profile types. Now fixed.	441356
3D-Beam	459263	3D-Beam - deflection view when a tapered beams was selected. Graphic representation of the deflection was corrupted. Corrected.	461592
3D-Beam	00136664	3D-Beam - ghost points with loads occurred causing analysis to crash. Corrected, solver updated to prevent such crashes. An export to xml and import from xml is still needed to manually remove the ghost loads.	476063
Other		View case selection were showing wrong content after switching to Compartments and Loads node and back. Other navigation scenarios were also eventually giving unexpected content in graphic view when returning. Corrected.	408980
Other	444809	When opening Single Panel Buckling Tool (SPBT) from GeniE, "No stiffener" for stiffener 1 gave wrong results. Corrected.	434644
Other		When exporting a Nauticus Hull cross section to GeniE, watertightness was not correctly assigned to some surfaces in GeniE. Now fixed.	456581
Other	460697	Drawing calibration - specifying X-position for drawings in Y2-plane now using same approach as for cross-section positioning. This will eliminate possibility for entering erroneous syntax when locating a drawing along X-axis.	461878



Summary of enhancements and corrections, with reference to support case

Nauticus Hull V20.30 (January 2024) – Summary of enhancements and corrections

3.1 Enhancements and other improvements			
Area	Case #	Description	ID
Section Scantlings		Grouping - group detection process extended to detect multiple groups of two or more sequentially placed stiffeners within one panel.	489279
Section Scantlings	00158816	Cylindrical bilge defined by two or more spline segments can now be converted to segments with radius. Estimated radius is displayed as part of the tool output for the bilge segments that meets certain criteria. See user manual for detailed information.	528754
FE		When exporting 3D model from Nauticus Hull to GenIE, Sets can optionally be exported.	209697
FE		When exporting 3D model from Nauticus Hull to GenIE, Structure Types can optionally be exported.	210515
FE		When exporting structure types from Nauticus Hull to GenIE via RuleTools.xml file, the new structure type FacePlateOfPSM is automatically assigned. This information is used by JavaScript corrosion additions according to CSR.	523905
3D Model		For Nauticus Hull 3D model, connection graphics was previously only available in 2D view. Now also available in 3D view.	408811
3D Model		For 3D model Rule check of cross section with cylindrical bilge, the program was not able to determine a bilge radius. Now a radius will be automatically computed for cylindrical bilge.	501799
Analysis Tools	00152946	Rule Calculator - show/hide rows. Any data entered in the rows before hiding the rows would be considered in analysis. This could cause unexpected results and lead to confusion. The checkboxes for hiding the additional rows are now greyed out if any value in these rows has been entered or otherwise modified. By this, the parameters used in analysis become transparent. To hide these rows the values must be removed and any checkboxes in these rows need to be set back to default state.	502569
Analysis Tools		Spreadsheet for DNV-HP-C202. For WSD calculations, usage factors for area check are now adjusted. Minimum ring area in equation 3.5.1 is now checked without adjusting for allowable stress factor n_p.	527719
Other	428213	Added possibility to delete multiple cross-sections or Transverse Bulkhead models. The function is invoked by choosing Delete from Top level menu of Section Scantlings or Transverse Bulkheads. Added possibility to delete multiple rule calculation files in Analysis. Support for sorting also added.	399655
Other		In Nauticus Hull's profile library, plastic section modulus for standard profiles is now available.	526443
Other		Archived workspaces (zip-files) attached in e-mails. In certain situations, depending on the security policies applied, it was not possible to save the attachment to disk. The reasons for blocking could be multiple. To eliminate the possibility that the blocking is due to the potential risk with JavaScript files (these files typically have the extension .js), the file suffix .txt is now added to the JavaScript files when archived and removed when extracting the archive.	529154

3.2 Corrections

Area	Case #	Description	ID
Rules/DNV		DNV - torsional buckling - calculation of coefficient omega C was based on old rules. Corrected.	417718
Rules/DNV		Sea chest compartment - erroneous corrosion addition to t determined under analysis. Corrected.	520467
Rules/DNV	00157301	DNV Offshore - sea impact. Requirements for sea impact were not considered for July 2023 rule edition and never. Corrected.	523034
Rules/DNV	00158105	DNV Offshore - fatigue. Calculations were using parameters as defined for 'Others' in table Pt.3 Ch.9 Sec.4 [4.5] Table 2 causing Msw to be used for ballast condition. This was now changed, and the following applies: - Operating load cond: sag - Transit load cond: sag - Full load load cond: sag - Ballast load cond: hog	528479
Rules/CSR		CSR - slenderness - plates. Error in rounding of net thickness requirement, Example: 8.25 was rounded to 8.0. Corrected, now rounding to 8.5.	501177
Rules/CSR		CSR Buckling of stiffeners - rule edition January 2022 - stress due to torsional deformation σ_{tr} should be set to 0 when axial stress σ_{ax} is less than 0. This was not done. Corrected.	524674
Rules/CSR		CSR BC - update of Kc for January 2023 rule edition was not considered in the pressure calculations for fatigue. Updated Kc now considered also for the fatigue calculation.	539911
Ship Data		Yt grid, erroneous definition of workpiece that could cause error message "Failed to load workpiece item ShipData - Object not set to an instance..." when opening workpiece. Corrected, opening process now will attempt to repair any erroneous definitions.	532311
Section Scantlings	00144635	Shear flow calculations for cross-sections with longitudinal vertically corrugated bulkhead could fail depending on the calculation positions. Corrected.	490585
Section Scantlings	00153501	DFF factor applied to longitudinals according to DNV OS-C101 (Offshore). Fatigue was not accessible from the stiffener property grid. DFF-1 was always used. Corrected.	510276
Section Scantlings	00154528	Cross-section with corrugated bulkhead in CL - analysis aborts with message about panel not fully covered by plate. Corrected. Analysis now completes normally. This was a false error as panel was fully covered by plate.	517907
Section Scantlings		In the Transverse bulkhead tool, for DNV Rules, user-defined angle between the stiffener and PSM was ignored. Now corrected.	529130
Section Scantlings	00180061	DNV Offshore rules - vertical hull girder strength - wrong material for determination of applicable k-factor in deck was used giving erroneous results. Corrected.	536496
Transverse Bulkhead	00157926	Transverse bulkhead tool - since January 2023 release, flooding check did not consider the deepest equilibrium waterline table defined in Ship Data. This could produce non-conservative results as freeboard deck height defined in Ship Data was used. This error did not appear in Rule Calculator. Corrected.	525676
Transverse Bulkhead		Stiffeners on transverse bulkhead for LNG carriers - determination of bending moment factor F_{b1} did not properly consider horizontal stiffeners. Corrected.	534158
Transverse Bulkhead		Stiffeners - bending span L_{b1} specified or determined based on end connections were not considered in analysis. Corrected.	534173
Analysis Tools		For standard profiles defined under Libraries Profiles, the calculated plastic section modulus was not according to Pt.3 Ch.3 Sec.7 [14.5]. Now corrected.	244297
Analysis Tools	00145797	Spreadsheet - connection strength. Description of parameter P was not updated for July 2018 edition (P=F-FB) to July 2019 edition (P=0.5F-FB) leading to possible doubt on what to input. Corrected, description updated.	489574
Analysis Tools		Rule Calculator - weather deck pressure - incorrect static pressure calculated when Z-coordinate of LCP was lower than D. Static pressure on deck was erroneously relating to D. Corrected.	496793
Analysis Tools	00150692	Minimum thickness for Deckhouse position codes incorrect when deckhouse EPP starting at the height defined as "Height of freeboard deck" in ship data. Corrected, also applies to cross-section analysis.	498769
Analysis Tools	00182120	Rule Calculator - definition of Hull girder properties - "Redefine from cross-section" was deactivated. Corrected.	539790

Nauticus Hull V20.31 (July 2024) – Summary of enhancements and corrections

Area	Case #	Description	FE	ID
Rules	300973	When switching to another rule set in Applicable rule Set data (e.g. from DNV to constant CSR class), the H-loads are not automatically re-calculated when acc. gear loads are loaded. This limitation is now removed.	FE	362
Rules		Welding in way of connection between stiffeners at Thrust thicknesses now shown in additional result "FE sizes".	FE	428
Rules/DNV		For DNV Rules the design load sets are now independent each loading condition: in constant CSR class, the compartment load/wheel load/UDL is created in any condition, the relevant design load sets are always the analysis.	FE	001
Rules/DNV		DNV Offshore - Naming of load scenarios updated to with DNV Offshore rule-terms Transit and Survival.	FE	
Rules/DNV		Stiffener fatigue results - report of part damage. Re showing damage and predominant EDW per loading added to the fatigue result.	FE	
Rules/DNV		For DNV Rules the local scantlings requirements for not implemented.	FE	
Rules/DNV	00182158	IC - Polar Class - sumship or abled propellers - the boundary of stern region is not considered minit forward of the section where the parallel ship side ends, as described in (4.7.3). Now implemented.	FE	
Rules/CSR		CSR - fatigue results - Ka and Kb stress concentration now shown in result table - advanced results.	FE	
Section Scantlings	00158829	Performance and memory consumption. Slow perf and increased memory usage over time while repl analysis runs. Improved, performance and increase consumption addressed in several parts of the anal	FE	
Section Scantlings	00159001	Repeated analysis runs of same cross-section cause increased memory consumption. Now implemented practically not all. Memory handling significantly now forcing memory cleanup after previous run wh of analysis is completed.	3D Model	
Section Scantlings		In Section Scantlings and TBHD tool, if selecting str in the results table, the stiffener's properties g also available.	3D Model	
Section Scantlings		Import from POSEIDON - alignment of longitudinal inconsistent use of GlobalZ or GlobalB reference for positioning longitudinal stiffeners in model and spacings calculated from the hull form. When a has reference GlobalZ, program assumes stiffener positioned at constant Z, along vessel and view versa GlobalB. Import from POSEIDON improved.	3D Model	
Section Scantlings	00186511	Unmapped compartment cells when running analysis certain situations there may be compartment cells cross-section or transverse view load model that is mapped to a compartment. The mapping status is visible unless view case Compartments is selected. Compartment may lead to false results, it is easy to spot. The mapping status will now be checked opening the Run dialog and a message stating the run status, "3 of 18 compartment cells not mapped shown	3D Model	
Section Scantlings		Memory consumption - program did not properly remove memory from previous analysis runs of the same memory eventually causing out-of-memory and slow behavior. Memory now cleared and load model before run resulting in a significant reduction of consumed	3D Model	
Section Scantlings		For Section Scantlings, additional intermediate pressure results are now provided: static load contours in static pressure (one from each side) and dynamic pressure plot (on each side).	3D Model	
Transverse Bulkhead		When copying in-plane stiffeners in TBHD tool / 3d that is overlapping existing stiffeners, a check is implemented preventing overlapping stiffeners).	Analysis Tools	
Compartments and Loads	566913	Joined compartment - message "Could not update joined compartment. Did not find matching original compartments." The name of the compartment was included in the message causing some challenges to subject compartment to remedy the problem. Nam	Analysis Tools	
FE	292633	In the FE template for the ship hull, the midship area, LC12 according to DNV-OS-1013 Sec was missing flooding of the void space surrounding independent tanks. Corrected.	Analysis Tools	
FE		In FE manager, a warning is provided if any design is affecting the hull girder loads is changed.	Analysis Tools	
FE		For Multi-purpose dry cargo ship with a long centre hold, the standard FE design load cases in Table 1 are according to P15 Ch.1 Sec.1 Table 1 are now imple	Resources	

3.2 Corrections

[illegible]

Continuous improvements of our existing calculation tools

Section Scantlings

Transverse Bulkheads tool

3D-Beam

Excel spreadsheets

Rule Calculator

FE Manager

Improved usability – Design iteration tool (DNV Rules)

- Original scantling: VL-32 steel**



Try VL-36 steel shows OK results



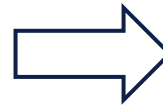
Section Scantlings – V20.24

Improved usability – UDL tolerance of deck height

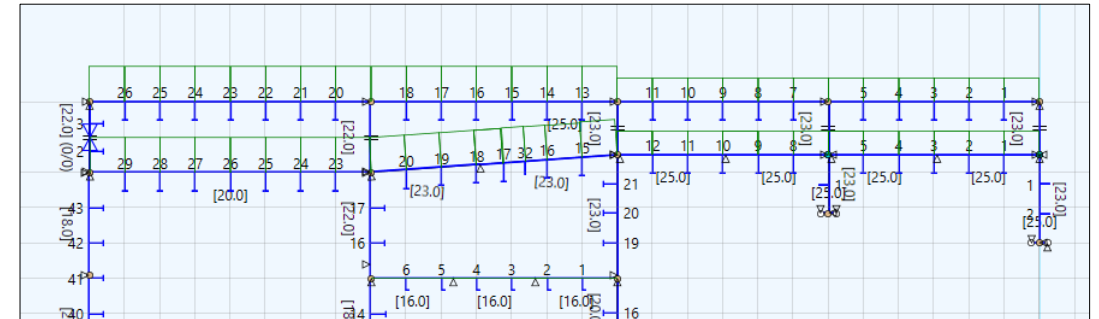
- Unified Distributed Loads (**UDL**) are defined under **Compartments and loads**
- Before V20.24, in **Section Scantlings**:
 - For **horizontal decks** having a vertical distance between each other **lower than a fixed tolerance**, UDL would be **wrongly applied to both decks**
 - For a **slanted deck** having a vertical extension **greater than a fixed tolerance**, UDL would be **wrongly not applied**
- From V20.24, in Compartments and loads, additional input for **Tolerance of deck height** now introduced

In Compartments and loads, additional input for user-defined tolerance

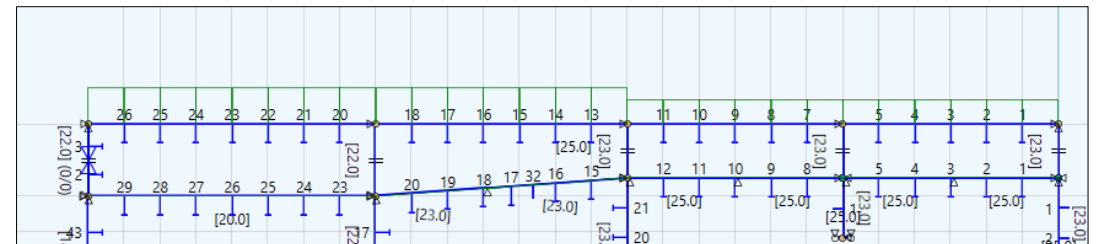
Compartments loads		Deck loads	Wheel loads	Loading condition: Ballast				
Create standard		Deck height from BL (mm)	Tolerance of deck height (mm)	UDL (t/m2)	Specify load area	Load area X aft (#)	Load area X forward (#)	Load area Y starboard (mm)
Create new								Load area Y port (mm)
Edit		21000	500	20	☒	#34	#67	-12000
Delete		21000	500	30	☒	#34	#67	12000



Before V20.24, without input for tolerance, UDL wrongly applied to the cofferdam deck



From V20.24, with input for tolerance, UDL correctly applied to the strength deck only

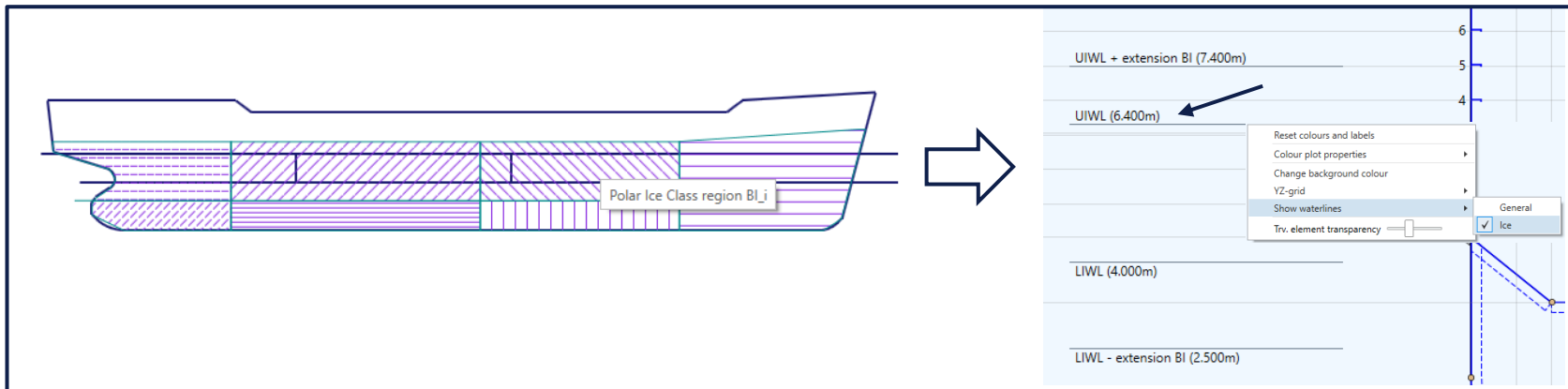


Section Scantlings – V20.29

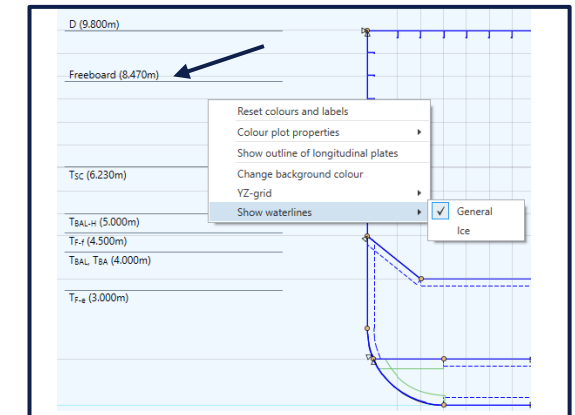
Improved usability – Plot of waterlines

- **Ice belt regions and waterlines** defined under Ship data introduced in **Section Scantlings** and **Transverse Bulkheads**. Applies to Baltic / Polar Class requirements.
- **Draughts, Depth** and **Freeboard** defined under ship introduced in **Section Scantlings** and **Transverse Bulkheads**
- Context menu for switching waterlines on / off

Baltic / Polar Ice class regions from Ship data available as waterlines in Section Scantlings and Transverse Bulkheads



Draughts from Ship data available as waterlines in Section Scantlings and Transverse Bulkheads



Section Scantlings – V20.29

Extended Rule coverage – Grouping principle for stiffeners

- Support for optionally applying the **grouping principle** for **Z** and **t_w** requirements is introduced for longitudinal stiffeners
- Applies to DNV-RU-SHIP July 2019 and newer (Pt.3 Ch.6 Sec.5 [1.1.3]), and for IACS CSR (Pt.1 Ch.6 Sec.5 [1.1.3])
- The option is controlled from the **Run dialog**
- Detection of the groups is based a comparison of multiple stiffener parameters and panel geometry

Grouping principle controlled from the Run dialog

Cross Section Analyses

Positions	Prescriptive	HULS	Fatigue
#20	☒	☐	☐
	☐	☐	☐

Prescriptive

Vertical wave bending moments M_{wv} scaling factors

Sagging	1
Hogging	1

Buckling stress combination factors

Combination 1 (τ):	0.7
Combination 2 (σ):	0.7

Grouping of stiffeners

Apply grouping principle ☒

Calculate

Original requirement before grouping principle applied can be found in Advanced view

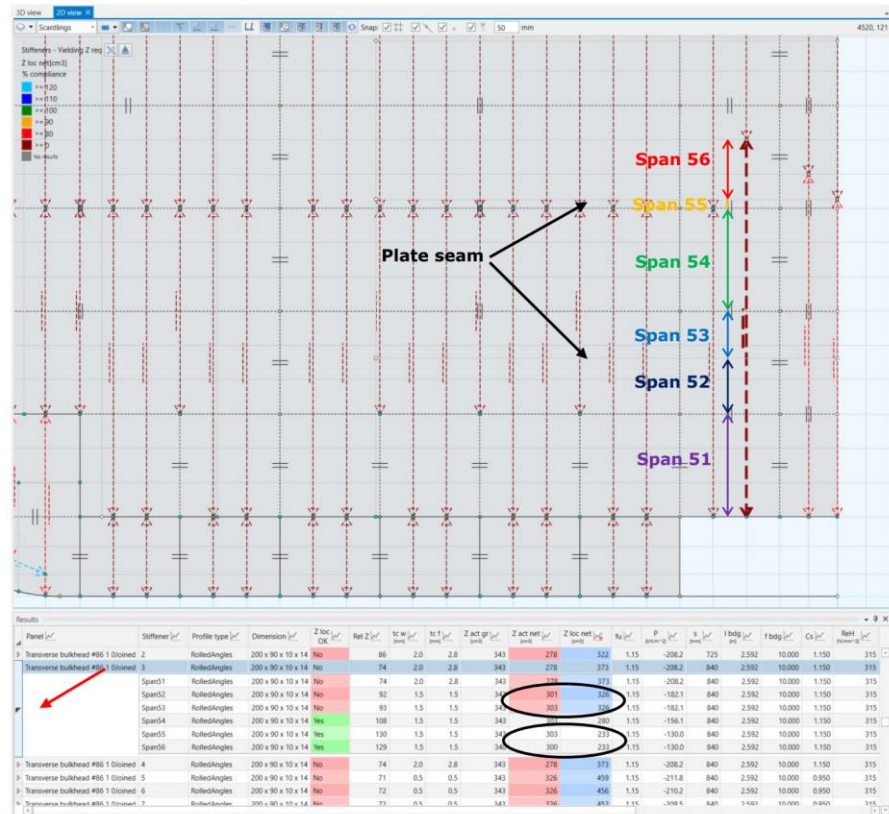
tc w [mm]	tc f [mm]	Z act gr [cm ³]	Z act net [cm ³]	Z loc net [cm ³]	Group?	Z loc net original	P [kN/m ²]
1.5	1.5	481	424	190	Group 3	204	46.7
1.5	1.5	481	424	190	Group 3	198	45.4
1.5	1.5	481	424	190	Group 3	193	44.2
1.5	1.5	481	424	190	Group 3	188	42.9
1.5	1.5	481	424	190	Group 3	182	41.7
1.5	1.5	481	424	190	Group 3	177	40.5

Section Scantlings – V20.30

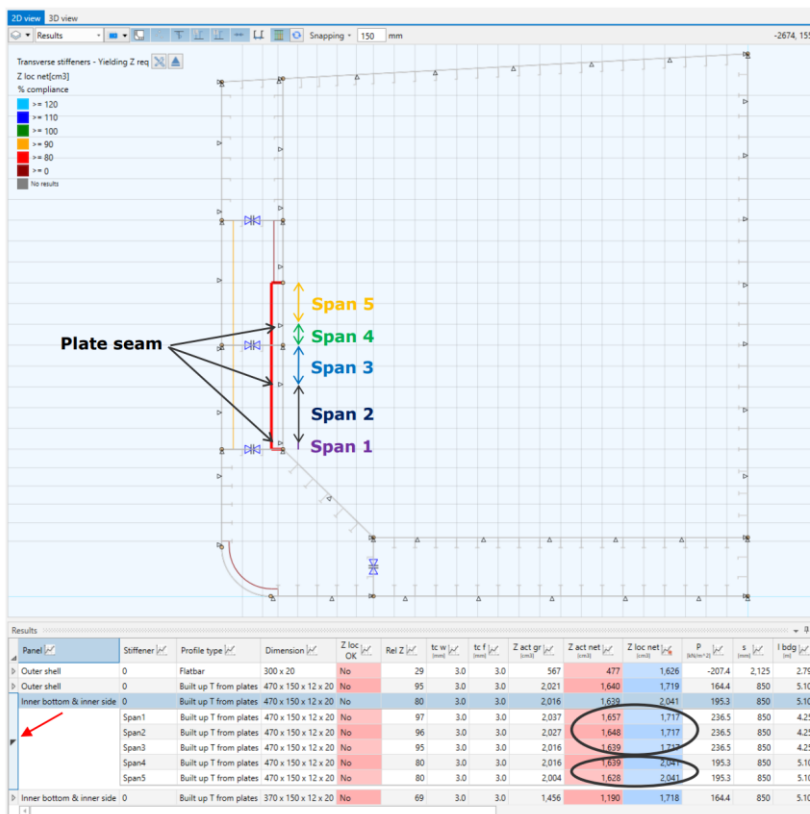
Extended Rule coverage – Continuous transverse stiffeners

- When a stiffener is penetrating an intersecting geometry object, a span is created. This is already implemented in TBHD tool and 3D model (for longitudinal stiffeners only)
- The same logics is now implemented for transverse stiffeners, allowing for continuous transverse stiffeners with multiple spans (Section Scantlings and 3D model cross section analysis)

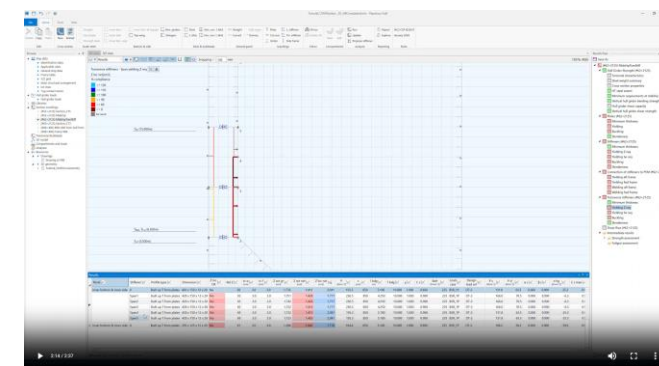
Transverse Bulkhead tool



Sections Scantlings



Demo



Extended Rule coverage – NAABSA notation

- **NAABSA** (not always afloat but safely ground) notation applies typically to **General dry cargo ships** and **Multi-purpose dry cargo ships**, with $L \leq 90$ m
- Additional local prescriptive requirements to plates, stiffeners and stiffener connections implemented in Section Scantlings

Ship data input

Applicable rules

☒ DNV rules
☐ Bulk carriers and dry cargo ships
☐ DNV HSLC rules
☐ DNV RU-NAV rules (only usable in Analyses->Rules)
☐ DNV RU-YACHT rules (only usable in Analyses->Rules)
☐ IACS CSR for bulk carriers and oil tankers

☐ No ship type notation
☒ Bulk carriers and dry cargo ships
☐ Container ships
☐ RO/RO ships
☐ Passenger ships
☐ Oil tankers
☐ Chemical tankers
☐ Liquefied gas tankers
☐ Compressed gas tankers
☐ Service vessels

☐ Vessels for special operations
☐ Fishing vessels
☐ Service area restrictions
☒ Ice strengthening
☒ Maximum cargo density
☒ Long centre cargo hold
☐ No MP
☐ Holds ... may be empty
☐ Holds ... are assigned as ballast holds in seagoing condition
☐ Grab

β_L for double bottom longitudinals

☒ NAABSA notation
☐ ESP notation
☐ SBC notation
☐ Special operations are applicable
☐ Gas fuelled
☐ LFL fuelled

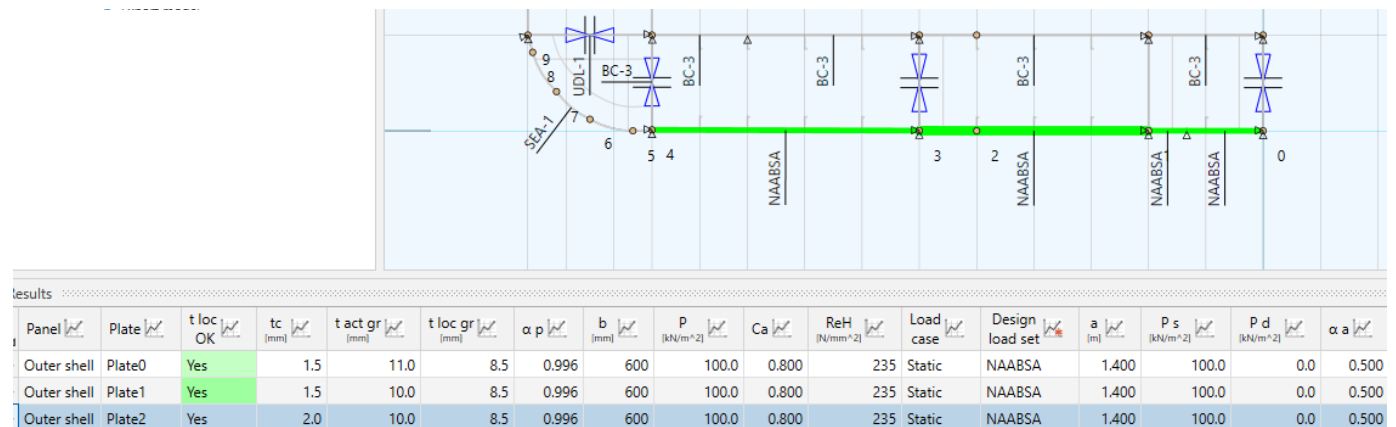
Rule version:
 July 2023

General dry cargo ship
 None
 Offshore service vessel
 Standby vessel
 None
 Ice(1C) Baltic ice class, 0.4 m thick ice
 0.70 [t/m³]

Weight of grab: 0.00 [t]
 Inner bottom: 0.80
 Outer bottom: 0.80
 AC-I: 0.90
 AC-II: 0.90

P_NA-s: 100.00 [kN/m²]

Section Scantlings analysis results



Section Scantlings – V20.31

Extended Rule coverage – DNV Offshore: Plate fatigue

- For floating offshore units additional fatigue assessment is required for plate shell connection to longitudinal stiffener
- Default stress concentration factor according to Rules, may be overridden in Run dialog

DNV-OS-C102 Ch.2 Sec.4 [1.4.1]

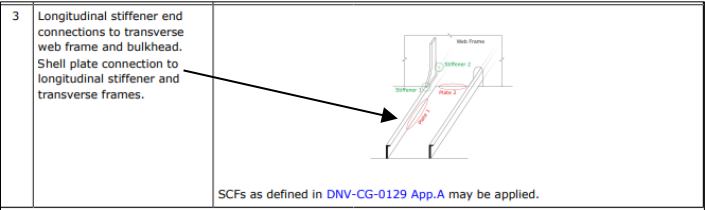


Plate fatigue activated in Run dialog

Cross Section Analyses

Positions	Prescriptive	HULS	Fatigue
#76	☐	☐	☒

5 of 5 compartment cells mapped

▲ Fatigue

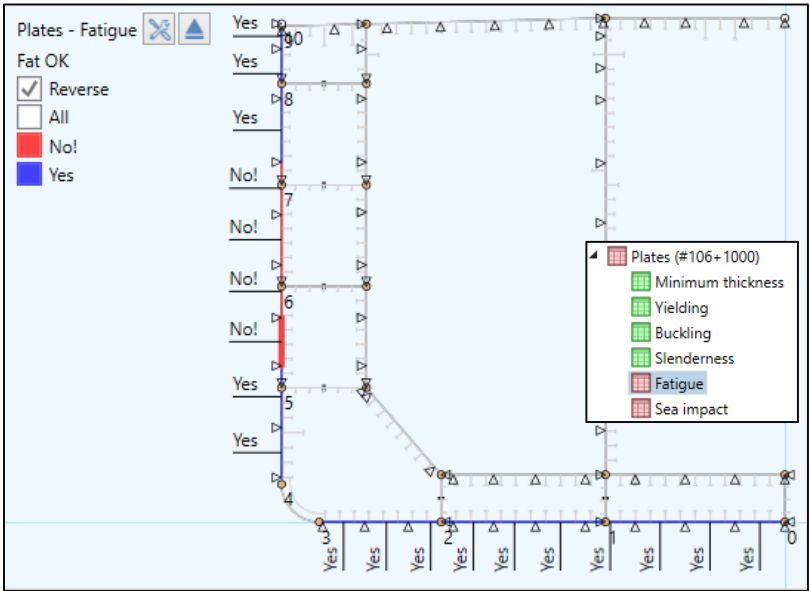
- ▶ Vertical wave bending moments M_w scaling factors
- ▶ Relative displacements
- ▶ Stiffener fatigue - permissible K-factors

▲ Plate fatigue, DFF not considered (DFF = 1)

Calculate (conversion disregarded) ☒

Stress concentration factor, K 1.13

Calculate



Results													
Panel	Plate	XPos (mm)	YPos HS1 (mm)	ZPos HS1 (mm)	YPos HS2 (mm)	YPos HS2 (mm)	Fat OK	T DF (years)	T F Min (years)	T F Min rel (%)	T F HS1 (years)	T F HS2 (years)	T C 25 (years)
Outer shell	Plate16	131,000	32,000	17,720	32,000	18,640	No	25.0	18.8	75.2	18.8	0.0	5.0
	EPP64	131,000	32,000	17,720	32,000	18,640	No	25.0	18.8	75.2	18.8	22.1	5.0
	EPP65	131,000	32,000	18,640	32,000	19,560	No	25.0	22.1	88.5	22.1	23.0	5.0
	EPP66	131,000	32,000	19,560	32,000	20,480	No	25.0	23.0	92.1	23.0	25.7	5.0
	EPP67	131,000	32,000	20,480	32,000	21,400	Yes	25.0	25.7	102.8	25.7	32.9	5.0

Section Scantlings – V20.31

Improved usability – Stiffener fatigue damage per LC

- Additional intermediate stiffener fatigue damage results are now available. For each loading condition:
 - Predominant EDW;
 - Stress range; and
 - Part Damage
- Implemented for DNV-RU-SHIP and CSR BC&OT

Results tree – new result node

- Stiffeners (#62+2125)
 - Minimum thickness
 - Yielding Z req
 - Yielding tw req
 - Buckling
 - Slenderness
 - Fatigue
 - Fatigue – damage (with LC)

Results grid – detailed intermediate stiffener fatigue results

Results															
Panel	Stiffener	Profile type	Dimension	Fatigue OK	Loading condition	α	Predominant EDW aft	Stress range aft	D aft	D aft %	Predominant EDW fwd	Stress range fwd	D fwd	D fwd %	
Outer shell	0	WeldedTbar	468 x 150 x 12 x 18	Yes		1.00			0.110	100.0			0.087	100.0	
Outer shell	1	HPBulb	340 x 12	Yes		1.00			0.553	100.0			0.451	100.0	
Outer shell	3	WeldedAngle	300 x 150 x 12 x 12	No		1.00			1.075	100.0			0.847	100.0	
					Full load	0.50	FSM	16.880	0.006	0.6	FSM	15.979	0.005	0.6	
					Ballast	0.50	HSM	81.638	1.069	99.4	HSM	75.734	0.841	99.4	
Outer shell	4	Built up T from plates	315 x 100 x 12 x 15	Yes		1.00			0.419	100.0			0.349	100.0	
					Full load	0.50	FSM	13.796	0.003	0.8	FSM	13.278	0.003	0.8	
					Ballast	0.50	HSM	60.876	0.415	99.2	HSM	57.559	0.346	99.2	

Section Scantlings – V20.31

Improved usability – Intermediate pressure results

- Additional intermediate pressure results are available after cross-section is analysed
- Static and dynamic internal and external pressures are shown separately, in addition to total pressure P

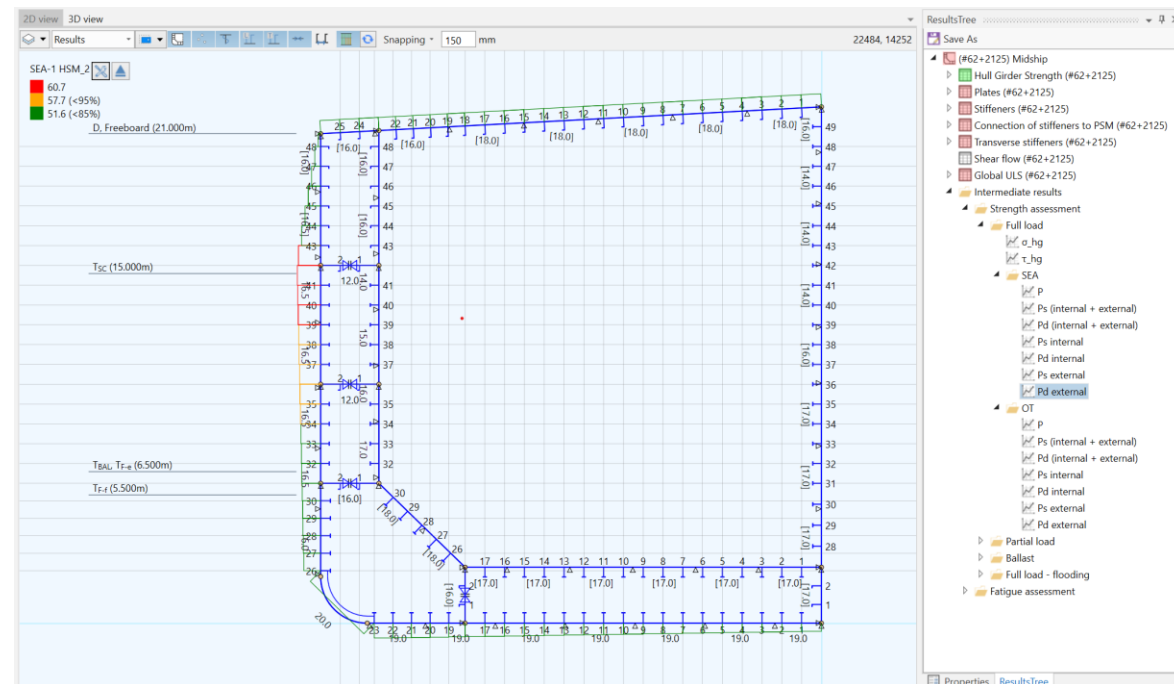
V20.30 January 2024

- Intermediate results
 - Strength assessment
 - Full load
 - σ_{hg}
 - τ_{hg}
 - SEA
 - P
 - OT
 - P
 - Partial load
 - Ballast
 - Full load - flooding
 - Fatigue assessment

V20.31 July 2024

- Intermediate results
 - Strength assessment
 - Full load
 - σ_{hg}
 - τ_{hg}
 - SEA
 - P
 - OT
 - P
 - Partial load
 - Ballast
 - Full load - flooding
 - Fatigue assessment

Dynamic external pressures in Section Scantlings for SEA-1 HSM-2



Section Scantlings – V20.31

Improved usability – Check of compartment mapping prior to analysis

- Status of mapped compartments for the current cross-section or transverse bulkhead is shown in the Run dialog, reducing the need for manually confirming the mapping prior to analysis
- A check whether any loading conditions are defined in Compartments and Loads is also performed
- The status reflects the situation at the time the dialog is opened

Status – Not all compartments mapped, and missing fatigue LCs

Positions	Prescriptive	HULS	Fatigue
#75+100	☒	☐	☒
	☐	☐	☐

1 of 6 compartment cells not mapped
No fatigue loading conditions defined

←

Prescriptive

- Vertical wave bending moments M_{wv} scaling factors
- Buckling stress combination factors
- Grouping of stiffeners

Fatigue

Calculate

Status – All compartments are mapped

Positions	Prescriptive	HULS	Fatigue
#75+100	☒	☐	☐
	☐	☐	☐

6 of 6 compartment cells mapped

←

Prescriptive

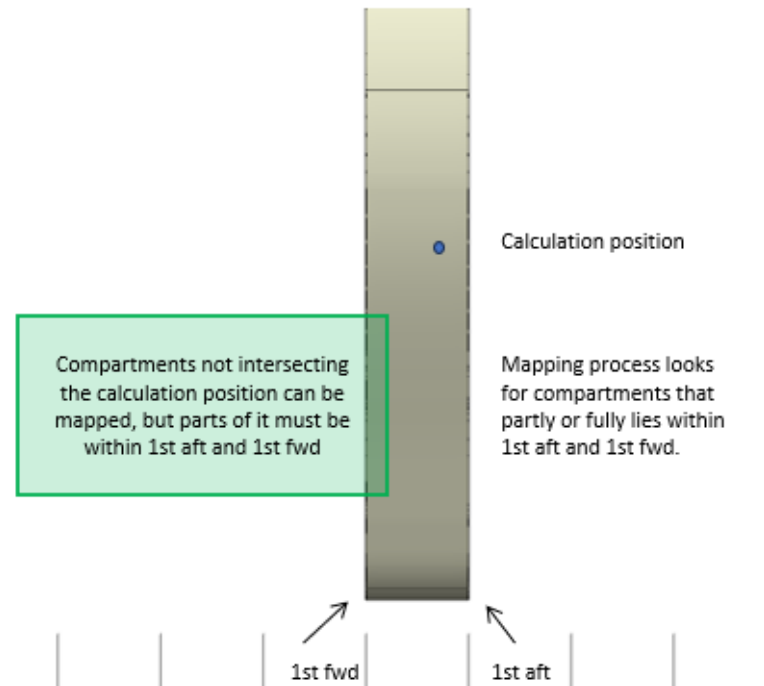
- Vertical wave bending moments M_{wv} scaling factors
- Buckling stress combination factors
- Grouping of stiffeners
 - Apply grouping principle ☐

Calculate

Section Scantlings – V20.31

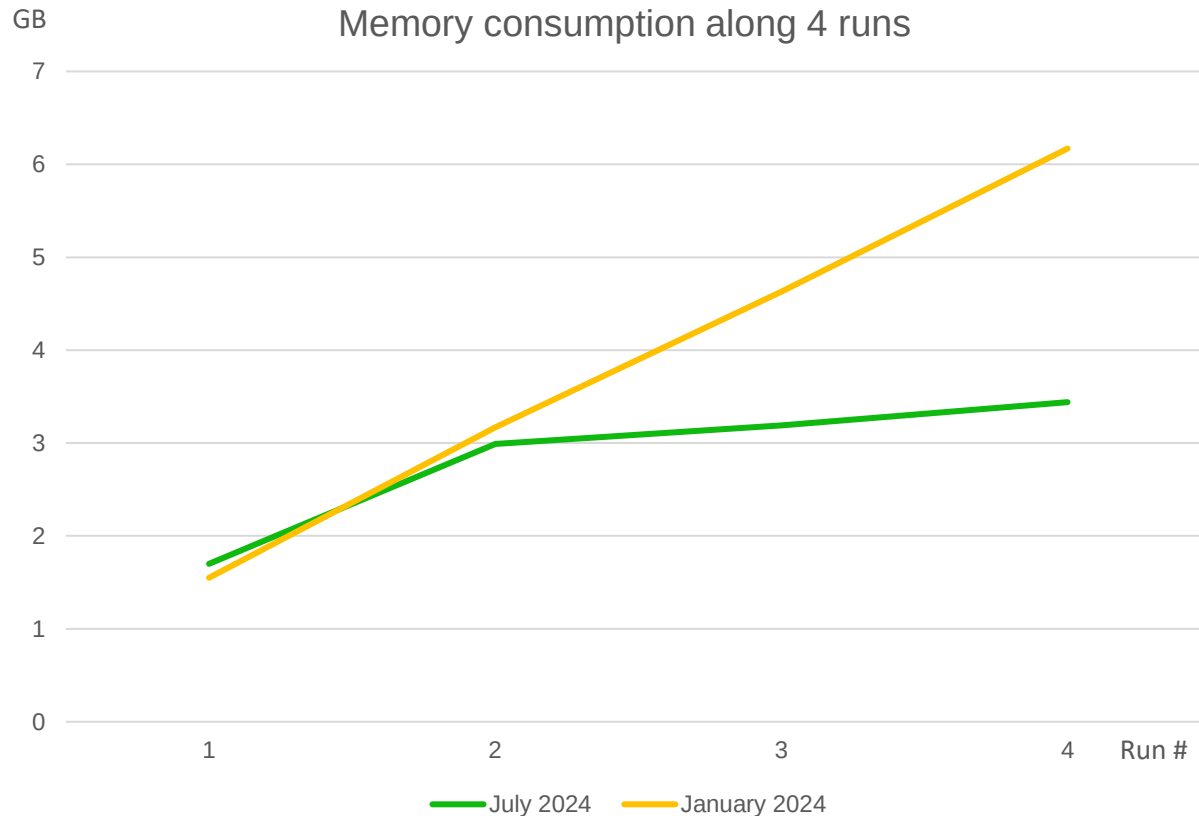
Improved usability – Mapping lost when re-opening workspace

- Most of us have experienced loss of compartment mapping when re-opening a cross-section
- A likely reason for this has been the stricter mapping constraints applied 'under the hood' when opening a cross-section. These constraints have now been relaxed and follows the same procedure as when mapping a cell to a compartment interactively.



Section Scantlings – V20.31

Improved usability – Memory consumption and performance



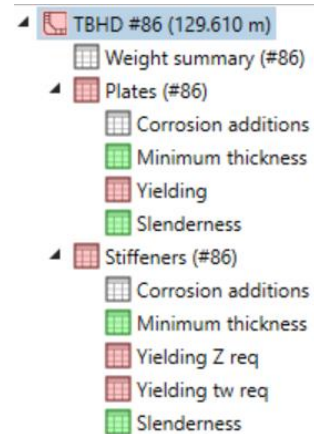
- For each analysis run, memory consumption was accumulated (not releasing results for previous run)
- Now, memory released for each analysis run. A small memory leakage remaining for 2D display of results
- Performance for large analysis models improved by 1/3

Transverse Bulkhead tool – V20.24

Improved Rule coverage – CSR BC&OT

- The Transverse bulkhead tool was deployed in April 2021, limited to covering **DNV Rules**
- From Nauticus Hull V20.24 (January 2023), **CSR BC&OT Rules** are also covered, available for January 2022 Rule edition and later
- Rule coverage: **Plate** requirements and **Stiffener** requirements (Minimum, yielding and slenderness)
- Results available on **EPP level** (for plates) and **stiffener span level** (for stiffeners)

DNV Rule coverage



CSR BC & OT Rule coverage

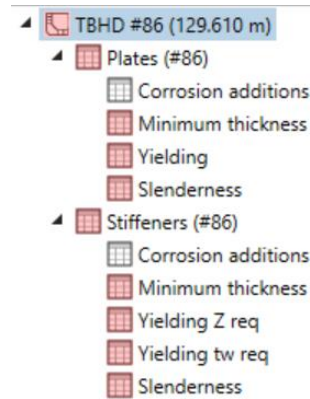
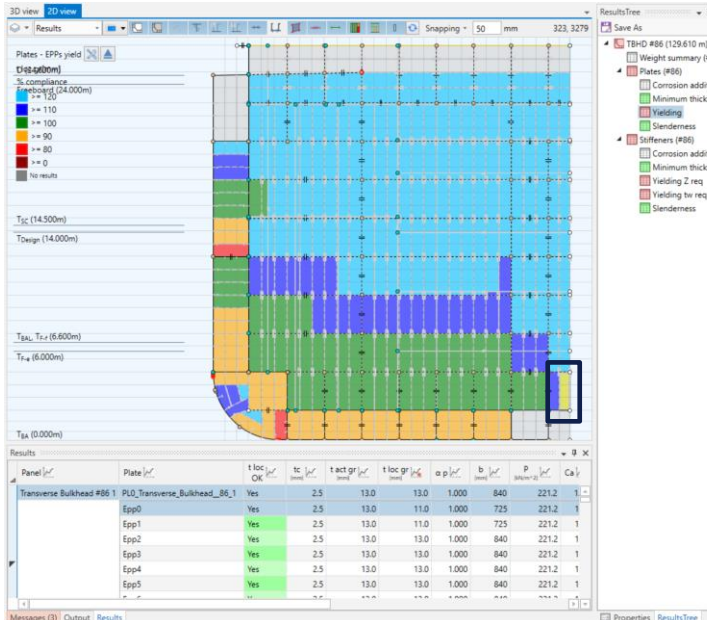
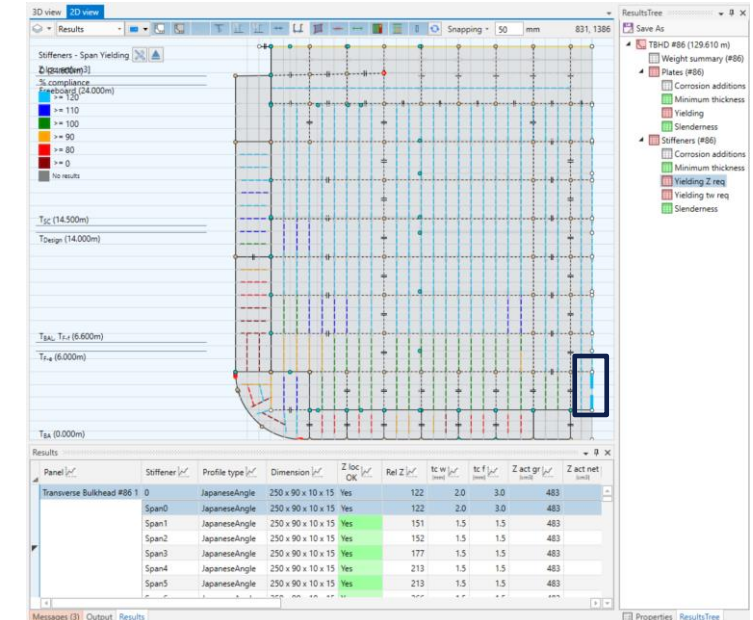


Plate results on EPP level



Stiffener results on stiffener span level

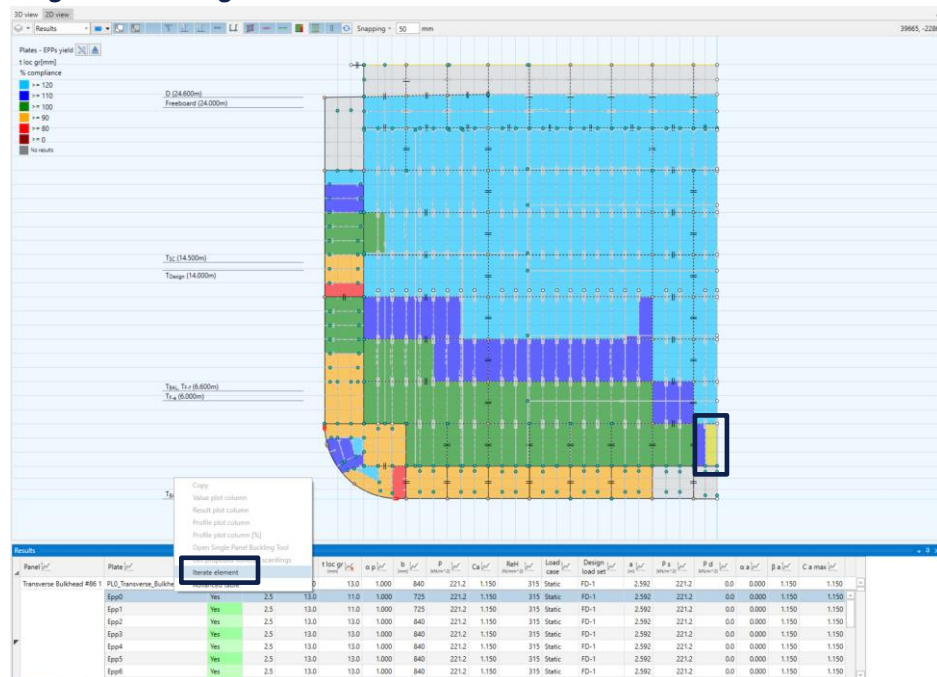


Transverse Bulkhead tool – V20.24

Improved usability – Design iteration tool (DNV Rules)

- The intention with the **iterate** feature is to allow the end user to try other variants of scantlings /spacings (that will not be committed to the model) and see how this affects the required scantlings. This feature is currently only supported for **DNV Rules**.
- Implemented for plate requirements and stiffener requirements
- In the **Iterate element wizard**, the user may change parameters and then press **Calculate**. The analysis will only **re-run** the local prescriptive requirements for the **selected EPP (stiffener)**. All other EPP (stiffener) results will remain unchanged. The variants applied will not be committed to the Transverse Bulkheads model but can be used to get a better understanding on how different parameters will affect the required scantlings.

Original scantling: VL-32 steel



Iterate: Try VL-NS steel

Iterate element

Panel: Transverse Bulkhead #86 1

Plate: PL0_Transverse_Bulkhead_86_1

Element: Epp0

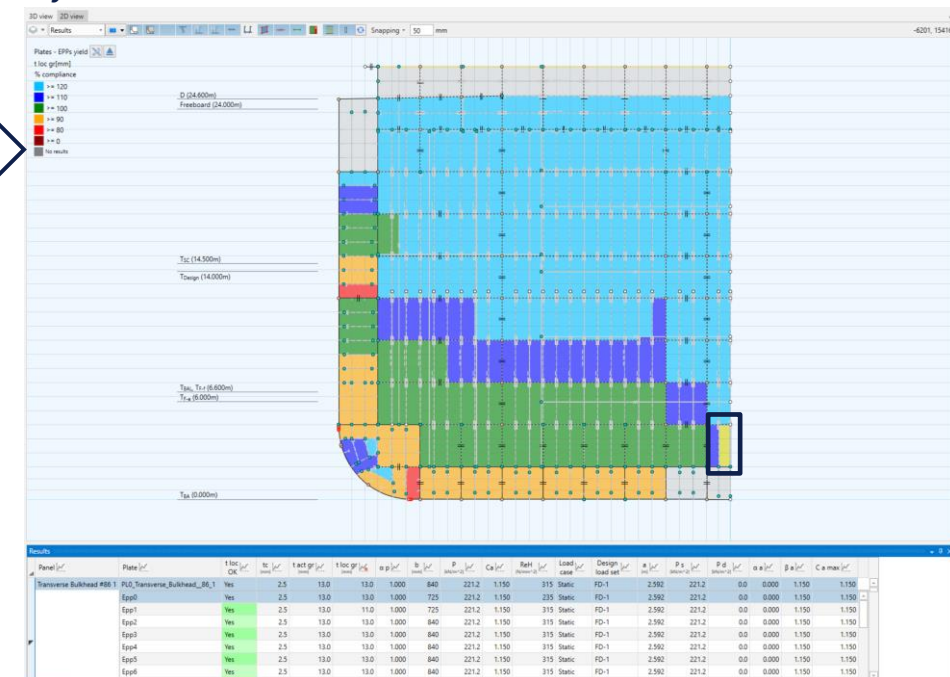
Yield stress: 235 [N/mm²]

Short side: 725 [mm]

Long side: 2592 [mm]

Calc

Try VL-NS steel shows OK results



Transverse Bulkhead tool – V20.29

Extended Rule coverage – Stiffener connections to PSM

- From Nauticus Hull V20.29 (September 2023), **Stiffener connection requirements to PSM** are covered, available for DNV Rules and CSR BC&OT
- Rule coverage (same as Section Scantlings): **Yielding** requirements and **Welding** requirements
- Results available for all **continuous connections** (stiffener slotted continuously through an intersecting geometry object e.g. stringer/deck)
- Connections:** a new graphical object introduced, with its own display control and selection filter (like other objects) and holds all information needed for running connection area requirements

DNV Rules: Yielding requirements

1.2.4 The load, in kN, transmitted through the PSM web stiffener shall be taken as:

- If the web stiffener is connected to the intersecting stiffener:
$$W_2 = W \left(1 - \alpha_a - \frac{A_f}{A_w + A_f} \right)$$
- If the web stiffener is not connected to the intersecting stiffener:
$$W_2 = 0$$

1.2.3 The load, in kN, transmitted through the shear connection shall be taken as follows.

- If the web stiffener is connected to the intersecting stiffener:
$$W_f = W \left(\alpha_a + \frac{A_f}{A_w + A_f} \right)$$
- If the web stiffener is not connected to the intersecting stiffener: $W_f = W$

where:
 W = total load, in kN, transmitted through the stiffener connection to the PSM taken equal to:

$$W = \frac{P \cdot f_1 \left(S_1 - \frac{S_1}{2000} \right) + P \cdot f_2 \left(S_2 - \frac{S_2}{2000} \right)}{2 \sin(\varphi_{w,1}) \sin(\varphi_{w,2})} 10^{-3}$$

DNV Rules: Welding requirements

2.5.6 Welding size of connection between stiffeners and primary support members

The minimum leg length of welding for the connection between stiffener and primary supporting member (PSM) shall not be less than t_{leg} given in Table 2 and [2.5.2] with weld factors $f_{weld} = 0.25$.

The required welding size at stiffener connection to primary supporting members shall not be less than the values obtained from the following formula:

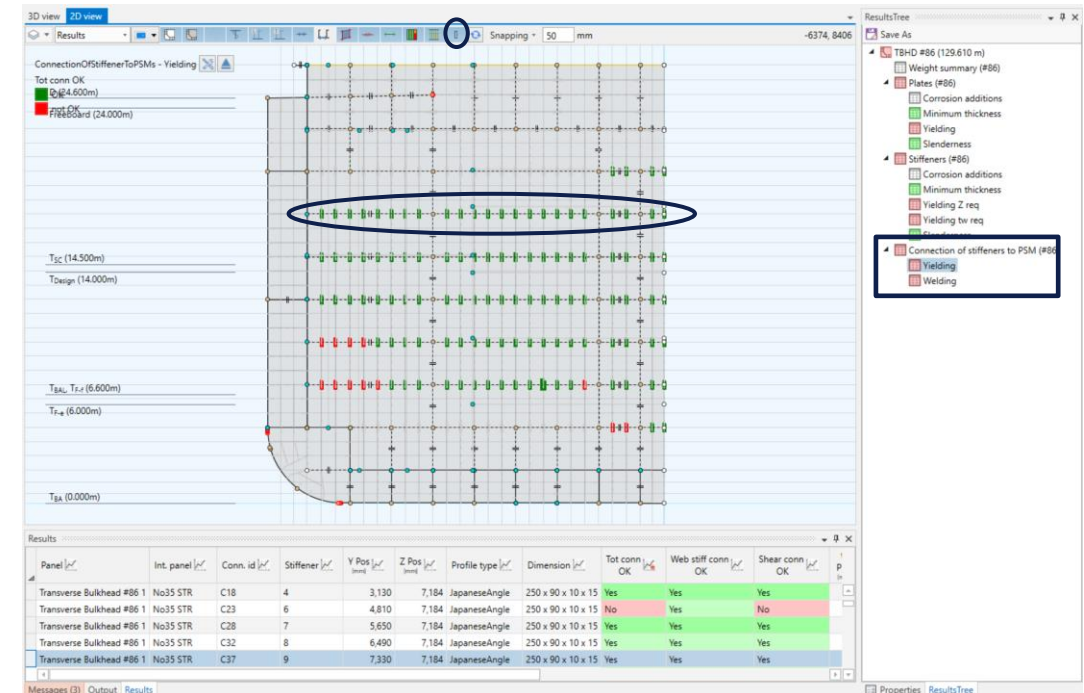
a) Shear connection inclusive of lug or collar plate:

$$t_{leg-s} = \sqrt{2} f_{yd} f_c \frac{2}{\sqrt{a_{norm}}} + t_{gap}; \max. \frac{\sqrt{2}}{2} f_{yd} f_c t_s + t_{gap}$$

b) PSM stiffener to intersecting stiffener:

$$t_{leg-w} = \sqrt{2} f_{yd} f_c \frac{2}{\sqrt{a_{norm}}} + t_{gap}; \max. \frac{\sqrt{2}}{2} f_{yd} f_c t_w + t_{gap}$$

**Connection area requirements (yielding and welding)
where stiffeners are penetrating stringers**

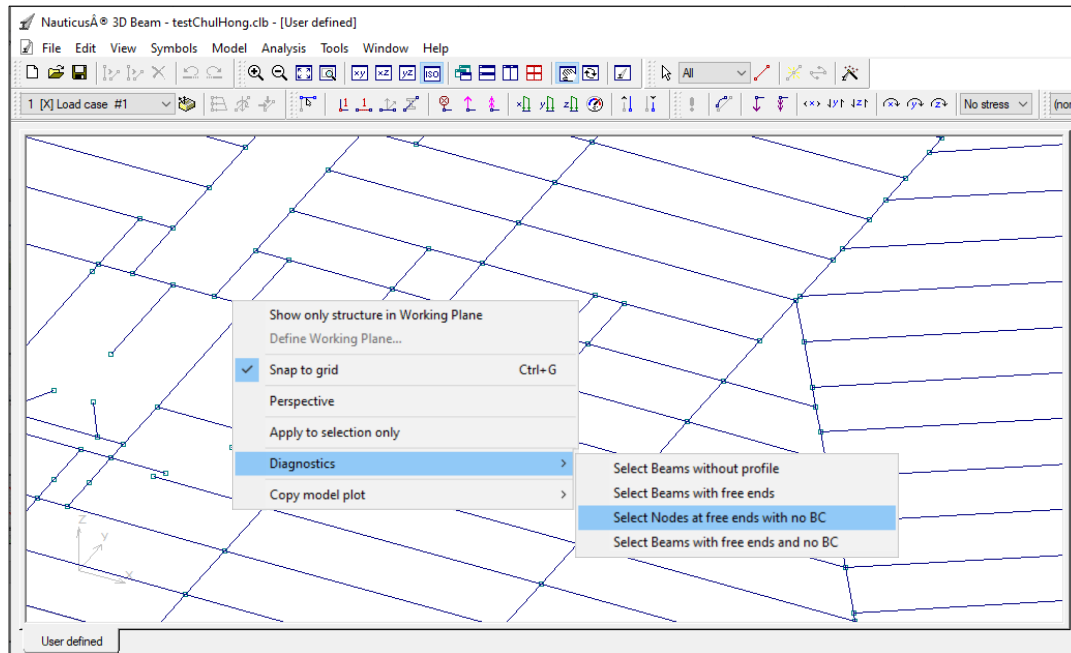


3D-Beam beam – V20.24

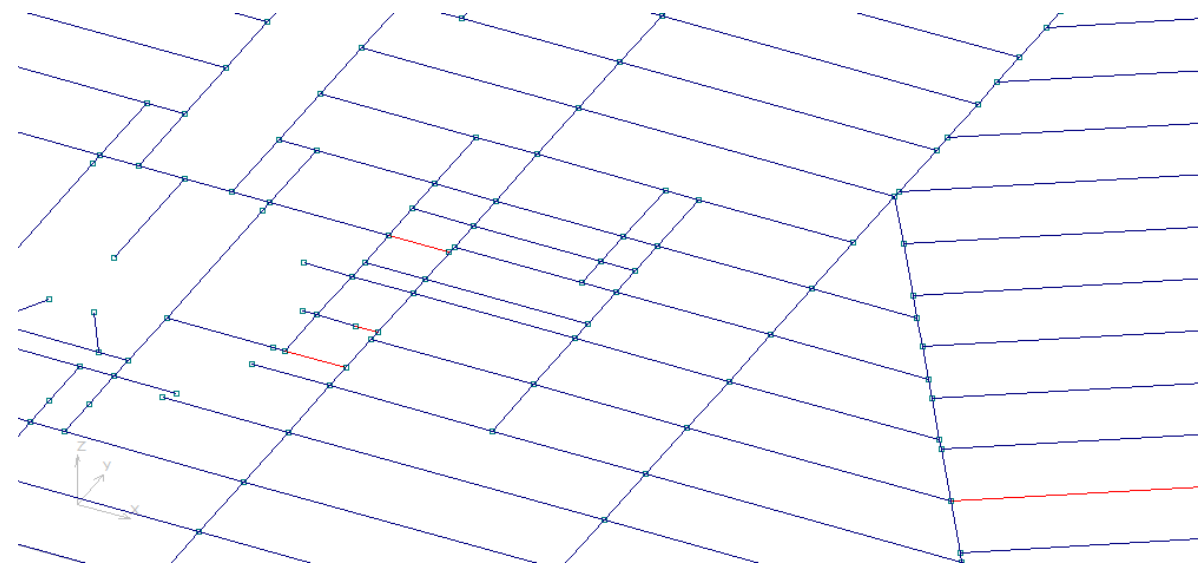
Improved Usability – Connectivity diagnostics

- When running analysis in 3D-Beam, the program might return **error messages** (typically due to missing profile dimensions / missing boundary conditions), or analysis results with **unrealistic deformations** (typically due to disconnected beams)
- On the context menu, additional options for **Diagnostics** is introduced, highlighting elements meeting certain criteria

Diagnostics available on the context menu



Elements meeting the certain diagnostics criteria highlighted

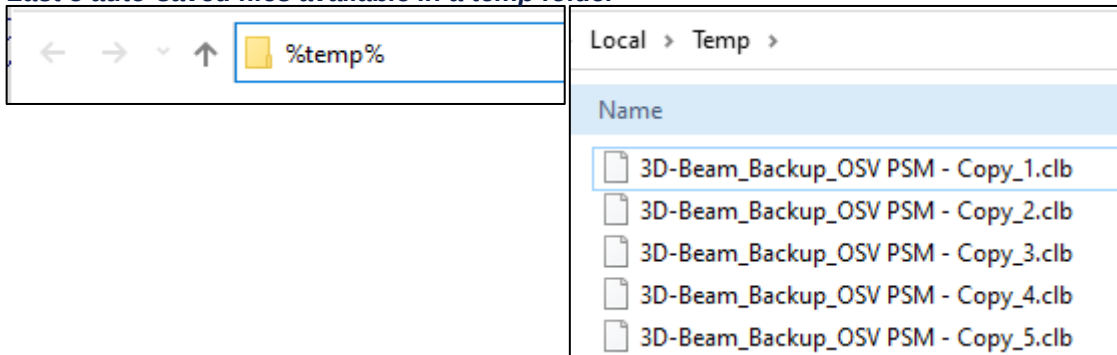


3D-Beam beam – V20.29

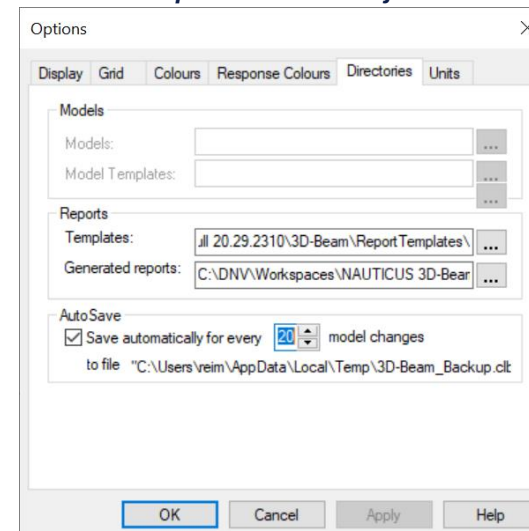
Improved Usability – Autosave / backup

- The **auto-save** functionality has been updated to store the last 5 auto-saved files
- This is expected to improve the chances for re-establishing the model to a previous stage after abnormal termination of 3D Beam
- The files are stored in the temporary folder, accessible by entering **%temp%** in the address bar of Explorer
- The **auto-save** functionality can be **adjusted** under Options -> Directories (default enabled, and for every 20 model changes)

Last 5 auto-saved files available in a temp folder



Auto-save options can be adjusted



Excel spreadsheets – V20.24

Extended Rule coverage – Minimum thickness list

- From Nauticus Hull V20.24 (January 2023), Excel spreadsheet with minimum thickness lists is provided
- Applicable Rule sets: DNV Rules and CSR BC&OT
- Rule coverage : Plates, stiffeners and TB, PSM, and ship specific requirements (DNV Rules Pt.5)
- The spreadsheet also allows for custom calculation based on user-specified ***a***, ***b*** and ***k***

Minimum thickness list for plates, stiffeners and TB, and PSM

Stiffeners and tripping brackets (Pt.3 Ch.6 Sec.3 (2))					
Element	Location	footnote(s)	a	b	t _{min} mm
Stiffeners and attached end brackets	Tank boundary				7.00
	boundary of cargo holds for dry bulk cargo				7.00
	Single strength deck				7.00
	Shell up to freeboard deck				7.00
	Structures in deckhouse and superstructure				4.00
	Decks for vessels with more than 2 continuous decks above 0.7 D from baseline				4.00
Tripping brackets	Other structure				6.00
					7.00

Primary supporting members (Pt.3 Ch.6 Sec.3 (3))					
Individual calculation	a	b	k	rounded 0.00 0.0	b ² L ² 0.0
	Element				
				footnote(s)	a
Bottom centreline girder below longitudinal bulkhead in cargo area if arranged				5.0	0.030
Bottom centreline girder outside cargo area in general for cargo ships				5.0	0.030
Bottom centreline girder over full length of other ship types than cargo ships				5.0	0.030
Bottom longitudinal girders in general				5.0	0.077
Floors in all peak tanks including reduced floors or floors with large opening	a)			5.0	0.025
Floors in general				5.0	0.015
PSM at tank boundaries and boundaries of holds intended for cargo in bulk				4.5	0.015
PSM at single strength deck and shell up to freeboard deck	2)			4.5	0.015
PSM in deckhouses and superstructures and decks for vessels with more than 2 continuous decks above 0.7 D from baseline	3)			4.5	0.010
PSM in general				4.5	0.010

k	t _{min} mm		
	1	0.78	0.72
0.66	13.50	12.50	12.00
	13.50	12.50	12.00
	13.50	12.50	12.00
	10.00	9.00	9.00
	10.00	9.00	9.00
	3.50	3.50	3.50
8.5	3.00	8.50	8.50
	8.50	8.00	8.00
	7.00	6.50	6.50
6.5	6.50	6.50	6.00
	7.50	7.00	7.00

1) $\Delta L_2 \leq 5.0$

2) $\Delta L_2 \leq 2.5$ for stringers in double side next to dry space not intended for cargo in bulk.

3) $\Delta L_2 \leq 2.0$

a) See Pt.3 Sec. 5.1.4 for arrangement and treatment of all peak tank

Separate list for ship specific requirements (DNV Pt.5)

Offshore service vessels (Sec.2 [J])			
Plates			
#	Location		b [mm]
[3-2]	Side plating including bilge strake, up to second deck above freeboard deck	all cases but...	
[4-2]	Weather deck for cargo	... fender committed in fender zone	
Offshore service vessel(s) (Sec.2 [J3])			
Plates			
#	Location		b [mm]
[1-1]	Plating adjacent to the stern roller and shark jaw		
[1-2]	Side plating up to forecastle deck (as [2.3-2])	all cases but...	
[2-1]	Bulkhead gross plate thickness	... fender committed in fender zone	
[4-3]	Plates in superstructures and deckhouses	front bulkheads and weather deck forward of the lowest tier of the front bulkhead sides and aft end bulkheads and weather decks elsewhere superstructure and deckhouse decks (in way of accommodation)	
Standby vessel (Sec.4)			
Plates			
#	Location		b [mm]
[1-2]	Plating in way of steel fender area along the level of the freeboard cargo deck and second deck above	with steel fender steel fender committed	
[1-2]	Side plating above the bilge, in way of the rescue zone, if vessel not assigned class notation OSV		
[1-3]	Exposed weather deck at the rescue zone		
o	Min thick general	Min thick service vessel	o

Allows for custom calculation with user-defined a, k and b

Info:	All minimum thickness values shown on this sheet are net thicknesses. Corrosion addition to t_c is to be added to get minimum gross thickness.																				
Disclaimer:	The minimum thickness values shown on this sheet reflect the general requirements, as specified in Pt. 3 Ch. 6 Sec. 3 (1), [2] and [3]. Please note that there may be additional requirements to be fulfilled, e.g. ship type specific ones, as specified in Pt. 5.																				
	recalc																				
	Plates (Pt. 3 Ch. 6 Sec. 3 (1))																				
Individual calculation	a b k $t = a \cdot b \cdot \sqrt[4]{\frac{1}{k}}$ rounded 0.00																				
Element	<table> <tr> <th>Location</th><th>Footnote(s)</th><th>a</th><th>b</th></tr> <tr> <td>Keel</td><td></td><td>5.0</td><td>0.050</td></tr> <tr> <td>Bottom</td><td></td><td>4.5</td><td>0.035</td></tr> <tr> <td>Bilge</td><td></td><td>4.5</td><td>0.035</td></tr> <tr> <td>Side plates</td><td>From upper end of bilge plating to $T_{10} + 4.6$ m</td><td>4.0</td><td>0.035</td></tr> </table>	Location	Footnote(s)	a	b	Keel		5.0	0.050	Bottom		4.5	0.035	Bilge		4.5	0.035	Side plates	From upper end of bilge plating to $T_{10} + 4.6$ m	4.0	0.035
Location	Footnote(s)	a	b																		
Keel		5.0	0.050																		
Bottom		4.5	0.035																		
Bilge		4.5	0.035																		
Side plates	From upper end of bilge plating to $T_{10} + 4.6$ m	4.0	0.035																		

		Table 3.3.3			
		VL-NS	VL-32	VL-36	user
R_{H1}	235	315	355		
k	1	0.78	0.72	0.66	
		19.00	17.50	17.00	15.50
		14.50	13.00	13.00	12.50
		14.50	13.00	13.00	12.50
		14.00	12.50	12.50	12.00

Buckling codes other than CFM

- Nauticus Hull V20 includes Excel spreadsheets for other buckling codes than CFM
- Ported to NH V20 and updated to latest revision

PULS Excel spreadsheet – V20.24

[illegible]

DNV-RP-C202 – V20.30

NAUTICS
HULL

DNV

Program: **Buckling strength of shells** Rule ref: **DNV-RP-C202** Rev: **September 2019, Amended September 2021**

PRINCIPAL DATA

Identification	LRF2 ref. RP-C202 1.1
User defined safety factor	?? $S_F = 1.000$
Modulus of Elasticity	?? $E = 210.000 \text{ N/mm}^2$
Material Factor (1/5 Condition)	?? $\gamma_m = 1.150$
Poisson's Ratio	?? $\nu = 0.3$
Shear Modulus	?? $G = 80.769 \text{ N/mm}^2$

SHELL

Orthogonally Stiffened shell (Force input)

Thickness	?? $t = 18.0 \text{ mm}$
Yield stress	?? $f_y = 235 \text{ N/mm}^2$
Shell Radius (middle of plate)	?? $r_s = 11.000 \text{ m}$
Distance between rings	?? $L_r = 5.500 \text{ m}$
Length of shell	?? $L = 10.000 \text{ m}$
Total cylinder length	?? $L_c = 10.000 \text{ m}$
Eff. Buckling length factor	?? $k = 1.0$

Show calc.ulation Sheets

Print Page

LONGITUDINAL STIFFENER

Stiffener type	Select from table
Yield stress	?? $f_y = 235 \text{ N/mm}^2$
Total Height of section	?? $h_{tot} = 200.0 \text{ mm}$
Web thickness	?? $t_w = 20.0 \text{ mm}$
Flange width	?? $b_f = 20.0 \text{ mm}$
Flange thickness	?? $t_a = 0.0 \text{ mm}$
Stiffener spacing	?? $s = 800.0 \text{ mm}$

Plot longitudinal Stiffener

Notes to the spreadsheet

RING STIFFENER AND RING FRAMES

Stiffener Type	Select from table
Yield stress	?? $f_y = 235 \text{ N/mm}^2$
Total Height of section	?? $h_{tot} = 500.0 \text{ mm}$
Web Thickness	?? $t_w = 20.0 \text{ mm}$
Flange width	?? $b_f = 35.0 \text{ mm}$
Flange thickness	?? $t_a = 35.0 \text{ mm}$
Man flange outstand	?? $b_{fs} = 100.0 \text{ mm}$
Distance between tripping brackets	$l_T = 0.0 \text{ mm}$ (use 0 if none)
Initial out of roundness of stiffener:	$\delta_o = 0.005 \text{ %}$

Ring stiffeners:

$I_{profile}$	Select from table
f_y	?? $f_y = 235 \text{ N/mm}^2$
h_{tot}	?? $h_{tot} = 500.0 \text{ mm}$
t_w	?? $t_w = 20.0 \text{ mm}$
b_f	?? $b_f = 35.0 \text{ mm}$
t_a	?? $t_a = 35.0 \text{ mm}$
b_{fs}	?? $b_{fs} = 100.0 \text{ mm}$
l_T	?? $l_T = 0.0 \text{ mm}$ (use 0 if none)
δ_o	?? $\delta_o = 0.005 \text{ %}$

Heavy Ring Frame:

$I_{profile}$	Select from table
f_y	?? $f_y = 235 \text{ N/mm}^2$
h_{tot}	?? $h_{tot} = 630.0 \text{ mm}$
t_w	?? $t_w = 12.0 \text{ mm}$
b_f	?? $b_f = 20.0 \text{ mm}$
t_a	?? $t_a = 35.0 \text{ mm}$
b_{fs}	?? $b_{fs} = 94.0 \text{ mm}$
l_T	?? $l_T = 0.0 \text{ mm}$
δ_o	?? $\delta_o = 0.005 \text{ %}$

L. brs. Grades: L_{275} 10.000.0 L_{275} 10.000.0 L_{275} 10.000.0

Fabrication method of stiffener:

Cold formed ring frame:

Cold formed Heavy ring frame:

LOAD DATA: ??

Specify forces

Design Axial force	?? $N_{ax} = 0.00 \text{ kN}$
Design bending moment	?? $M_{bx} = 0.00 \text{ kNm}$
Design torsional moment	?? $T_{ax} = 0.00 \text{ kNm}$
Design shear force	?? $V_{ax} = 0.00 \text{ kN}$
Design lateral pressure	?? $p_{ax} = 0.00 \text{ N/mm}^2$

Load

Specify Stresses

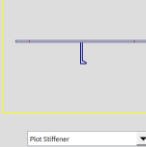
Design axial stress	?? $\sigma_{ax} = 0.00 \text{ N/mm}^2$
Design bending stress	?? $\sigma_{bx} = 0.00 \text{ N/mm}^2$
Design torsional stress	?? $\tau_{ax} = 0.00 \text{ N/mm}^2$
Design shear stress	?? $\tau_{ax} = 0.00 \text{ N/mm}^2$

DNV-RP-C201 – V20.31

NAUTICS®
HULL

DNV

Program: **Buckling strength of plated structures**
Rule ref: **DNV-RP-C201**
Rev: **September 2022**

PRINCIPAL DATA		Save to Stack		Goto Stack →	
Identification Material Factor		UFD, ref. RP-C201 §2			
Yield stress		γ_{M} = 1.15			
Modulus of Elasticity		E = 210 000 N/mm ²			
Poissons Ratio		ν = 0.3			
Shear Modulus		G = 80 769 N/mm ²			
PLATE					
Thickness		t_w = 12.0 mm			
Stiffener Spacing		s = 600.0 mm			
Stiffener Length		l_s = 1500.0 mm			
Girder Length		L_g = 4000.0 mm			
Panel length (max.still open space) L_p		L_p = 9800.0 mm			
		Plot stiffener v			
		Notes in the spreadsheet			
STIFFENER AND GIRDERS		Stiffeners:		Girders:	
Stiffener Type		Select from table	HP-profile	Select from table	T-profile
Total Height of section		$h_{st} =$ 140.0 mm	$h_{st} =$ 425.0 mm		
Web thickness		$t_w =$ 10.0 mm	$t_w =$ 14.0 mm		
Flange width		$b =$ 23.0 mm	$b =$ 122.0 mm		
Flange thickness		$t_f =$ 15.3 mm	$t_f =$ 45.0 mm		
Buckling lateral factor: (optional)		$k_{wp} =$	$k_{wp} =$		
Distance between tripping brackets: l_b		mm	mm		
Fabrication method: welded cross section		☒ welded cross section			
Continuous stiffeners		☒ Continuous girder			
Tension field action: External Tension Field Action is Allowed		☒ (tension plate is effective against sagging V (i.e. Method I in usage))			
LOAD DATA:					
Load factor for stresses: $\gamma_m =$		1.00	Interaction option at high shear: See NS-EN 1993-1-1, [6.2.10]		
Load fact. for lateral load: $\gamma_m =$		1.00	Reduce thickness in cross section		
⊗ Uprying Stress C / Varying Stress					
Stiffener stresses		Girder stresses			
Side1 Side2		Side1 Middle Side2			
					
Longitudinal comp.: $\sigma_1 =$		0.00 0.00 0.00 0.00			
Transverse compress.: $\sigma_2 =$		N/mm ² N/mm ² N/mm ² N/mm ²			
Shear Stress: $\tau_{xy} =$		M ₁ M ₂ M ₁ M ₂			
Bending moments		Moment reduction factor: $M_{red} =$ 0.00E+00 0.00E+00 0.00E+00 0.00E+00			
Lateral load / pressure: $p_{sd} =$		N/mm ²	Find Max		
Min. pr. in dist. sp.: $p_{dist.sp.} =$		N/mm ²	Calc. pressure		
Press. variation both spans: Equal pressure		Support moment factor: $k_{sp} =$ 12.00 0			
		Midspan moment factor: $k_{mid} =$ 24.00 0			
		(for stiffener with effective plate)			
Calculate Buckline					

Rule Calculator – V20.31

Extended Rule coverage – End brackets slenderness criteria

- Slenderness criteria according to RU-SHIP Pt.3 Ch.8 Sec.2 [5.2]

Pt.3 Ch.8 Sec.2 [5.2]

Pt.3 Ch.8 Sec.2 [5.3.1]

Pt.3 Ch.8 Sec.2 [3.1]

▶ Calculate all		▶ Calculate selected		Pt.3 Ch.8 Sec.2 [5.2] Slenderness - End brackets	
		1	3	4	5
Input					
Id text	S1D				
Gross bracket thickness, t_b [mm]	20	12	12	12	12
Total corrosion addition, t_c [mm]	2	0,5	2	1	1
Length of bracket, l_b [mm]	1202	1200	600	600	600
Depth of bracket, d_b [mm]	601	600	400	650	650
Material, bracket	VL-36	VL-NS	VL-NS	VL-NS	VL-NS
Edge reinforcement					
Edge stiffener profile	WeldedAngle 200 x 100 x 10	FlatBar 100 x 8			
Edge material	VL-36	VL-32	VL-32	VL-32	VL-32
Bracket proportions					
Information					
Slenderness coefficient C for t_b	70,0	26,0	70,0	0,0	0,0
Net required, $t_{b_slend_net}$ [mm]	10,6	23,1	5,7	∞	∞
Gross required, $t_{b_slend_gr}$ [mm]	12,5	23,5	7,0	∞	∞
Proportions OK?	OK	NOT OK	OK	db/lb NOT OK	db/lb NOT OK
Edge stiffener, h_w					
Slenderness coefficient C for h_w	75		75		
Net required, h_{w_net} [mm]	110,8		52,1		
Gross required, h_{w_gr} [mm]	109,0		50,5		
Actual h_w [mm]	175,0		100,0		
h_w OK?	OK		OK		
Edge stiffener, slenderness					
Gross web slend thk, $t_{w_slend_gr}$ [mm]	3,5		6,5		
Gross flange slend thk, $t_{f_slend_gr}$ [mm]	11,0		0,0		
Gross flange breadth, b_f [mm]	0,0		0,0		
Slenderness ok?	OK		OK		
Applied corrosion additions					
Applied corrosion addition for bracket, t_c [mm]	2,0	0,5	2,0	1,0	1,0
Total corrosion addition for web, t_c [mm]	2,0	0,0	1,6	0,0	0,0
Total corrosion addition for flange, t_c [mm]	2,0	0,0	1,6	0,0	0,0

Rule Calculator – V20.31

Extended Rule coverage – Tripping brackets slenderness criteria

- Slenderness criteria according to RU-SHIP Pt.3 Ch.8 Sec.2 [5.1]

Pt.3 Ch.8 Sec.2 [5.1]

Pt.3 Ch.8 Sec.2 [5.3.1]

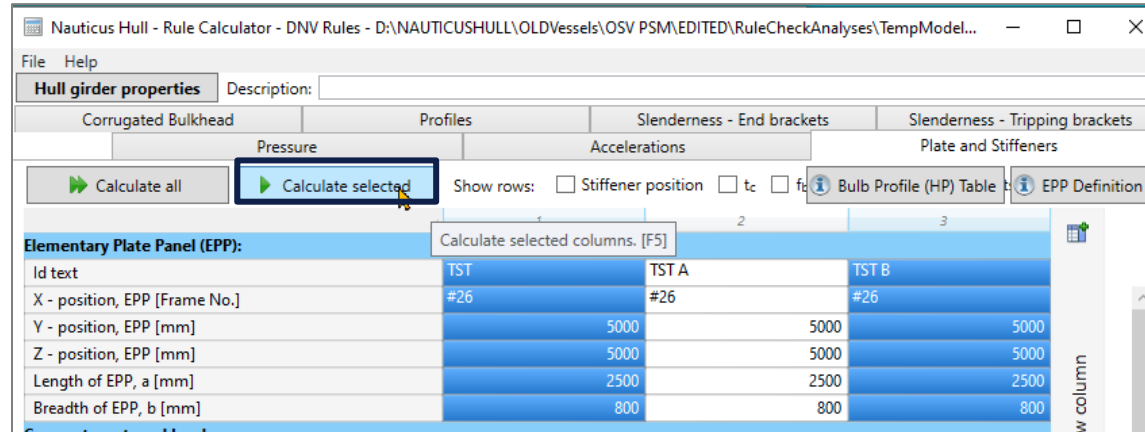
Pt.3 Ch.8 Sec.2 [3.1]

Calculate all Calculate selected		Pt.3 Ch.8 Sec.2 [5.1] Slenderness - Tripping brackets			
	1	2	3	4	
Input					
Id text					
PSM location	Bulkhead and side	Deck or bottom	Deck or bottom	Deck or bottom	
Unsupported length of PSM flange [m]	5	5	2	6	
PSM flange breadth, gross, bf [mm]	200	250	344	100	
Unsymmetrical flange?	☐	☒	☒	☐	
Gross bracket thickness, tb [mm]	12	12	9	7	
Total corrosion addition, tc [mm]	2,5	3	2	2	
Length of bracket, lb [mm]	1200	1200	800	1200	
Edge stiffener profile	FlatBar 100 x 10	FlatBar 100 x 10			
Edge material	VL-NS	VL-NS	VL-NS	VL-NS	
Distance between tripping bkts					
Information					
Slenderness coefficient C	0,015	0,025	0,025	0,020	
Sb [m]	3,000	6,000	6,000	3,000	
Unsupported PSM flange length OK?	NOT OK	OK	OK	NOT OK	
Tripping bracket edge stiffening					
Edge stiffening required?	Yes, specified	Yes, specified	Yes, not specified	Yes, not specified	
Edge stiffener, hw					
Slenderness coefficient C for hw	50	50			
Net required, hw_net [mm]	60,0	60,0			
Gross required, hw_gr [mm]	58,0	58,0			
Actual hw [mm]	100,0	100,0			
hw OK?	OK	OK			
Edge stiffener, slenderness					
Gross web slend thk, tw_slend_gr [mm]	5,5	5,5			
Gross flange slend thk, tf_slend_gr [mm]	0,0	0,0			
Gross flange breadth, bf [mm]	0,0	0,0			
Slenderness ok?	OK	OK			
Applied corrosion additions					
Applied corrosion addition for bracket, tc [mm]	2,4	2,4	1,8	1,4	
Total corrosion addition for web, tc [mm]	2,0	2,0	0,0	0,0	
Total corrosion addition for flange, tc [mm]	2,0	2,0	0,0	0,0	

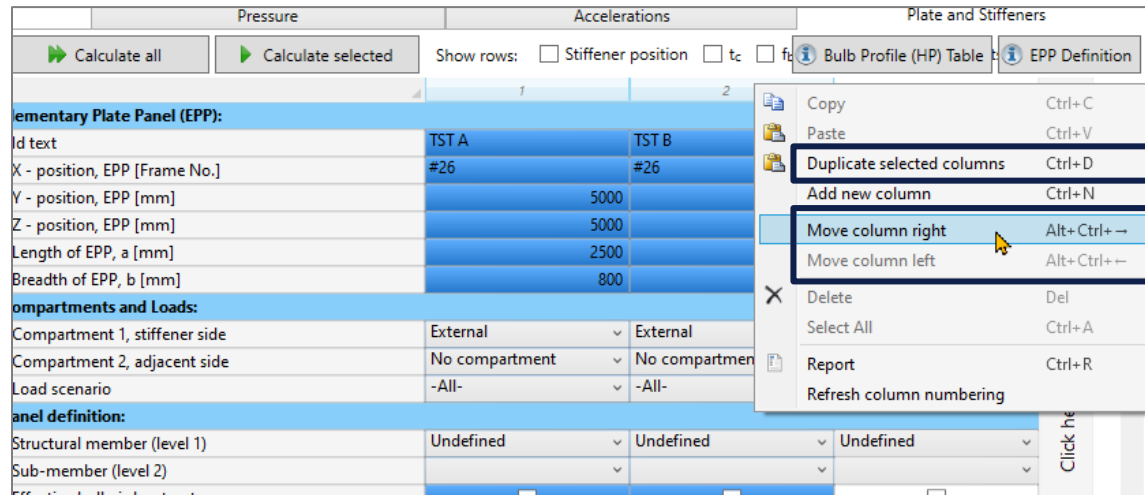
Rule Calculator – V20.31

Improved usability – General improvements to UI

- Calculate multiple selected columns



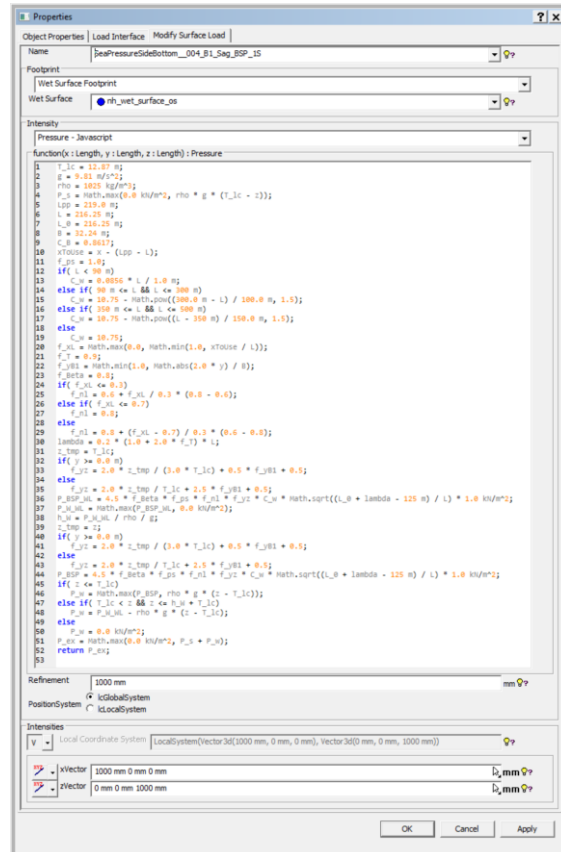
- Duplicate multiple selected columns
- Rearrange sequence of selected columns – move right or left



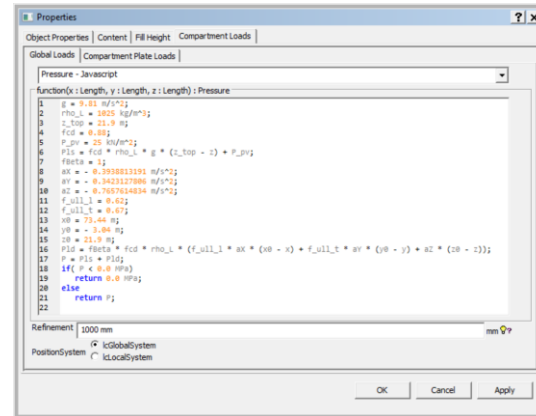
FE manager – V20.29

Improved Usability – Pressures as JavaScript commands

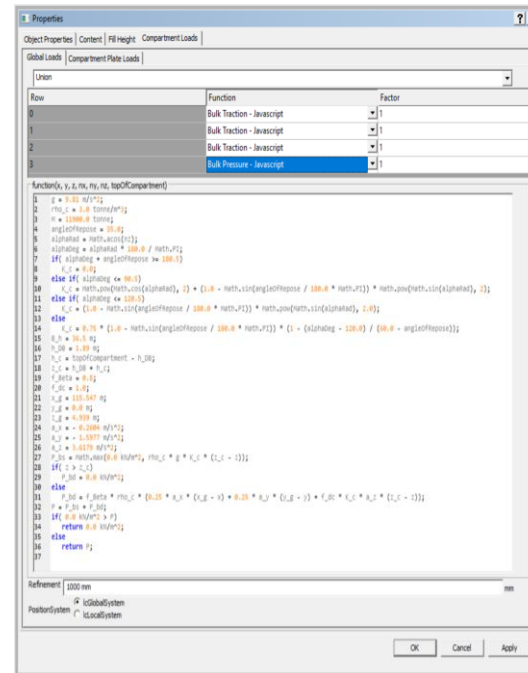
Sea pressure



Liquid compartment pressure



Bulk compartment pressure

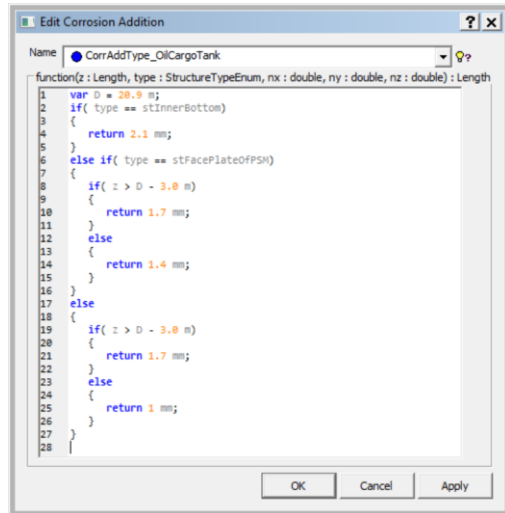


FE manager – V20.30

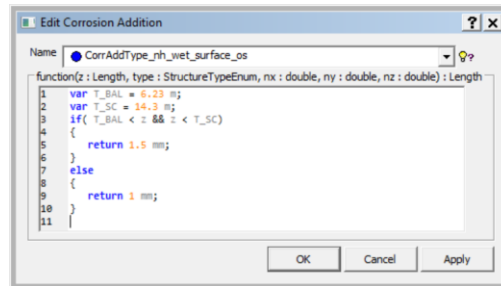
Improved Usability – Corrosion additions as JavaScript commands

- Arguments that is used in the JavaScript corrosion additions typically assigned to compartments:
 - z-value for element centroid
 - Structure type (can be exported from Nauticus Hull to GeniE)
 - Surface normal vector (DNV corrosion additions Void spaces)

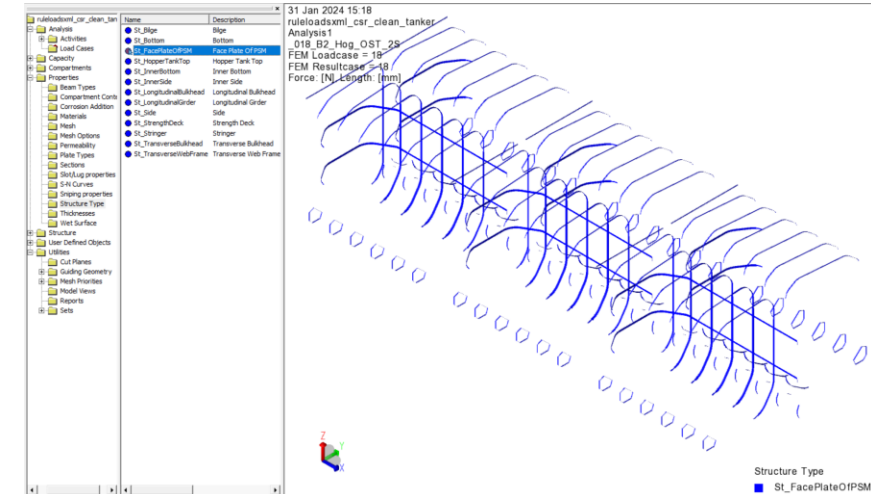
Oil cargo tank



Outer shell



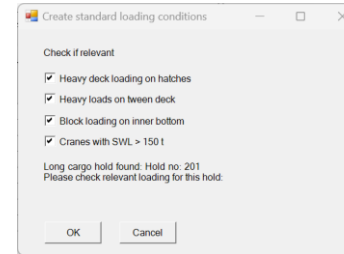
New Structure type FacePlateOfPSM automatically assigned [Demo](#)



FE manager – V20.31

Improved Rule coverage – MPV load template

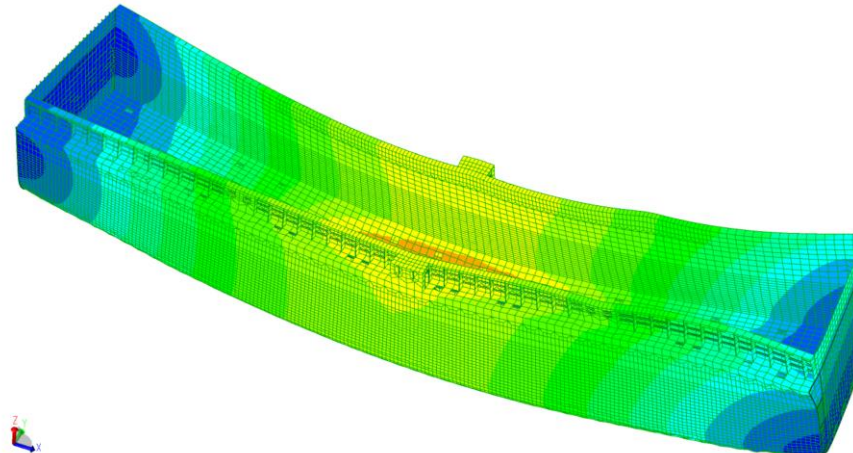
- Template for automatic creation of Standard FE loading conditions available
- MPV ship specific loads supported:
 - Block loading on inner bottom
 - ULD on hatches
 - Crane loads



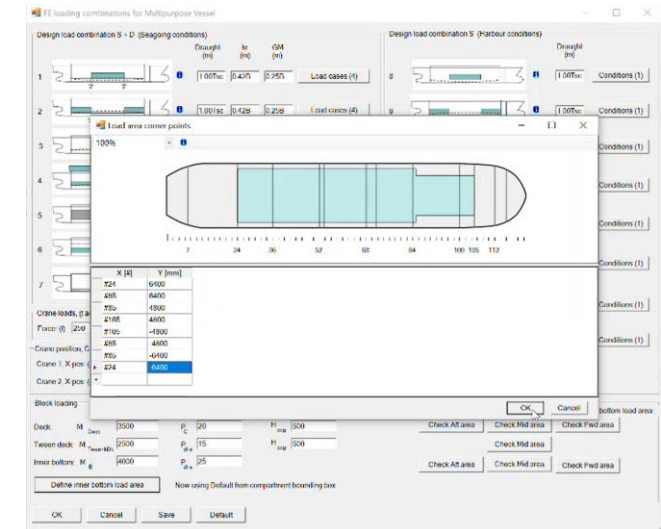
MPV load template



GeniE used for partial ship FE model



MPV load template



FE manager – V20.31

Model export to GeniE

- 1. New **Local model export** to GeniE (Specify bounding box)
- 2. Improved **Cargo hold export** to GeniE (adding openings, stabilization, performance)
- 3. Changed **Global model export** (only available for Container Ships and MPV)

Local model export to GeniE

FEA General Settings

General information

Name:

FE model extent

Aft end #
#94-500

Fwd end #
#94+500

Min y (mm)
unlimited

Max y (mm)
unlimited

Min z (mm)
unlimited

Max z (mm)
unlimited

Hullform settings

No. of points on each hull form curve

Hull form curve min distance [m]

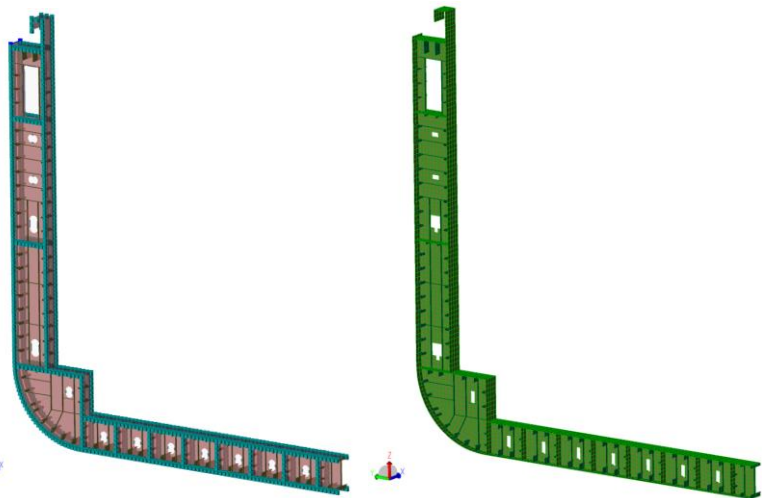
Exporting scope

☒ 1: Include all scantlings
☐ 2: Skip outer shell scantlings
☐ 3: Include only outer shell scantlings

Include

☒ Modelling grids
☒ Boundary conditions
☒ Wet surface properties
☒ Sets
☒ Structure types
☒ Default mesh density [mm]

GeniE workspace name:



Cargo hold model export to GeniE

Export to GeniE

☒ 3D Model
☐ Cross section
☐ Transverse bulkhead

Hullform settings

No. of points on each hull form curve

Hull form curve min distance [m]

Exporting scope

☒ 1: Include all scantlings
☐ 2: Skip outer shell scantlings
☐ 3: Include only outer shell scantlings

Include

☒ Modelling grids
☒ Boundary conditions
☒ Wet surface properties
☒ Sets ☒ HGLA Sets
☒ Structure types
☒ Default mesh density [mm]

GeniE workspace name:

Global model export to GeniE

FEA General Settings

General information

Name:

FE model extent

Aft peak bulkhead #
#18

Fwd peak bulkhead #
#138

Hullform settings

No. of points on each hull form curve

Hull form curve min distance [m]

Exporting scope

☒ 1: Include all scantlings
☐ 2: Skip outer shell scantlings
☐ 3: Include only outer shell scantlings

Include

☒ Modelling grids
☒ Wet surface properties
☒ Sets
☒ Structure types
☒ Default mesh density [mm]

GeniE workspace name:

3D model in Nauticus Hull – Status July 2024

3D structural modelling

3D model export to GeniE

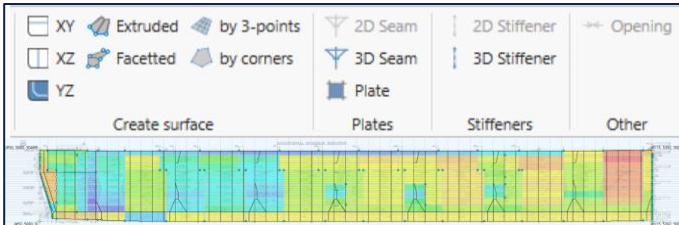
3D model Rule checks

Nauticus Hull 3D model

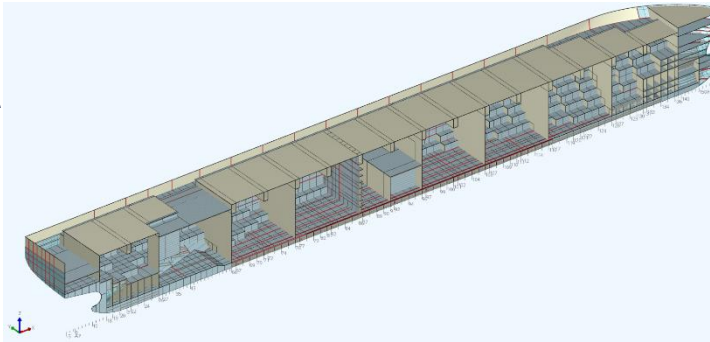
How to obtain a model and how to run Rule checks

- Two alternative ways to obtain a Nauticus Hull 3D model
 1. Model from scratch using interactive modelling; or
 2. Re-use the full design model by import using the 3D OCX exchange format
- Two alternative ways to run cross-sectional analysis on a Nauticus Hull 3D model
 1. Iterate directly on the 3D model: Temporarily intersections of the 3D model – **From V20.29**; or
 2. Check variants of the 3D model: Permanent Section Scantlings independent of the 3D model

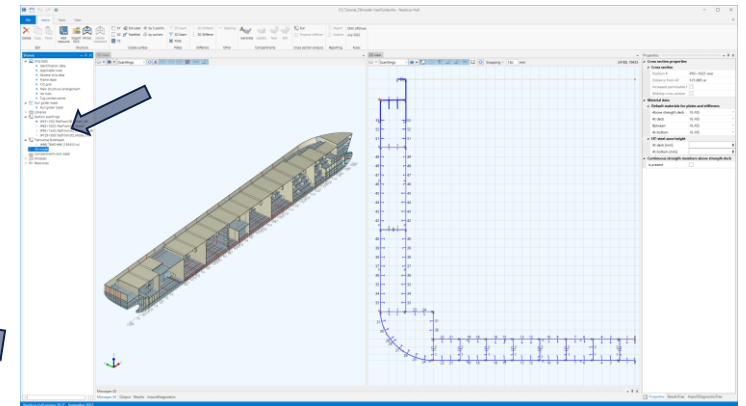
Alt 1: Model from scratch using interactive modelling



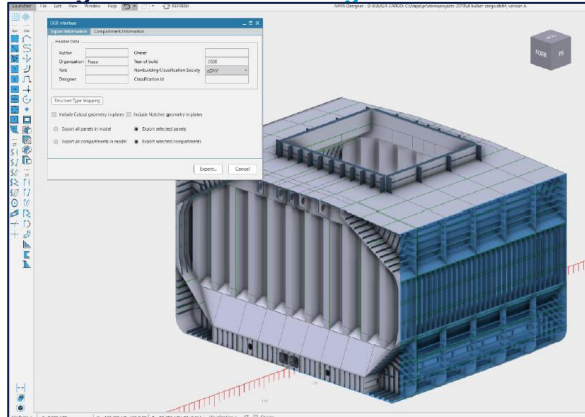
Prescriptive 3D model in Nauticus Hull for Rule checks (Cross sectional analysis and TBHD analysis)



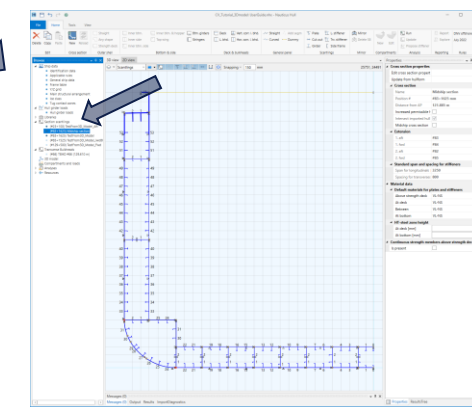
Iterate directly on the 3D model: Temporarily intersection of the 3D model



Alt 2: Re-use the full design model by Import using the 3D OCX exchange format



Check variants of the 3D model: Permanent Section Scantlings independent of the 3D model



Epic 346138: 3D structural modelling

Incremental steps by deployment of new features

July 2020

April 2021

Jan 2022

July 2022

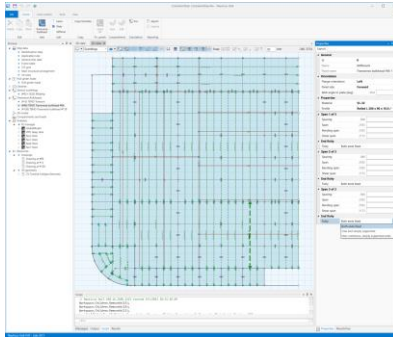
Jan 2023

Sep 2023

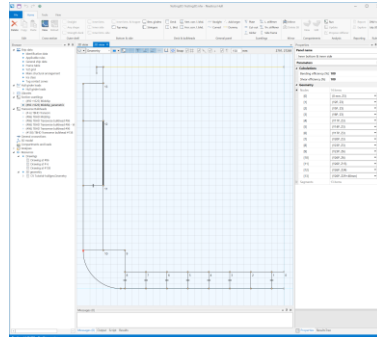
3D WT geometry



2D scantlings modeller



Parametric modelling



Con. 2D modeller to 3D model

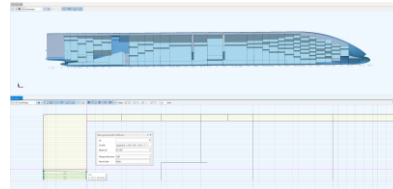
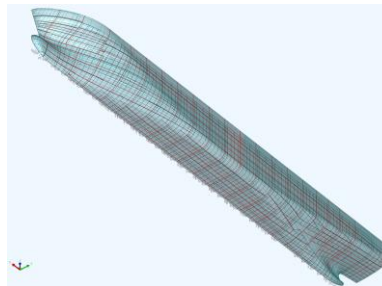
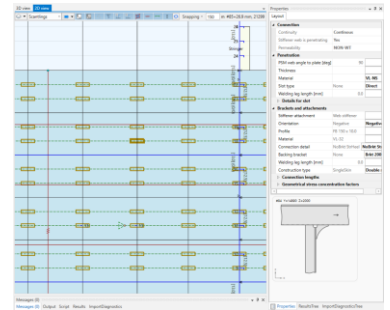


Plate seams on outer shell



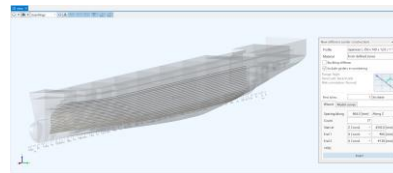
New connections



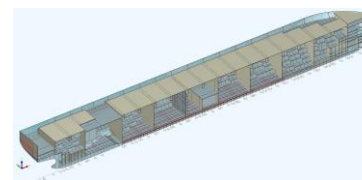
3D compartments



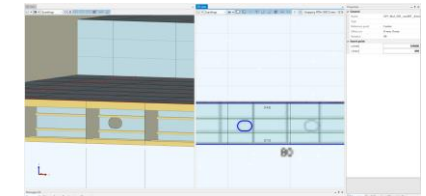
Wizards for stiffeners on shell



Bug fixes and improvements



Openings

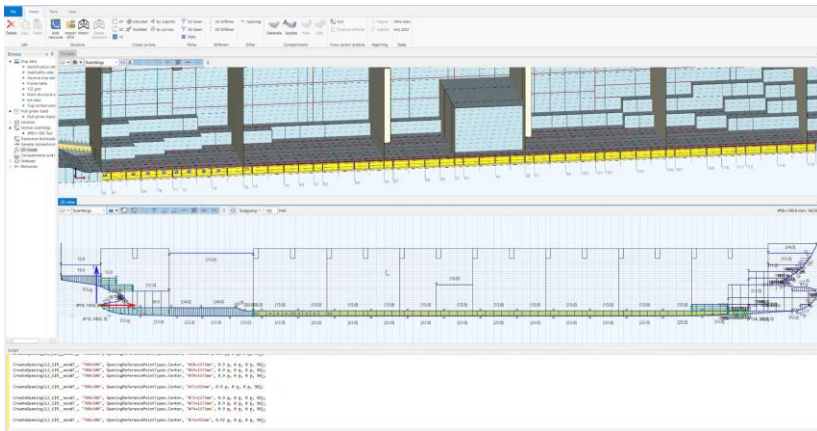


Epic 346138: 3D structural modelling

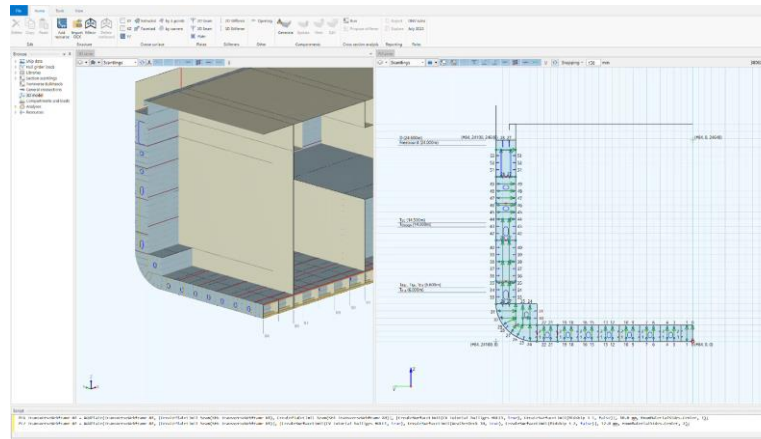
Status V20.31 July 2024

- Used in two newbuilding projects (MPVs)
- Further improving modelling capabilities in close cooperation with approval experts
- Mainly focusing on improving scantlings modelling efficiency

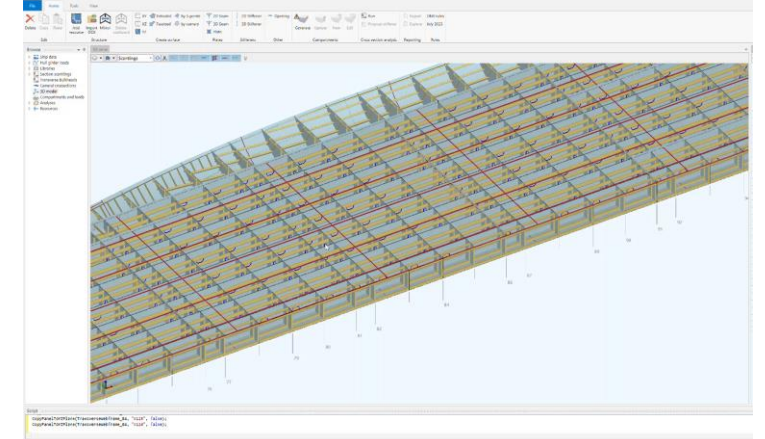
Copy openings on longitudinal girders



Model typical web frame



Copy typical web frame



Epic 496491: 3D model export to GeniE

Incremental steps by deployment of new features

Jan 2020

April 2021

Jan 2022

July 2022

Jan 2023

Jan 2024

Cross section

3D geometry

Transverse bulkheads

3D geometry and scantlings

Loads as JavaScript funct.

Corrosion additions as JS

Liquid compartment pressure

Static liquid pressure for normal operations at sea according to DNV-RU-SHIP Pt.3 Ch.4 Sec.6 [1.2.1]:
 $P_{ls} = \rho \cdot g \cdot (z_{top} - z)$
 // Dynamic liquid pressure according to DNV-RU-SHIP Pt.3 Ch.4 Sec.6 [1.3.1]:
 $P_{ld} = f_{cd} \cdot \rho \cdot (a_z \cdot (z_0 - z) + f_{u11} \cdot a_X \cdot (x_0 - x) + f_{u11} \cdot a_Y \cdot (y_0 - y))$
 // Total liquid pressure according to DNV-RU-SHIP Pt.3 Ch.4 Sec.6 [1.1.1]:
 $P = P_{ls} + P_{ld}$
 if (P < 0.0 MPa)
 return 0.0 MPa;
 else
 return P;

Compartment oil cargo tk

```
var t = 20.0 t;  
if (type == "oilCargo")  
{  
    return 2.5 m;  
}  
else if (type == "steelDeck")  
{  
    if (z > 0 - 3.0 m)  
    {  
        return 1.7 m;  
    }  
    else  
    {  
        return 1.4 m;  
    }  
}  
else  
{  
    if (z > 0 - 3.0 m)  
    {  
        return 1.7 m;  
    }  
    else  
    {  
        return 1 m;  
    }  
}
```

Try / catch handling

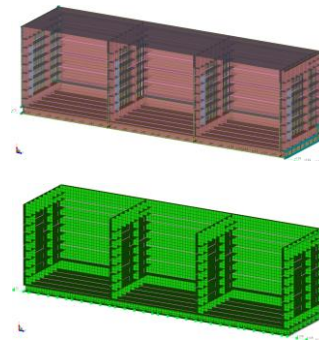
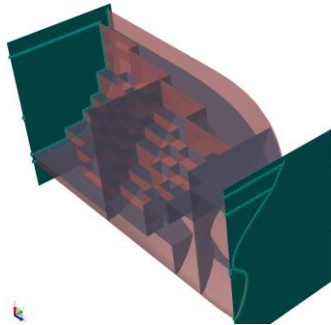
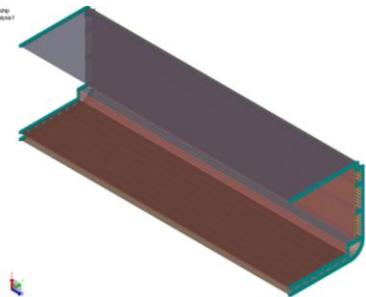
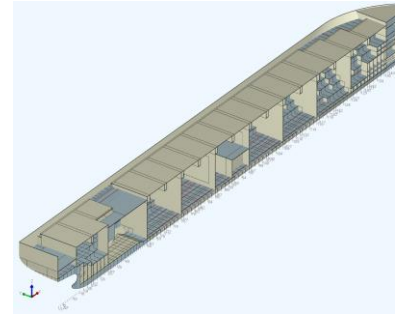
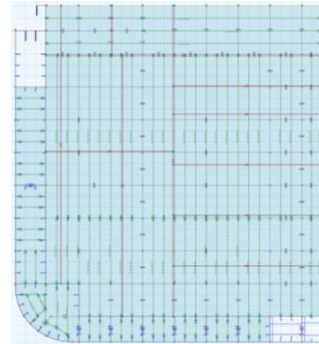
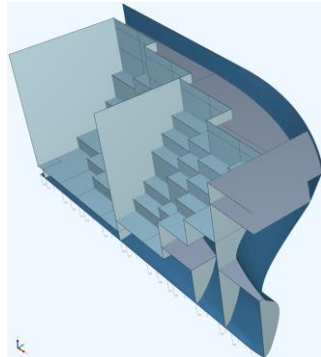
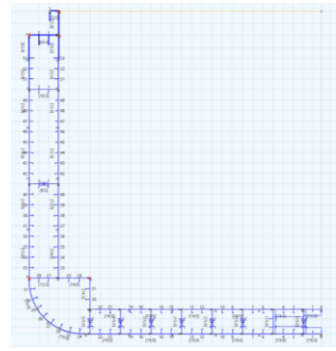
Sets and structure types

Splitting of a surface

try(refPnt = Point(7125 mm,6000 mm,750 mm);
 SplitExtedFace(F215_A_3LBH_1, refPnt);
 }catch (ex) { errorMsgArray.add(ex);}
Exception thrown by GeniE
 ->Error message No. 1:
 ->[JS0002] Invalid operation (line: 2253:
 In function: SplitExtedFace(F215_A_3LBH_1, refPnt) :
 [JS0006] Unknown identifier (line: 2253: F215_A_3LBH_1)

Include:

- ☒ Modelling grids
- ☒ Boundary conditions
- ☒ Wet surface properties
- ☒ Sets ☒ HGLA Sets
- ☒ Structure types
- ☒ Default mesh density 800 [mm]

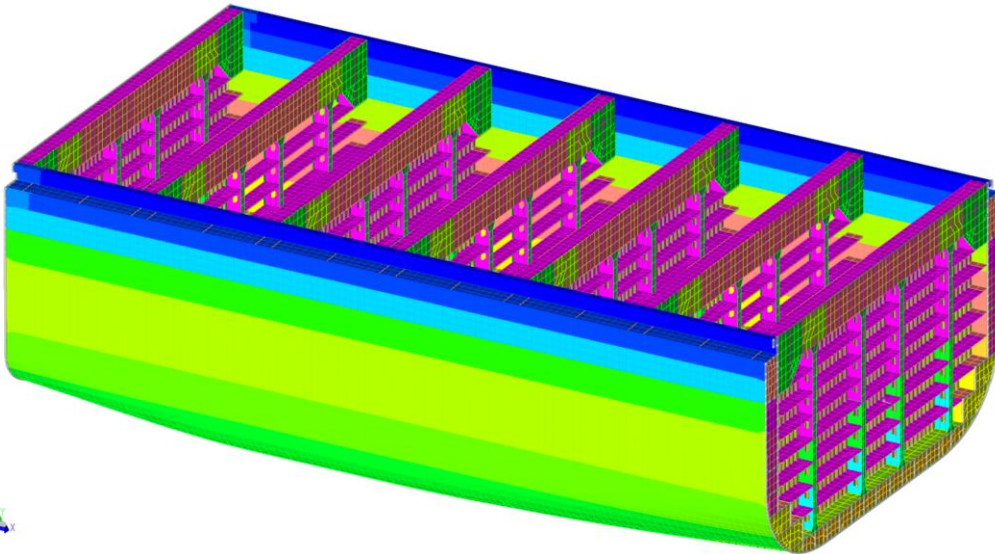


Epic 496491: 3D model export to GeniE

Status V20.31 July 2024

1. Nauticus Hull's FE manager is writing a JavaScript file with all commands needed to build the model in GeniE
 - Geometries and scantlings
 - Sets, structure types, wet surfaces, boundary conditions
2. GeniE reads the JavaScript command and builds the model
3. Loads and corrosion additions imported to GeniE via RuleLoads.xml file transfer

Export Cargo Hold model to GeniE



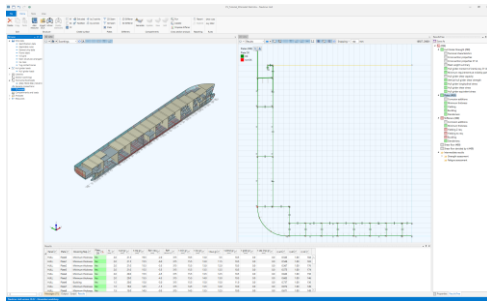
Epic 496482: 3D model Rule checks

Incremental steps by deployment of new features

September 2023

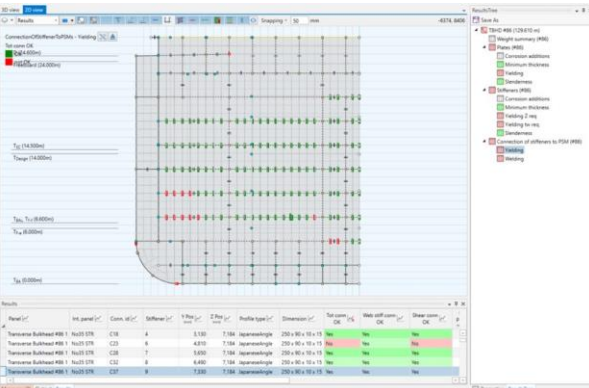
Jan 2024

Cross-sectional analysis – Step 1



- Intersect the 3D model and re-use the **Section Scantlings calculation engine** (continuous transverse stiffeners not included)
- New connection concept (for spans, fatigue SCF, connection area)

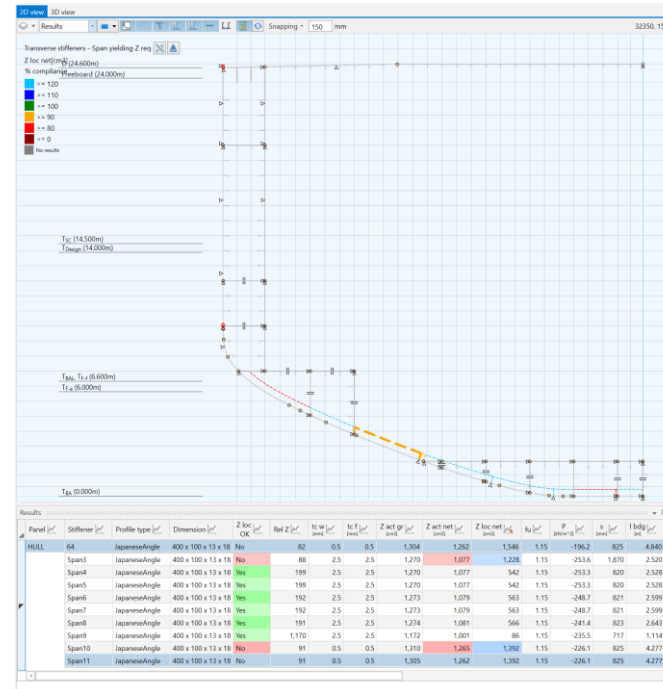
TBHD tool – Conn. area calc.



- New connection concept (for spans, connection area)
- **Connection area calculations** are available in the TBHD tool

Cross-sectional analysis – Step 2

- Run analysis on **transverse continuous stiffeners**
- This is already available in the **Transverse Bulkhead tool**

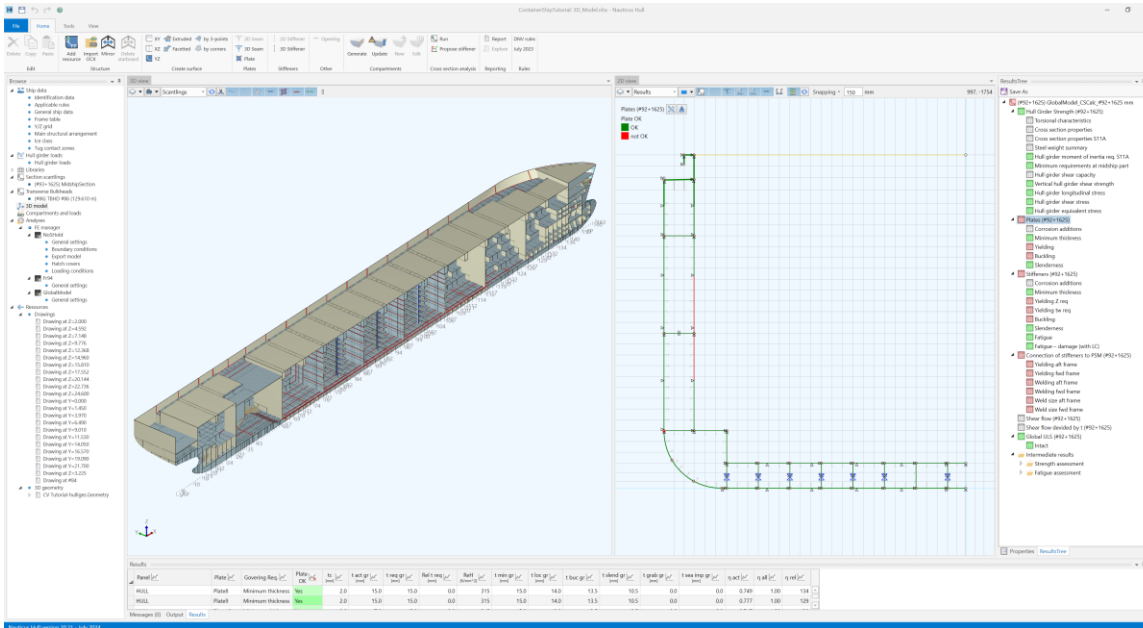


Epic 496482: 3D model Rule checks

Status V20.31 July 2024

1. Two alternative ways to run cross section analysis:
 - A. Make a temporarily 2D cross section of the 3D model and run analysis; or
 - B. Make a permanent Section Scantlings cross section from the 3D model
2. Transverse Bulkhead analysis model can be copied from the 3D model

3D model Rule checks



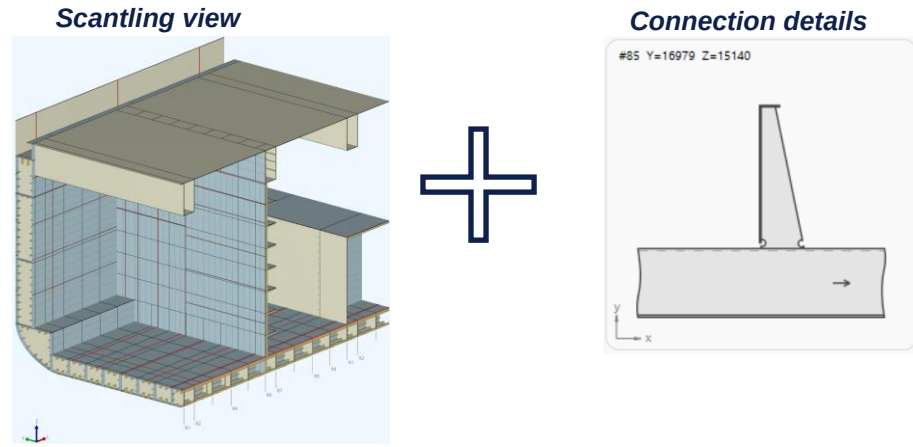
Nauticus Hull 3D model Rule checks – V20.29

3D model cross section analysis will partly re-use Section Scantlings

Model

Calculation engine and
Results presentation

3D model cross
section analysis



Capacity models

No.	Geometry Connection type	Point A		Point B	
		K_x	K_y	K_x	K_y
22		1.34	1.34	1.34	1.34

Calculation engine

Calculation engine interface showing various input parameters and calculation options.

Existing calculations: #85=2460 mm

Current position: #85=2460 mm

Midship cross section: ☐

Increased permissible hull girder stress outside midship region: ☐

Prescriptive: ☒ HULL ☐ Fatigue

Vertical wave bending moments M_w scaling factors

Sagging	1
Hogging	1

Buckling stress combination factors

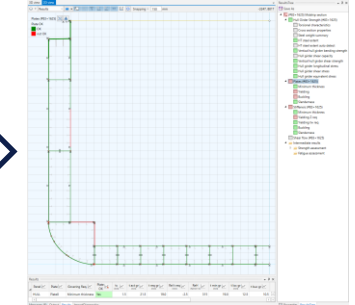
Combination 1 (c)	0.7
Combination 2 (d)	0.7

Grouping of stiffeners: ☐

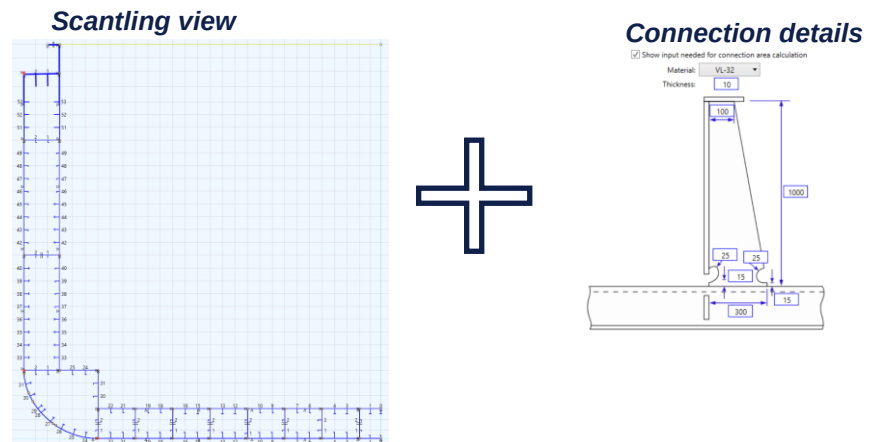
Apply grouping principle: ☐

Calculate

Results



Section Scantlings
analysis



- For 3D model cross section analysis:
 - New **Libraries** for definitions of end connections and shear connections
 - New **Connection Concept** for displaying intersections between PSM and stiffener, and for displaying parameters used in calculations
 - Re-use capacity models from Section Scantlings
 - Re-use calculation engine from Section Scantlings
 - Re-use results presentation from Section Scantlings

Thank you!

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