PACKAGE DESCRIPTION

Sesam

Software suite for hydrodynamic and structural analysis of offshore wind, offshore oil and gas, and maritime structures

Sesam Package Description

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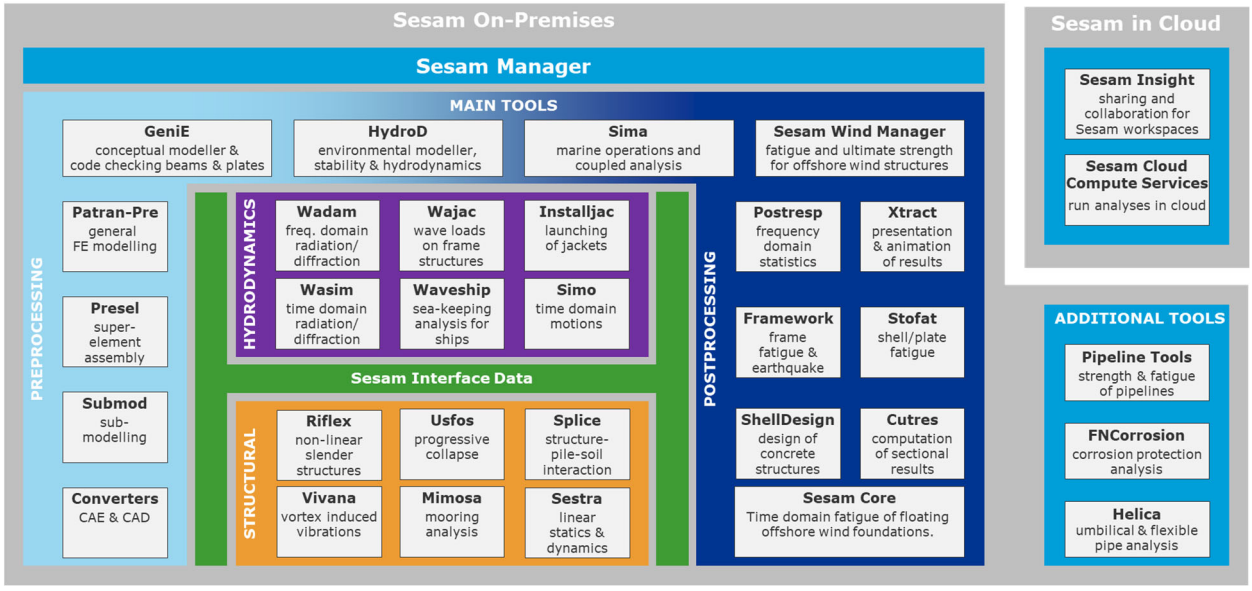
Introduction to Sesam

Sesam is a software suite for hydrodynamic and structural analysis of ships and offshore structures. It is based on the displacement formulation of the finite element method. An overview of Sesam is shown below. The four groups of programs: **preprocessors**, **hydrodynamic analysis programs**, **structural analysis programs** and **postprocessors**, are bound together by a set of **Sesam Interface Files and Formats**, the green "H" in the figure. All major inter-program communication goes via this well-defined set of files. The exception is for Sesam Core that streams data from Sestra directly.

Sesam customers can access the functionality via customized enterprise packages or pre-configured Sesam Packages. In many cases, the Sesam Packages will meet the demands for functionality. If not, a customized enterprise package can be made by contacting our sales staff.

Sesam Manager at top of the figure is the master control program of Sesam. Analysis workflows including any of the Sesam programs and of any complexity may be set up and run. This tool is part of all relevant customized enterprise or pre-configured packages.



Sesam Overview

This document describes the pre-configured Sesam packages:

- A general overview of the Sesam Packages
- Education and Topside Modules
- Jackets and jack-ups
- Life extension and non-linear
- Offshore floaters
- Fixed offshore wind foundations (inclusive of Bladed)
- Floating offshore wind foundations (inclusive of Bladed)
- Transportation & Installation
- Offshore pipelines and cables

For details of individual programs listed in the package definitions, please refer to the Sesam Feature Description.

Sesam Packages

There are eight main groups of Sesam Packages. Each of them has individual packages with different level of functionality. In contrary to the customized enterprise packages, the Sesam programs are bundled together in a Sesam Package.

High level overview

Education and Topside Modules	**Main functionality**
Starter Package	A free package to learn modelling, structural analysis, eigenvalue analysis and member code check of models with less than 100 members
Module Package	Modelling, structural analysis, eigenvalue analysis and member code check of models with less than 500 members or 10.000 finite elements including plates. This package is also used for in-place analysis of sub-sea templates
Topsides, jackets and jack-ups	**Main functionality**
Topside Package	Modelling, structural analysis and member code check of topside structures. Wind loads can be applied to wind areas. Dynamic loads can be represented by use of accelerations and import of Response Amplitude Operators (RAO). This package is also used for transportation and installation when the topside is not integrated with hydrodynamic analysis
Jacket Package	Modelling, wave load analysis, pile/soil analysis, structural analysis (static and dynamic) and member/tubular joint code check of substations, jackets and jack-ups. This package is also used for transportation and installation when the asset is not integrated with hydrodynamic analysis and for early analysis of fixed offshore wind foundations
Jacket Fatigue Package	Modelling, wave load analysis, pile/soil analysis, structural analysis (static and dynamic), member/tubular joint code check and fatigue (member and shell) of substations, jackets and jack-ups. This package is also used for transportation and installation when the asset is not integrated with hydrodynamic analysis

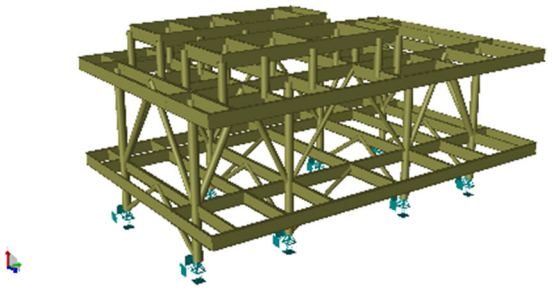
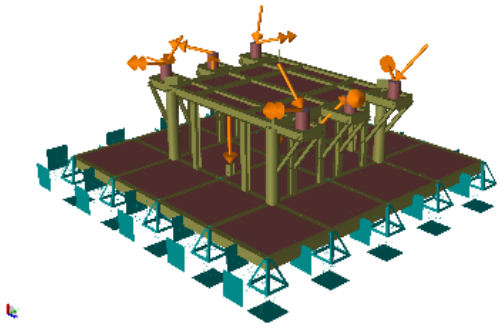
Life extension and non-linear	Main functionality
Jacket Collapse Package	Modelling of jackets and topsides and non-linear analysis (push-over, boat impact, dropped objects, accidental analysis). Import from other analysis tools is possible
Jacket Reserve Strength Package	Modelling of jackets and topsides, wave load analysis, pile/soil analysis, structural analysis, member/tubular joint code checking and non-linear analysis. Import from other analysis tools is possible
Jacket Life Extension Package	Modelling of jackets and topsides, wave load analysis, pile/soil analysis, structural analysis, member/tubular joint code checking, fatigue analysis of beams and shells and non-linear analysis. Import from other analysis tools is possible
Offshore floaters	**Main functionality**
Structural Analysis Package	Modelling and structural analysis of general structures including ships and offshore floaters. This package aims at structural stress analysis when the loads are defined by the user or imported from Nauticus Hull
Offshore Floater Design Package	Modelling, structural analysis, code checking and fatigue analysis of general structures including ships and offshore floaters. Loads can be defined by the user, imported from Nauticus Hull or from integrated hydrodynamic analysis (frequency or time domain)
Linear Hydrodynamic Package	Make panel model (incl. Morison elements), linear hydrodynamic analysis in frequency and time domain and post processing in frequency and time domain. It covers zero to low forward vessel speed
Offshore Floater Hydrodynamics Package	Make panel model (incl. Morison elements), all stability and hydrodynamics functionality (frequency and time domain) in Sesam for stationary structures with no to low forward speed. 2nd order effects FD and non-linear TD are included
Marine Dynamics Package	Marine operations and coupled analysis of mooring & riser systems (ULS and FLS)

Fixed Offshore Wind Foundations	Main functionality
Fixed Offshore Wind Support Structure Design Light Package	Modelling of jacket, tower, transition piece (by beams). Wave load and pile/soil analysis, static and dynamic analysis, member/tubular joint code check and fatigue. Turbine loads from integrated coupled analysis with Bladed. Turbine loads by use of superelement method together with Bladed, BHawC, VTS/Flex5 or others. The turbine load tools are not part of the package. Desktop or cloud computations
Fixed Offshore Wind Support Structure Design Package	Modelling of jacket, tower, transition piece (by beams and curved shells). Wave load and pile/soil analysis, static and dynamic analysis, member/tubular joint code check and fatigue. Turbine loads from integrated coupled analysis with Bladed. Turbine loads by use of superelement method together with Bladed, BHawC, VTS/Flex5 or others. The turbine load tools are not part of the package. Desktop or cloud computations
Fixed Offshore Wind Support Structure Design With Integrated Load Analysis Package	Modelling of jacket, tower, transition piece (by beams and curved shells). Wave load and pile/soil analysis, static and dynamic analysis, member/tubular joint code check and fatigue. Turbine loads from integrated coupled analysis with Bladed or by use of superelement method together with Bladed, BHawC, VTS/Flex5 or others. Bladed is part of the package, other turbine load tools are not part of the package. Desktop or cloud computations
Floating Offshore Wind Foundations	**Main functionality**
Floating OWT Hydrodynamic Package	Modelling of panel, mass, Morison and compartment models, stability analysis and linear hydrodynamic analysis in frequency and time domain. Create the hydrodynamic linear coefficients for the coupled analysis
Floating OWT Coupled Analysis and Mooring Line Package	Fully coupled analysis of the complete wind turbine system, including floater, mooring lines and turbine, with focus on the design of the floater and mooring lines
Floating OWT Coupled Analysis and Turbine Package	Fully coupled analysis of the complete wind turbine system, including floater, mooring lines and turbine, with focus on the design of the floater and turbine
Floating OWT Hydrodynamic Load Generation Package	Import of data from a coupled analysis to generate hydrodynamic loads on the floater and transfer of the loads from the panel model to the structural mesh. Not needed when the Floating Wind Hydrodynamic Package has been used
Floating OWT Structural Design Package	Modelling of the structures, transfer of loads from the hydrodynamic model to the structural mesh, and to perform structural analysis and post-processing. Includes plate/shell and beam ultimate and fatigue strength analysis. Fatigue of the hull can be done using the new functionality for rainflow fatigue counting

Transportation and Installation *)	Main functionality
Topside Package (used for T&I)	Perform transportation and lifting analysis where the dynamic loads are defined by accelerations or Response Amplitude Operators (RAO) from hydrodynamic analysis. The main objective of the analysis is to calculate the structural strength inclusive of member and tubular joint code check. In addition, it is possible to do simplified deterministic fatigue by specifying two pair of load cases to find the stress envelopes by adding the option Framework Fatigue.
Offshore Floater Design Package and Linear Hydrodynamic Package (used for T&I)	The combination of these packages will calculate the hydrodynamic loads on an integrated structural model (hull and transported objects), perform structural analysis, member code check and fatigue assessment.
Marine Dynamics Package	Marine operations like float-over, lifting, lowering, tow-out etc. with focus on motion characteristics, contact forces and forces in connectors and lifting arrangements.
Pipeline Package	**Main functionality**
Free spanning pipeline analysis	Design the fatigue lifetime for free spanning pipelines due to Vortex Induced Vibrations and direct wave loading and re-assess fatigue lifetime of pipelines in operation according to the DNV Recommended Practice, DNV-RP-F105
Stability analyses of cables, umbilicals and pipelines	Static and time domain dynamic lateral stability analyses of cables, umbilicals and pipelines according to DNV-RP-F109 (May 2021) in combination with PILS JIP Guideline 2017
Pipeline wall thickness design code checks	Wall thickness design code checks according to DNV-ST-F101, i.e. limit state design criteria for pressure containment (bursting), pipeline collapse, propagating buckling and combined loading
Assessment of corroded pipelines	Assessment of corroded pipelines according to the DNV Recommended Practice RP-F101
Global buckling analysis of submarine pipelines	Simplified global buckling analysis for submarine pipelines according to DNV-RP-F110 in early-phase engineering practice
Early phase offshore pipeline assessment	Quick concept evaluation and decision-making tool for technical support during field developments according to DNVGL-ST-F101 and its older version DNV-OS-F101
Umbilicals, cables and flexible risers	Cross section analysis of umbilicals, cables and flexible risers, including fatigue analysis of section components such as helix wires and steel tubes. The results from a coupled mooring analysis (Marine Dynamics Package or Floating OWT Coupled Analysis and Turbine Package) are used basis for the fatigue calculations

*) The majority of jacket installations today are based on lifting. In case a launching analysis must be done to calculate structural responses this can be done using the combination of the Jacket Package and the program Installjac.

Education and Topside Modules

The **Starter Package** is made for students and others who want to explore the user interface and the basic capabilities of Sesam for structural analysis. The package allows for modelling and static analysis of small structural components like topside modules and helidecks using beams and plates for conditions like transportation, lifting and in-place. Member code checking can be done. This package is free of charge and does not include support. Rights of usage is granted for periods of 3 months and assumes non-commercial usage.	
The **Module Package** is a beginner's package that includes finite element capabilities and the ability to design steel structures quickly. This software enables the construction of modest deck structures, flare towers, helidecks, topside modules and subsea templates using beams, flat plates, and other structural components for conditions like transportation, lifting and in-place. The package will do modelling, analysis and member/plate code checking.	

Comparison between packages

Functionality	Starter Package	Module Package
Straight Beam/Flat Plate	✓	✓
Curved Beam/Shell	✓	✓
Import from other CAE and CAD	✓	✓
FEM generation and control	✓ *	✓ **
Point load, line load, surface load	✓	✓
Area wind loads	✓	✓
Acceleration loads, temperature	✓	✓
Linear Static	✓	✓
Linear Dynamic Solver	✓	✓
Code check beams	✓	✓
Code check flat plates		✓
Basic post-processing of FE results	✓	✓ ***
Cloud Enabled Visualization		✓

*Limited to 100 beams or analysis model (FE model) including beams and plates up to 2.500 finite elements. No compartment definitions.

**Limited to 500 beams or analysis model (FE model) including beams and plates up to 10.000 finite elements. No compartment definitions.

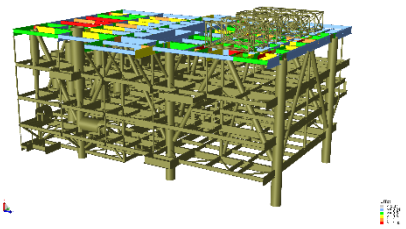
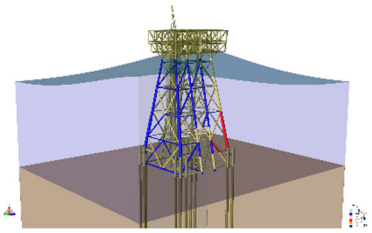
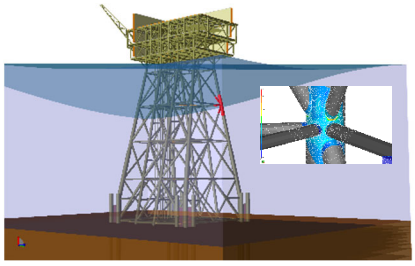
***Detailed post-processing of FE results can be done in Sesams finite element post-processor Xtract. This tool is optional to the package.

Program modules part of packages

Module	Starter package	Module package
GeniE.starter *	✓	
GeniE.lite		✓
Sesam Insight		✓
Optional tools to packages		Xtract

*Limited to 3 months non-commercial usage on node locked PC

Topsides, jackets and jack-ups

The **Topside Package** using the conceptual modelling approach to generate large models more quickly, specify the loads, then maintain and analyze these intricate models more effectively utilizing automated structural techniques to perform ULS, all while saving both time and money. The focus is on the structure above sea water level of any size.	
The **Jacket Package** enables you to model offshore complete structures including topside, equipment, module, flare boom, jacket, pile, boat-landing. The wave and wind loads are calculated and automatically applied to the model together with other specified loads. The structural analysis (static or dynamic) including non-linear pile/soil analysis leads up to ULS.	
The **Jacket Fatigue Package** is the most sophisticated package level, allowing users to model and evaluate the full offshore structure, including all its intricacies in structure, environmental conditions, and soil. It enables the structure to be designed in accordance with the latest design requirements, as well as for fatigue and seismic resistance. You may also easily refine beam models to shell models for a better prediction of the dynamic stresses for use in predicting stress concentration factors for use in beam fatigue or to do shell fatigue according to DNV-RP-C203.	

Comparison between packages

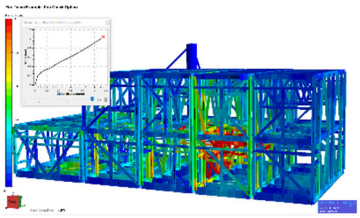
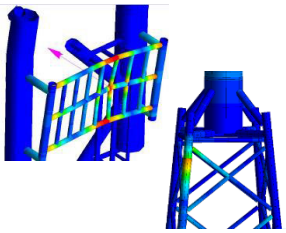
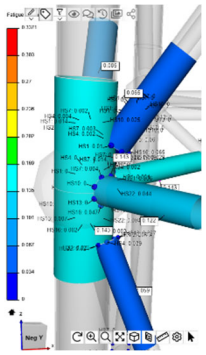
Functionality	Topside Package	Jacket Package	Jacket Fatigue Package
Straight Beam/Flat Plate	✓	✓	✓
Curved Beam/Shell			✓
Conversion beam/joint to shell			✓
Import from other CAE and CAD	✓	✓	✓
FEM generation and control	✓	✓	✓
Edit FEM			✓
Point load, line load, surface load	✓	✓	✓
Area wind loads	✓	✓	✓
Acceleration loads, temperature	✓	✓	✓
Environment (wind & wave)		✓	✓
Soil Modelling		✓	✓
Linear Static/Dynamic Solver	✓	✓	✓
Non-linear pile/soil analysis		✓	✓
Code check beams	✓	✓	✓
Fatigue Beams (stochastic, spectral, deterministic, time domain)			✓
Fatigue Plates/Shells (stochastic, time domain)			✓
Earthquake code check of beams			✓
Basic post-processing of FE results*	✓	✓	✓
Cloud Enabled Visualization	✓	✓	✓

* Detailed post-processing of FE results can be done in Sesams finite element post-processor Xtract. This tool is optional to the package

Program modules part of packages

Module	Topside Package	Jacket Package	Jacket Fatigue Package
GeniE	✓	✓	✓
GeniE_CGEO			✓
GeniE_REFM			✓
GeniE_CCBM	✓	✓	✓
Wajac		✓	✓
Splice		✓	✓
Sestra	✓	✓	✓
Framework for Erqk/Fatg			✓
Stofat			✓
Sesam Insight	✓	✓	✓
Optional tools to packages	Xtract, Genie_CCPL Framework Fatg	Xtract, GeniE_CCPL, FNCorrosion Framework Fatg	Xtract, GeniE_CCPL, FNCorrosion

Life extension and non-linear

The **Jacket Collapse Package** includes non-linear analysis and modelling (or importing data) of a complete structure for use in non-linear analysis. If you are analysing a jacket, the wave/wind loads and pile/soil data needs to be edited in a separate input file. For a topside analysis this is normally not needed	
The **Jacket Reserve Strength Package** is more complete as it supports ULS and non-linear analysis of a complete jacket including environmental loads and data for pile and soil. This means that a linear model can be used as is in a non-linear analysis such as collapse and boat-impact. When importing a model from other sources, code checking can be performed to document that the Sesam model behaves similarly	
The Jacket Life Extension Package builds on the jacket collapse package. It also includes fatigue analysis of beams and shells. The Jacket life extension package is thus a complete package that can be used to prove life extension based on code checking, fatigue and/or pushover analysis	

Comparison between packages

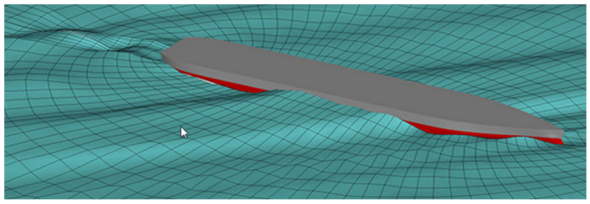
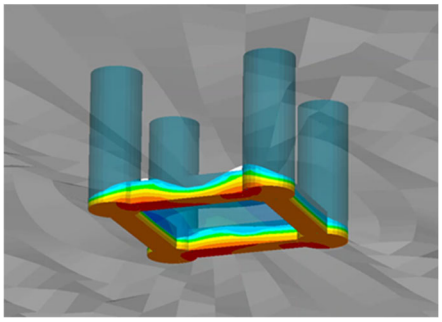
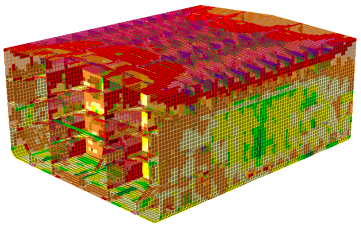
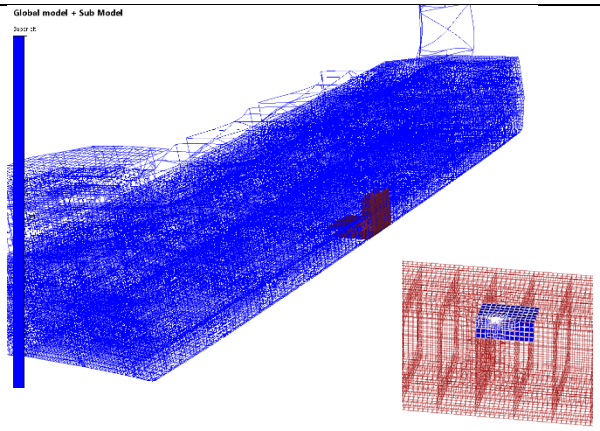
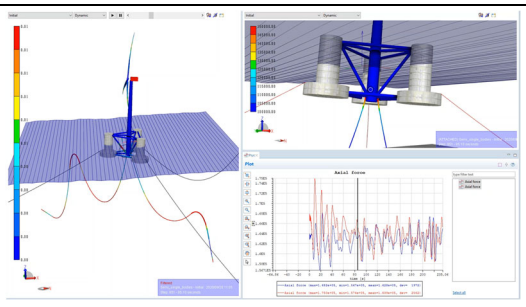
Functionality	Jacket Collapse Package	Jacket Reserve Strength Package	Jacket Life Extension Package
Straight Beam/Flat Plate	✓	✓	✓
Curved Beam/Shell			✓
Conversion beam/joint to shell			✓
Import from other CAE and CAD	✓	✓	✓
FEM generation and control	✓	✓	✓
Edit FEM			✓
Point load, line load, surface load	✓	✓	✓
Area wind loads	✓	✓	✓
Acceleration loads, temperature	✓	✓	✓
Environment (wind & wave)		✓	✓
Soil Modelling		✓	✓
Linear Static/Dynamic Solver		✓	✓
Non-linear pile/soil analysis (Usfos)		✓	✓
Code check beams		✓	✓
Fatigue Beams (stochastic, spectral, deterministic, time domain)			✓
Fatigue Plates/Shells (stochastic, time domain)			✓
Earthquake code check of beams			✓
Basic post-processing of FE results*		✓	✓
Non-linear analysis	✓	✓	✓
Cloud Enabled Visualization	✓	✓	✓

* Detailed post-processing of FE results can be done in Sesams finite element post-processor Xtract. This tool is optional to the package

Program modules part of packages

Module	Jacket Collapse Package	Jacket Reserve Strength Package	Jacket Life Extension Package
GeniE	✓	✓	✓
GeniE_CGEO			✓
GeniE_REFM			✓
GeniE_CCBM		✓	✓
Wajac		✓	✓
Splice		✓	✓
Sestra		✓	✓
Usfos	✓	✓	✓
Framework for Erqk/Fatg			✓
Stofat			✓
Sesam Insight	✓	✓	✓
Optional tools to packages		Xtract, FNCorrosion	Xtract, FNCorrosion

Offshore floaters

The **Linear Hydrodynamic Package** is a start package for hydrodynamic analysis in Sesam. It supports the basic modelling, and the linear hydrodynamic analysis with post-processing both in frequency- and time-domain. The package enables the hydrodynamics analysis and statistical performance prediction of stationary floaters, and vessels with zero to low forward speed.	
The **Offshore Floater Hydrodynamic Package** is a comprehensive package contains all stability and hydrodynamics functionality (frequency- and time-domain) in Sesam for stationary structures and modelling of such. Nonlinear hydrodynamics, such as 2nd order effects in frequency-domain, and nonlinear effects in time-domain, are also included.	
The **Structural Analysis Package** is a start package for the modelling, analysis and stress evaluation of shell structure design with manually applied loads. Prescriptive loads from Nauticus Hull can be imported to support DNV rule-based analysis approach.	
The **Offshore Floater Design Package** is the complete package for doing structural analysis of general and floating structures. It enables structural modelling with advanced refined mesh function. The structure analysis can be done using manual defined or rule-based loads, or hydrodynamic calculations. The stress evaluations and code checking for beam and plate are included. In addition, global fatigue screening and hotspots fatigue can be done out using refined parts in global model or with a sub-modelling approach. Fatigue analysis of beams is also included.	
The **Marine Dynamics Package** supports a range of analyses from complex marine operations, to mooring design, and coupled analysis of floaters with mooring & riser systems. It also supports the fatigue and code check for metallic risers. The simulation is streamlined through a user-friendly graphical interface with 3D visualisation which is tailored for marine engineers.	

Comparison between packages

Functionality	Linear Hydrodynamic Package	Offshore Floater Hydrodynamic Package	Structural Analysis Package	Offshore Floater Design Package	Marine Dynamics Package
Panel modelling	✓	✓	✓	✓	
Hydrostatic analysis		✓			
Linear hydrodynamics (FD and TD)	✓	✓			
2nd order FD		✓			
Nonlinear hydrodynamic & Forward Speed		✓			
Zero to low speed	✓	✓			
Animation of motion	✓	✓			
Structure modelling			✓	✓	
Mesh editing			✓	✓	
Manual defined / import DNV prescriptive loads			✓	✓	
Import hydrodynamic loads				✓	
Strength analysis			✓	✓	
Detailed stress evaluation			✓	✓	
Code check beams and plates				✓	
Fatigue analysis beam and shell				✓	
Marine operations					✓
Coupled mooring/riser analysis					✓
Slender structure fatigue and code check					✓
Cloud Enabled Visualization	✓	✓	✓	✓	

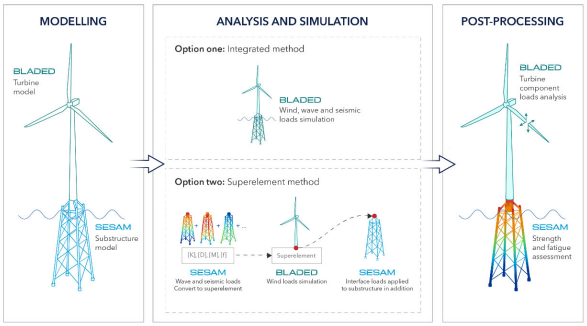
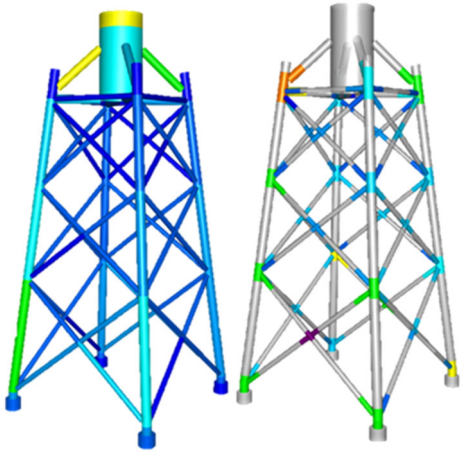
* Detailed post-processing of FE results can be done in Sesams finite element post-processor Xtract. This tool is optional to the package

Program modules part of packages

Module	Linear Hydrodynamic Package	Offshore Floater Hydrodynamic Package	Structural Analysis Package	Offshore Floater Design Package	Marine Dynamics Package
GeniE.panel	✓	✓			
HydroD	✓	✓			
HydroD.Stab		✓			
HydroD.Stru				✓	
Wadam	✓	✓			
Wadam 2nd order		✓			
Wasim	✓	✓			
Wasim Non-linear & Forward speed		✓			
Wamod		✓			
Postresp	✓	✓			
Postresp 2nd order		✓			
Postresp Time	✓	✓			
Xtract animation	✓	✓			
Sima					✓
Riflex					✓
Simo					✓
GeniE			✓	✓	
GeniE_CGEO			✓	✓	
GeniE_REFM			✓	✓	
GeniE_CCBM				✓	
GeniE_CCPL				✓	
Presel/Submod				✓	
Sestra			✓	✓	
Cutres				✓	
Xtract			✓	✓	
Stofat				✓	

Module (continued)	Linear Hydrodynamic Package	Offshore Floater Hydrodynamic Package	Structural Analysis Package	Offshore Floater Design Package	Marine Dynamics Package
Framework fatigue				✓	
Sesam Insight	✓	✓	✓	✓	
Optional tools to packages			ShellDesign	ShellDesign	

Fixed offshore wind foundations

The **Fixed Offshore Wind Support Structure Design Light Package** is suitable for early and detailed design of fixed offshore wind structures but lacking some of the capabilities for modelling and results viewing of curved shell geometries (like for example a complex transition piece or tubular joints converted to shell models. The package includes beam and flat plate modelling, wave load generation on beams, non-linear pile-soil interaction and linearization, structural analysis, fatigue and ultimate strength checks on beams and analysis result visualization and animation. It supports static analysis for deterministic, stochastic and time domain. It includes a customized workflow tool for set-up and execution of the design load case setups, workflow control (locally and in the cloud), data management, time domain FLS/ULS analysis, and result reporting. Interfaces to and from Bladed, BHawC and VTS/Flex5 are included for superelement analysis and integrated design (for Bladed only). A starter package of cloud services including online result visualization and collaboration in Sesam Insight, and Sesam's cloud compute and storage services is included.	
The **Fixed Offshore Wind Support Structure Design Package** is suitable for early and detailed design of fixed offshore wind structures including the capabilities for modelling and results viewing of curved shell geometries (like for example a complex transition piece or tubular joints converted to shell models. The package includes modelling of beams, flat plates and curved shells, wave load generation on beams, non-linear pile-soil interaction and linearization, structural analysis, fatigue and ultimate strength checks on beams and analysis result visualization and animation. It supports static analysis for deterministic, stochastic and time domain. It includes a customized workflow tool for set-up and execution of the design load case setups, workflow control (locally and in the cloud), data management, time domain FLS/ULS analysis, and result reporting. Interfaces to and from Bladed, BHawC and VTS/Flex5 are included for superelement analysis and integrated design (for Bladed only). A starter package of cloud services including online result visualization and collaboration in Sesam Insight, and Sesam's cloud compute and storage services is included.	

The **Fixed Offshore Wind Support Structure Design With Integrated Load Analysis Package** includes Bladed on top of everything that is included in the Fixed Offshore Wind Support Structure Design Package. Bladed allows the wind turbine and support structure (as a beam model or a superelement) to be included in the same model, environmental loads (wave, wind and/or seismic) and control system to be added, and coupled structural analysis to be performed. This unique combination empowers non-turbine OEM stakeholders to perform in-house integrated load analyses (ILA), for example for foundation design initialization, more optimized early designs, R&D and sensitivity studies, additional structural design loops (outside of the turbine OEM), or learning the process of turbine foundation design. The ILA can be performed using either the integrated design approach or the superelement analysis approach, both with Bladed and Sesam. The support structure can be taken from Sesam to Bladed as a beam model (for integrated design) or as a superelement. After running the analyses in Bladed the support structure can be post-processed in Sesam either by directly post-processing the Bladed results (after converting them into Sesam format, this is for the integrated design approach) or by using the interface loads obtained from Bladed to perform structural analysis and post-processing in Sesam (in the superelement approach). DNV can upon request also provide Bladed turbine concept models that are representative of the state-of-the-art turbines from leading turbine OEM's, which can be used in Bladed in the in-house ILA process with Sesam.

Comparison between packages

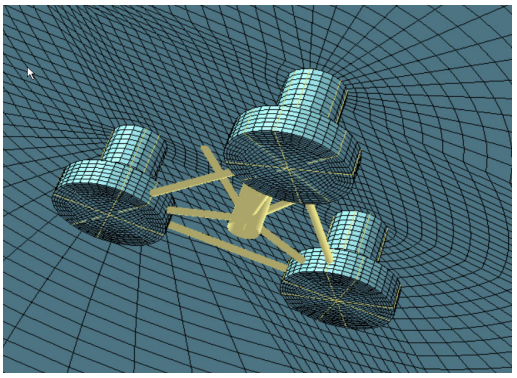
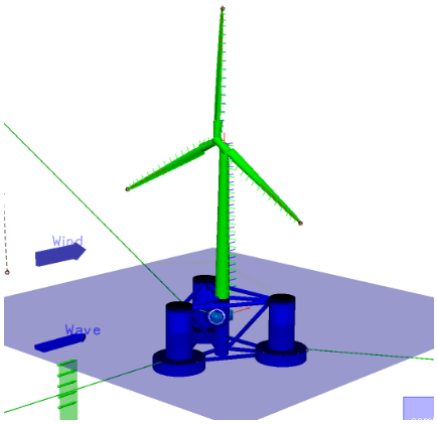
Functionality	Fixed Offshore Wind Support Structure Design Light Package	Fixed Offshore Wind Support Structure Design Package	Fixed Offshore Wind Support Structure Design With Integrated Load Analysis Package
Modelling with beams, flat plates and external matrices (jackets, monopiles, tripods) in Sesam	✓	✓	✓
Modelling curved shell geometries (transition pieces, tubular joints) and refined meshing in Sesam		✓	✓
Wave load generation on beams in Sesam	✓	✓	✓
Non-linear pile-soil interaction and linearization in Sesam	✓	✓	✓
Static and dynamic structural analysis in frequency and time domain in Sesam	✓	✓	✓
Preliminary design in Sesam: - Natural frequency analysis - Fatigue analysis using damage equivalent loads and wave-induced loads - Ultimate strength checks	✓	✓	✓
Detailed design in Sesam: - Interfaces for integrated design with Bladed - Interfaces for superelement generation for Bladed, BHawC (SGRE) and VTS/Flex5 (Vestas) - Perform structural analysis including wave loads, wind turbine loads and/or seismic loads - FLS analysis in time domain with rainflow counting and varying SN curves over the lifetime - ULS analysis in time domain using load factors and offshore code checking standards - Cloud-enabled load generation, structural analysis and post-processing allowing multiple iterations in a single day - Automatic data management and FLS/ULS result aggregation overall design load cases	✓	✓	✓

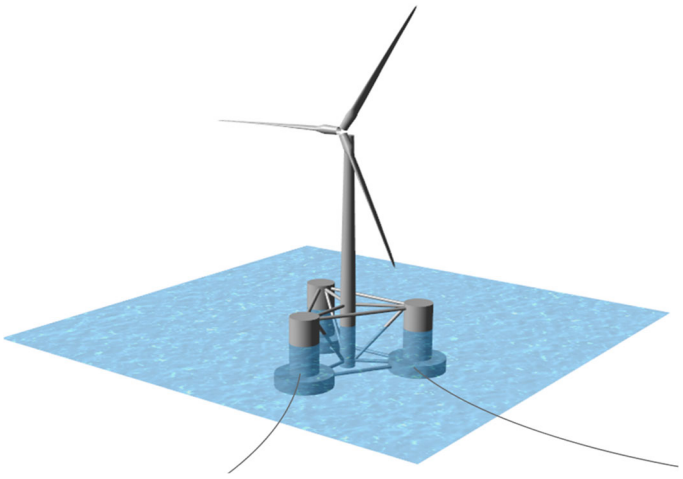
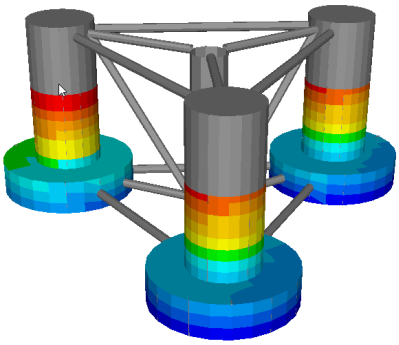
Functionality (continued)	Fixed Offshore Wind Support Structure Design Light Package	Fixed Offshore Wind Support Structure Design Package	Fixed Offshore Wind Support Structure Design With Integrated Load Analysis Package
In-house integrated load analysis (ILA) in Bladed: - For the superelement analysis and integrated design process with Sesam - Model wind turbine and support structure (as beam model or superelement) in same model - Include environmental loads (wave, wind and/or seismic) and control system - Perform coupled structural analysis - Result visualization (plotting and animation)			✓
Result visualisation (beam and shell elementwise results) in Sesam	✓	✓	✓
Result visualisation (other than beam and shell elementwise results) and animation in Sesam		✓	✓
Online result sharing and collaboration in Sesam	✓	✓	✓
Sesam cloud compute and storage starter pack	✓	✓	✓

Program modules part of packages

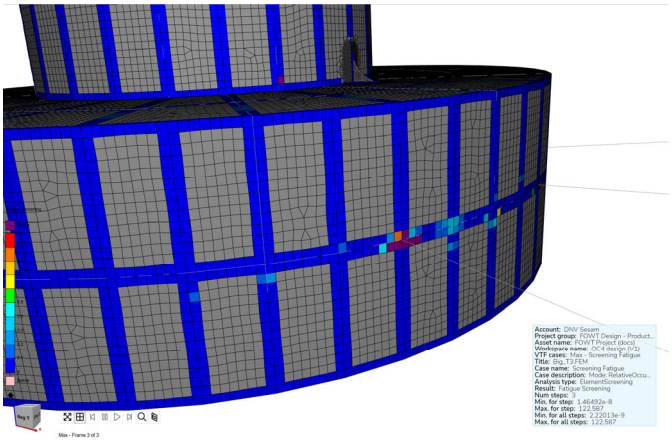
Module	Fixed Offshore Wind Support Structure Design Light Package	Fixed Offshore Wind Support Structure Design Package	Fixed Offshore Wind Support Structure Design with Integrated Load Analysis Package
GeniE	✓	✓	✓
GeniE_CGEO		✓	✓
GeniE_REFM		✓	✓
GeniE_CCBM	✓	✓	✓
Wajac	✓	✓	✓
Splice	✓	✓	✓
Sestra	✓	✓	✓
Framework for Earthquake and Fatigue	✓	✓	✓
Sesam Wind Manager	✓	✓	✓
Xtract		✓	✓
Sesam Insight	✓	✓	✓
Bladed (dongle license only) Base module, offshore support structure module, seismic module			✓
500 Sesam cloud credits per month for a year	✓	✓	✓
1 TB Sesam cloud storage per month for a year	✓	✓	✓
Optional tools to packages	Usfos, Bladed, FNCorrosion, Sesam cloud compute credits and storage	Usfos, Bladed, FNCorrosion, Sesam cloud compute credits and storage	Usfos, FNCorrosion, Sesam cloud compute credits and storage, Bladed cloud compute hours. Bladed control module (for turbine control system design and optimization)

Floating offshore wind foundations

The **Floating Wind Hydrodynamic Package** is suitable for early hydrodynamic design of the floater, including modelling of panel, mass, Morison and compartment models, stability analysis and linear hydrodynamic analysis in frequency and time domain. It also creates the hydrodynamic linear coefficients for the coupled analysis. In combination with the Floating Wind Structural Design Package, this package is also used to import data from the coupled analysis to generate hydrodynamic loads on the floater panel model.	
The **Floating Wind Coupled Analysis and Mooring Line Package** is suitable for coupled analysis of the complete wind turbine system, including floater, mooring lines and wind turbine, with focus on the design of the floater and mooring lines, through the module Sima. Sima can perform a fully coupled analysis where the environmental loads of wind, waves and current are combined with the dynamic response of the wind turbine, with elastic effects from slender structural components in the rotor blades, the tower, the floater and the mooring lines. Sima can also handle mooring line optimization as well as marine operations, which means that it will cover all phases in the life cycle of the floating offshore wind turbine, i.e. towing, installation, in-place and decommissioning. Hydrodynamic coefficients of the floater can be computed using the Floating Wind Hydrodynamic Package, while the results from the coupled analysis can be read back into Sesam and used for a structural analysis of the floater using the Floating Wind Hydrodynamic Package when combined with the Floating Wind Structural Design Package.	

The **Floating Wind Coupled Analysis and Turbine Design Package** is suitable for coupled analysis of the complete wind turbine system, including floater, mooring lines and wind turbine, with focus on the design of the floater and turbine, through Bladed. Bladed can perform a fully coupled analysis where the environmental loads of wind, waves and current are combined with the dynamic response of the wind turbine, with elastic effects from slender structural components in the rotor blades, the tower, the floater and the mooring lines. Bladed can also be used for turbine control system design and optimization (requires an add-on module). Hydrodynamic coefficients of the floater can be computed using the Floating Wind hydrodynamic package, while the results from the coupled analysis can be read back into Sesam and used for a structural analysis of the floater using the Floating Wind Hydrodynamic Package when combined with the Floating Wind Structural Design Package.	
The **Floating Wind Hydrodynamic Load Generation Package** is suitable for import of data from a coupled analysis to generate hydrodynamic loads on the floater and transfer of the loads from the panel model to the structural mesh. It is only relevant if the user does not have the Floating Wind Hydrodynamic Package (or a more advanced Sesam hydrodynamic package), for example for users that only want to perform the structural analysis in Sesam using coupled analysis outputs for example from OrcaFlex.	

The **Floating Wind Structural Design Package** is suitable for transfer of loads from the panel model to the structural mesh, and to perform structural analysis and post-processing. It includes ultimate and fatigue strength analysis capabilities for plate/shell and beam models. It contains possibilities for sub-modelling and calculation of cross-sectional forces and moments as well for further analysis of the floater. A starter package of cloud use through Sesam Insight and Sesam's cloud compute and storage services is included. If load transfer is to be performed, then either the Floating Wind Hydrodynamic Package (or a more advanced Sesam hydrodynamic package) or the Floating Wind Hydrodynamic Load Generation Package is required in addition to import data from a coupled analysis (such as from Sima, Bladed or OrcaFlex) to generate hydrodynamic loads on the floater panel model.



Picture illustrating fatigue screening results

Comparison between packages

Functionality	Floating Wind Hydrodynamic Package	Floating Wind Coupled Analysis and Mooring Line package	Floating Wind Coupled Analysis and Turbine Design Package	Floating Wind Hydrodynamic Load Generation Package	Floating Wind Structural Design Package
Modelling floaters (e.g. semi-subs, barges) for the purpose of hydrodynamic models with beams and plate/shell elements	✓				
Modelling floaters (e.g. semi-subs, barges) for the purpose of FE analysis with beams, plate/shell elements, external matrices and refined meshing					✓
Linear hydrodynamic analysis in frequency and time domain, incl. panel modelling	✓				
Hydrostability analysis	✓				
Hydrodynamic coefficient generation for coupled analysis	✓				
Perform coupled analysis of complete floating wind system (including floater, mooring lines, turbine and environmental loads)		✓	✓		
Mooring line design and optimization		✓			
Marine dynamic operations, including towing, lifting and more		✓			
Turbine design			✓		
Turbine control system design and optimization (requires add-on module)			✓		

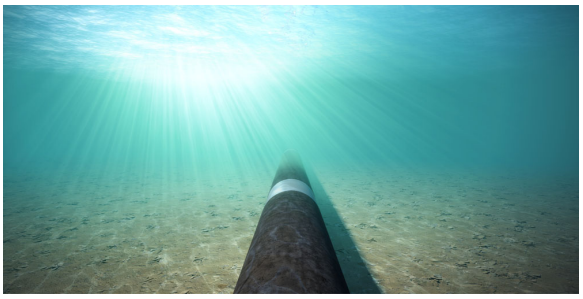
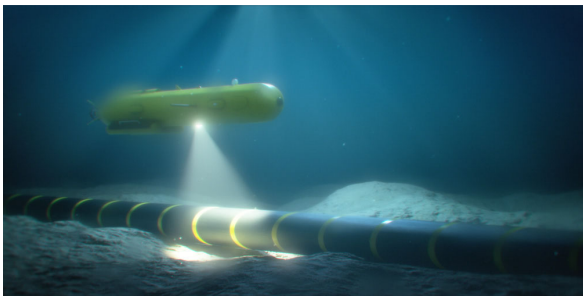
Functionality (continued)	Floating Wind Hydrodynamic Package	Floating Wind Coupled Analysis and Mooring Line package	Floating Wind Coupled Analysis and Turbine Design Package	Floating Wind Hydrodynamic Load Generation Package	Floating Wind Structural Design Package
Hydrodynamic load generation on panel model using data from coupled analysis (e.g. Bladed, Sima)	✓			✓	
Load transfer from floater panel model to structural mesh (incl. turbine loads, Morison loads etc)					✓
Static and dynamic structural analysis in frequency and time domain					✓
Ultimate (ULS) strength yield and buckling checks on beam and shell elements					✓
Fatigue (FLS) analysis in frequency and time domain on beam and shell elements.					✓
Time domain FLS result aggregation					✓
Result visualisation and animation	✓	✓	✓		✓
Online result sharing and collaboration in Sesam	✓				✓
Sesam cloud analysis and storage starter pack					✓

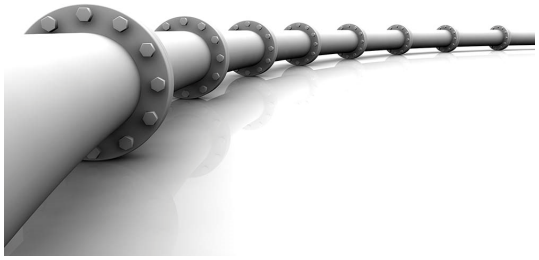
Program modules part of packages

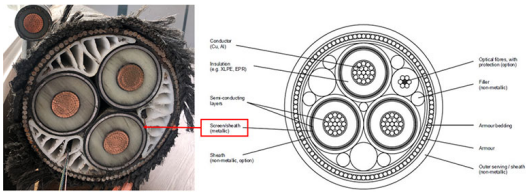
Module	Floating Wind Hydrodynamic Package	Floating Wind Coupled Analysis and Mooring Line package	Floating Wind Coupled Analysis and Turbine Design Package	Floating Wind Hydrodynamic Load Generation Package	Floating Wind Structural Design Package
GeniE.Panel	✓				
HydroD	✓			✓	
HydroD_STAB	✓				
HydroD_STRU					✓
Wadam	✓				
Wasim.Lite				✓	
Wasim	✓				
Wasim_STRU					✓
Postresp	✓				
Postresp_Time	✓				
Xtract animation	✓				
Sima		✓			
Riflex		✓			
Simo		✓			
Bladed (base module)			✓		
Bladed_offshore support structure module			✓		
Bladed_advanced hydrodynamics module			✓		
GeniE					✓
GeniE_CGEO					✓
GeniE_REFM					✓
GeniE_CCPL					✓
GeniE_CCBM					✓

Module (continued)	Floating Wind Hydrodynamic Package	Floating Wind Coupled Analysis and Mooring Line package	Floating Wind Coupled Analysis and Turbine Design Package	Floating Wind Hydrodynamic Load Generation Package	Floating Wind Structural Design Package
GeniE_SCORE					✓
Presel					✓
Submod					✓
Sestra					✓
Cutres					✓
Sesam Core					✓
Framework_FATG					✓
Stofat					✓
Xtract					✓
Sesam Wind Manager					✓
Sesam Insight	✓				✓
500 Sesam cloud credits per month for a year					✓
1 TB Sesam cloud storage per month for a year					✓
Optional tools to packages			Bladed control module for turbine control system design & optimization Bladed cloud compute hours		FNCorrosion, ShellDesign, Sesam cloud compute credits and storage

Offshore pipelines and cables

Free spanning pipeline analysis **Tool: FatFree** FatFree software is used for the design, assessment and reassessment of submarine pipeline spans in compliance with the DNV Recommended Practice DNV-RP-F105. The software enables you to design fatigue lifetime for new free spanning pipelines due to Vortex Induced Vibrations and direct wave loading and re-assess fatigue lifetime of pipelines in operation. It supports the requirements for free spanning pipelines according to recognised design standards such as e.g. DNV-ST-F101, API RP 1111 and ASME B31.8	
Stability analyses of cables, umbilicals and pipelines **Tool: StableLines** The StableLines software module is for engineering analysis of pipelines, based on DNV Recommended Practice DNV-RP-F109. **Tool: PILSS** PILSS software for pipeline, umbilical, cable and flexibles lateral stability analysis, is a stand-alone tool that complements the StableLines software. PILSS provides detailed dynamic analysis, while StableLines supports simplified methods (absolute static and generalized methods) in accordance with DNV-RP-F109.	

Pipeline wall thickness design code checks **Tool: DNV-OS-F101 Code Compliance** Calculates minimum required wall thickness for the given conditions, such as varying depth. Calculates utilization based on wall thickness given by the user. All calculations are based on DNV-OS-F101	
Assessment of corroded pipelines **Tool: DNV-RP-F101 Assessment of corroded pipeline** Perform assessment of a) single defects measured with either relative or absolute depth measurements, b) sensitive studies by comparison to the base case input, c) an isolated longitudinal defect under internal pressure loading and superimposed longitudinal compressive stresses, d) interacting defects, e) complex shaped defects. Evaluate multiple isolated defects simultaneously.	
Global buckling analysis of submarine pipelines **Tool: SimBuck** DNV Recommended Practice DNVGL-RP-F110 is a code providing structural design criteria for high pressure/high temperature pipelines. The Sesam Pipeline software module SimBuck – Simplified Global Buckling Analysis for Submarine Pipelines – enables direct interpretation of DNVGL-RP-F110 for global buckling of submarine pipelines in early-phase engineering practice.	

Early phase offshore pipeline assessment Tool: PET Quick assessments of offshore pipeline design including - Design Checks in accordance with DNVGL-ST-F101 and its older version DNV-OS-F101 - Weight and Volume - Expansion - Simplified stability calculations according to DNV-RP-F109 - Reel Straining - Reel Packing - Cathodic protection - J-Lay and S-Lay - Upheaval Buckling - Simplified free span calculations according to DNV-RP-F105	
Umbilicals, cables and flexible risers – Tool: Helica The combination of Sima and Helica provides the most comprehensive solution for dynamic power cable analysis. Normally, engineers will start with cross section design, using Helica. Detailed modelling of components and internal contact (helix wires) will be considered. The equivalent structure parameters generated from Helica are used by Sima in a coupled analysis including the wind turbine and floaters, or decoupled analysis to cover the high number of load cases in fatigue analysis. The results from such analysis can be read back into Helica for local cross section analysis, e.g. capacity check and local hotspots fatigue analysis of section components such as helix wires and steel tubes.	

Hardware and operating systems

Sesam is supported on Windows 10 (64-bit).

Minimum hardware recommendation

This recommendation is for tasks like jacket, deck and topside design analyses including wave and pile-soil analysis. Hydrostatic analysis and smaller hydrodynamic analysis in frequency domain can also be done.

- Graphics card: Open GL or DX11 compatible. May be integrated with a processor (e.g. Intel HD)
- Memory: 8-16 GB
- Processor: Dual core, Intel I5 or equivalent 64-bit version of Windows operating system
- Storage: 250-500 GB
- Display: 17” supporting 1280x1024, alternatively laptop 15” supporting 1280x1024

Preferred hardware recommendation

This recommendation is for all types of Sesam analysis, also larger models of ships or similar structures with beam and shell elements.

- Graphics card: In general, a dedicated DX11-compatible GPU with at least 1 GB (preferably 2 GB or more) dedicated GPU RAM, especially for larger models
- Memory: 16-32 GB
- Processor: Quad core, Intel I7 or equivalent
- Storage: 500 GB - 1 TB
- Display: 24” supporting 1900x1200 (or -1080), alternatively laptop 17” supporting 1900x1200 (or -1080)

Graphics driver

By ‘graphics driver’ below is meant the system level software provided by your graphics card supplier (most likely Intel, NVIDIA or ATI) to interface between Windows and the GPU. This is supplied with your operating system or graphics card.

By ‘GeniE graphics driver’ below is meant the software used by GeniE to interface with the graphics driver defined above.

Use of DX11

DirectX 11.0 is the preferred GeniE graphics driver and it is the default on installation.

Use of DX9

GeniE will run on integrated Intel CPU/GPUs and on older GPUs using legacy driver.

Use of OpenGL

The GeniE OpenGL2 driver is a shader-based driver that is offered as an alternative should a user encounter problem with other drivers. It attempts to support all OpenGL 2.0+ hardware.

About DNV

We are the independent expert in risk management and quality assurance. Driven by our purpose, to safeguard life, property and the environment, we empower our customers and their stakeholders with facts and reliable insights so that critical decisions can be made with confidence. As a trusted voice for many of the world's most successful organizations, we use our knowledge to advance safety and performance, set industry benchmarks, and inspire and invent solutions to tackle global transformations.

Digital Solutions

DNV is a world-leading provider of digital solutions and software applications with focus on the energy, maritime and healthcare markets. Our solutions are used worldwide to manage risk and performance for wind turbines, electric grids, pipelines, processing plants, offshore structures, ships, and more. Supported by our domain knowledge and Veracity assurance platform, we enable companies to digitize and manage business critical activities in a sustainable, cost-efficient, safe and secure way.

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