DNV·GL

TIDAL BLADED

Tidal Turbine Design Software

SAFER, SMARTER, GREENER

Tidal Bladed has been developed for tidal turbine and component manufacturers, certification agencies, design consultants and research organisations across the world.

Harnessing engineering models developed over the last 25 years, Tidal Bladed utilises common functionality with the industry leading wind turbine design tool Bladed, whilst introducing essential subsea science.

Although Tidal Bladed is the first software of its kind, the heritage of Bladed provides users with a robust commercial design package with high quality modelling capabilities enabling technology developments to be accelerated with confidence.

Tidal Bladed is already being utilised by tidal turbine device developers and it continues to improve and develop along with this growing sector.

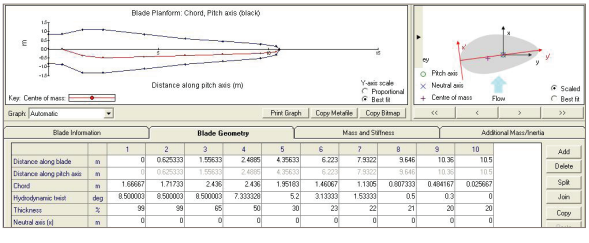
Tidal Bladed currently features:

- Time-domain simulation of combined current, wave and wind loading with full hydroelastic modelling and seismic excitation, plus a range of supporting steady state calculations.
- A range of wave and current models to define the hydrodynamic forces acting on the device.
- Models to describe 'added mass' effects on both the rotor and support structure.
- An accurate representation of buoyancy forces acting on the device.
- A Windows-based graphical user interface and on-line help facility for ease of use.

A number of modules are available, covering steady state analysis, dynamic load simulations, analysis of loads and energy capture, batch processing and automated report generation, interaction with the electrical network, and model linearisation for control design.

Multibody structural dynamics

Tidal Bladed utilises a new, completely self-consistent, and rigorous formulation of structural dynamics. This provides consistently reliable and accurate results and forms a solid foundation from which to extend the structural model with many new features in the ongoing development programme.



Rotor

- 1, 2 or 3 blades, with cone and pre-bend.
- Full and partial span pitch or aileron control.
- Fixed or teetered hub.
- Upstream or downstream orientation.
- Clockwise or anticlockwise rotation.
- Blade vibration dynamics.
- Blade element momentum with dynamic inflow and stall hysteresis.
- Comprehensive hydrofoil interpolation.
- Rotor mass, geometric and pitch imbalances.
- Blade vibration dampers.
- Rotor added mass modelled.

Drive train

- Stiff or torsionally flexible shafts.
- Geared and direct drive layouts.
- Flexible mountings on gearbox or pallet.
- Alternative shaft brake positions.
- User specified shaft brake characteristics.
- Mechanical losses from look-up tables.
- Interface for user-specified gearbox DLL.

Control

- Stall, pitch or aileron control.
- Collective or independent pitch.
- Fixed or variable speed.
- Transducer dynamics.
- Parked, idling, start-up, shutdown and power production simulations.
- Yaw dynamics and yaw bearing friction.
- Built in PI controllers with gain scheduling.
- All turbine control functions can be user-defined through DLL interface.
- Example controller DLL source code provided in C and FORTRAN.
- Comprehensive pitch actuator models.
- Rotary and linear pitch drives.
- Load-dependent pitch bearing friction.

Project management

- Use project files to store and share turbine and calculation definitions.
- Use calculation records to repeat and verify earlier work.
- Import project data from other project files or from completed calculations.
- Manage batch calculation lists for one stop certification calculations.
- Rapid quality checking of simulation results using flexible plotting facility.
- Automatic generation of MS Word project file and calculation reports suitable for certification.

Support structure and nacelle

- Multimember support structures e.g. monopile, tripod, jacket.
- Support structure vibrational dynamics including twist.
- Foundation flexibility including non-linear P-Y models.
- Wave and current loading.
- Nacelle and support structure added mass modelled.
- Hub and nacelle user-defined drag coefficients.
- Wind loading on surface piercing elements.

Generator and electrical

- Variable speed, fixed speed, two-speed and variable slip models.
- Range of electrical loss models.
- Electrical models for current, voltage and network interactions.
- Network transients, short-circuits, electrical flicker, etc.
- Interface for user-specified electrical system DLL.

Graphics

A graphics facility allows the user to view results quickly and easily, and to incorporate graphs into any MS OLE compliant documents.

- Multiple line graphs.
- Cross plots.
- Bar charts.
- Linear and logarithmic axes.
- 3D surface and column plots.
- Automated batch plotting and tabulation to screen or MS Word document.

Post-processing facility

A powerful post-processing facility is provided for analysis of the results of calculations:

- Annual energy capture.
- Electrical flicker.
- Prediction of extreme loads.
- Extraction of periodic and random loads.
- Probability distributions.
- Autospectral analysis.
- Cross spectra, coherence and transfer functions.
- Calculation of stress histories from combinations of loads.
- Peak value and level crossing analysis.
- Lifetime fatigue analysis in a single calculation from multiple load cases.
- Rainflow cycle counting.
- Fatigue analysis.
- Damage equivalent loads.
- Ultimate loads analysis.
- Basic statistics.
- Fourier harmonics.
- Export data to ASCII files.
- Bearing life calculations.
- Gearbox time and revolutions at level.

Response Calculations

- Modal analysis of blades and support structure.
- Blade hydrodynamics.
- Performance coefficients.
- Power curves.
- Mean steady loads.
- Detailed simulations of performance and loading for all turbine states.
- Full order linearised models in Matlab format.
- Earthquake loading.

The user is allowed very flexible control of the calculation outputs:

- Forces and moments at specified blade and support structure stations.
- Forces and moments at the hub and yaw bearing.
- Shaft, gearbox, brake and generator loads.
- Rotational speeds at rotor and generator.
- Mechanical and electrical losses.
- Blade and support structure deflections and yaw motion.
- Nacelle accelerations.
- Blade pitch, controller and transducer signals.
- Detailed pitch actuator information.
- Detailed hydrodynamic information at specified blade stations.

Flow field model

- Current shear models: standard and user-defined.
- Near-surface, sub-surface and near-shore current.
- JONSWAP and Pierson-Moskowitz wave spectra.
- Regular and random wave histories.
- Non-linear wave theory for extreme wave modelling.
- Tower shadow, upstream and downstream.
- 3-dimensional, 3 component models of in-stream turbulence.
- Eddy viscosity model of upstream turbine wake.
- Compatibility with draft design guidelines.

Support and training

After sales support and maintenance includes telephone and email support and incremental upgrades to the software. DNV GL will also provide changes to the software to meet a user's specific requirements. Such changes will be provided on a commercial basis. Training courses are also available.

Try a demo

For more information about Tidal Bladed and its individual modules or to request a demonstration version, please visit *www.dnvgl.com/renewables*. Alternatively, please contact our Tidal Bladed team by emailing *tidal.bladed@dnvgl.com*.

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DNV GL
Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organisations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil & gas and energy industries. We also provide certification services to customers across a wide range of industries.

Combining leading technical and operational expertise, risk methodology and in-depth industry knowledge, we empower our customers' decisions and actions with trust and confidence. As a company, we continuously invest in research and collaborative innovation to provide customers and society with operational and technological foresight. With our origins stretching back to 1864, our reach today is global. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping customers make the world safer, smarter and greener.

In the Energy industry
DNV GL delivers world-renowned testing and advisory services to the energy value chain including renewables and energy efficiency. Our expertise spans onshore and offshore wind power, solar, conventional generation, transmission and distribution, smart grids, and sustainable energy use, as well as energy markets and regulations. Our 2,500 energy experts support clients around the globe in delivering a safe, reliable, efficient, and sustainable energy supply.