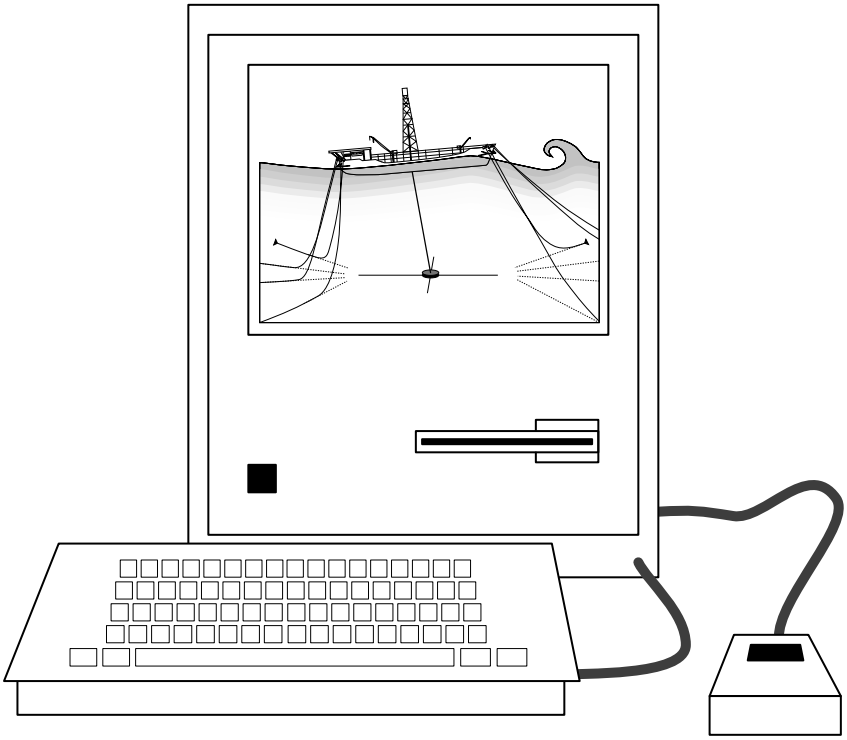
Introducing

The Ocean Engineering Software Library

from SeaSoft® Systems



CONTENTS

Executive Summary

PROLOGUE

The **SeaSoft** family of computer programs comprises a group of stand-alone state of the art software analysis packages for ocean engineering applications. These programs are designed to enhance in-house engineering productivity by providing a consistent, intuitive and easy to use software environment for analysis of a broad range of problems of importance to the offshore industry.

AUDIENCE

Marine engineers and naval architects engaged in offshore operations or design. No special analytical, computational or computer skills are required to make full use of these tools.

OBJECTIVES AND CAPABILITIES

The library was developed to investigate problems commonly studied in model-scale tests. Emphasis is on motions and loads, which are analyzed using regular wave and short- and long-crested irregular wave models. Irregular wave capabilities comprise comprehensive statistical summaries, including root-mean-square motions and loads required for downtime or fatigue analyses and storm "peak" motions and loads required for survival or equipment failure analyses. The programs utilize nonlinear dynamical and statistical procedures to prepare estimates of system performance using "nonlinear frequency-domain" analytical methods whose output is much easier to interpret than conventional "time-domain" analyses and whose execution requires only a fraction of the computational effort. The programs possess capabilities for evaluation of conditions which are difficult to study at model scale in conventional test facilities, such as deep water moorings or multi-directional sea conditions.

EXTENDED PROGRAM DESCRIPTIONS

Demonstration programs and extended descriptions of individual library volumes, including sample problem input and output streams, are available from **SeaSoft** Systems upon request or at the **SeaSoft** website (http://www.seasoftsys.com).

MICROCOMPUTER EXECUTION ABILITY

Each program is highly transportable and has been engineered to execute efficiently on portable and desktop microcomputers; the same programs used in the office on a multi-user mainframe computer can be used in the field for on-site operational support. Microcomputer execution ability has been achieved by careful program planning rather than sacrifice of capabilities; in every case, the **SeaSoft** programs are of greater power than comparable codes requiring mainframe computers for execution.

AUTHOR QUALIFICATIONS

The author of the library holds a Ph.D. degree in theoretical physics from the University of California and an M.S. degree in aerodynamics and hydrodynamics from the University of Minnesota. He has been directly involved in mathematical and computer analysis and model testing of offshore systems since 1973. The basic theoretical methods employed in the packages have received extensive confirmation in model-scale and full-scale tests during that time.

AVAILABILITY

Software is available in object-code and/or source-code format on a limited perpetual license basis which prohibits transfer or commercial timeshare applications. In addition, **SeaSoft** will customize library volumes to accommodate special needs or to incorporate unusual or proprietary features and capabilities. For further information regarding license of individual volumes, contact **SeaSof t** systems.

SERVICES

SeaSoft Systems provides expert analysis services based upon the program library volumes. These services provide a mechanism for interested parties to become thoroughly acquainted with library software capabilities before committing to license purchase.

Phone: (805) 683-3002 ***610 Alto Drive, Santa Barbara, CA 93110*** ***Fax: (805) 683-0440***

Expected release dates of unfinished volumes are indicated in brackets; [A] indicates immediate availability.

• Volume 1 - **Shipsim®**

Models displacement-hull wave-frequency vessel dynamics and seakeeping performance. [A]

• Volume 2 - **Jacksim™**

Models jack-up drilling platforms while floating, setting-down or moving off; estimates leg loads incurred during spud-can/bottom impact in a seaway. [In Progress]

• Volume 3 - **Semisim®**

Models seakeeping performance of semi-submersible platforms in the ballasted condition (displacement hulls submerged). [A]

• Volume 4 - **Discsim®**

Models seakeeping performance of disc-shaped vessels and buoys which are azimuthally symmetric in plan view. [A]

• Volume 7 - **Statmoor®**

Computes lateral static restoring characteristics of complex multileg catenary mooring systems with buoys, clumped weights and varying ocean bottom topography. [A]

• Volume 8 - **Catsim®**

Computes static restoring characteristics of complex multileg catenary mooring systems for arbitrary horizontal, vertical or rotational offsets. [A]

• Volume 9 - **Slowsim®**

Computes static and low-frequency heading-dependent vessel forces and moments arising from wind, current and wave drift action for a variety of vessel types and configurations. [A]

• Volume 10 - **Towsim®**

Models a pair of vessels connected by a towline of arbitrary composition. Computes line dynamic load variations; requires **Shipsim**, **Semisim**, **Jacksim** or user-specified vessel RAOs for execution. Static, low-frequency and wave-frequency modeling of motions and towline loads with emphasis on towline structural integrity in extreme conditions. [A]

• Volume 11 - **SALMsim®**

Models articulated riser-buoy-yoke single-point mooring systems with attached storage vessels. Requires **Shipsim**, **Semisim**, or user-specified vessel RAOs for execution. Static, low-frequency and wave-frequency dynamic modeling of vessel and riser/buoy motions and loads with emphasis on SALM integrity in extreme conditions. [A]

• Volume 12 - **Moorsim®**

Models a vessel in a conventional spread moor. Requires **Shipsim**, **Semisim**, **Discsim** or user-specified vessel RAOs for execution. Static, low-frequency and wave-frequency dynamic modeling of vessel motions and mooring line loads with emphasis on mooring line structural integrity in extreme conditions. [A]

• Volume 13 - **CALMsim®**

Models the interconnected buoy and vessel of single-point mooring arrangements comprising CALM-buoy systems with attached storage vessels. Requires **Shipsim**, **Semisim**, **Discsim** or user-specified vessel RAOs for execution. Emphasis on mooring line and hawser structural integrity in extreme conditions. [A]

• Volume 14 - **TLPsim®**

Models platform motions and tendon structural loads for a tension leg platform. Requires **Semisim** or user-specified vessel RAOs for execution. [A]

• Volume 15 - **SPMsim®**

Models single-point catenary-based mooring systems including turret-moored vessels. Requires **Shipsim**, **Semisim**, or user-specified vessel RAOs for execution. Static, low-frequency and wave-frequency dynamic modeling of vessel motions and mooring line loads with emphasis on mooring line structural integrity in extreme conditions. [A]

• Volume 16 - **Sparsim®**

Models mooring of caisson-spar vessels with catenary based moorings. Static, low-frequency and wave-frequency dynamic modeling of vessel motions and mooring line loads with emphasis on mooring line structural integrity in extreme conditions. [A]

General Features

All **SeaSoft** program packages include the following general features and capabilities:

• Input/output of data in either English or metric units.

• Complete six-degree-of-freedom motion and load analysis and estimation of acceleration, velocity or displacement response characteristics at any point on the vessel. The latter ability facilitates many important engineering evaluations. For example:

❖ dynamic mooring loads due to fairlead motions

❖ vessel motions relative to a fixed platform or crane load

❖ jack-up spud can motions relative to the sea floor

• Attractive formatted tabular output on 8-1/2 x 11 inch sheets for easy inclusion in reports or other documentation.

• Transportability of programs to virtually any computer, achieved by careful adherence to ANSI FORTRAN-77 standards in source code preparation. All code has been carefully optimized to execute efficiently on microcomputers.

• Output control, allowing user selection of output variables for each run and specification of output device (console, printer or magnetic media).

• Complete control over water depth, with full accommodation of shallow-water wave effects which generally become significant in water less than 300 feet deep whenever wave periods exceed about 14 seconds or when wind-driven seas exceed a significant wave height of about 30 feet. These conditions are well within the probable scope of any moderately comprehensive vessel motion study. In drilling, jack-up or single point mooring applications, water depths considerably less than 300 feet are commonplace.

• Interface to **SeaSoft**'s universal plotting routine to produce x-y point plots of selected tabular data.

• Comprehensive user manuals which outline the use of each program and explain in detail its capabilities. Each contains a detailed sample input/output session comprising a realistic application. Manuals include table of contents and index.

• A data entry and editing interface (the "editor") which provides simplified access to the main computational program. This permits input files, once created, to be easily modified to account for major or minor changes or errors. The editor programs utilize an easy-to-use single-item replacement format for data entry and update. Input files can be archived and reused any number of times. Backup files are made each time an input file is modified, facilitating the archival process and protecting against inadvertent loss of important data. Built-in "help" menus reduce the need for consultation of user manuals. Insofar as possible, each program uses the same input/output formats, procedures and nomenclature conventions so that the user of any program will easily be able to use and interpret procedures and results of any other program.

General Features 2

All dynamics packages include the following *REGULAR WAVE* capabilities:

• Complete user control over regular wave periods, directions, and wave heights or slopes used in the calculation of regular wave response characteristics (RAOs).

• Output of both amplitude and phase of regular wave response characteristics for all requested regular wave conditions and all requested output variables.

• In addition, vessel motions packages feature user control over the regular wave output stream allowing suppression or inclusion of:

❖ Regular Wave Motion response for any or all six degrees of freedom.

❖ Acceleration, velocity or displacement response characteristics at user-specified points on the vessel.

❖ Net Regular Wave Force and/or Moment responses for any or all six degrees of freedom.

Where appropriate, dynamics packages produce wave-height dependent RAOs, reflecting important system nonlinearities.

All dynamics packages include the following *IRREGULAR WAVE* capabilities:

• Specification of wave spectral type, including :

❖ Pierson-Moskowitz
❖ Mean, Sharp, Very Sharp JONSWAP
❖ Bretschneider/ISSC
❖ User-Specified

• Calculation of r.m.s. values, r.m.s. rates and characteristic spectral periods of all requested variables.

• Specification of the degree of azimuthal spreading of irregular wave energy; i.e., the degree of wave crest shortening due to cross seas, leading to modeling of operations in short-crested irregular waves.

• Specification of simultaneous swell (period, height, direction).

• In addition, vessel motions packages feature calculation of "air-gap" statistics at any point on the vessel to estimate wave clearance characteristics (e.g., wave slap on the deck of a semi-submersible in survival conditions).

Typical Applications

OPERATIONAL SUPPORT

• A semi-submersible moves from the North Sea, where wind-wave frequency spectra are typically sharply peaked, to offshore Africa where normal conditions include a persistent background ocean swell and where wind-wave energy is generally spread over a larger frequency bandwidth; how will motion-related downtime be affected by the move? [**Semisim**]

• An ocean-going barge under tow passes from an area with wave conditions dominated by intense, locally generated wind driven waves into an area with wave conditions dominated by heavy, unidirectional swell from a distant storm. Can towline tension oscillations be reduced by paying out or taking home towline or by a temporary course alteration? [**Towsim**]

• A jack-up moves from an area subjected to moderate local wind-driven sea conditions but protected from distant swell to a location exposed to persistent long-period swell; what quantitative difference in motion performance afloat and during leg installation can be expected? What is the expected waiting-on-weather window for setting-down operations given the anticipated swell height and period? [**Jacksim**]

• A crane barge moves outside the exposed mouth of a sea-facing channel from inside the channel proper; how will crane motions and accelerations be affected by the deeper water and the increased directional spreading of the seas at the new location? [**Shipsim**]

• A drilling company wishes to bid on a drilling contract for a lease area in water deeper than that for which their wire-rope mooring system was designed. Will the simple addition of anchor-end chain provide the required station keeping capability and will the redesigned mooring system produce tolerable line tension oscillations in the forecast 10 year storm? [**Moorsim**]

EQUIPMENT FAILURE

• A drilling company is experiencing periodic link failures in the oil-rig-quality mooring chain on a drillship even though logs of shipboard tensiometer readouts do not indicate that line tensions have exceeded tolerable limits. Can the repeated failures be attributed to predictable environmentally-produced line-tension oscillations, perhaps implicating maladjusted tensiometer equipment, or is the quality of the chain suspect? [**Moorsim/Shipsim**]

• A moored weather buoy is lost due to a mooring line failure in an exceptionally heavy winter storm. Can the line failure be attributed to the storm alone, or is material fatigue implicated? [**Moorsim/Discsim**]

• A freight barge under tow from Japan to Seattle sinks during a severe storm due to towline failure and subsequent loss of directional control. Can the towline failure be attributed to a substandard towline, or were observed (and / or hindcast) conditions sufficient to result in towline failure regardless of towline condition, indicating a need for towline redesign for this route and season? [**Towsim**]

• A self-elevating unit's jacking gear is damaged during setting-down operations on an exceptionally hard, rocky bottom even though vessel motions remained within normal limits for the operation. Can the damage be rationally attributed to the unusually hard bottom or should fatigue or other structural flaws in the jacking gear be suspect? Should guidelines for operations in that area be modified as as result of the mishap? [**Jacksim**]

Typical Applications 2

• A near-shore SALM-moored tanker has experienced unexpected fatigue fractures in the yoke member of the mooring structure. Observers have noted that the low-frequency excursions of the tanker have been persistently larger for the observed wave, wind and current conditions than predicted on the basis of model test data. The presence of a weakly time-varying current component at the site, not modeled in the wave basin testing series, is suspected of exciting resonant low-frequency mooring oscillations. Are the observed spectral characteristics of these current speed fluctuations sufficient to account for the additional vessel motion and yoke fatigue damage? [**SALMsim**]

SYSTEM DESIGN ANALYSES

• Parametric studies on the influence of fore-aft turret location on pitch-related chain loads for a tanker-based marginal-field development system. [**SPMsim**]

• Screening of various combinations of Kevlar, wire rope and chain to achieve, at minimum materials expense, a prescribed load versus offset curve for a deep water catenary leg mooring system design. [**Statmoor**]

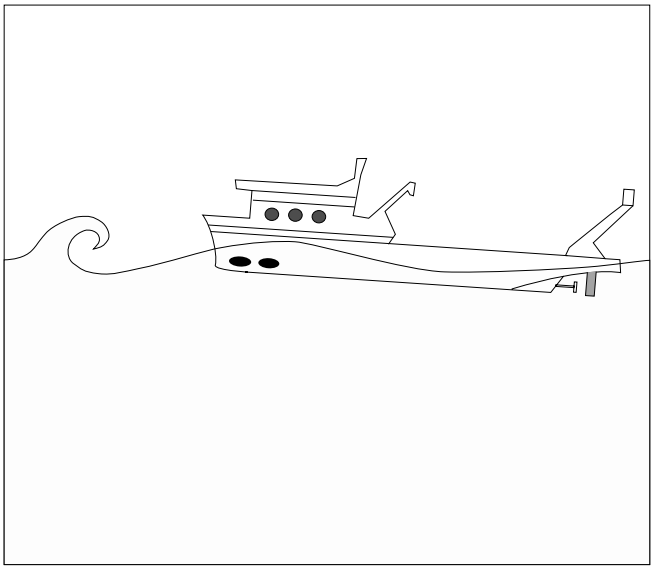
• Screening of CALM buoy designs to achieve minimum average fairlead motions in the presence of persistent eight to ten second swell conditions. [**Discsim**]

• Screening of potential candidates for award of a drilling contract to a moored drillship or semi-submersible in order to estimate, for a particular site and environment, which will be the most cost-effective. [**Shipsim/Semisim**]

• Screening of possible SALM designs (i.e., weight and buoyancy distribution) to achieve minimal dynamic load variations in preparation for a model basin analysis of a single candidate. [**SALMsim**]

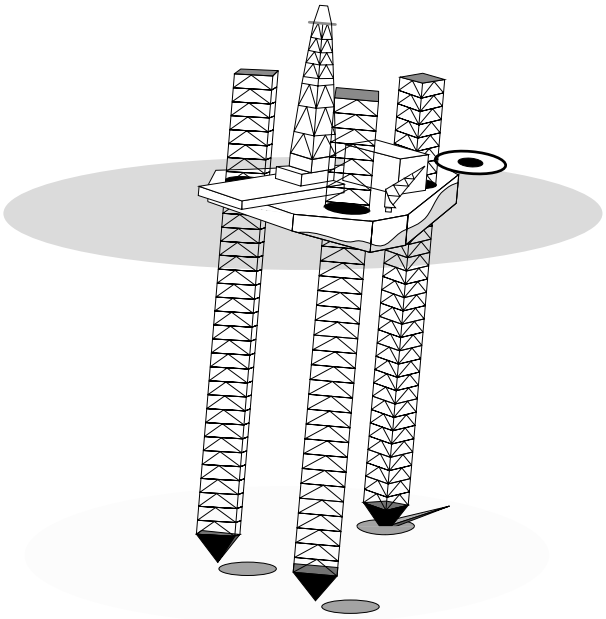
The appropriate **SeaSoft** library programs can quickly evaluate these situations and provide valuable guidance to system designers, analysts and operations personnel. Vessel performance in the complete range of possible sea conditions for a given site or route can be thoroughly investigated by engineering staff. Parametric studies of the effects on performance of vessel load conditions, irregular wave spectral composition, the effects of crossed seas and background swell can be carried out entirely in-house.

Volume 1: Shipsim



Shipsim is a general-purpose six degree-of-freedom wave-frequency vessel motions program specifically enhanced for displacement-hull vessels with relatively large block coefficients. Vessels in this category include drillships, barges and tankers. **Shipsim** utilizes an efficient algorithm for calculating wave-frequency forces and moments which permits accurate modeling using as input only gross hydrostatic and mass properties (metacentric heights, displacements, overall dimensions, centers of gravity, gyradii, etc.), eliminating the need for tedious and error-prone input of vessel lines details. This typically permits comprehensive analyses to be completed in one hour or less. Non-linear effects, particularly in the roll degree of freedom, are fully modeled, leading to realistic roll response predictions which depend on details of bilge geometry. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions and an optional independent background swell. Accelerations, velocities and displacements at any point on the vessel can be computed. Effects of finite water depth are fully modeled and either English or metric units may be selected for vessel specification and data output. Output is in the form of amplitude and phase of vessel Response Amplitude Operators (RAOs) and / or statistical characterizations of vessel response to irregular wave conditions. Calculations are carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.

Volume 2: Jacksim



Jacksim is a powerful motion modeler for analysis of wave-frequency motions of jack-up drilling vessels in the floating mode. In addition to the six degree-of-freedom afloat motions capabilities common to all **SeaSoft** motion programs, this package includes:

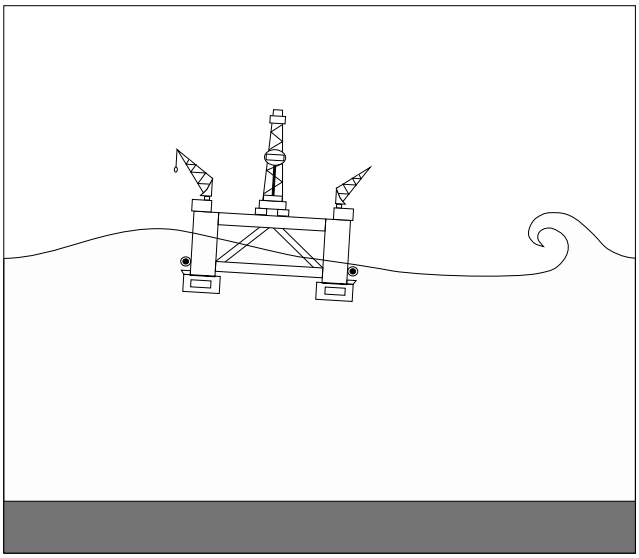
• A sophisticated analysis of the dynamic leg loads associated with going on location in the presence of waves. This feature includes specification of ocean bottom soil conditions. The leg-load estimation capability provides an important new tool for the operational engineer or marine surveyor. This capability aids in the quantification of the difficult and highly subjective process of evaluating structural risks associated with going on location in marginal sea conditions. The ease of use and microcomputer execution capability of this program mean that the program load estimates can be obtained in real time, on location, by the engineer or surveyor in charge.

• A novel calculation of leg bending loads incurred going off location in the presence of waves when one or more legs are trapped or otherwise restrained by entrapment in soft bottom materials.

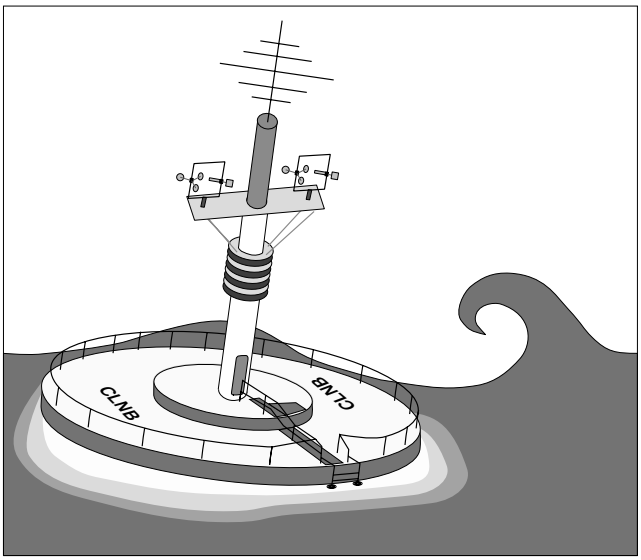
• A nonlinear hull and leg damping algorithm which leads to realistic nonlinear response functions.

• Evaluation of vessel motion characteristics for any position of the legs, from fully raised to fully lowered, and specification of the degree of leg-well blockage by spud can insertion during tow or other legs-elevated operations.

Volume 3: Semisim



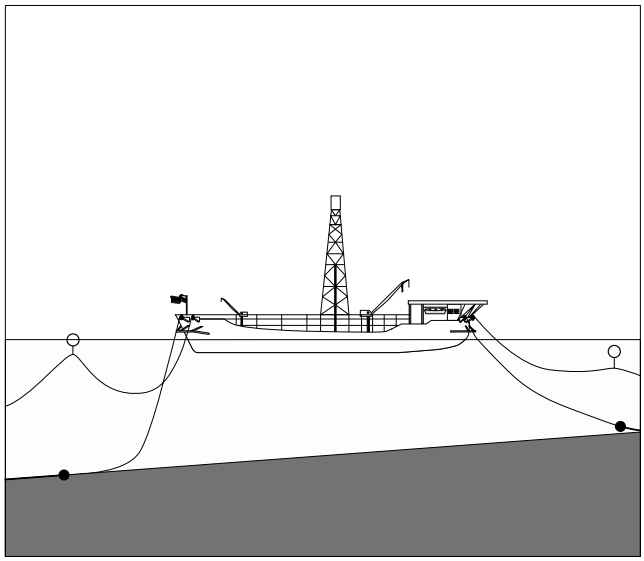
Volume 4: Discsim



Semisim is a six degree-of-freedom wave-frequency motions program for use with semi-submersible vessels in the non-transit, hulls-submerged mode. Computed response characteristics reflect the highly nonlinear nature of motion damping and excitation for this type of vessel. Features include efficient input of column and hull forms based on the use of simple geometrical shapes, permitting quick specification and easy modification of the underwater configuration for comparative performance analysis and evaluation. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions and an optional independent background swell. The program provides for calculation of air gap clearances between deck and water surface in addition to absolute displacements, velocities and accelerations at any point on the vessel. Effects of finite water depth are fully accommodated and either English or metric units may be selected for vessel specification and data output. Output is in the form of amplitude and phase of vessel Response Amplitude Operators (RAOs) and / or statistical characterizations of vessel response to irregular wave conditions. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.

Discsim is a comprehensive 6 degree-of-freedom wave-frequency motion program for the special case of azimuthal hull symmetry. This program is thus suited for analysis of buoy motions and loads in single-point mooring applications and for round vessel geometries often associated with operations in the presence of persistent ice. **Discsim** utilizes an efficient algorithm for calculation of wave-frequency forces and moments which permits accurate modeling using as input only gross hydrostatic and mass properties (metacentric heights, displacements, overall dimensions, centers of gravity, gyradii, etc.), eliminating the need for tedious and error-prone input of vessel lines details. This typically permits comprehensive analyses to be completed in one hour or less. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions and an optional independent background swell. Accelerations, velocities and displacements at any point on the vessel can be computed. Effects of finite water depth are fully modeled and either English or metric units may be selected for vessel specification and data output. Output is in the form of amplitude and phase of vessel Response Amplitude Operators (RAOs) and / or statistical characterizations of vessel response to irregular wave conditions. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.

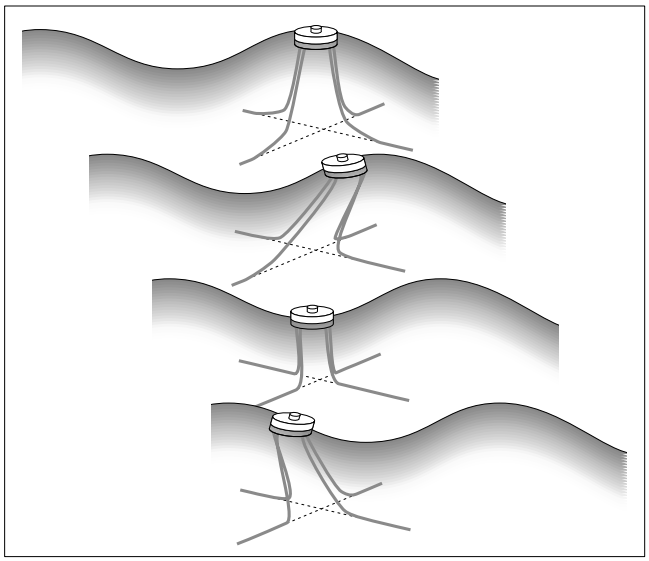
Volume 7: Statmoor



Statmoor is a first-generation comprehensive static mooring analysis program used for calculation of lateral restoring characteristics of multileg catenary mooring systems. The program is used in design and analysis of complex single-vessel multi-point mooring systems and special applications including static response characteristics of most elasto-gravitational lines of importance to the offshore industry (towlines, reinforced coflex-type hoses, etc.). Analytically exact solutions to the elasto-gravitational static response of mooring line elements are employed; these exact equations apply to arbitrary degrees of nonlinearity in the tension-elongation characteristics for the mooring line elements, permitting analysis of strongly non-linear materials such as nylon and polypropylene. Extensive on-line default values for weight, strength and elastic properties of steel and synthetic mooring materials are provided to enhance efficiency in preliminary parametric design studies. The program supports clumped weights, surface-resident spring buoys and azimuth-dependent sloping seafloor conditions. Output capabilities include individual line characteristics and net restoring forces and moments associated with yaw offsets or lateral offsets in any direction. Either fairlead pretensions, pretension line angles or horizontal distances to anchors may be specified for a given length of deployed line.

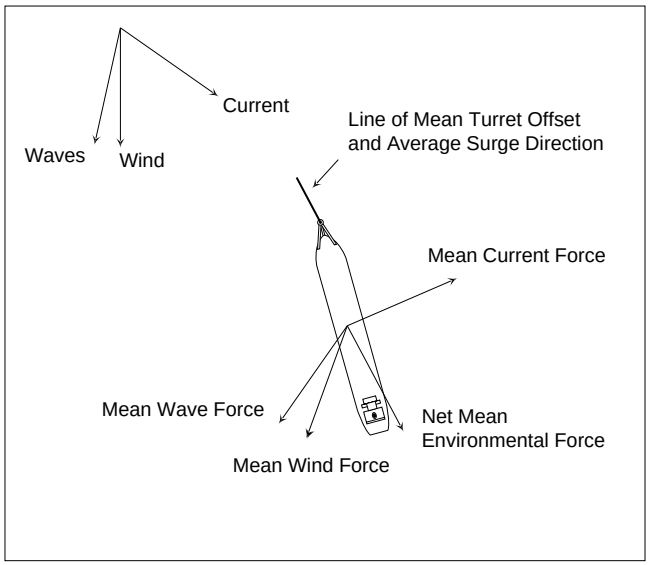
In developing **Statmoor**, special attention was given to deficiencies in the treatment of mooring element elasticity by widely used static mooring codes. In some cases, commonly-employed approximations to elastic response can result in errors as great as 100% in predicted line loads and mooring forces.

Volume 8: Catsim



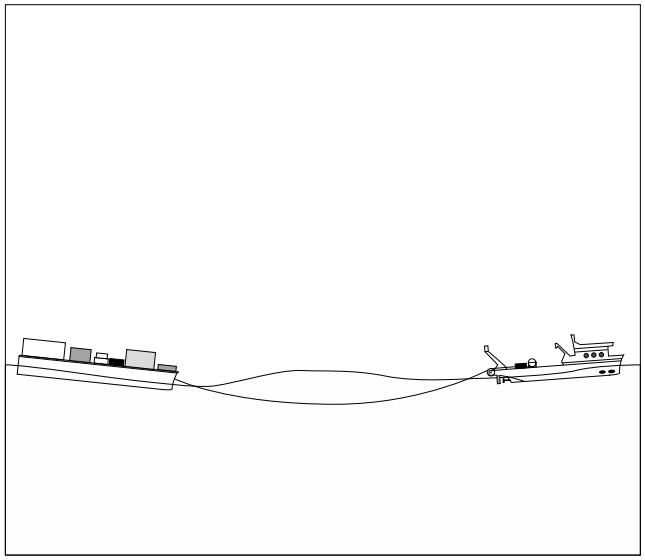
Catsim is a second-generation comprehensive static mooring analysis program for multileg catenary mooring systems. **Catsim**'s strengths include the ability to accommodate the latest generation of complex deepwater mooring systems and the ability to compute line tension variations for arbitrary quasi-static motions, including rotational offsets about any oblique axis and translational offsets in any direction. These capabilities are used, in particular, for ruptured-hull damage analysis of moored vessels and for a new class of multileg mooring buoys with variable vertical positioning capabilities. **Catsim** shares with **Statmoor** the exact solution to the elasto-gravitational static response of mooring line elements, permitting analysis of strongly nonlinear materials such as nylon and polypropylene. Extensive on-line default values for weight, strength and elastic properties of steel and synthetic mooring materials are provided to enhance efficiency in preliminary parametric design studies. **Catsim** supports surface and submerged buoys, clumped weights and individually specifiable anchor depths, but not sloping bottom conditions. Output capabilities include both individual line characteristics and net restoring forces and moments associated with rotational offsets about any oblique axis or translational offsets in any direction. Automatic evaluation of the force-moment equilibrium configuration associated with user-specified external forces and moments acting in conjunction with hydrostatic and mooring forces and moments is a built-in option.

Volume 9: Slowsim



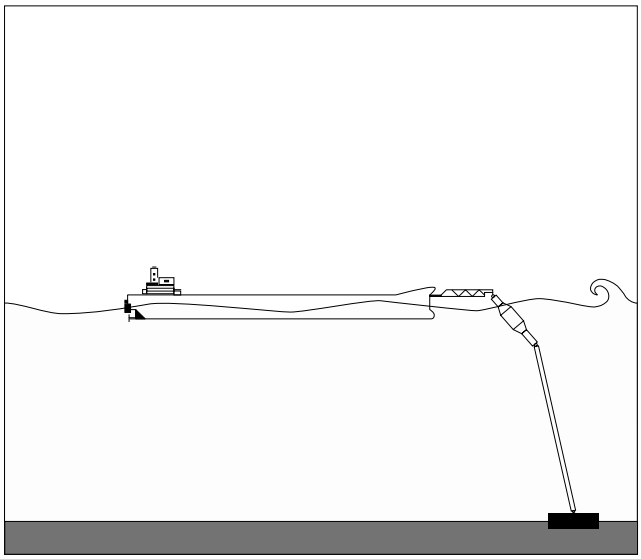
Slowsim is used for computing static and low-frequency heading-dependent vessel forces and moments arising from wind, current and wave drift action for a variety of vessel types and configurations. These computations comprise a normal subset of calculations required for comprehensive programs such as **Moorsim**, **SPMsim**, **Towsim**, **CALMsim**, **SALMsim** and **TLPsim**, and are used to estimate the environmentally-associated mean position and low-frequency motion amplitudes of vessels in these programs. A built-in selection of standard vessel types including barges, VLCC and ULCC tankers, semisubmersibles and azimuthally-symmetric vessels are accommodated for rapid estimation of environmental vessel loads on these vessel types. In addition, a built-in help facility is available online to estimate average vessel characteristics such as windage areas, hydrostatic and mass properties for seagoing tanker-type vessels.

Volume 10: Towsim



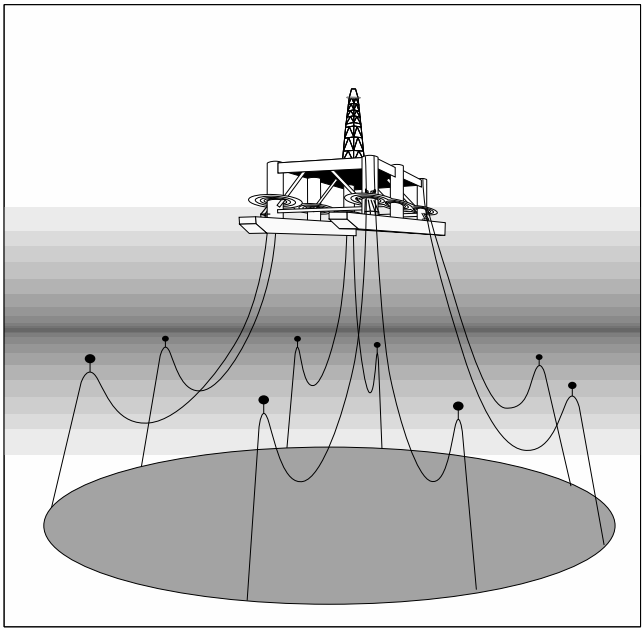
Towsim is a comprehensive analysis program used for design, evaluation, maintenance and failure analysis of simple or composite towlines used in open-ocean tug-barge-towline systems. It provides detailed towline and vessel performance data under arbitrary water depth and environmental conditions, including characteristic (r.m.s.) and peak towline loads in the forecast maximum storm for a particular route. The analysis can be used to optimize towline characteristics in trip planning for a specific route / environment and is suitable for on-board real-time use in an advisory capacity for setting optimal towline scope and / or optimal tug heading during storm penetration or survival preparations. Characteristics of the towline, including mass, hydrodynamic and elastic properties of each element of a multi-element towline, are fully specifiable. Tug-barge-towline systems are characterized by extreme nonlinearities at every phase of performance analysis; **Towsim** fully accommodates these nonlinearities at all levels, including system statics, quasi-statics (low-frequency oscillations, produced by variable wind and wave-drifting forces, with typical periods of oscillation of one to ten minutes) and dynamics (wave-induced oscillations with typical periods of 4 to 30 seconds). Direct comparison of **Towsim's** nonlinear dynamic load calculation with the quasi-static catenary calculation often used as an approximation is provided as an output option. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.

Volume 11: SALMsim



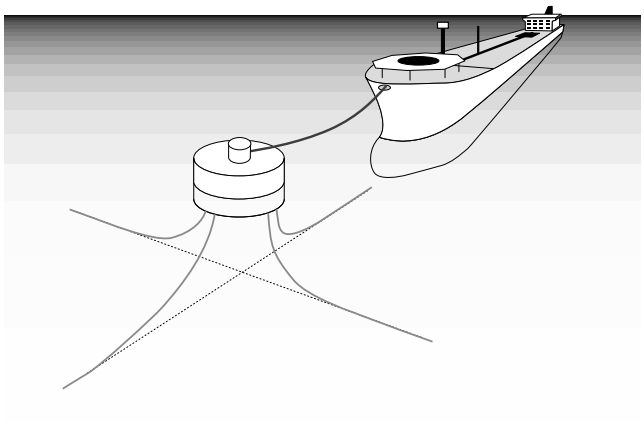
SALMsim is a comprehensive analysis program used for design, evaluation, maintenance and failure analysis of riser-buoy-yoke type single anchor-leg mooring (SALM) systems with an attached storage vessel. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions, an optional independent background swell, and steady or fluctuating wind and / or current. Integrated modules compute static, low-frequency (typical periods of oscillation of one to twenty minutes) and wave-frequency (typical periods of oscillation of 4 to 30 seconds) behavior of the vessel and its associated mooring structures. Emphasis is on estimation of characteristic (r.m.s.) and storm peak motion and load values at any point in the system for a particular wind, wave and current environment. Effects of finite water depth are fully modeled and either English or metric units may be selected for vessel specification and data output. Output is in the form of amplitude and phase of Response Amplitude Operators (RAOs) and / or statistical characterizations of vessel and mooring system motion and load response to irregular wave conditions. Capabilities for analysis of free (vessel detached) SALMs in arbitrary environmental conditions are incorporated. Full accommodation of square-law hydrodynamic driving and damping forces acting on the mooring structure is provided. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values. **SALMsim** versions accommodating both conventional buoyant SALMs and more recent designs based upon pendular masses are available.

Volume 12: Moorsim



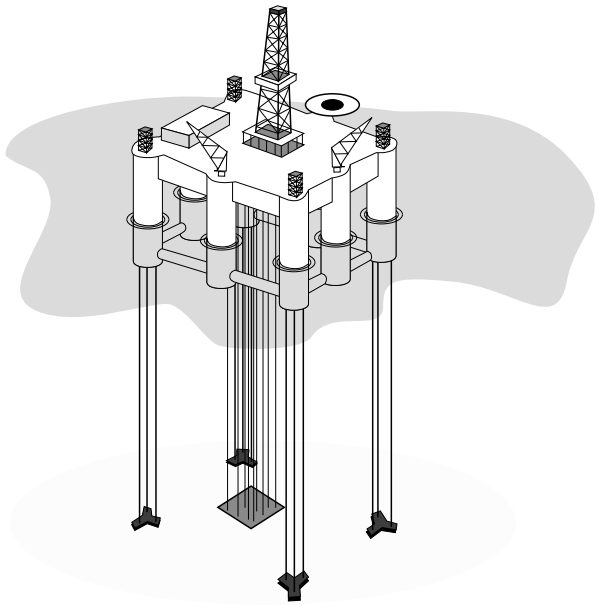
Moorsim is a comprehensive analysis program used for design, evaluation, maintenance and line failure analysis of catenary-type spread mooring systems. It provides detailed mooring line and vessel performance data under specifiable water depth and environmental conditions, including characteristic (r.m.s.) and peak mooring line loads in the forecast maximum storm. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions, an optional independent background swell, and steady or fluctuating wind and / or current. Spread mooring systems are characterized by extreme nonlinearities at every phase of performance analysis; **Moorsim** accommodates these nonlinearities at all levels, including system statics, quasi-statics (low-frequency oscillations with typical periods of one to ten minutes) and dynamics (wave-frequency oscillations with typical periods of 4 to 30 seconds). **Moorsim** is suitable for on-board use in an advisory capacity during mooring setup or storm preparation. The program is especially useful for deep-water applications which are difficult to study thoroughly using conventional model-scale tests. Direct comparison of **Moorsim's** nonlinear dynamic load calculation with the quasi-static catenary calculation often used as an approximation is provided as an output option. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.

Volume 13: CALMsim



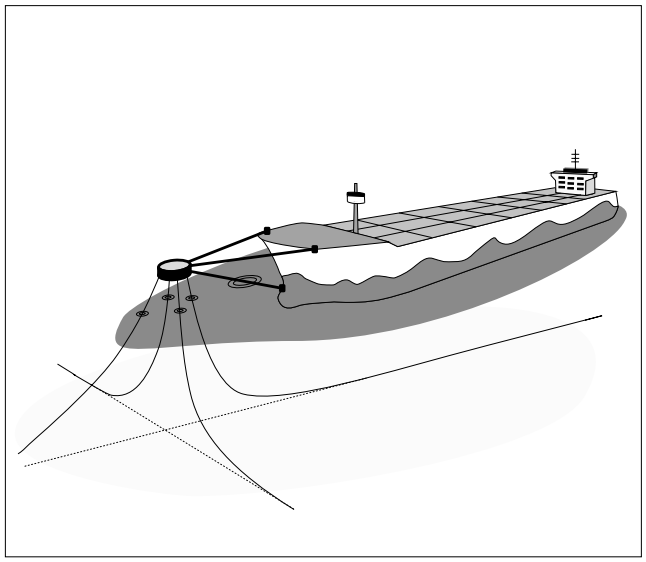
CALMsim is a comprehensive analysis program used for design, evaluation, maintenance and failure analysis of catenary anchor-leg mooring (CALM) systems. These systems comprise a storage vessel attached by means of a hawser or a rigid, articulated yoke assembly to a large catenary-moored surface buoy. It provides detailed mooring line and vessel performance data under specifiable water depth and environmental conditions, including characteristic (r.m.s.) and peak system loads in the forecast maximum storm. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions, an optional independent background swell, and steady or fluctuating wind and/or current. CALM mooring systems are characterized by extreme nonlinearities at every phase of performance analysis; **CALMsim** accommodates these nonlinearities at all levels, including system statics, quasi-statics (low-frequency oscillations with typical periods of one to ten minutes) and dynamics (wave-frequency oscillations with typical periods of 4 to 30 seconds). Direct comparison of **CALMsim'**s nonlinear dynamic load calculation with the quasi-static catenary calculation often used as an approximation is provided as an output option. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.

Volume 14: TLPsim



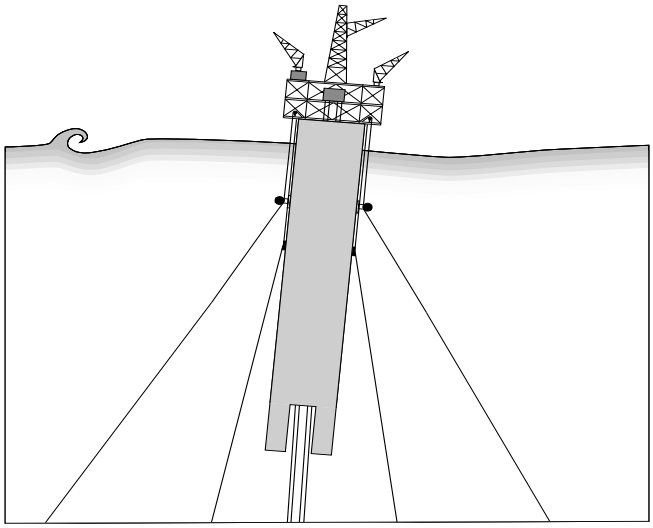
TLPsim is a comprehensive analysis program used for design, evaluation, maintenance and failure analysis of Tension Leg Platform (TLP) systems. It provides detailed tendon and platform performance data under specifiable water depth and environmental conditions, including characteristic (r.m.s.) and peak tendon loads in the forecast maximum storm. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions, an optional independent background swell, and steady or fluctuating wind and/or current. The program is especially useful for deepwater applications which are difficult to study thoroughly using conventional model-scale tests. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.

Volume 15: SPMsim



SPMsim is a comprehensive analysis program used for design, evaluation, maintenance and failure analysis of catenary-based single-point mooring (SPM) systems, including vessel-fixed turret systems. It provides detailed mooring system and vessel performance data under specifiable water depth and environmental conditions, including characteristic (r.m.s.) and peak mooring line loads in the forecast maximum storm. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions, an optional independent background swell, and steady or fluctuating wind and/or current. Catenary-based mooring systems are characterized by extreme nonlinearities at every phase of performance analysis; **SPMsim** accommodates these nonlinearities at all levels, including system statics, quasi-statics (low-frequency oscillations with typical periods of one to ten minutes) and dynamics (wave-frequency oscillations with typical periods of 4 to 30 seconds). The program is especially useful for deep-water applications which are difficult to study thoroughly using conventional model-scale tests. Direct comparison of **SPMsim**'s nonlinear dynamic load calculation with the quasi-static catenary calculation often used as an approximation is provided as an output option. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.

Volume 16: Sparsim



Sparsim is a comprehensive analysis program used for design, evaluation, maintenance and failure analysis of moored, deep-draft caisson-style offshore development and production systems. These systems comprise a massive spar-shaped vessel, usually positioned with a more-or-less conventional taut catenary mooring system. The program provides detailed mooring line and vessel performance data under specifiable water depth and environmental conditions, including characteristic (r.m.s.) and peak system loads in the forecast maximum storm. A wide range of environmental conditions is accommodated, including extensive built-in wave spectral types, azimuthal spreading of wave directions, an optional independent background swell, and steady or fluctuating wind and/or current. These systems are characterized by extreme nonlinearities at every phase of performance analysis; Sparsim accommodates these nonlinearities at all levels, including system statics, quasi-statics and dynamics. Analysis is carried out in the frequency domain, resulting in short execution times and unambiguous predictions of statistical response values.