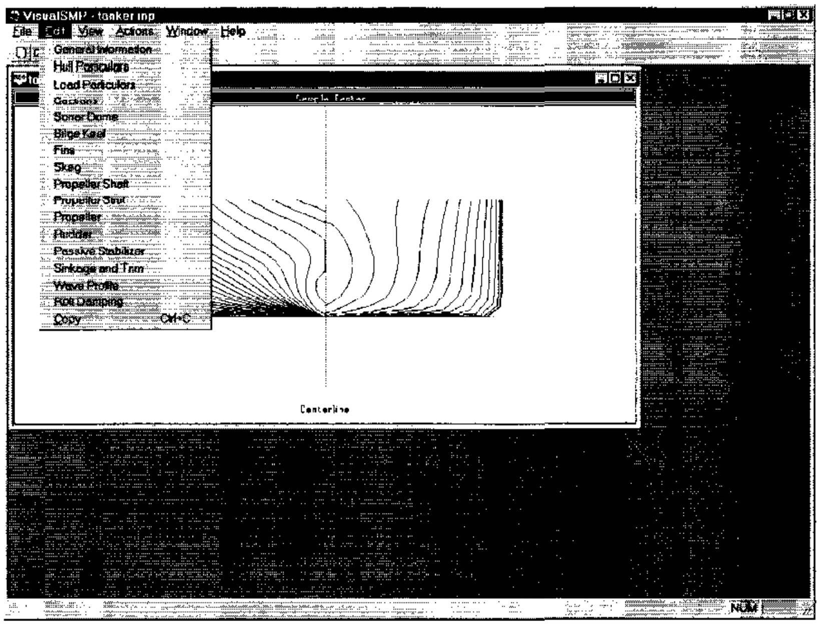
5 Monohull Regular Waves Module

The monohull regular wave module of VisualSMP is run by either opening an existing monohull regular wave input file (*.inp) or creating a new monohull regular wave run file. The standard Windows File menu interface controls both actions.

The input to be developed for the Regular Wave Module consists of hull form data, loading data, and appendage data. The actual input of this data into VisualSMP is accomplished via a series of Windows dialog forms, which are accessed via the Edit menu. The data record sets required for the monohull regular wave module are described below.

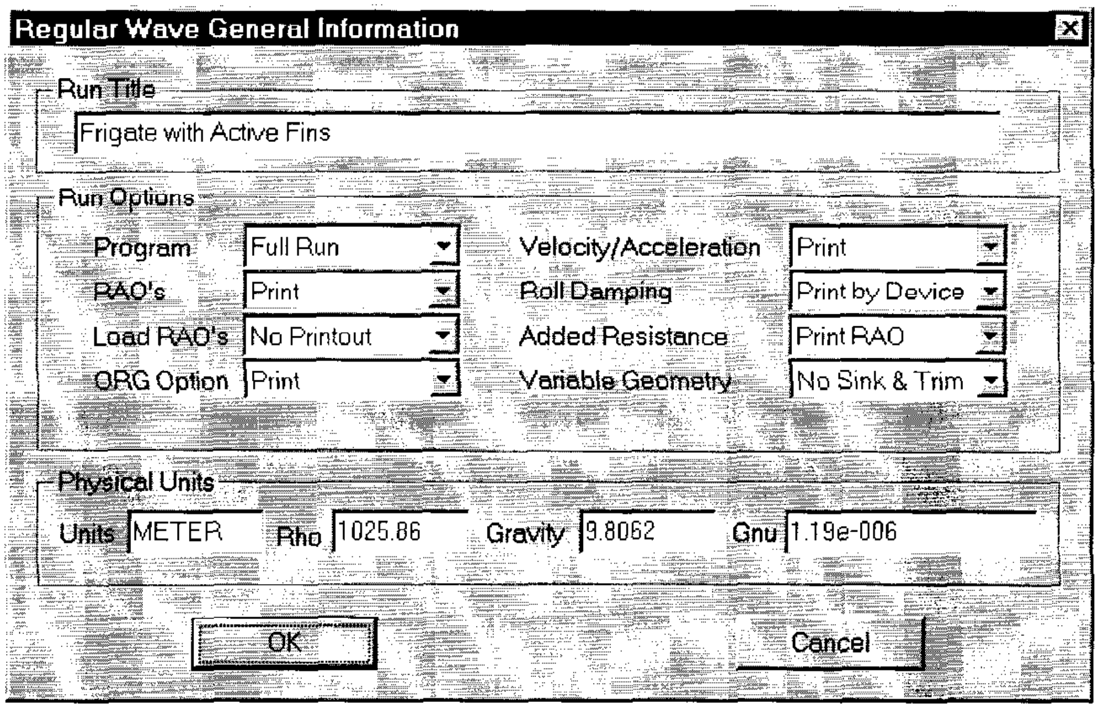
5.1 Edit



Inputs such as general project information, hullform data, loading, wave profile, and other project and analysis data is provided to the monohull regular waves module of VisualSMP through the Windows Edit menu on the main program toolbar.

The user can use the copy to clipboard function from the Edit menu or the toolbar. This option will create an Enhanced Graphics Meta File and place it on the clipboard where the user can paste it into any documentation tool that accepts Enhanced Meta Files.

5.1.1 General Information



The general information dialog box provides for definition of the project, selection of run and output options, and selection of units.

The first input box is the title for the project. Any name up to 80 characters may be entered for the Run Title. The title usually includes the ship, project, date, and/or other parameters identify that run. This information will be output at the top of each printed page. For historical reference, the user may desire to cite the ship's trim on the title record.

Run and output options are set in the second portion of the dialog box. Options are selected via standard pull-down list boxes.

Program options.

- Hydrostatics - This selection runs hydrostatic calculations only. Output consists of an input record "echo," and input record description, and tables of ship and appendage particulars.
- Full Run - A full run of SMP for all motions. First part of printout is the same as for Hydrostatics. The following files are written: Origin Transfer Function file, Root Mean Square (RMS)/Toe file, and a Speed Polar file. The Speed Polar file is used for off-line plotting of the RSV data.

Response Amplitude Operator (RAO) options. RAO data is created for the six-degree-of-freedom motions for long-crested seas, and for each speed, heading, and wave frequency defined in SMP95. It should be noted that the lateral motion RAO's are nonlinear with sea state. The user should also be aware of the large amount of data generated when this option is selected. An RAO file is generated only when this option is selected. RAO output is created in the Irregular Wave Module, but this option must be selected in order to create the required transfer functions.

- No Printout - No RAO output file created.
- Print - Generate RAO tables and RSV/T_{oe} tables.

Load RAO options. RAO output option for the vertical shear force and vertical bending moment response amplitude operators (RAO) and phase angles. A load RAO file is generated only when this option is selected. RAO output is created in the Irregular Wave Module, but this option must be selected in order to create the required transfer functions.

- No Printout – No load RAO tables are created.
- Print RAO's– Load RAO tables are created.

ORG options. This options selects whether or not transfer functions are written to the *.out file.

- No Printout
- Print

Velocity/Acceleration options. Because the standard SMP output is extensive, care should be exercised when selecting this option. The RSV printout will triple when this option is selected. The velocities and accelerations are always written out to the Speed Polar file, so the user may prefer to plot this data rather than print it out.

- No Printout - No velocity and acceleration files are created.
- Print – Print out the velocity and acceleration RSV/T_{oe} tables.

Roll Damping. This output is extensive. If RLDMPR > 0 then roll decay value "n" is printed out. If RLDMPR < 0 then nondimensional B_44 is printed. The later is also labeled "n", although strictly speaking it is not.

- No Printout– No roll damping tables created.
- Print Summary - zero speed potential speed added mass and damping, summary of roll damping.
- Print by Device - above plus damping and percent of total damping by device (hull, bilge keel, etc).
- Print by Mechanism - above plus damping and percent of total damping by physical mechanism (wave making, lift, etc)

Added Resistance. Option to turn on the added resistance calculation.

- No Printout – No Added resistance tables are created.
- Print RAO - Added resistance tables are created.

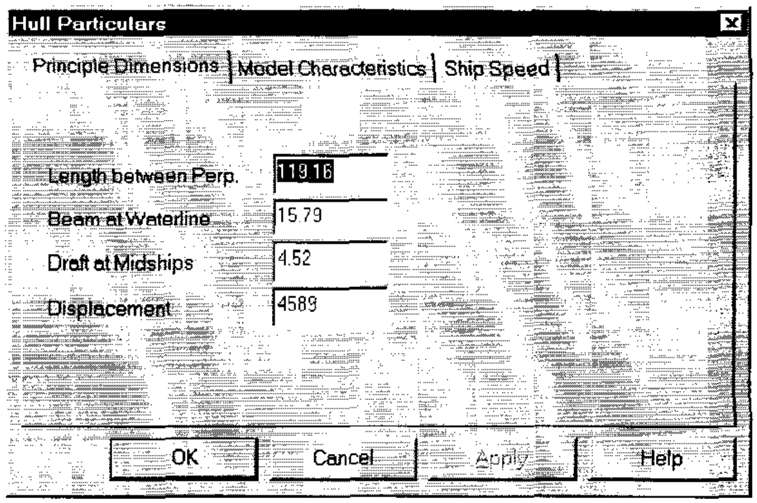
Variable Geometry. The variable geometry option combined with trim results in the hull being distorted as the sections are simply moved vertically. Consequently, results will be best if the trim is relatively small. Also, with the variable geometry option, segments are generated as specified; the geometry input is separated from the segmentation specification. A rectangular section, for example, requires only three input points, even if finely segmented. Sections may enter or leave the water. It will work for "normal" monohulls, unusual shapes may result in difficulty. The resulting immersed form must be a monohull. Sections must be simply connected; a hull with a large protruding bulb and a large protruding above water bow will fail.

- No Sink & Trim– Existing Static stations definition.
- Allow Sink & Trim– Allow Sinkage and Trim.

The third portion of the dialog box allows the user to set the units to be used in the analyses. Default units are length - FEET, Rho - 1.9905 slug/ft^3, Gravity - 32.1725 ft/sec^2, and Gnu - 1.279e-005 ft^2/sec. Metric units are supported, values to be entered are length - METERS, Rho - 1025.82 kg/m^3, Gravity - 9.8062 m/sec^2 and Gnu - 1.19e-006 m^2/sec. If results are desired for fresh water, Rho and Gnu values need to be set accordingly.

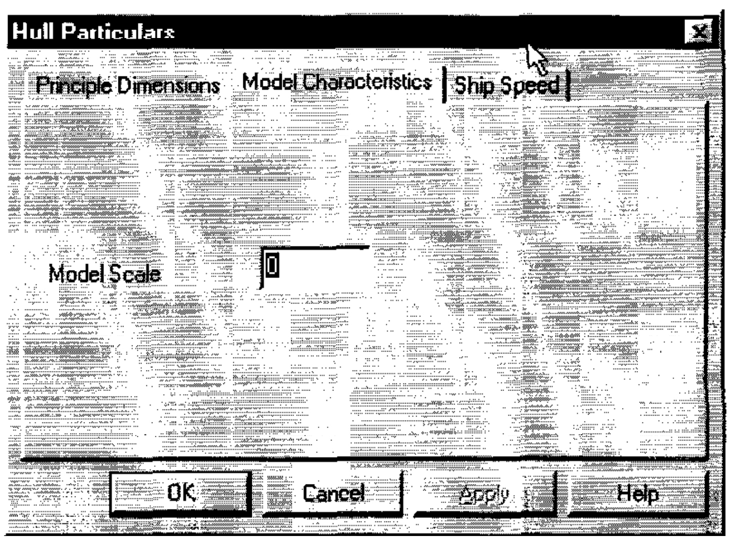
5.1.2 Hull Particulars

5.1.2.1 Principle Dimensions



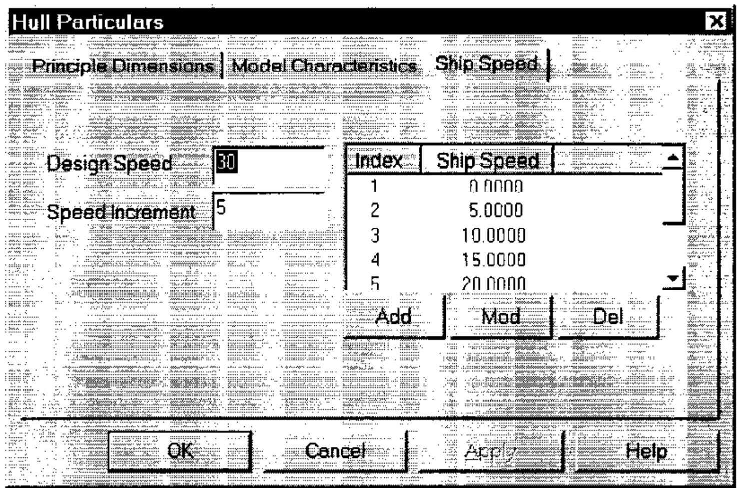
The user inputs ship's length between perpendiculars, beam at waterline, draft at midships and displacement in long tons if length units are feet, metric tons if length units are meters.

5.1.2.2 Model Characteristics



Model scale is used for scaling Reynolds number, skin friction and bilge keel calculations when model results are desired (change Rho and Gnu to fresh water values). Set Model Scale to zero for full-scale calculations.

5.1.2.3 Ship Speed

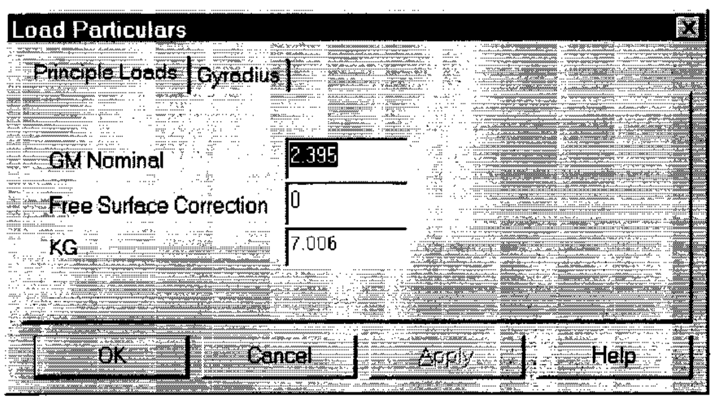


The user inputs the design speed and increment to establish speeds for the analysis. The user then has the option to add, modify or delete the list of ship speeds to meet specific project requirements. Ship speeds start with zero and step up by the speed increment until the design speed has been reached or exceeded. For example, a design speed of 18 and speed increment of 5 would result in ship speeds of 0, 5, 15, and 20 being used in the calculations. A maximum of eight speeds may be run.

If a negative number is entered for the design speed, the user may enter or edit arbitrary values for speeds, as long as they are in increasing order. To enter an arbitrary speed click on the Add button, to modify a speed click on the speed in the list and click on the Mod button. A speed entry can be deleted by clicking on the speed and then clicking on the Del button.

5.1.3 Load Particulars

5.1.3.1 Principle Loads

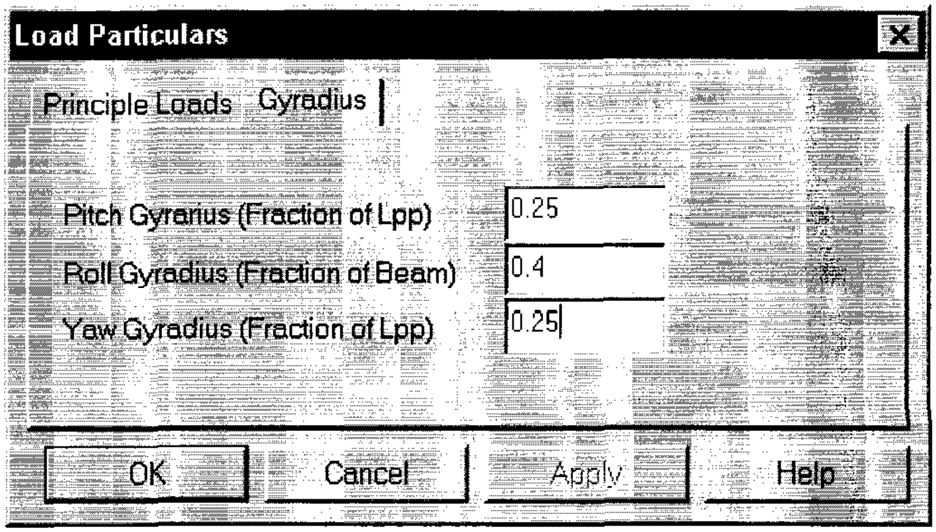


A nominal value for GM is entered, in the length units specified by the user, which should include any free surface corrections. The actual value of GM used in SMP95 is computed as part of the hydrostatic calculations. The nominal GM value is provided as a check for the user on the calculated GM value. However, the user should be aware that SMP95 uses the nominal GM to compute a nominal value of roll period, which, in turn, determines the range of frequencies and modal wave periods used in the motion calculations.

The free surface correction, if any, in the length units specified by the user. The free surface correction is always positive and included in the nominal GM; it does not affect the location of the metacenter (KM).

The KG value that is input corresponds to the uncorrected GM. The KG value output by SMP95 in the hydrostatic table includes any free surface correction.

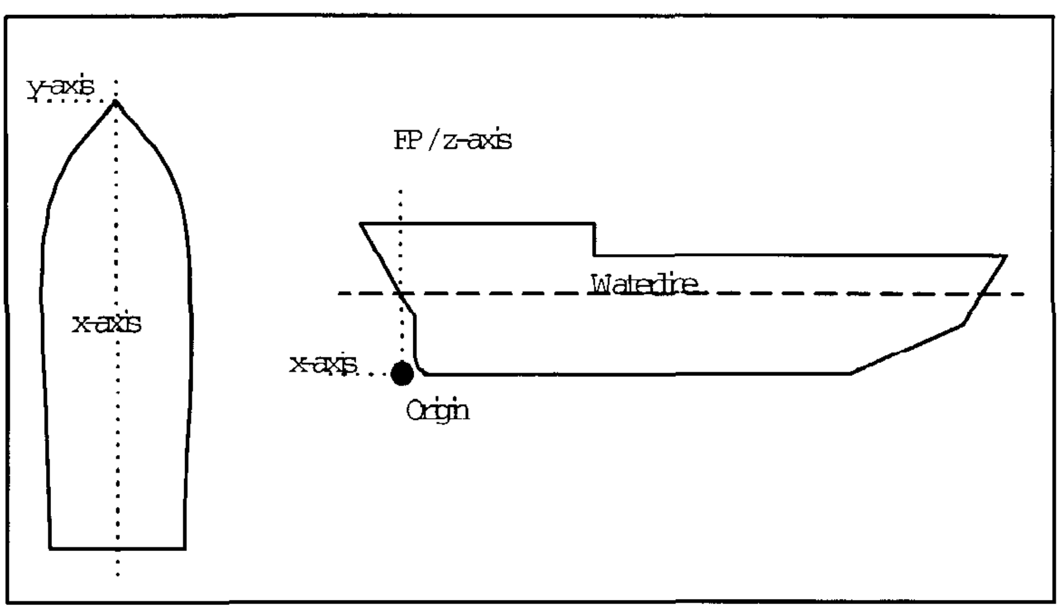
5.1.3.2 Gyradius



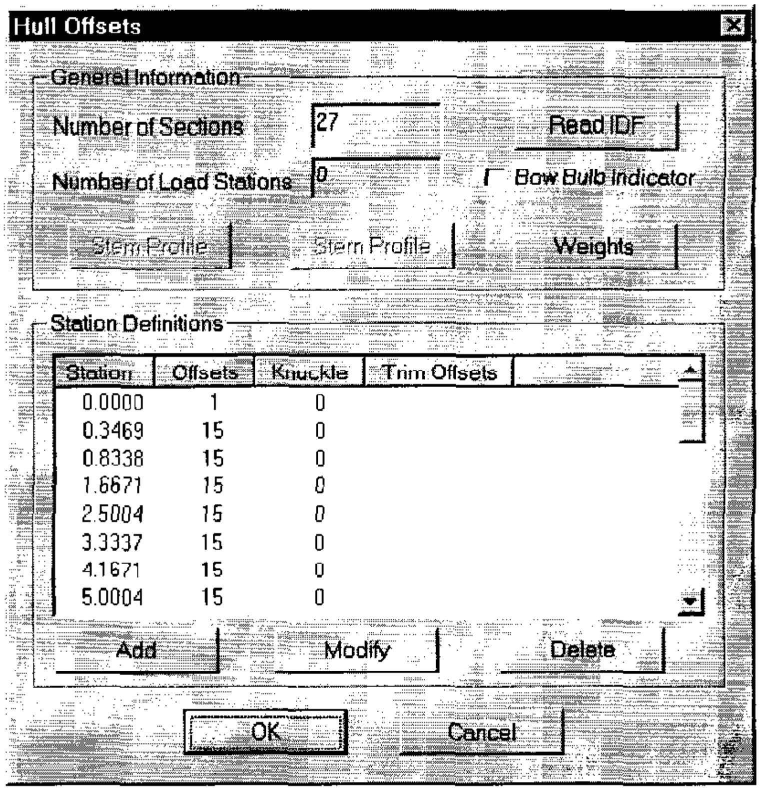
The user enters the radii of gyration for pitch, roll and yaw. Pitch and yaw gyradius are entered as a fraction of the length between perpendiculars, roll gyradius is entered as a fraction of beam. A typical value of the pitch or yaw radius of gyration is 0.25. A typical value for the roll radius of gyration is 0.35.

5.1.4 Hull Offsets

The underwater part of the hull is described in this record set by stations in the x direction and by station offsets in the y and z directions using the Input Reference System as shown below. The origin is the intersection of the ship's baseline and forward perpendicular at the centerline. The x-axis is the baseline, with positive aft. Y is positive to port and Z is positive up.



An important consideration in preparing the offsets is to include the skeg(s) when describing the aft hull lines. In addition to perhaps losing a significant amount of displaced volume, elimination of the skeg(s) from the hull description alters the computation of roll damping due to hull shape. A general rule of thumb is to include the skeg in the offsets if it represents a large integrated volume such as found on the DDG51. Slab sided skegs are usually defined only in the skeg appendage record. Even if the skeg has been defined in the offsets a separate input description of the skeg(s) as an appendage will also be required (see 4.1.8) to determine lift damping.



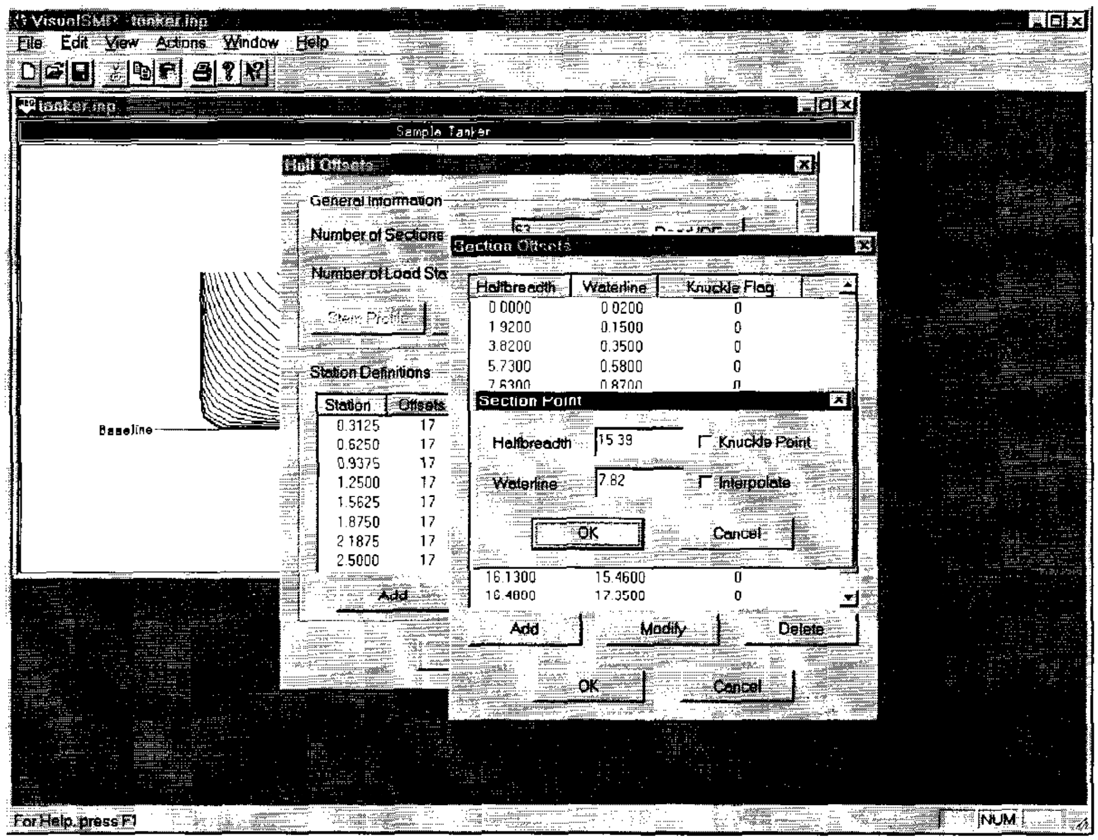
Stations may be added and modified manually by clicking the Add or Modify buttons.

SMP95 increased the number of stations and the number of points per stations significantly. Knuckle points or breakpoints can be defined in each section. Even though the spline algorithm was updated to include the knuckle points, the added mass and damping computations do not make use of them. The knuckle points were added to SMP95 to make it easier to input uniformly distributed points along a station

Stations should be defined along the hull in a uniform fashion. The following rules should be followed while entering section data.

- Each station must have a minimum of three points
- Distribute points uniformly along the section

5.1.4.1 Section Offsets



The stations are input in the order they occur along the ship, starting from the forward most underwater station and ending at the aft most underwater station. Stations forward of the FP and aft of the AP are allowed. For example, -0.28, 0.25, 0.5, 1.0, 2.0,..., 10.0, , 19.0, 20.0, 20.5. Station 10 (midships) must always be included. Stations forward of the FP are designated with negative station numbers, stations aft of the AP are designated with station numbers greater than 20. In addition to station 10, stations must be entered that define the end of the waterline. Only stations below the waterline may be considered.

Station curves are defined by sets of Section Offset points. The Section Offsets for a station can be viewed by double clicking on the Station number in the Station Definitions table. From the Section Offsets dialog, points may be added, modified or deleted by clicking on the appropriate button.

When defining sections the user should not have two adjacent points defined as knuckles. If the definition of the section warrants two knuckle points the user should enter two non-knuckle points between them.

The user controls the location of added points by selecting a point in the section offsets dialog. Clicking on the Add point button will add one or two points before the selected point based on the state of the interpolate button. If the user does not select the interpolate button, the point definition is take from the fields on the section point dialog. If the interpolate button is selected the program will check the selected point and the previous point to see if they are knuckle points. If the two points are knuckle points, two additional non-knuckle points will be added by linear interpolation. If either one of the points is not a knuckle point the program will add one point by linear interpolation.

5.1.4.2 Read IDF file

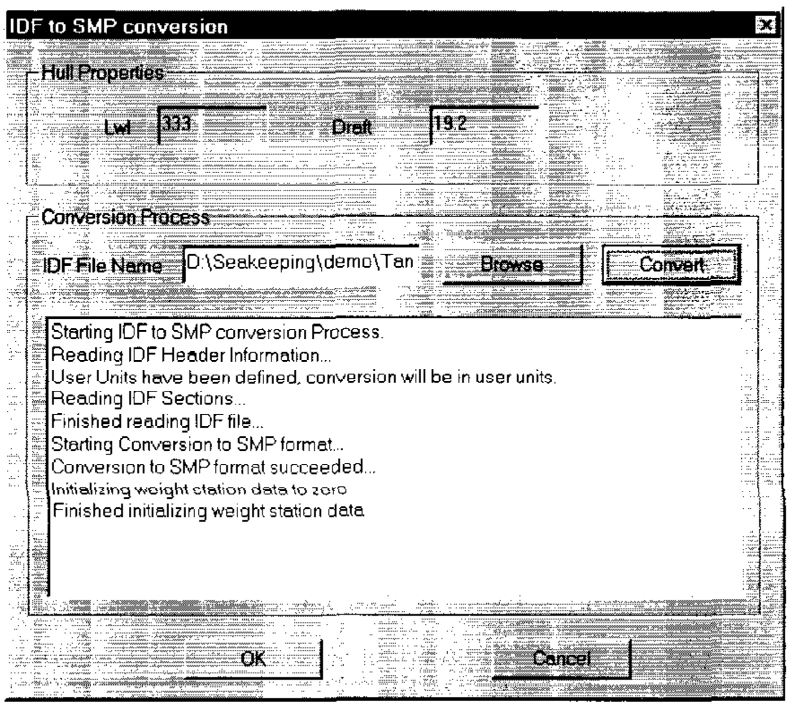
VisualSMP can read section offset data from an IDF file created using the 'write sections' option from FastShip. To create the IDF file in FastShip, follow these steps:

1. Orient the hull so that the FP is at X=0, and the keel is at Z=0.
2. Delete all buttocks, waterlines, and other non-stations from the sections dialog.
3. Refine the sections (0.001 usually works well).
4. Clip the stations to the waterline (Sections/Post Process/Clip to WL)
5. Even space the points on the sections (Sections/Post Process/Even Space/Girth). Use between 15 to 21 points per section (odd numbers work best). VisualSMP can use up to 70 points per station, but the higher the number of points, the more chance that the frank-close fit routine will fail.
6. Create the IDF file (File/Export). On the IDF Export dialog, be sure to select only those surfaces that should be included, and **CHECK THE COMPOSITE SECTIONS BUTTON.**

Reading an IDF file will create station numbers and offsets for the sections and station numbers for the Weights input.

If the units of measure is set to 'FEET' for the smp input file, the IDF file must use user defined units with the scale factor set to convert to feet.

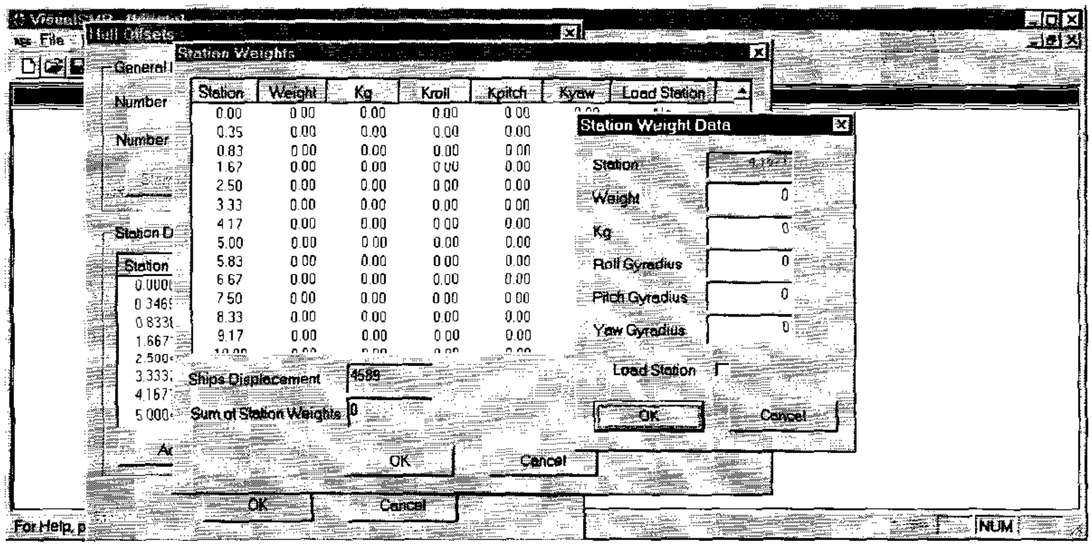
Warning: Any data manually entered in Hull Offsets or Weight stations will be overwritten by the IDF file data.



To read data from an IDF file, click the 'Read IDF' button on the Hull Offsets dialog, which brings up the IDF to SMP conversion dialog. From this box, either enter the IDF file name, with full path information, or use the 'Browse' button to locate and select the file. Once the file is selected, click the 'Convert' button to read the IDF data into SMP. The LBP and Draft must be entered prior to reading an IDF file.

5.1.4.3 Weights

If vertical loads are to be calculated, weight information needs to be entered for each station to define the ship's weight distribution. Weight data is needed for all stations, not just those selected for load calculations. If loads are not going to be calculated, weights data does not need to be entered.

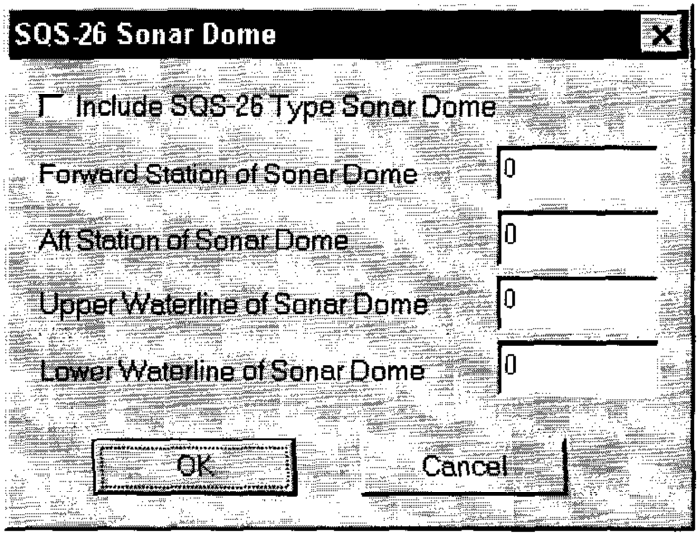


Station weight data is accessible by clicking the 'Weights' button in the Hull Offsets dialog box. That will bring up a table of stations. Data for each station is entered by double clicking on the station number in the Station Weights table, which brings up a data entry form for that station. Data required is the weight associated with the station (long tons if length is in feet, metric tons if in meters), KG of the weight associated with the station, and roll gyradius apportioned to the station. Pitch and yaw gyradius are not currently used by SMP95 and do not need to be entered. Checking the 'Load Station' box indicates loads are to be calculated for that station.

5.1.4.4 Profile Offsets

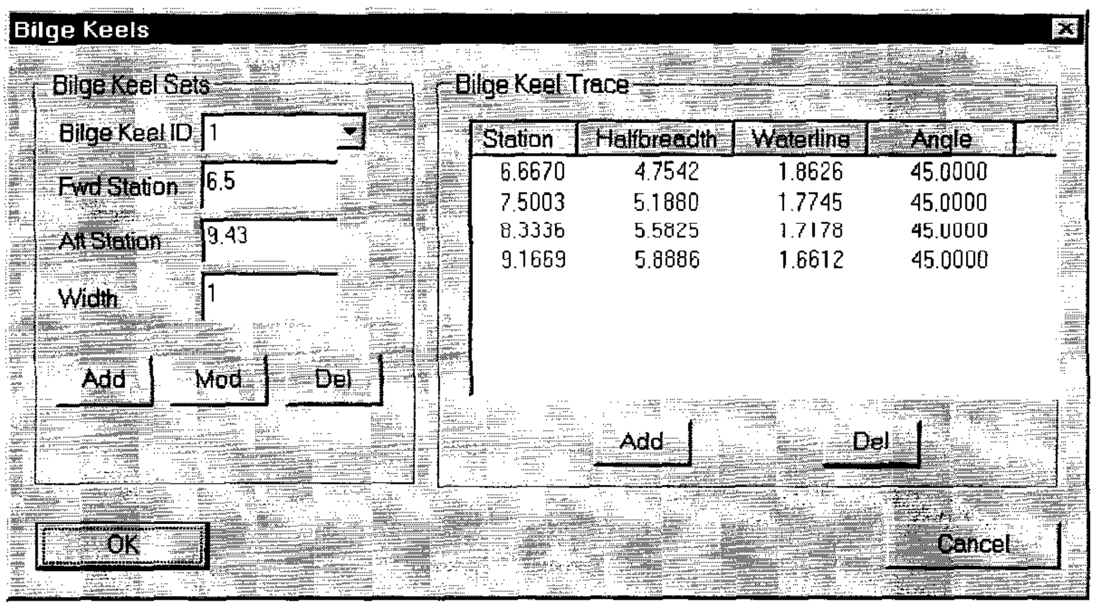
Stem and stern profiles are required input when 'Sink & Trim' is selected in the Variable Geometry option of the Regular Waves General Information dialogs. Profile offsets are entered in the same fashion as section offsets. The stem and stern profiles must be entered such that they are discontinuous with the hull data; that is, the profiles must not overlap longitudinally with the stations.

5.1.5 Sonar Dome



VisualSMP includes the option to add an SQS-26 type sonar dome to the hullform being analyzed. Inputs required are the station of the forwardmost point of the dome, station of the aftermost point of the dome, top of the dome (typically the baseline = 0.0), and the lowest point of the dome. The sonar dome is assumed to be a standard SQS 26 type of dome, modeled as a lifting surface with a lift curve slope from experiment. Only one per ship is allowed.

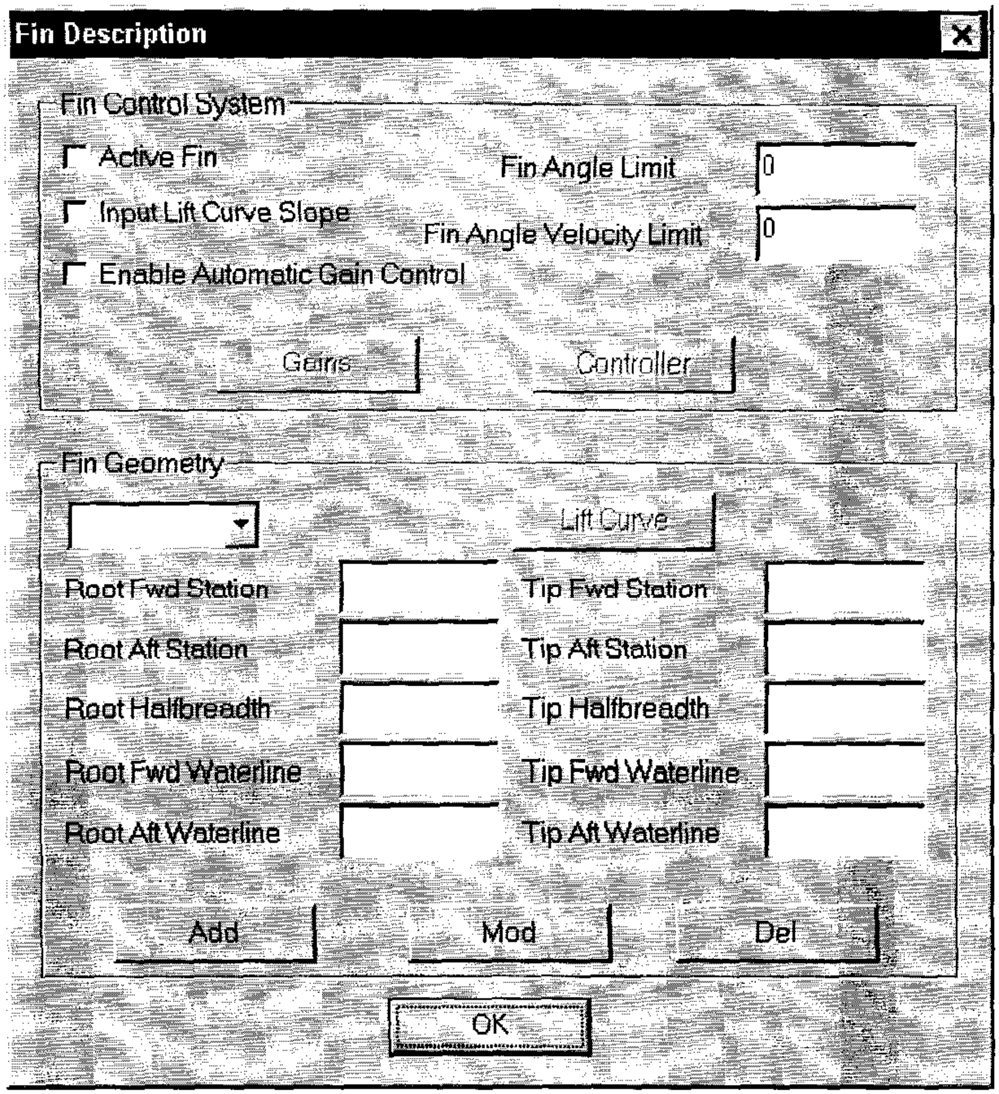
5.1.6 Bilge Keel



Bilge keel information is entered in the Bilge Keels dialog box. Inputs are the forward and aftmost stations of the bilge keel and the width of the bilge keel. The bilge keel is further defined by entering trace data. For each station along the bilge keel, halfbreadth and waterline of the trace and the angle of the keel are entered.

SMP95 allows the user to define more than one bilge keel on a hull form, and all bilge keels are active at the same time. Multiple bilge keels are particularly useful if the ship design has disjointed bilge keels.

5.1.7 Fins

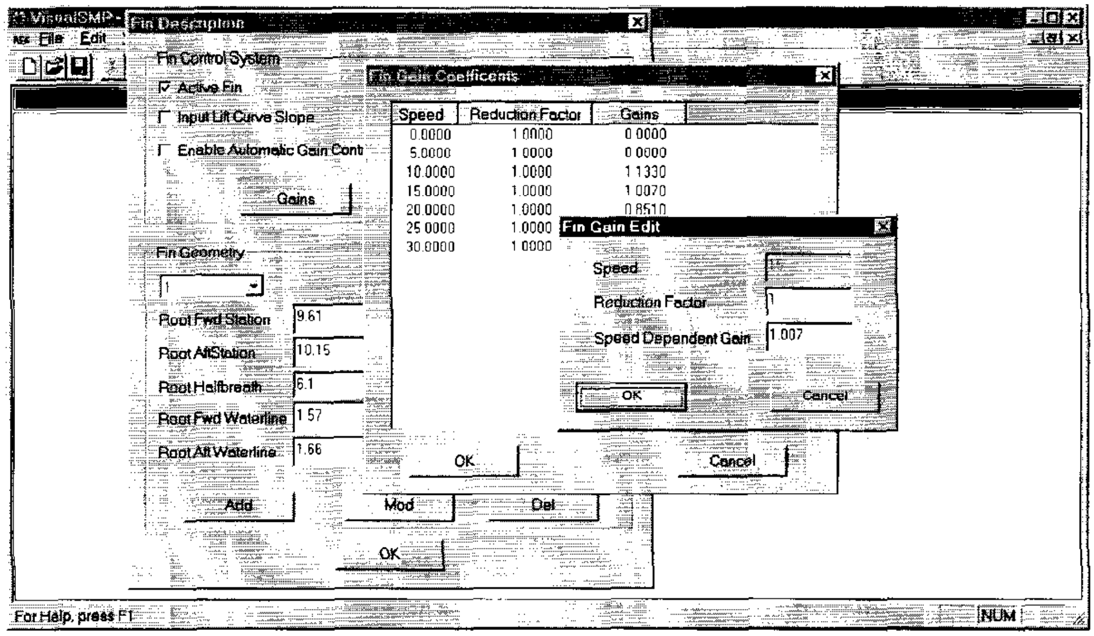


Fin control systems can be modeled in SMP95. The Active Fin check box indicates whether the fins are active or passive. If active, the user will need to input system gains and controller information as described below. SMP95 also allows lift curve slope information to be input as described below. This information is usually available from the manufacturer.

The Automatic Gain Control feature requires inputs for fin angle limit and fin angle velocity limit along with filling in the Gains and Controller coefficient tables.

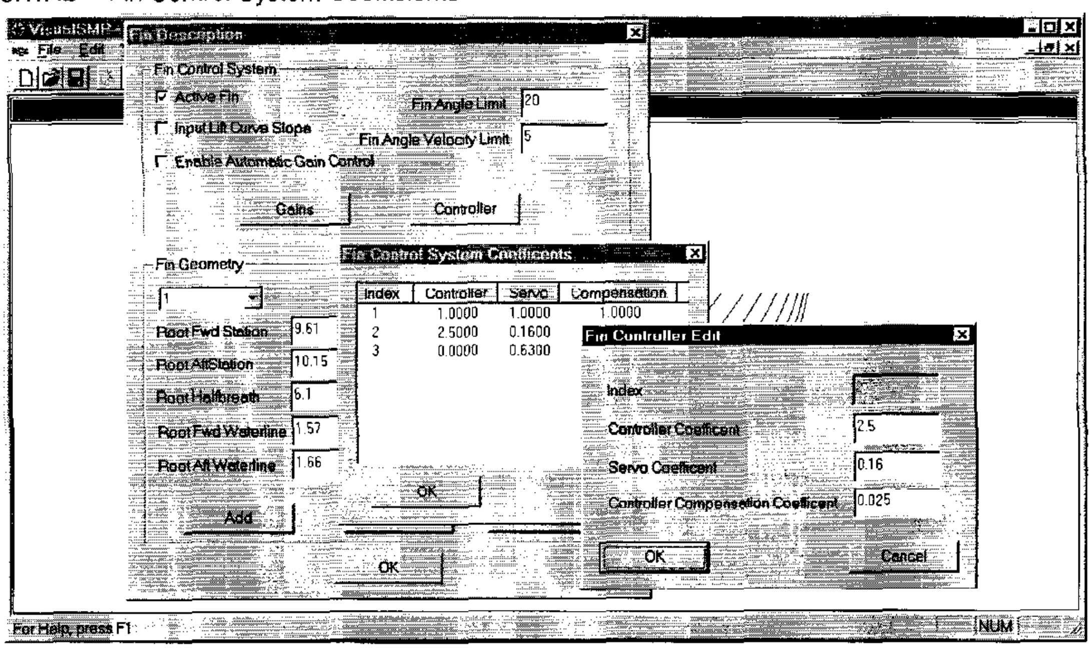
Remaining inputs describe the fin's geometry and location on the hull. As with bilge keels, multiple configurations may be modeled. In addition if the ship design has active rudder stabilization the rudder would be described as an active fin, and not as a rudder. Passive fins and rudders are treated identically in SMP95.

5.1.7.1 Fin Gain Coefficients



The table of Fin Gain Coefficients is viewed by clicking on the 'Gains' button. VisualSMP automatically creates a point for each speed index that was entered in the ship speed tab of the hull particulars input form. The Reduction Factor and Gain values are edited by double clicking on the speed value in the table. The reduction factor, which is applied to the fin angle limit, and the non-dimensional speed dependent gain are specified for each speed.

5.1.7.2 Fin Control System Coefficients

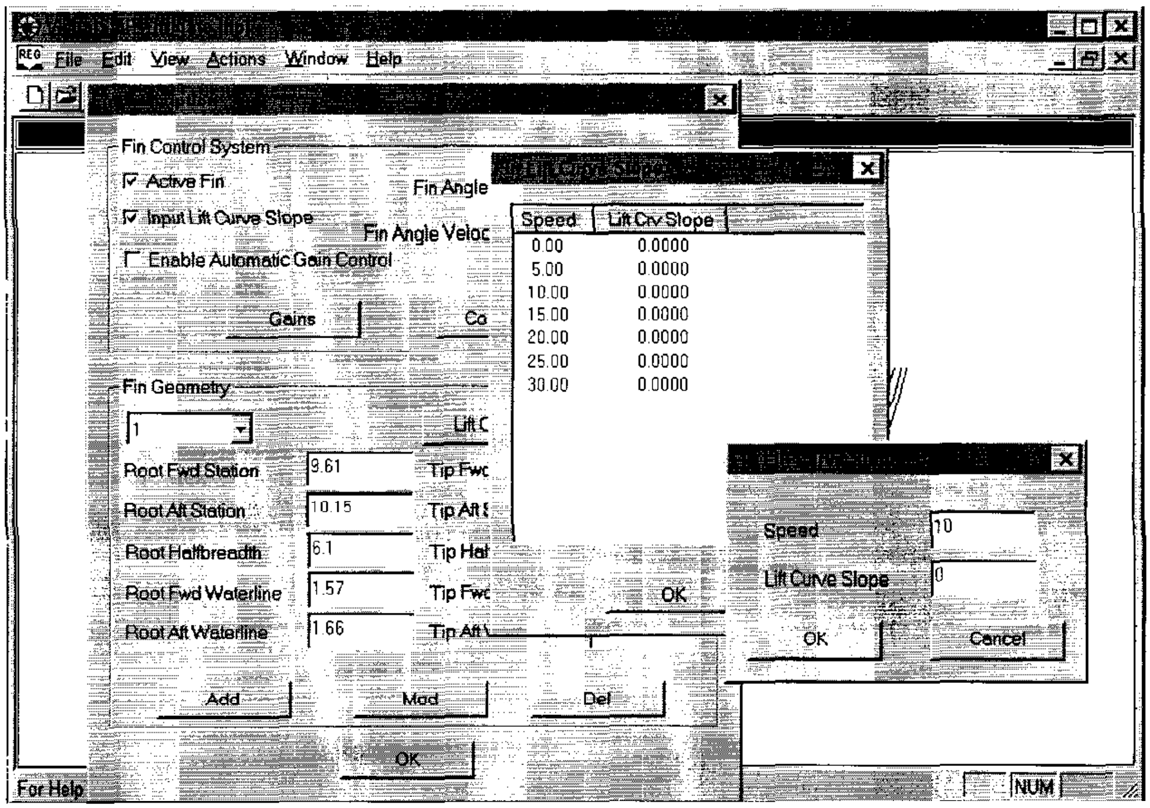


Clicking the 'Controller' button on the Fin Description form accesses the Fin Control System Coefficients table. Entries in the table can be edited by double clicking on the index number of the entry. Index 1 entries are proportional to roll angle, index 2 entries are proportional to roll velocity, and index 3 entries are proportional to roll acceleration.

Nominal values of fin controller coefficients, Kj, Fin Servo Coefficients, a_j, and Fin Controller Compensation Coefficients, b_j are provided below. These values are taken from the Brown Brothers, Ltd. fin system installed on the FFG7.

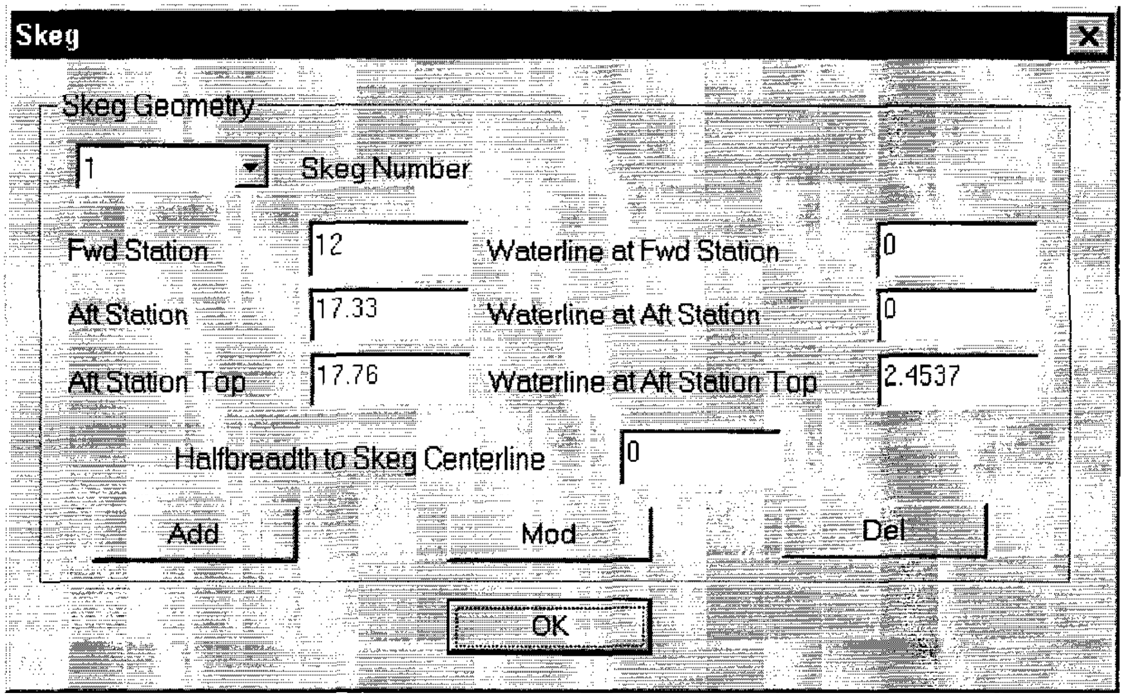
$K_1 = 1.0$	$a_1 = 1.0$	$b_1 = 1.0$
$K_2 = 2.5$	$a_2 = 0.16$	$b_2 = 0.025$
$K_3 = 1.0$	$a_3 = 0.63$	$b_3 = 0.092$

5.1.7.3 Fin Lift Curve Slope



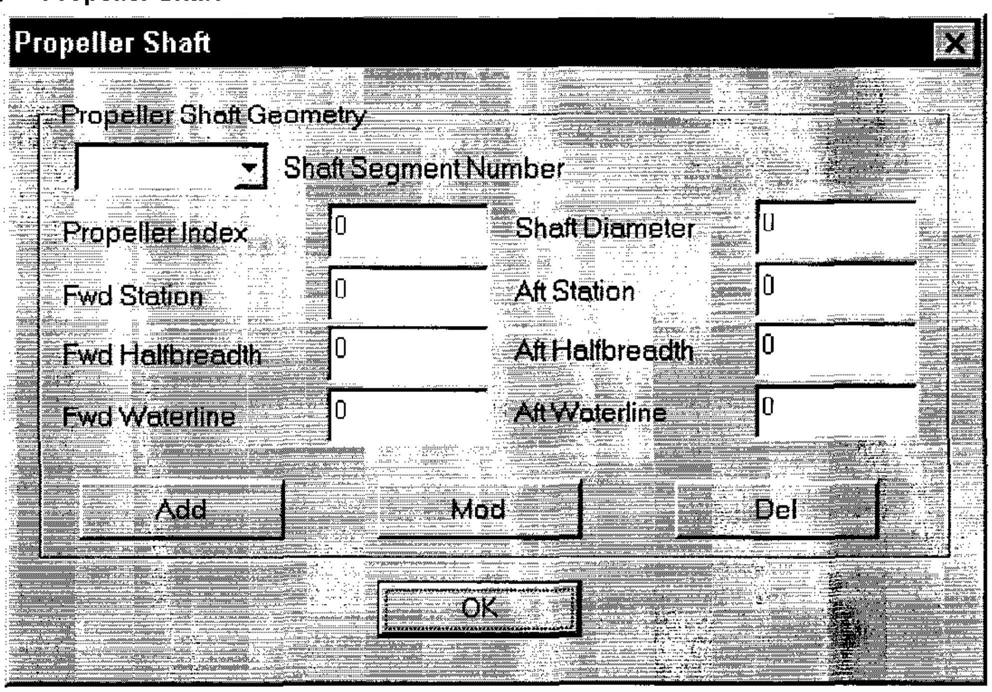
Lift Curve Slope data is entered by checking the 'Input Lift Curve Slope' box and clicking the 'Lift Curve' button on the Fin Description form. Points are provided for each speed index that was entered in the ship speed tab of the hull particulars input form. The points are edited by double clicking on the speed value in the table.

5.1.8 Skeg



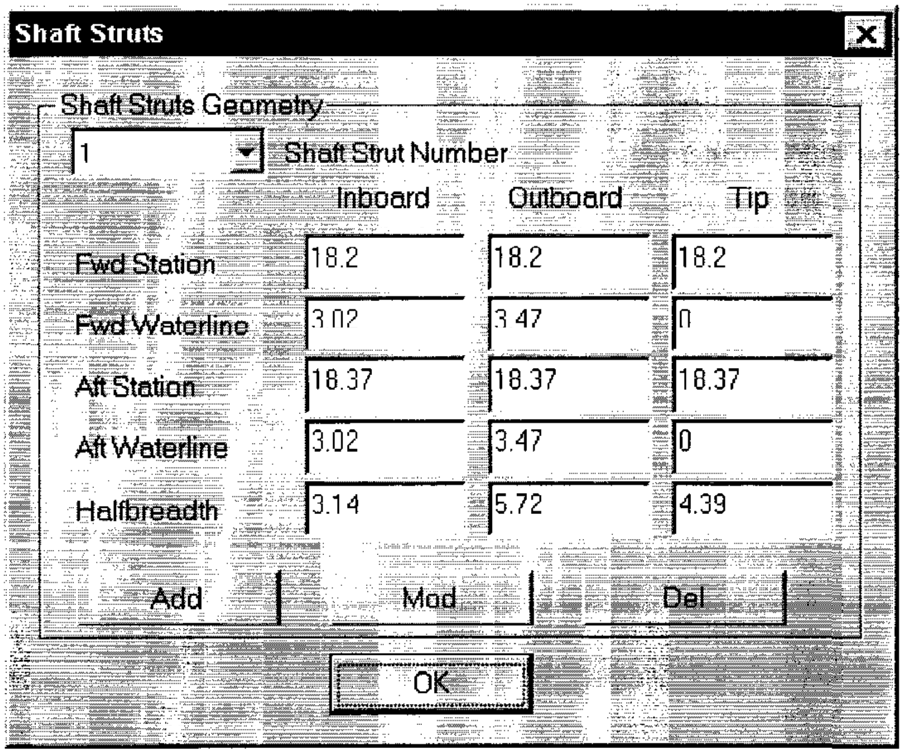
Skegs are modeled in SMP95 by describing the skeg's geometry and location on the hull. As with bilge keels, multiple configurations may be modeled.

5.1.9 Propeller Shaft



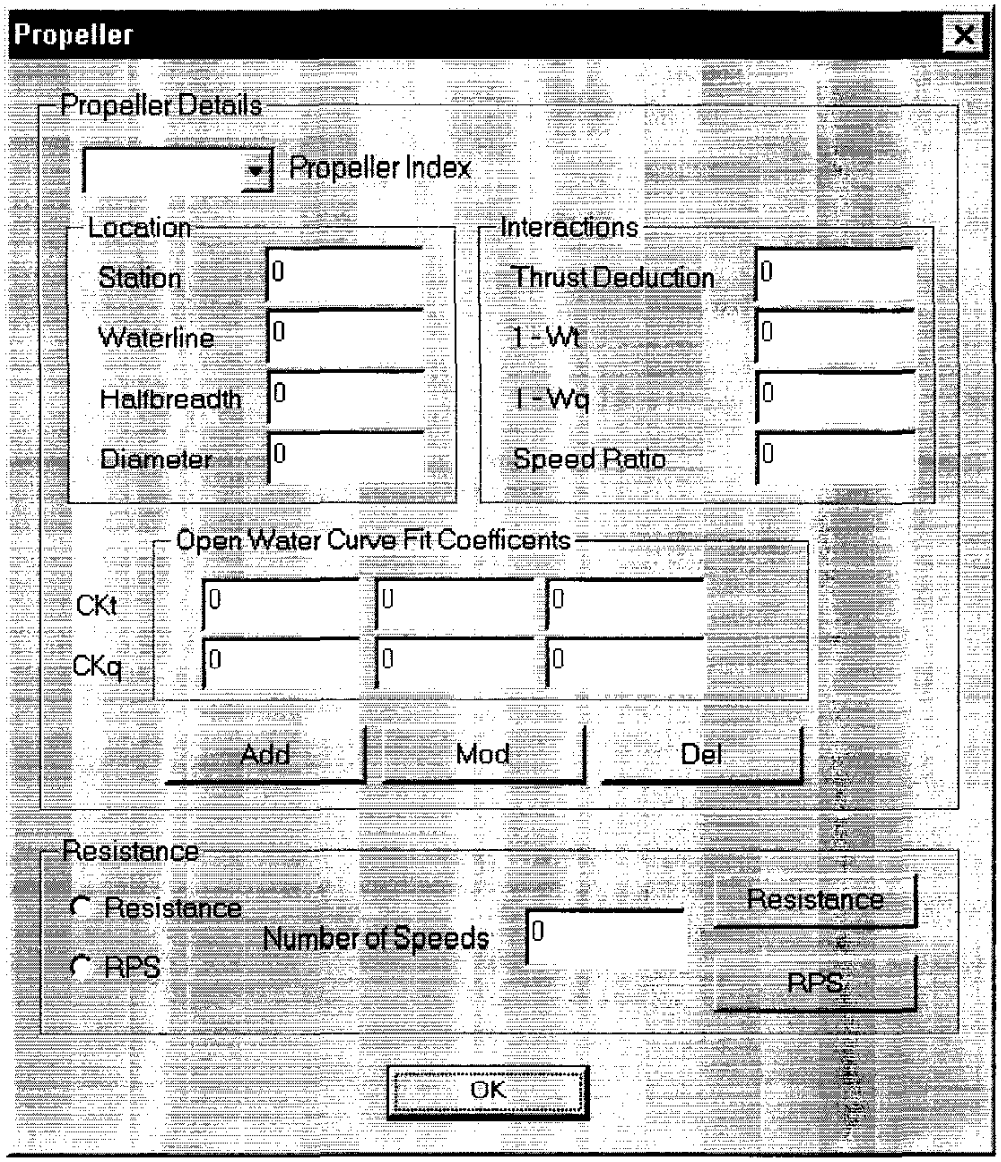
Propeller shaft information is input through the propeller shaft dialog box. The shaft geometry number indicates which segment of the shaft line is being modeled. A propeller index indicates the index of the associated propeller in a multi-screw configuration. This index should be consistent with the data entered in the Propeller input dialog. Required inputs for each shaft segment are the station, half breadth and waterline for the forward and aft ends of the shaft and the propeller shaft diameter.

5.1.10 Propeller Strut



Shaft Strut geometry and location information is input through the Shaft Struts dialog box for each strut on the hull.

5.1.11 Propeller

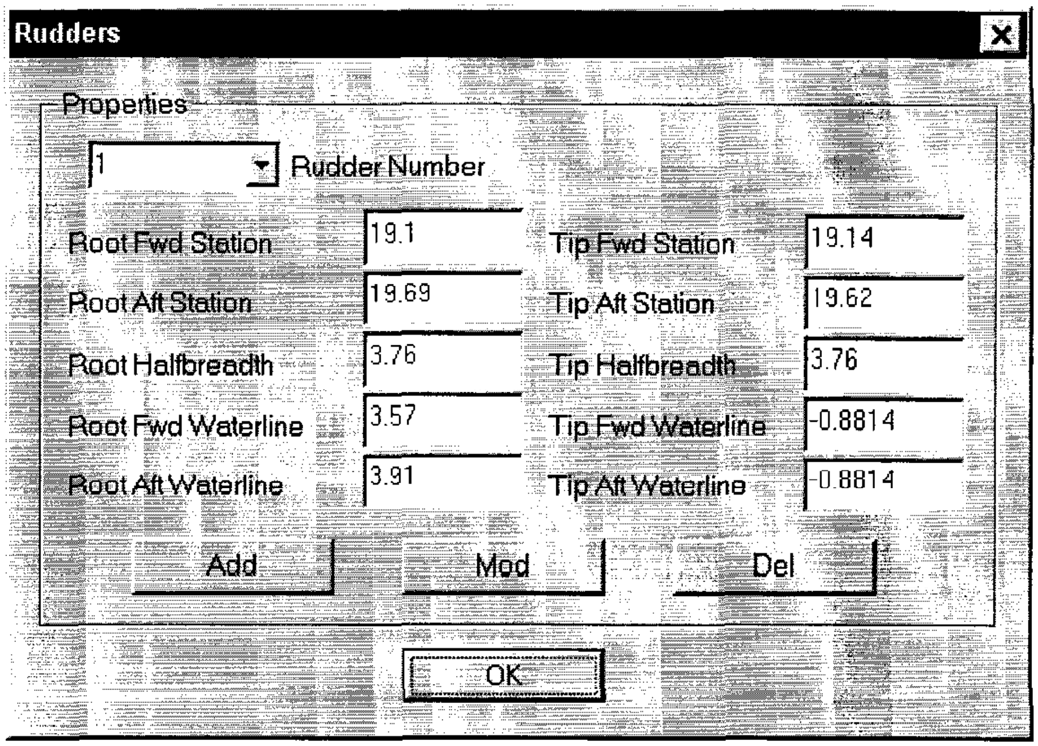


In addition to the location and diameter of the propeller, the following information is required:

- Thrust deduction factor,
- 1-torque based wake fraction,
- 1-thrust based wake fraction,
- Speed ratio of this shaft set speed to the reference set. This is relevant only if there is more than one shaft. If the speed ratio is not zero, it is assumed there is a pair of propellers equally spaced on either side of the centerline. If the propellers all turn at the same rate, this ratio=1.

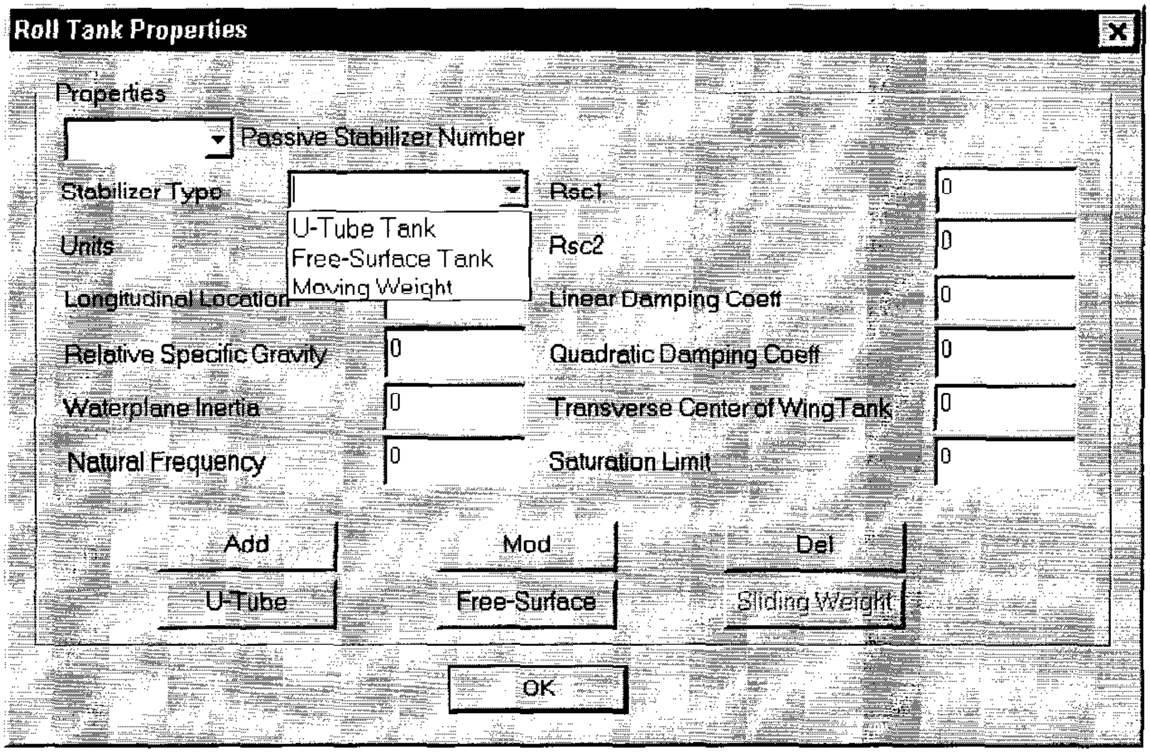
Coefficients for parabolic fits to the Kt and Kq curves are also required.

5.1.12 Rudder



Rudder geometry and location information is entered for each of the rudders. If active rudder roll stabilization is being modeled, the rudders should be entered as active fins.

5.1.13 Passive Stabilizer



Passive stabilizers include such mechanisms as Anti-Roll tanks, Sliding Weights, or other systems where the user can develop the requisite coefficients.

Up to three passive stabilizers may be modeled in SMP95. Required input data is listed below.

- Stabilizer Type - U-tube and Free surface tanks are supported. Moving weights can be modeled in SMP95 provided the coefficients are entered as described in Appendix C..
- Longitudinal Location - The location of the stabilizer, positive aft of the forward perpendicular.
- Specific Gravity - Specific gravity of the tank fluid relative to that of the water the ship is floating in. For fresh water in the tank and the ship in sea water, specific gravity is approximately 0.975.
- Waterplane Inertia - The transverse waterplane inertia of the tank liquid (feet^4 or meters^4, depending on run units). Do not include the corresponding free surface correction to GMT in the earlier input, as the dynamic solution takes care of it.
- Natural Frequency - The stabilizer natural frequency in radians/sec.
- RSC1 and RSC2 - The variables RSC1 and RSC2 define the effective vertical location of the stabilizer relative to the vertical CG of the ship. Internally this height is computed as RSC1-RSC2*KG, with KG found later from the other inputs for the ship. Units of RSC1 are feet or meters, RSC2 is non-dimensional.

  For U-Tube stabilizers:

  RSC1-RSC2*KG = S"/2, half the classical coupling length.

For Free Surface type stabilizers:

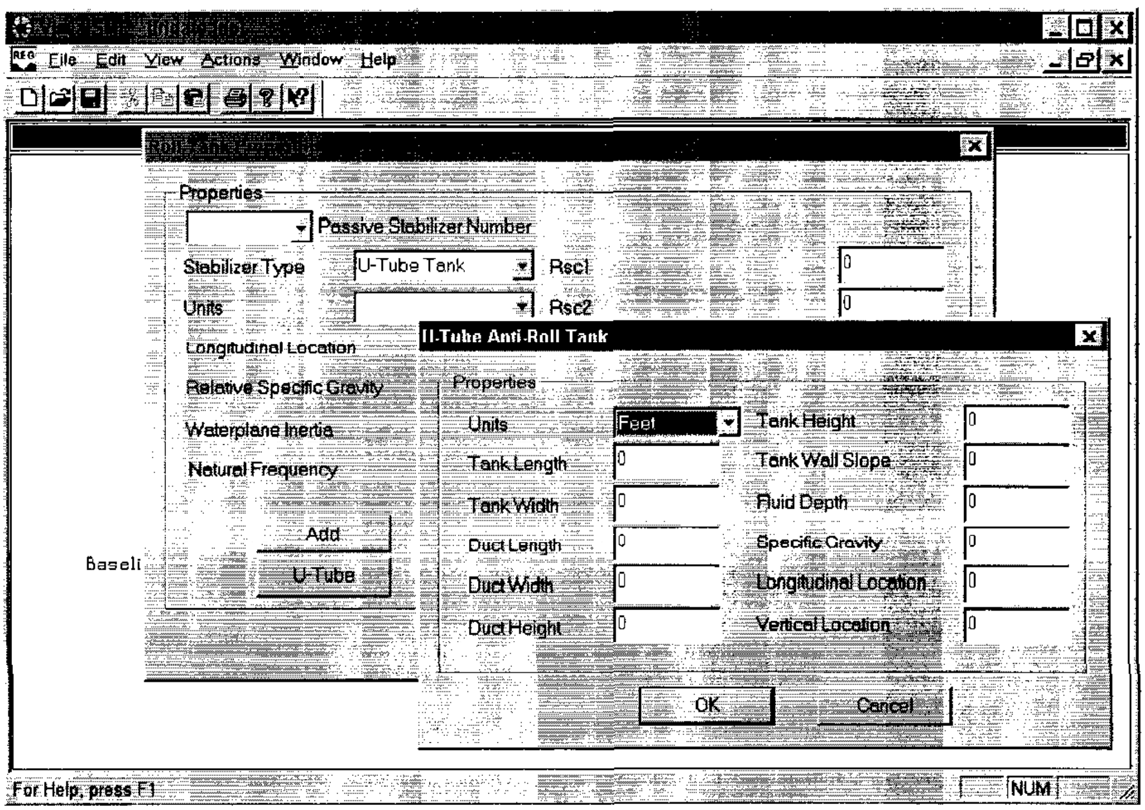
RSC1=(distance of tank bottom above keel + half the water depth), and RSC2=1.0.

- Linear Damping Coeff - Empirical linear stabilizer damping coefficient, fraction of critical.
- Quadratic Damping Coeff - Empirical nondimensional quadratic stabilizer damping coefficient. Definition varies somewhat with stabilizer type (see passive stabilizer background information in Appendix A).

  Note: Either, but not both of the damping coefficients may be zero.

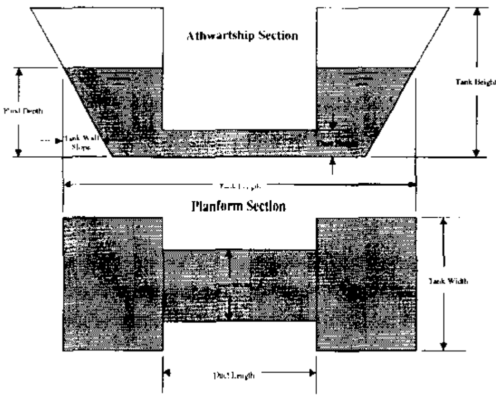
- Transverse Center of Wing Tank - Transverse offset of center of wing tank (feet or meters). Used to define the location of the vertical motion of the tank fluid that is used as the dynamic tank variable. For moving weight stabilizers, use a value 1.0.
- Saturation Limit - For U-Tube and Free Surface tanks, the distance above or below the static tank waterline, at the lateral offset defined by the Transverse Center of Wing Tank, where saturation is expected to begin. For moving weight stabilizers, the limit of transverse motion of the weight.

5.1.13.1 U-Tube Anti-Roll Tank

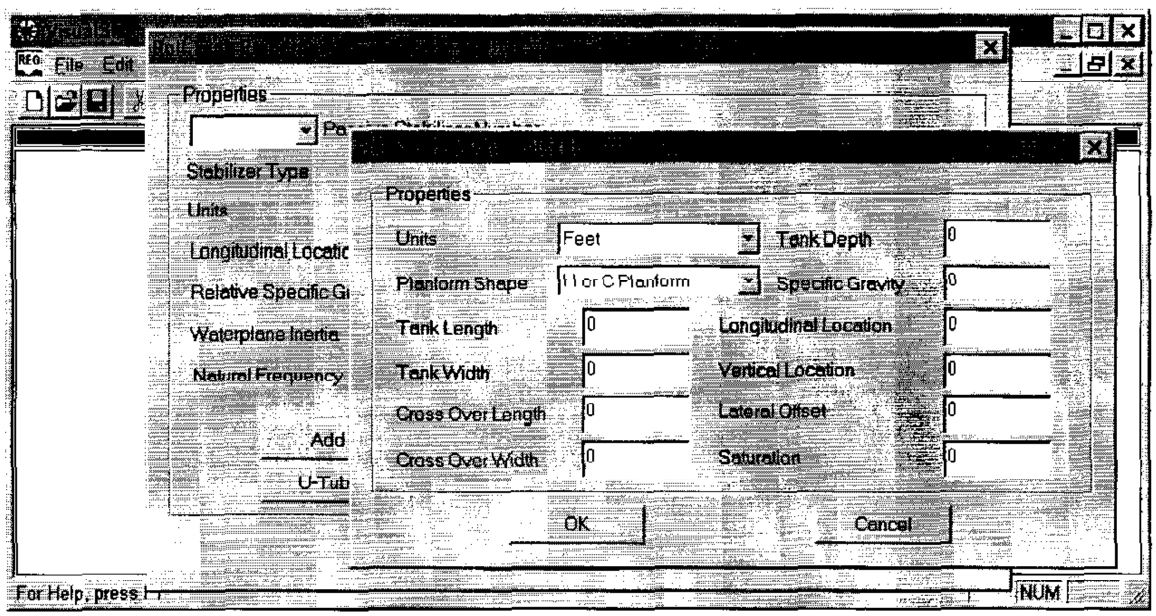


The U-Tube anti-roll tank dialog is designed to convert a geometrical description of a tank into the coefficients used by SMP95. After entering the data clicking on the OK button will calculate the coefficients and place coefficients on the previous dialog. The following diagram shows the relationship of the dimensions to the geometry.

U-Tube Anti-Roll Tank

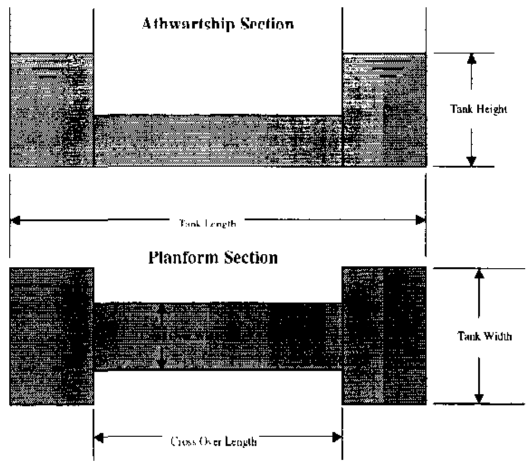


5.1.13.2 Free Surface Anti-Roll Tank

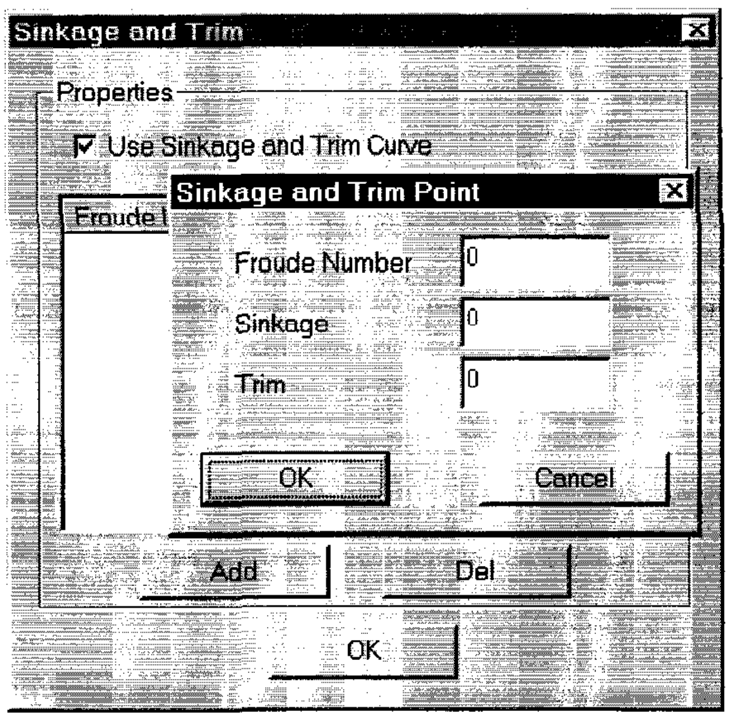


The Free-Surface anti-roll tank dialog is designed to convert a geometrical description of a tank into the coefficients used by SMP95. After entering the data clicking on the OK button will calculate the coefficients and place coefficients on the previous dialog.

Free Surface Anti-Roll Tank



5.1.14 Sinkage and Trim



SMP95 uses sinkage and trim in the relative motions calculations. There is a default sinkage and trim algorithm built into SMP95 that is based on regression of destroyer type hull forms. The purpose of this dialog is to allow the user to override the built in algorithm with either model test data or results from potential flow CFD analysis.

Sinkage and Trim may be accounted for in the seakeeping analyses by checking the 'Use Sinkage and Trim Curve' box and entering points for the curve. Enter points by clicking the 'Add' button and filling in the dialog box for each point.

Sinkage at midships, positive down, is entered in the units specified in General Information. Trim, also measured in the units specified in General Information, is defined as the difference between the bow and stern sinkage, positive bow up. These values are interpolated over speed and consequently do not need to be changed as requested speeds are changed. They must be in ascending order of Froude number and should cover the entire speed range requested.

5.1.15 Wave Profile.

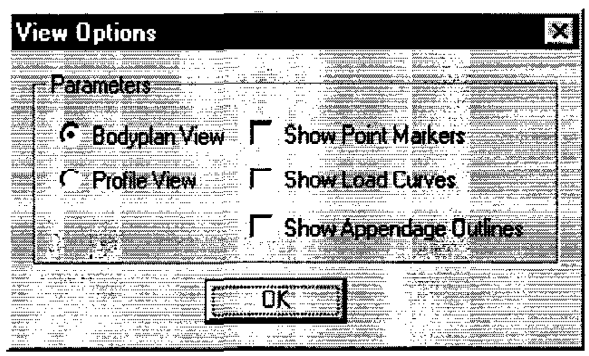
This dialog has not yet been implemented, however the user can input the data into the *.inp file by hand using the information supplied in Appendix A.

5.1.16 Roll Damping

This dialog is not available to users. It is only useful for research work.

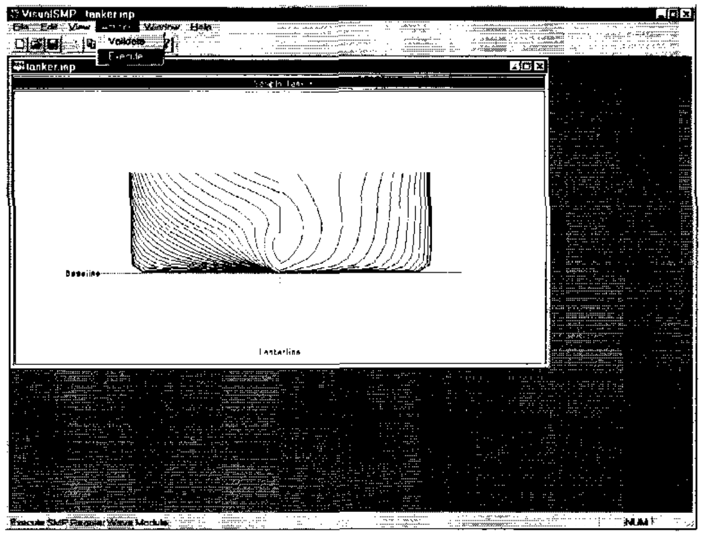
5.2 View

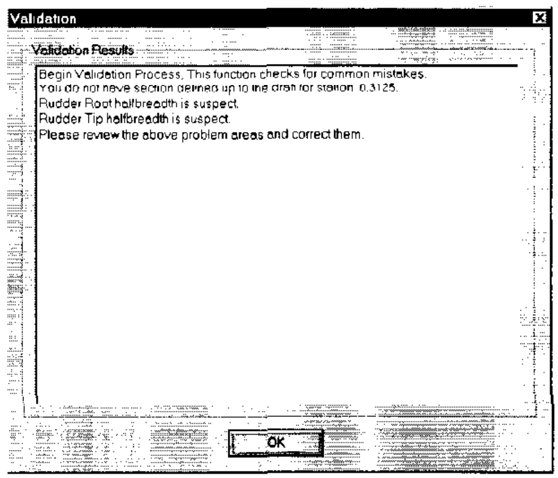
The View menu provides standard Windows commands for hiding or displaying the Toolbar and Status Bar. In addition, the user can set view options for displaying the bodyplan or profile view of the hull and showing point markers, load curves and appendage outlines.



5.3 Actions

There are two available options under the Actions menu, Validate and Execute. The Validate menu option will check the contents of the current file for many common problems and display a Validation dialog similar to the one shown below. The Execute menu option runs the regular wave seakeeping analyses.





5.4 Window

The Window menu provides standard Windows commands for arranging the display window.

5.5 Help

The Help menu provides standard Windows commands for help and general program information.