PASS
USER GUIDE & TUTORIAL

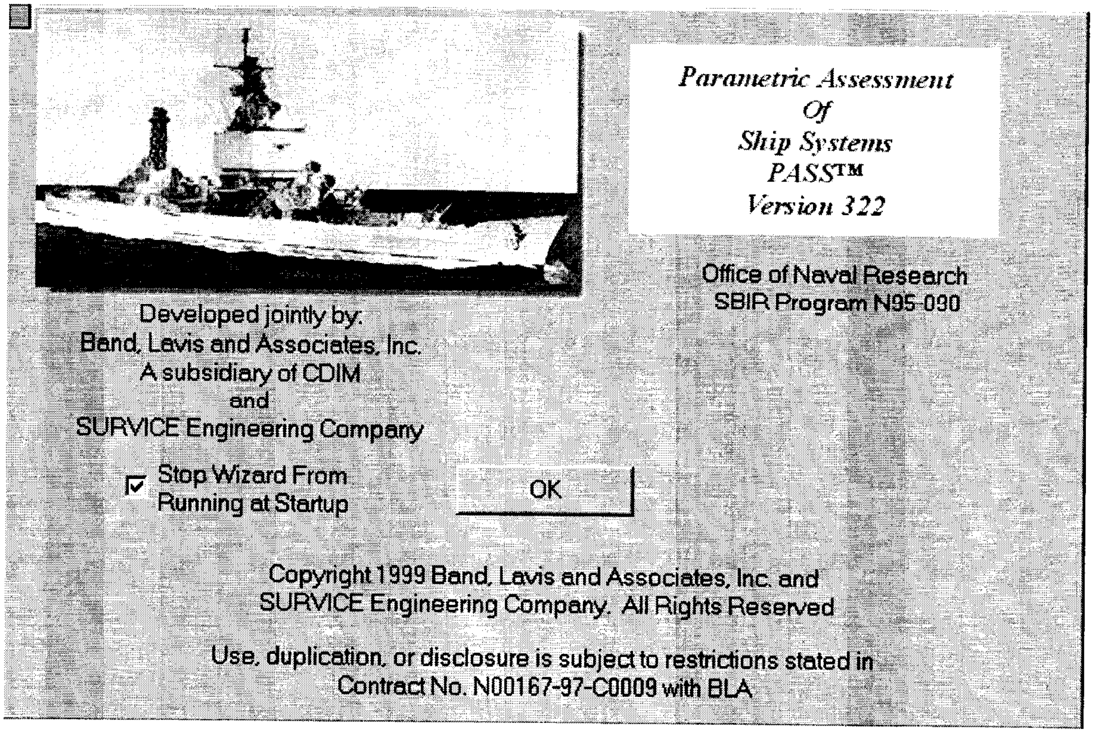

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 PROGRAM INSTALLATION

1.1 Introduction

Ship design computer programs, known in government circles as "Whole-Ship Design Synthesis Models" have been around for many years. These models are normally designed to perform the calculations of the typical Naval Architecture Design Spiral in a rapid, automated, and consistently repeatable manner. The models have often been finely tuned to represent, with good accuracy, the type of design primarily performed by a particular organization or user. Past design synthesis models were often specific to one ship type, and relied heavily on historic data to estimate size and performance of a new design. A user who did not understand the underlying theory and limits of such a program could easily make meaningless estimates of size and performance by using a synthesis model based on an inappropriate ship type, or by designing outside the valid range of the underlying data.

Ship design has been evolutionary, rather than revolutionary, largely due to the lack of knowledge, tools, and time to explore many solutions to customer's needs. PASS fills that need by assembling the calculations required to estimate ship size, performance and cost in a package, which allows exploration of a wide range of design alternatives in a rapid and consistent manner.

1.2 The Installation Process

The PASS program requires a computer running on Windows 95, Windows 98, Windows NT or Windows 2000. PASS is usually installed from a CD ROM. The CD ROM contains an automatic installation program, which will guide the user through the installation process. The necessary files are in four categories, some system *.dll files, PASS program executables, PASS database files, and some hard lock and graphics key related files. Note that the hard lock driver is on a separate 3.5 in floppy disk. It is not stored on the installation CD. Installation instructions for the hard lock driver are printed on the distribution floppy disk. This installation must be accomplished before you attempt to run PASS™.

If the user has a previously installed version of PASS, the previous version must be removed before installing PASS Version 3.22. This is **especially relevant** to users who have existing PASS models in the customer database file and do not want to lose them. The removal program will remove the existing customer database so make sure you save it before removing any previous versions of PASS.

2.0 TECHNICAL SUPPORT

2.1 E-Mail

You may contact the PASS Development Team at Band, Lavis & Associates through email:

brian.forstell@cdicorp.com

2.2 Telephone and Fax

You may also telephone the PASS Development Team (ask for Brian Forstell) or send a fax:

(410) 544-2800 (phone)
(301) 261-1030 (phone)
(410) 647-3411 (fax)

2.3 Update Request

To request the most recent version of PASS, you may e-mail, call or fax the PASS Development Team. If a new version exists, you will be contacted to arrange for receipt of the most recent version.

2.4 Change Request

You may suggest or request a particular change or changes. If your suggestions are deemed to be universally applicable, they will be incorporated into the next version and you will receive an interim version if a new version is not ready to be released. If the PASS Development Team decides not to adopt your suggestions, it is still possible to provide a customized version by special arrangement. You are encouraged to report every problem you encounter with PASS (see the next section).

2.5 Problem Reports

To report an error, bug, problem, unexpected results or program-crash, you may contact the PASS Development Team by e-mail, phone or fax. Please provide a thorough description of the problem with as much detail as possible. To facilitate the debugging process, you may need to attach the text format input file of your design model. To generate a text format input file, execute the following steps:

- With your model open, click ***Export Ship to File*** under ***Utility Features***.
- Browse for the desired folder and enter a file name.
- Click ***Save*** and PASS will write the text input file.
- Insert or attach the generated file in your e-mail.

3.0 PASS PROGRAM DESCRIPTION

3.1 What is PASS?

PASS stands for "Parametric Analysis of Ship Systems". It was initially designed to improve the process of evaluating the cost and potential technical benefits of newly emerging technologies to the overall ship system and the fleet as a whole. It is a computer model to analyze parametrically the whole-ship impact of advances in ship technology. It simulates the naval architecture design spiral (Figure 3-1) in a rapid and consistently repeatable way.

It is comprised of a group of modules that represent a collection of expertise in various fields of naval architecture and is able to find a balanced design in just a few seconds, which might otherwise take days, if not weeks, if done manually. PASS automates, assembles and integrates all the calculations to estimate ship size, performance and cost in a package, which allows exploration of a wide range of design alternatives in a rapid and consistent manner. This makes PASS an ideal tool not only for technology assessment, but also more importantly for concept exploration and platform optimization.

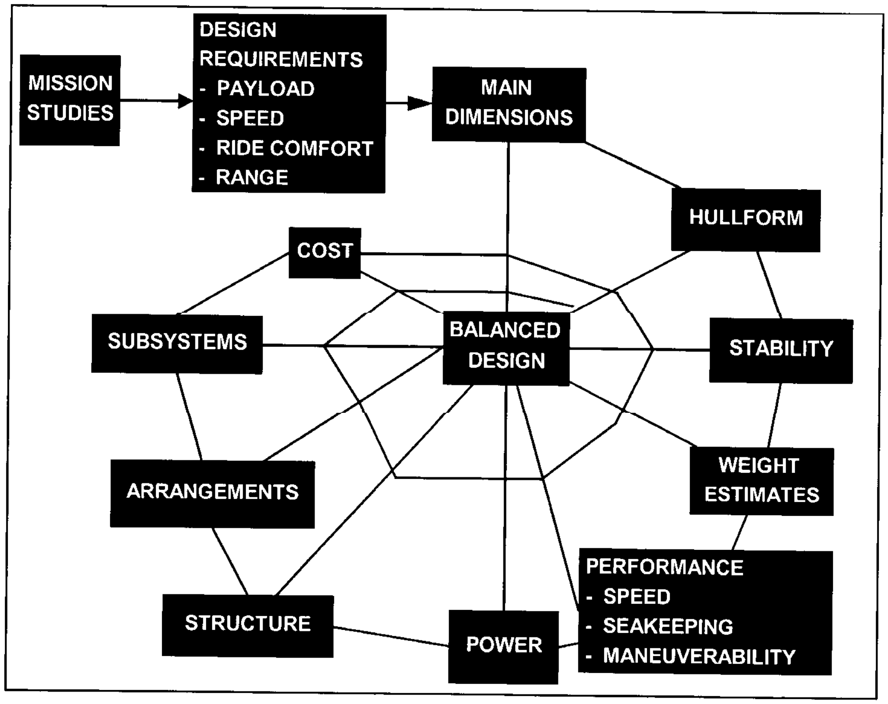


Figure 3-1. The Naval Architect Design Spiral

3.2 PASS Overall Architecture

The overall architecture of the PASS model is shown in Figure 3-2. Around the core ship design model, three essential modules are connected:

- Ship Database (PASS and Customer)
- Technology Input Module
- Design Synthesis Engine

All three modules are accessed by the user through a specially designed graphical interface. This Graphical User Interface (GUI) was developed to run in a Windows environment in order to facilitate the use of the model by non-specialists.

The technology and subsystem input module allows the user to specify how technology will evolve in the future and to analyze the impact on ships that will result from these technology advances. These inputs will interact directly with the first-principle algorithms built into the model to redefine the subsystems affected by the new technology while keeping within hard feasibility limits imposed by the laws of physics.

The ship database is intended to provide quick-reference baselines from which to generate a new design or parametric analysis study. The ship designs loaded in the reference database may, therefore, be used as baselines for such parametric assessments. They typically contain all relevant input information necessary to define a ship design. The user may change any of the subsystem input parameters to suit his/her own design requirements, new features or new technologies.

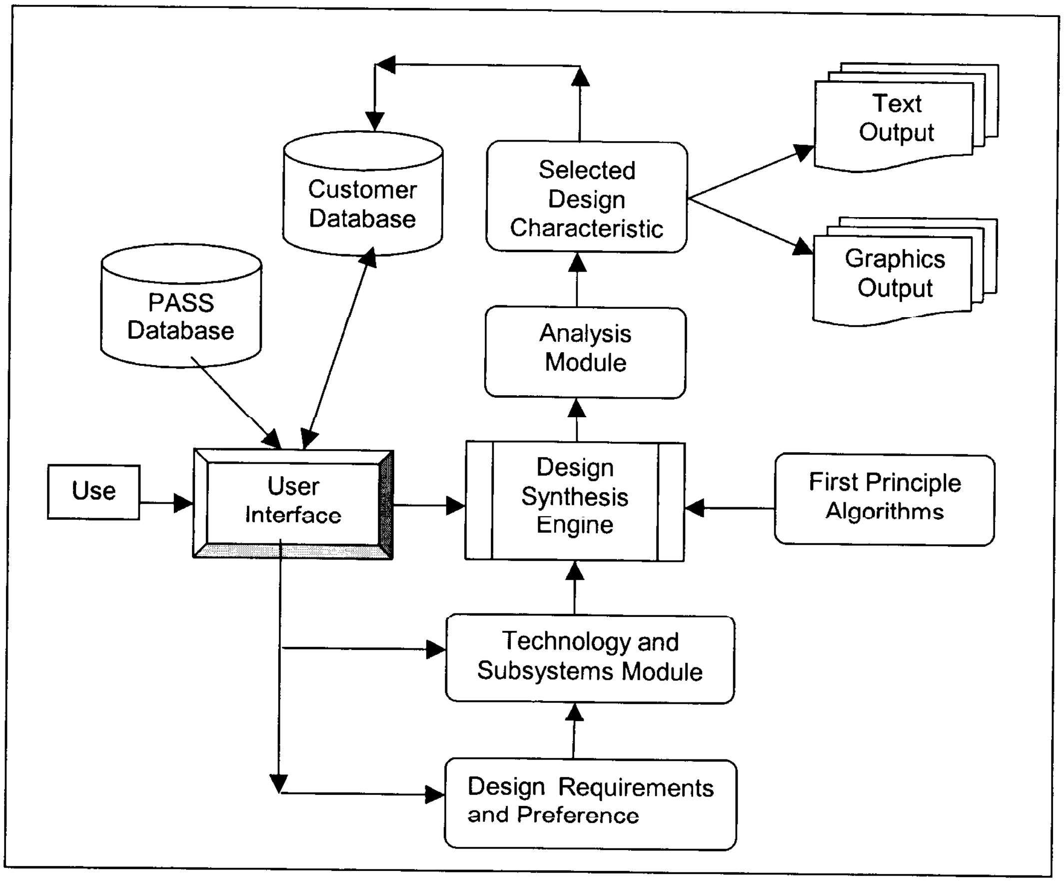


Figure 3-2. PASS Program Architecture

The ship design model, or the PASS Synthesis Engine, is where the simulation of the ship design process is carried out. It starts with an estimated displacement. The geometry module generates a set of offsets to provide the necessary hull displacement. With the offset information, the structure module sizes the structure scantlings and sums up the SWBS 100 weight, and the resistance module calculates the total drag. With the required thrust known (equal to drag), the program calls the propulsor module to design the propellers and/or waterjets. The shaft power required by the propulsor is then divided among each engine. The program then proceeds to design the engines, motors, generators and transmissions, and adds up all the SWBS 200 weights, deck area and volume. The next step is to design the ship service electric plant and estimate SWBS 300 weights, deck area and volume, which is accomplished in the electric plant module. If manning is not a direct input, the manning module will calculate it based on the type and size of the ship, its various systems, and the automation level of the subsystems. Manning information is then used to iterate and refine the electric load, deck area and volume, stores, hotel and supplies, etc. The auxiliary module sizes all the auxiliary machinery and sums up their weight, deck area and volume for the SWBS 500 group, while the outfit and furniture module assesses the SWBS 600 group weight, deck area and volume. Finally, various aspects of ship performance and cost are evaluated and the total fuel load is determined. At this point, the total weight can be recalculated since weights of all the SWBS groups are known (often, weights for SWBS 400 and 700 are known inputs for PASS). The arrangement module estimates and sums up the total deck area and volume requirement. The arrangement module also calculates the size of the superstructure needed to provide enough deck area and volume. If the total weight differs from the displacement it started with, the whole process will be iterated until they are within a certain tolerance. The whole design process concludes with a stability and seakeeping characteristics assessment and several types of cost calculation.

The overall architecture of PASS was designed to allow steady future growth of the model's capability. It is designed, for example, to easily allow future additions of subsystem modules. Its modular nature will also allow the connection with outside expert codes if the need arises.

The PASS parametric analysis and design synthesis results are presented in three modes: ***Output Data Forms*** (comparisons), ***Output Graphs and Charts***, and ***Open Output File*** (plain text). Under ***Data Forms***, there is one summary form for the overall ship system and one for each of the major subsystems. In each of these forms, both the current model (i.e., the optimum design) and the parent ship are compared and differences are marked. Graphics output includes: 2D plots for drag curve, body plan and water plane, 3D carpet plot to show the optimum design and design constraints, and 3D plot for geometry visualization. See Figure 3-3 for a sample carpet plot.

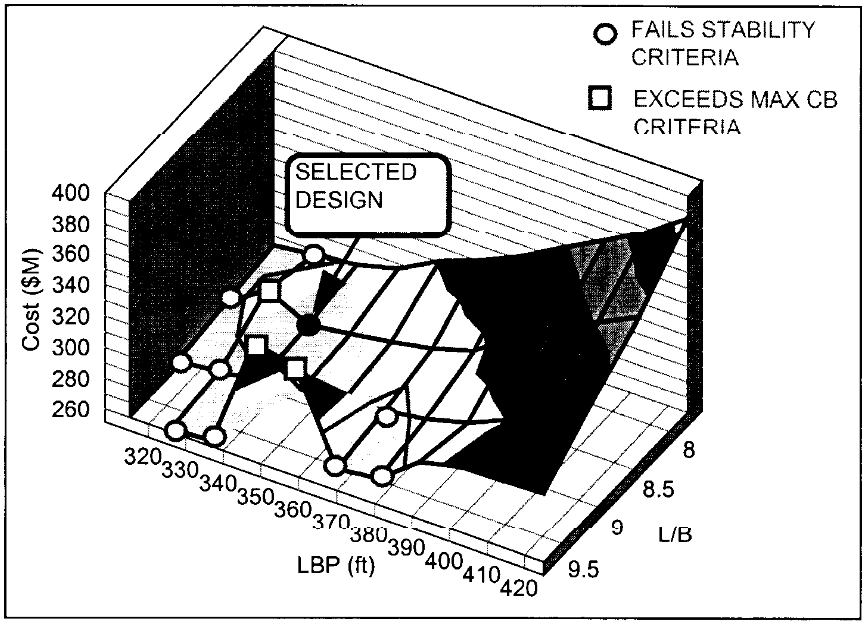


Figure 3-3. Sample Carpet Plot

3.3 Why PASS?

The PASS model is unique inasmuch as it uses, to whatever extent practical, algorithms derived from first-principle physics rather than from empirical data to characterize all major subsystems and their relationship to the overall ship. This approach was taken in order to ensure that new technologies were realistically modeled without being unduly biased by existing (and possibly out-dated) trends in ship or ship-subsystem design. In no case, however, are the algorithms completely without empiricism. As is customary for the prediction of hull surface friction resistance, for example, the product of the wetted surface of the hull and the dynamic pressure of water was predicted theoretically, but then multiplied by an empirical coefficient of frictional resistance made dependent upon Reynold's Number and surface roughness to obtain the hull frictional component of total hull resistance. Similarly, the propulsors (conventional subcavitating propellers, transcavitating propellers, supercavitating propellers, surface-piercing propellers, axial-flow/inducer waterjet pumps and mixed-flow waterjet pumps) are designed and described using a modification of classical axial-momentum theory, with individual elemental efficiencies (e.g., for inlets and nozzles of waterjets) assigned based upon practical experience. This approach, for example, provides for the prediction of a ship propulsive coefficient (PC) rather than relying upon an assumption for its value. It has, therefore, lent itself to the development of a very robust analytical and design capability within PASS that has both sufficient accuracy and flexibility to represent future technology advances while, at the same time, not permitting the analysis of a design that is physically impossible to achieve.

PASS features a user-friendly interface (GUI) and is capable of being used effectively by designers as well as program managers to assess the whole-ship impact of changes in technology and operational requirements. The GUI was designed to provide the user with the ability to intuitively manipulate the input data through pull-down menus and tabbed sets of forms. Each PASS input form has the parent ship value next to the input text box of each parameter to allow the user to always have immediate visual reference to the original or baseline value.

PASS is also designed to use as few parameters as possible to describe or define a ship, a subsystem or a requirement so that the user does not have to be an expert in all areas. This feature, combined with its intuitive user-friendly interface, makes the otherwise overwhelming ship design process less painful and much more manageable. PASS is a powerful tool not only for experienced naval architects but also for program managers. Furthermore, for each application, the user will start from a baseline or parent ship chosen from the PASS database or the users own (customer) database. Even though the user may change any input as desired, for the most part, many of these parameters will remain unchanged while technology-impact analyses are carried out. With this feature, the database provides quick initialization of a study.

In summary, these are the reasons that PASS is an excellent tool for you:

- Maximizes the use of physics-based calculations in place of historic data.
- Has internal data checks to guard against inadvertently producing impractical and erroneous design results.
- Utilizes a user-friendly interface to simplify the specification of information.
- Quick and reasonably accurate answers.
- More new technology and subsystem options.
- More Hullform and ship type options.
- Parametric variation and platform optimization.
- Comprehensive cost information, life cycle in particular.
- Open program architecture; ease of adding new hullforms and new subsystem technologies.

3.4 What Can PASS Do For You?

In a typical study on the impact of a new technology or modified mission profile, the user needs to change just a few parameters. For example, if a user wants to see the benefit of a waterjet on an existing propeller driven platform, he or she just needs to change the type of propulsor to waterjet and fill out a few other parameters on the waterjet input form. The user has the option to choose one of the four different kinds of waterjet pumps: mixed-flow, one-stage axial inducer, two-stage axial inducer, or VAMP.

An expert user may go into all the subsystems and details and create a new, unique and innovative design. This user may change any of the 400+ parameters describing the mission profile and requirements, weapons and payload, manning, hull geometry, structure, material, engines, transmissions, propulsors, electric system, auxiliary system and other subsystems. There are enough input parameters for each subsystem for the expert user to completely define his or her own unique system.

In a parametric run, the expert user may specify a range of length, length/beam ratio, and block coefficients for the ship's hull. The ship design model will examine each combination and find the solution for each or give a no-solution flag. The analysis module is designed to extract relevant information from the output of the parametric run of the ship design model and present it in a useful and graphic form to the user.

PASS is especially efficient in performing design and cost trade-off studies for different hullforms and subsystems, i.e., monohull vs. catamaran or trimaran, waterjet vs. propeller or podded propeller, one main propeller vs. one main plus two side propellers, diesels vs. gas turbines, diesels vs. CODOG, diesels vs. CODAG, electric drive vs. mechanical drive, etc.

While PASS is an excellent tool for technology/subsystem assessment and concept exploration, it will also assist you in the preliminary design. However, PASS is not intended for detail design, or to replace the good engineering judgment of a naval architect. PASS captures a snapshot of the whole ship and its systems, but does not go into the nuts-and-bolts details that a sound engineering design will require. In deck area calculation, for example, it estimates the total area requirement for all the major items such as machinery, accommodations, working and storage spaces, weapons, command and communications equipment, etc. It also checks how much of this area should be on the main deck. However, it does not tell you where the passageways or the stairwells should be, or exactly how the deck area is compartmented.

3.5 Why You Cannot Expect Exact Answers From PASS

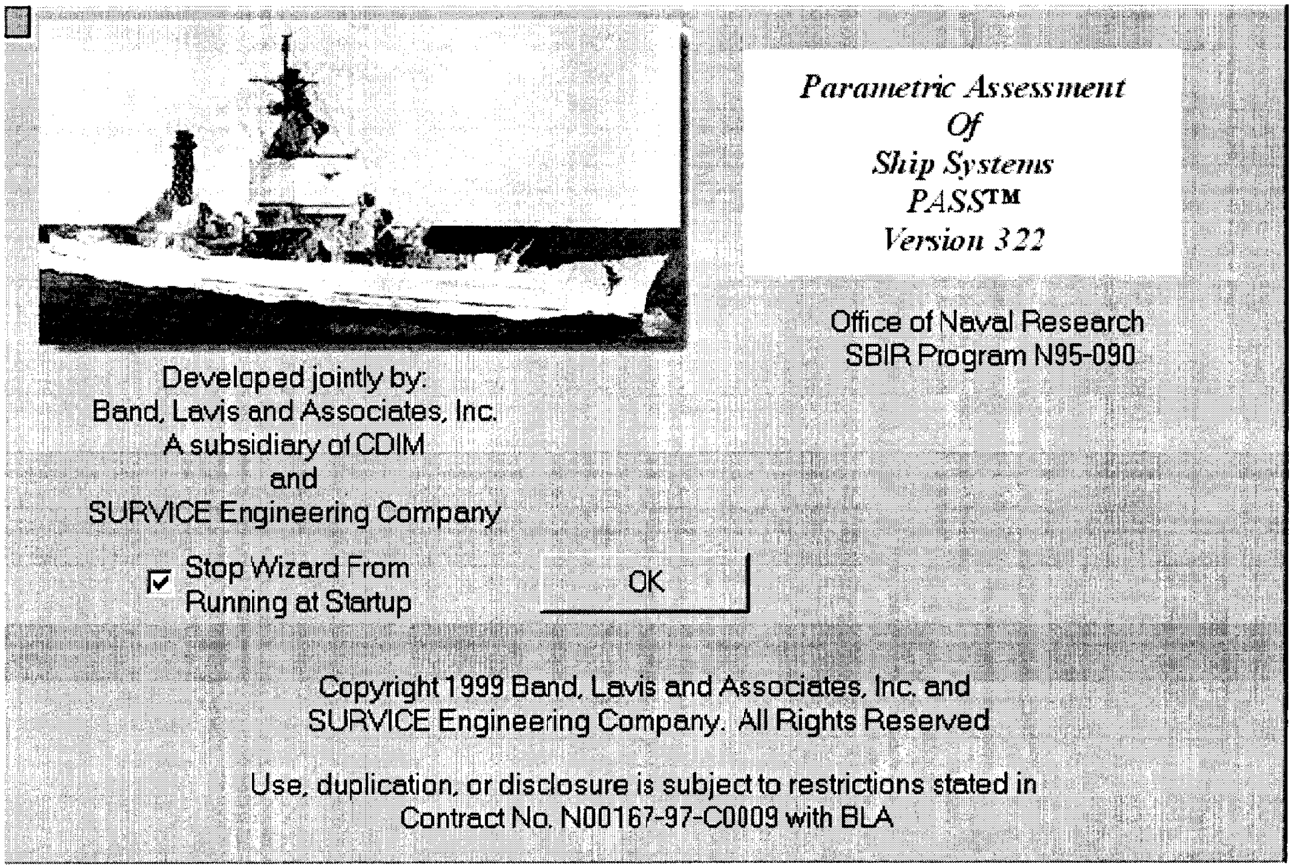
Ship design is one of the most complicated human engineering tasks. There are a large number of systems involved and the interactions amongst them are so complicated that the description and quantification of every aspect of them is extremely difficult, if not impossible. The larger and more elaborate a computer model is, the more difficult to use, less reliable and less predictable it will become. Even in the traditional detail design stage, where every detail is sought, there are still margins on the weight, space and power, etc. to account for the accumulation of many small inaccuracies as well as the vagaries of individual and shipyard work practices. The "exact" answer is extremely difficult to achieve, if it exists at all.

A concept design tool like PASS is not intended to account for every detail. There is a balance between the sophistication of the program and its ease of use. To save users time and effort, PASS' sophisticated design synthesis engine takes very basic and essential input and returns remarkably accurate solutions. It describes each subsystem using a set of essential parameters. Its first-principle-based algorithms are built with the analytical and design capability to characterize, with sufficient accuracy, each subsystem and its interaction with other systems. These algorithms are believed to be applicable to a wide range of similar subsystems that are available or physically possible. However, they may not exactly represent a particular product on the market or future product advancement.

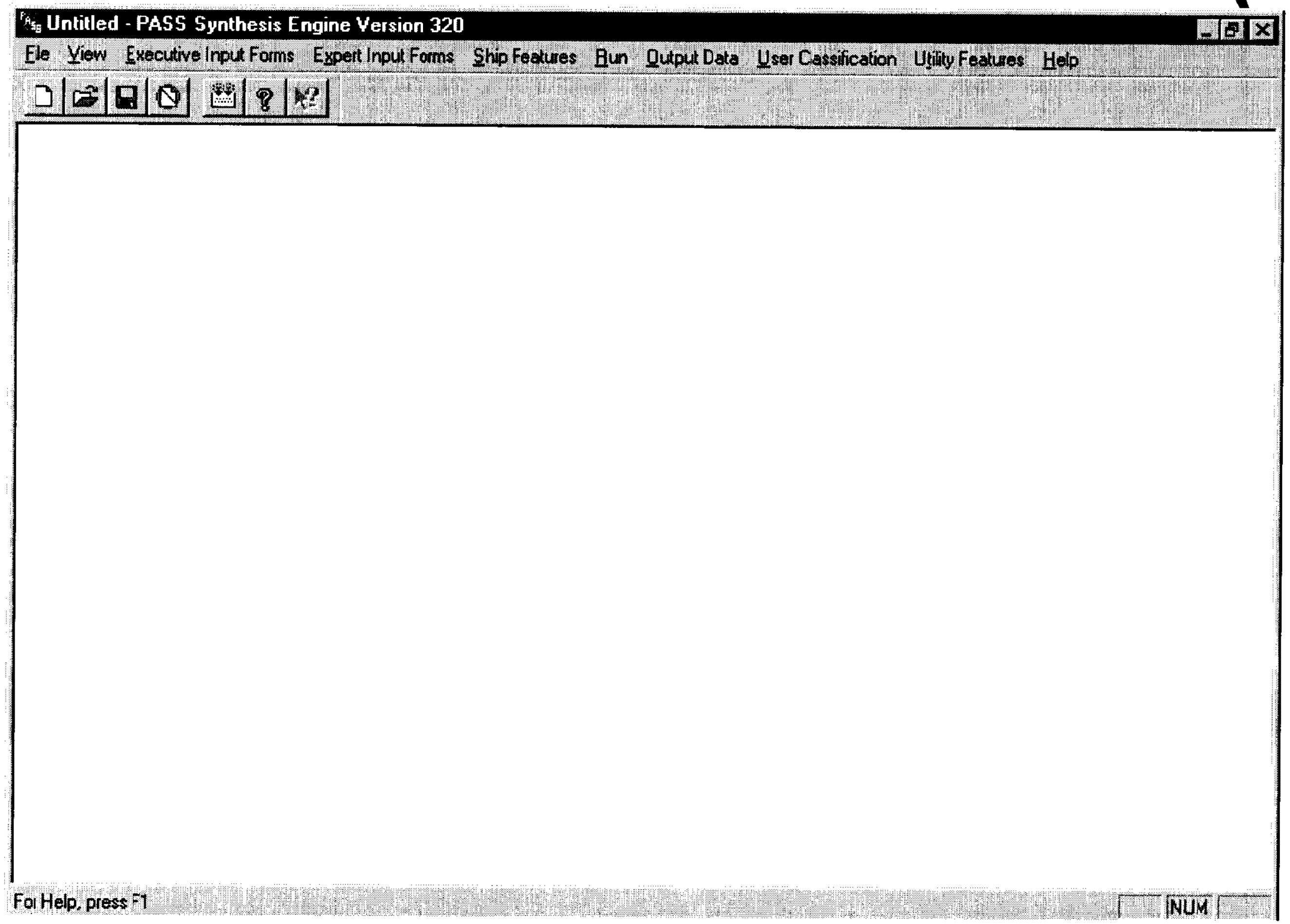
After all, PASS is a computer model. It does what a computer program does best; make "accurate" answers and exact errors. Tangible errors may be caused, in some cases, by flaws in the PASS algorithms or by programming bugs in the codes. More often, however, it occurs when the user is trying to push an algorithm to its limits. Sometimes it is caused by improper use or inconsistent inputs. One should always use his/her own knowledge and engineering judgment when using or interpreting the results from PASS. Even more care must be taken when pushing PASS to its limits. Be especially critical of results when using a new subsystem which has not been tested.

PASS is a living and ever-evolving program, particularly as it matures. PASS was developed with a very limited budget and has just finished its Phase II development and first β-testing. Even though it is built with all the expertise accumulated by Band, Lavis & Associates over more than 20 years, and has gone through extensive debugging and testing, minor problems are still possible and improvements are almost certain to be necessary. Additionally, modifications are inevitable to keep up with new technology development. Podded propulsion, for example, is undergoing significant evolution with the recent installation of these systems on several cruise ships. Catamaran technology is evolving quickly as more, faster and bigger ships are introduced to the market. Trimarans also gained significant recognition recently when construction of the first British trimaran prototype was started. Fuel cell technology is advancing rapidly as well. Technology of this nature needs constant and careful data gathering and monitoring, and this will be vital to maintaining PASS as a premier technology assessment tool.

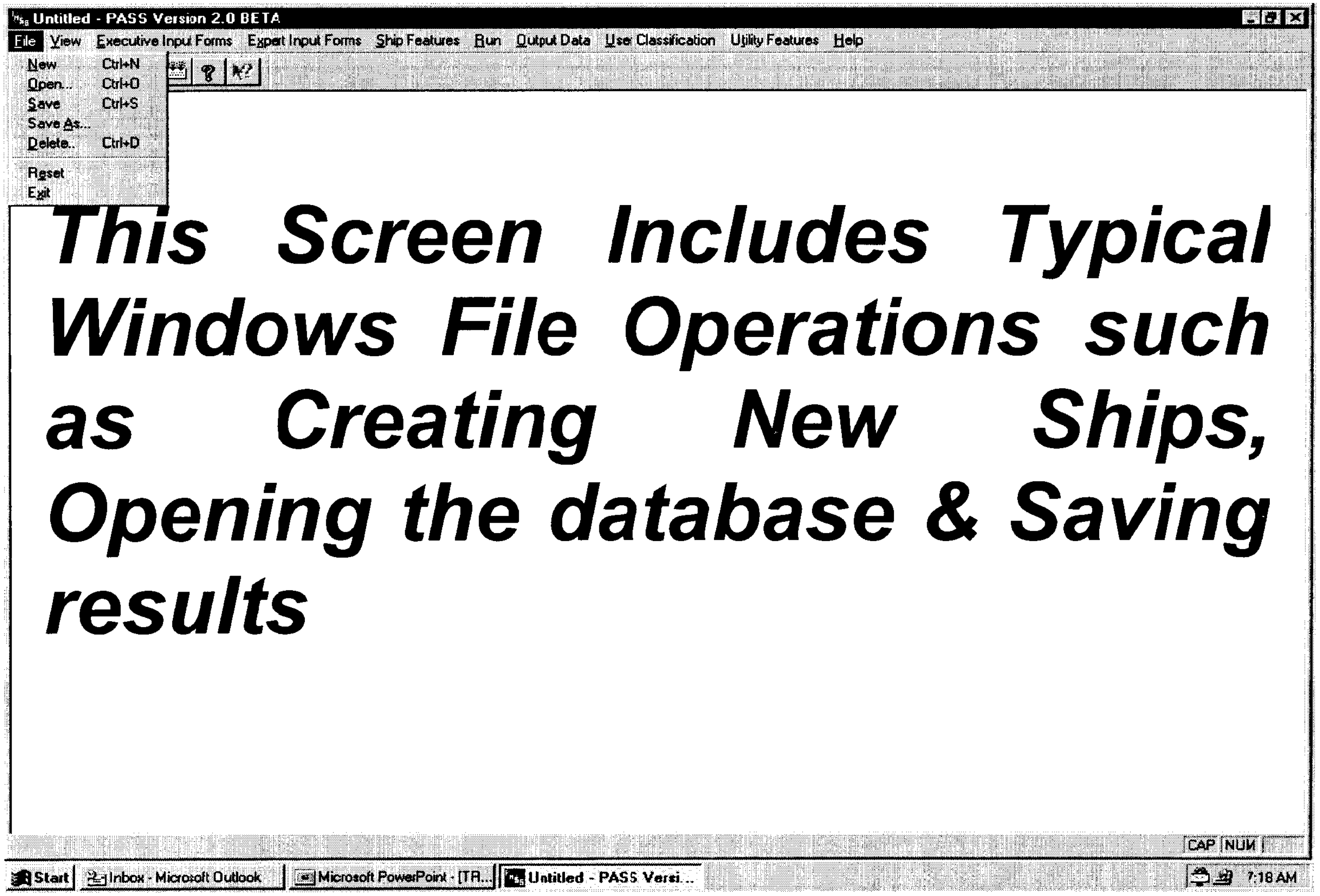
PASS STARTUP SCREENS



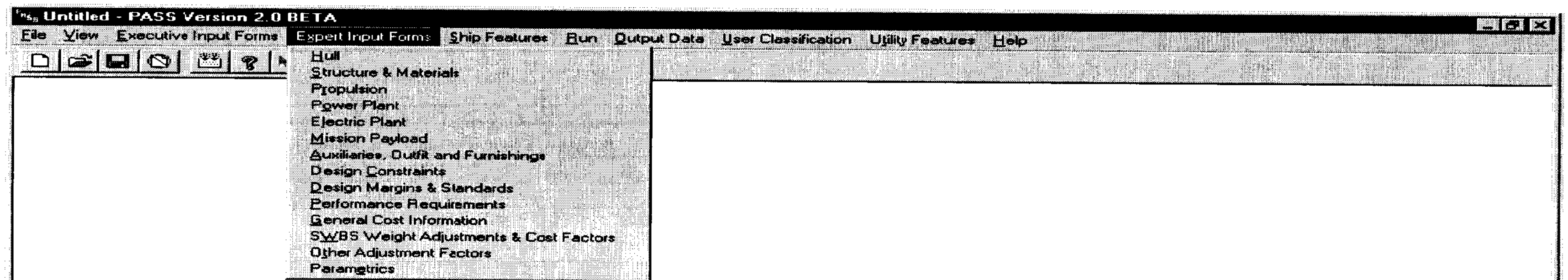
PASS START UP SCREEN (CON'T)



PASS FILE OPTIONS

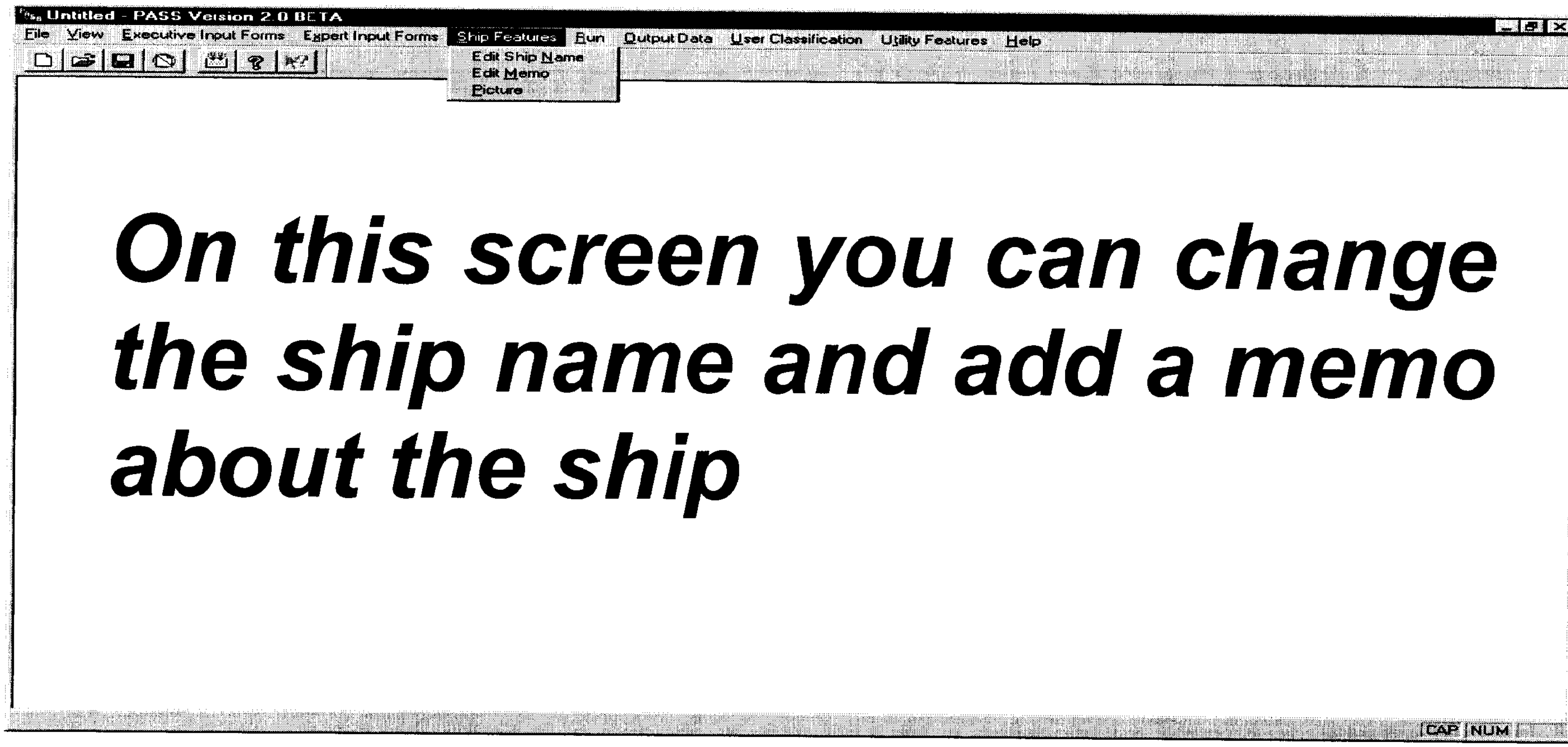


PASS EXPERT USER MENU



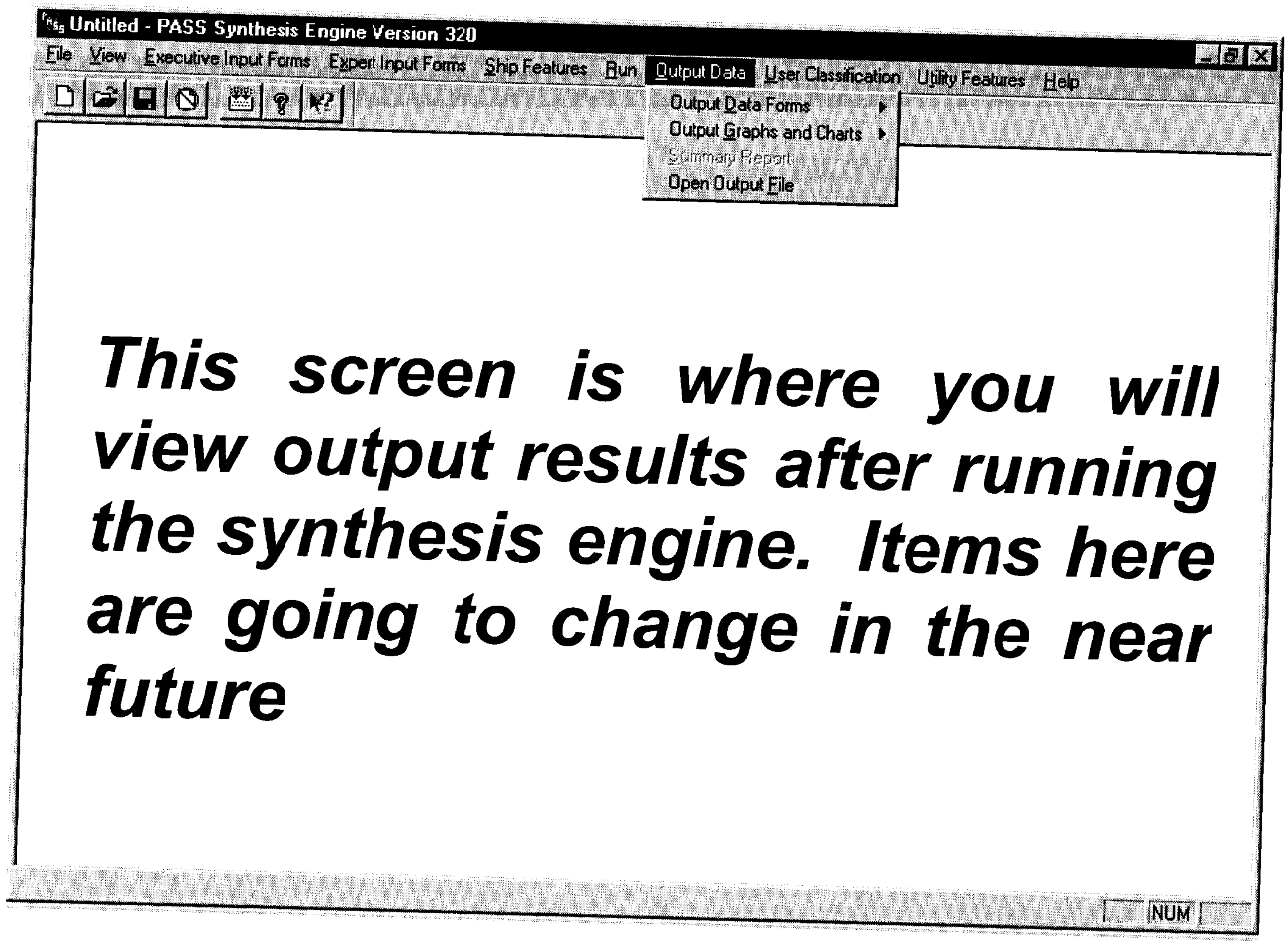
This Is the Menu Option That You Will Use to Edit All Ship and Operating Parameters Prior to Running the Synthesis Engine

PASS SHIP FEATURE MENU

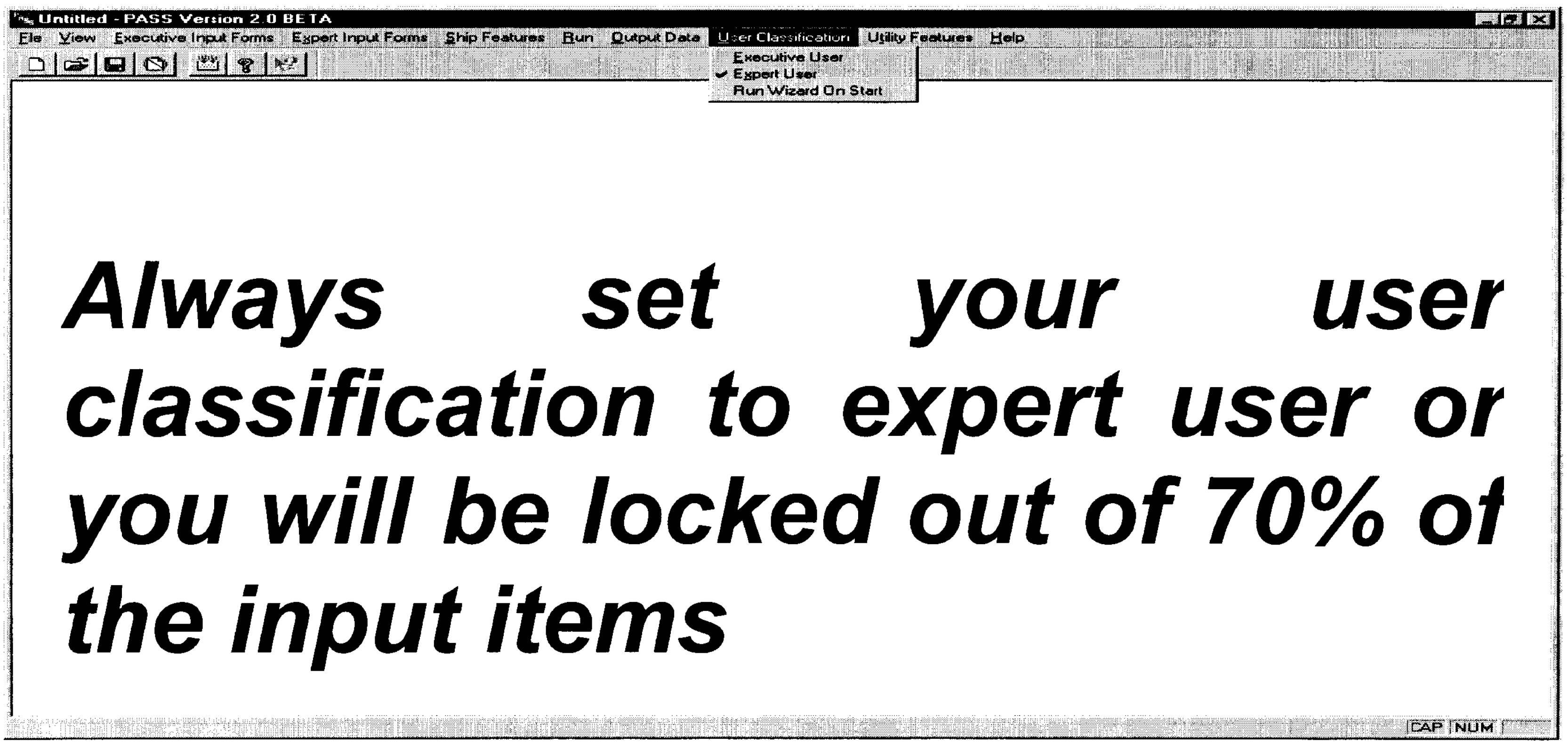


On this screen you can change the ship name and add a memo about the ship

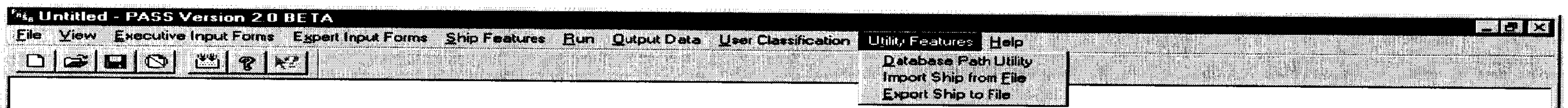
PASS OUTPUT MENU OPTIONS



MENU FOR SETTING USER CLASSIFICATION

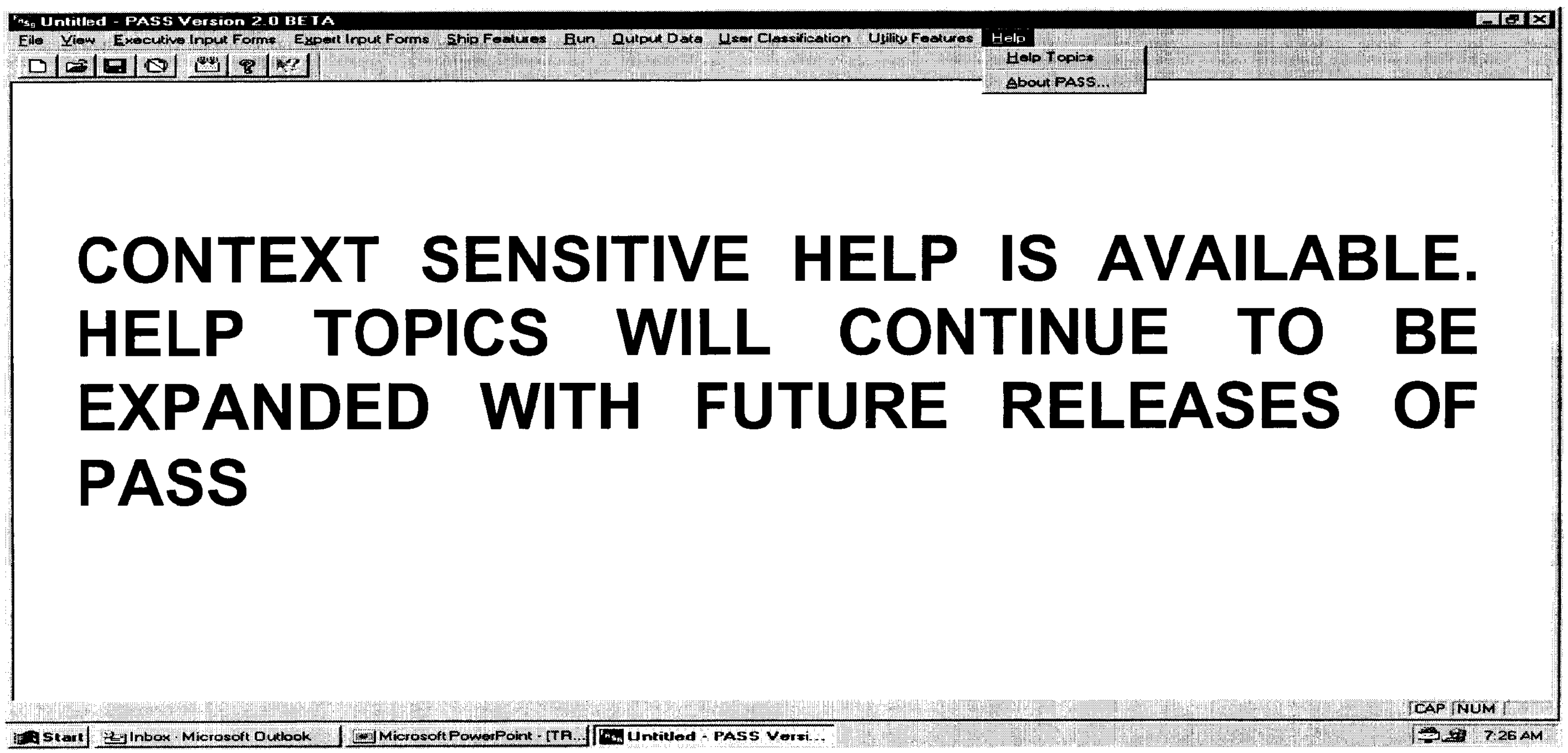


PASS UTILITIES MENU



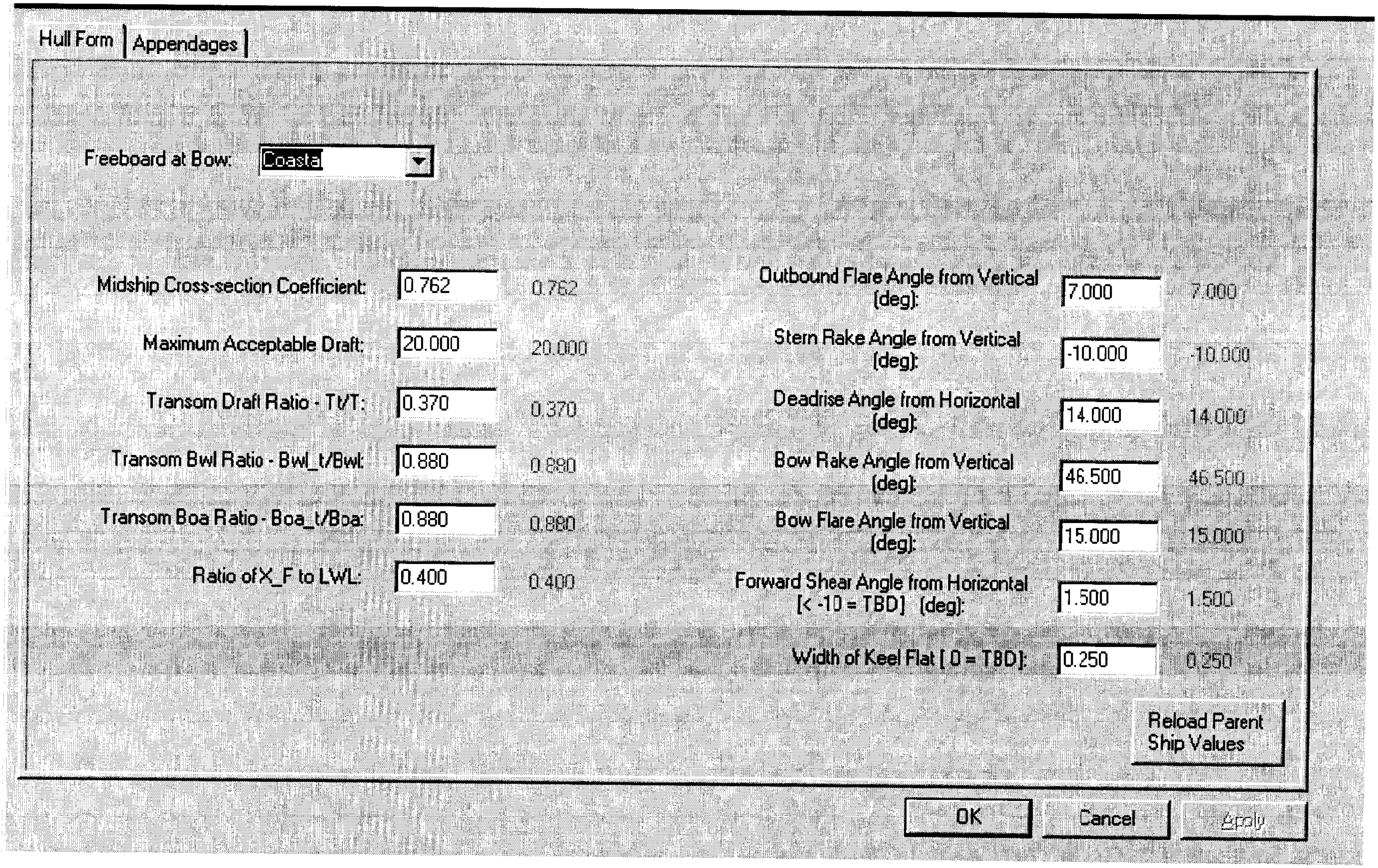
This menu is where you can change the location of the databases (not recommended) and import/export data files which is very useful for debugging purposes and sharing ships between users

PASS HELP MENU

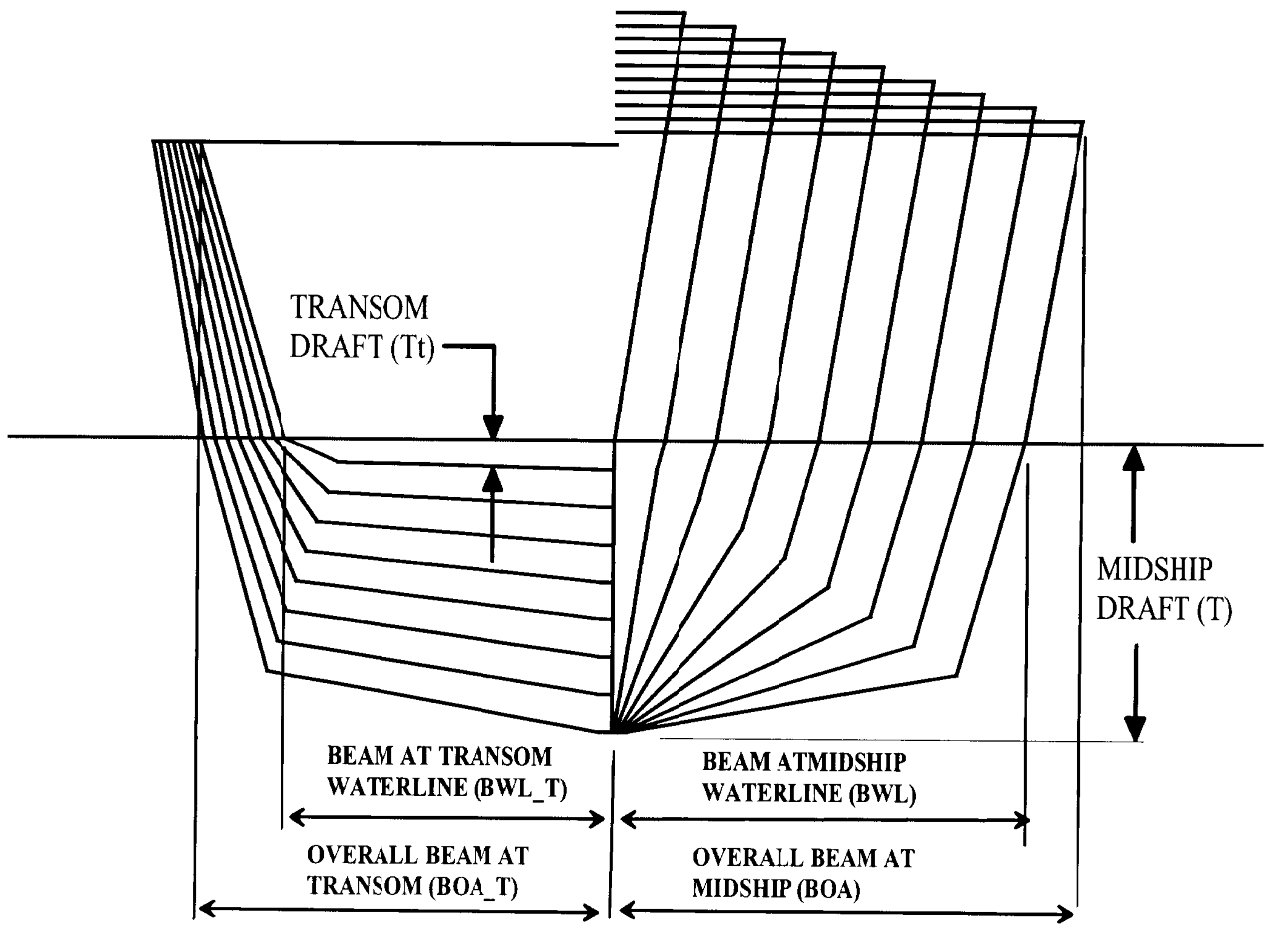


EXPERT USER INPUT FORMS

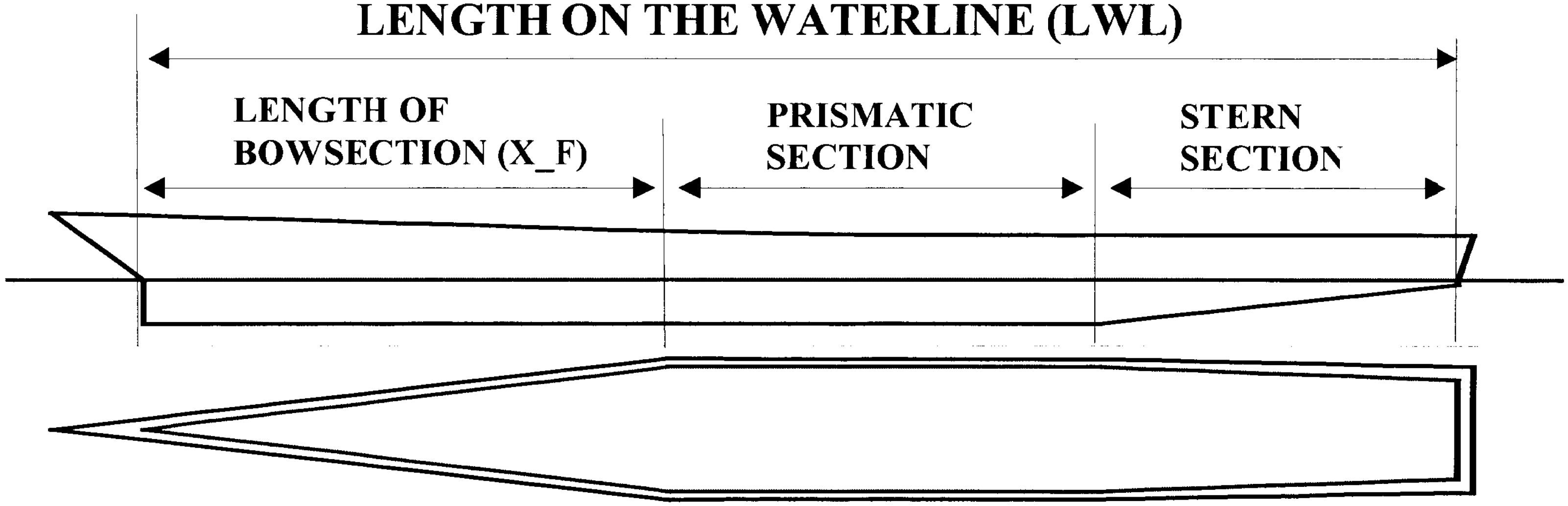
HULL GEOMETRY, HULLFORM PAGE



HULL GEOMETRY DEFINITION



HULL GEOMETRY DEFINITION (CON'T)



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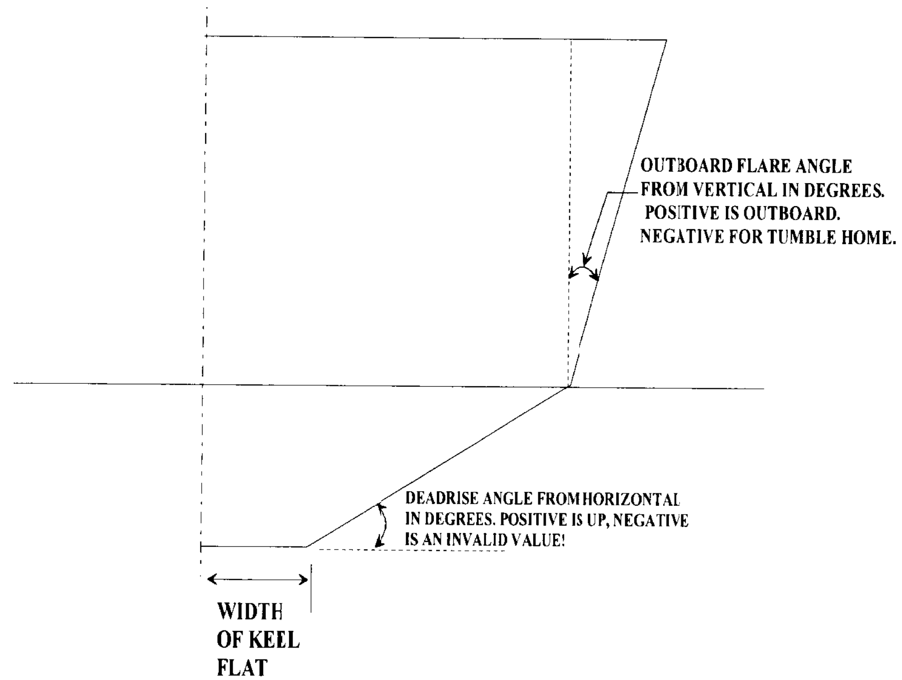
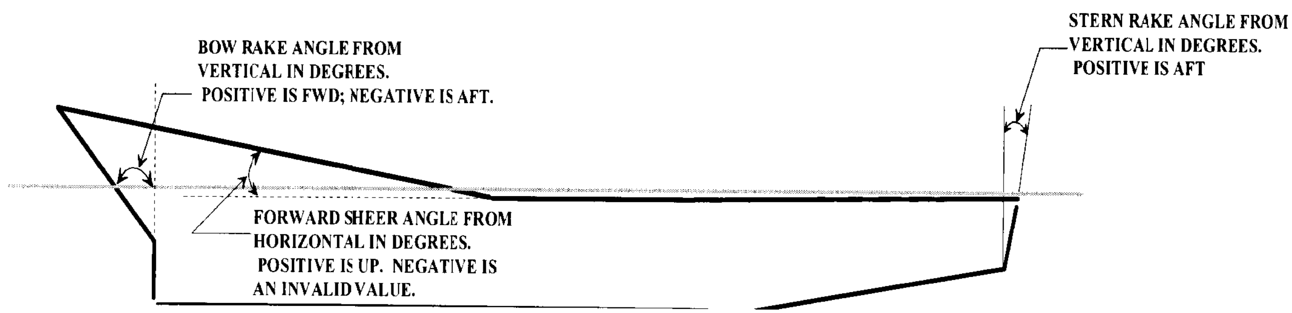
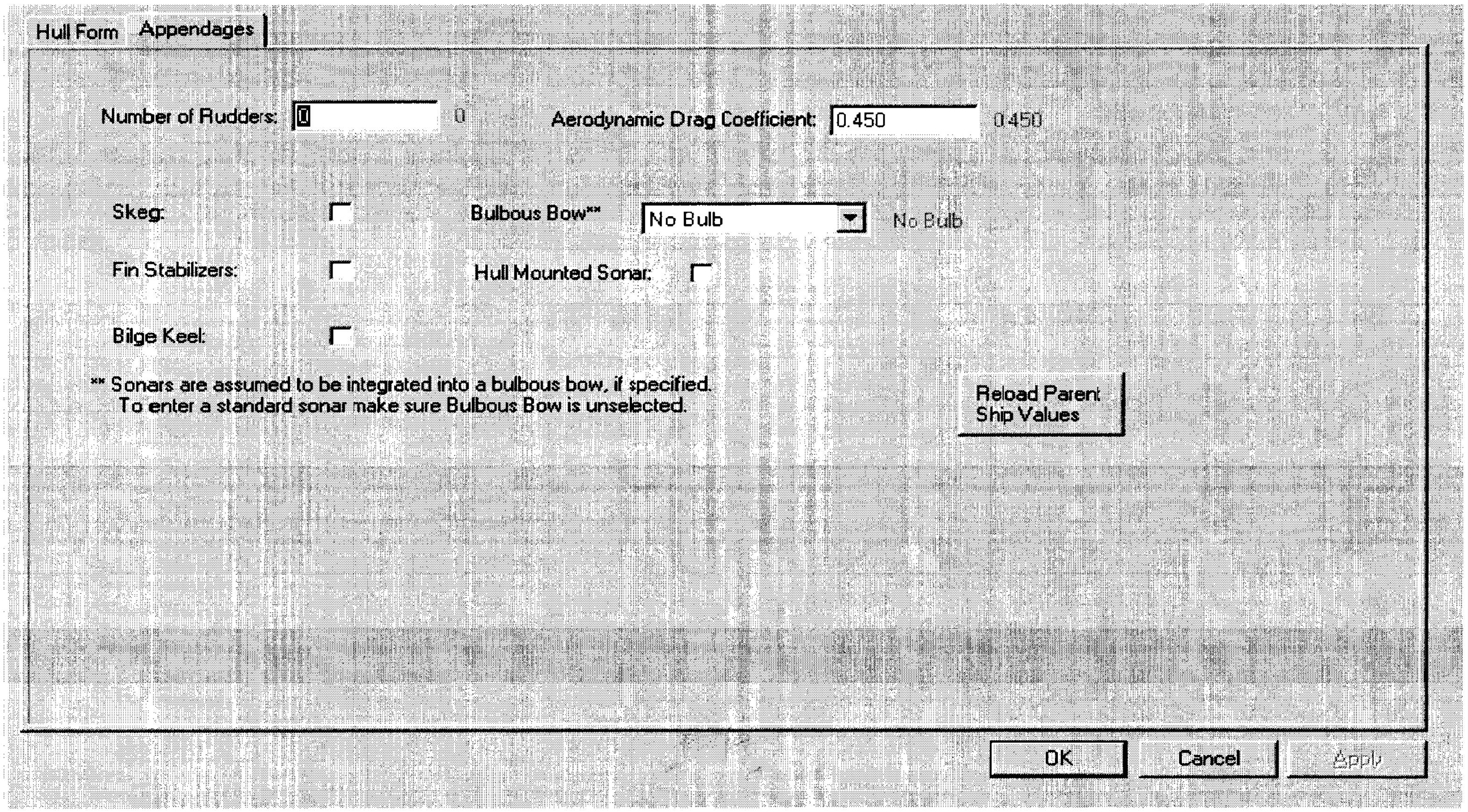
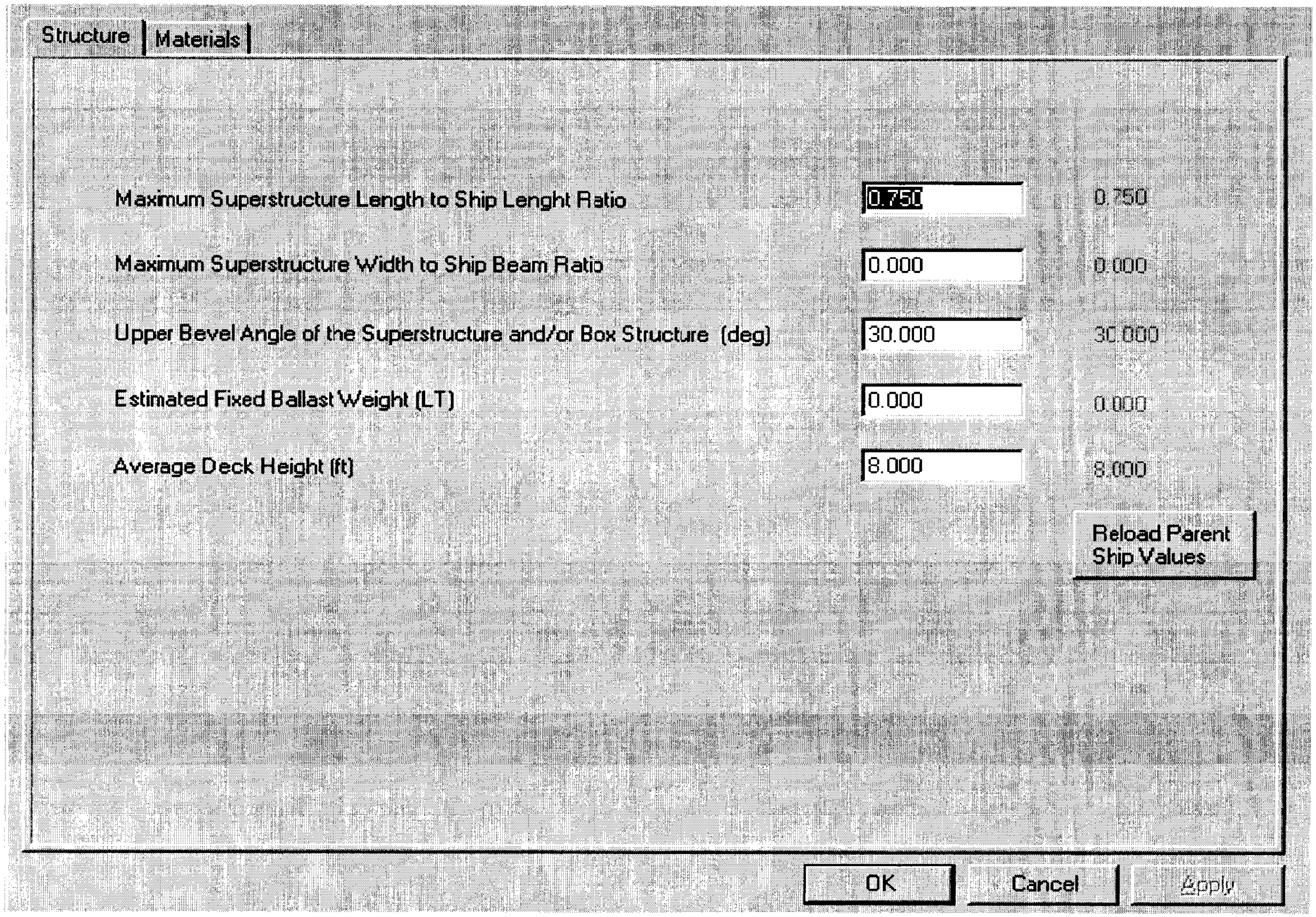




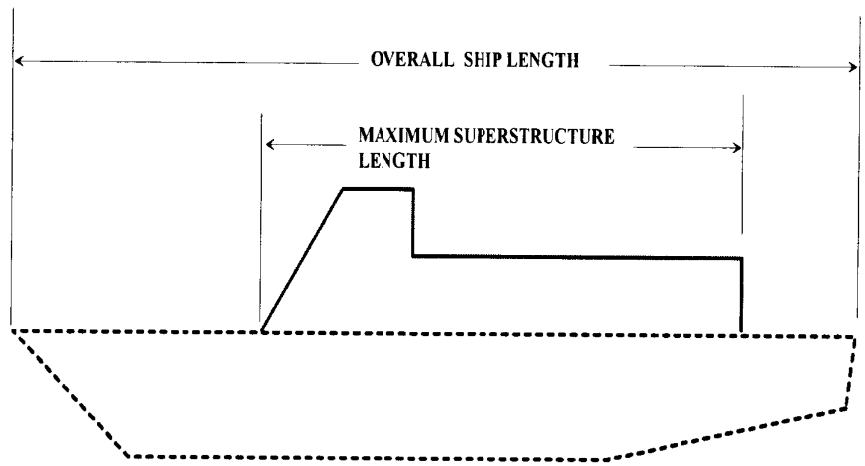
HULL GEOMETRY, APPENDAGE PAGE

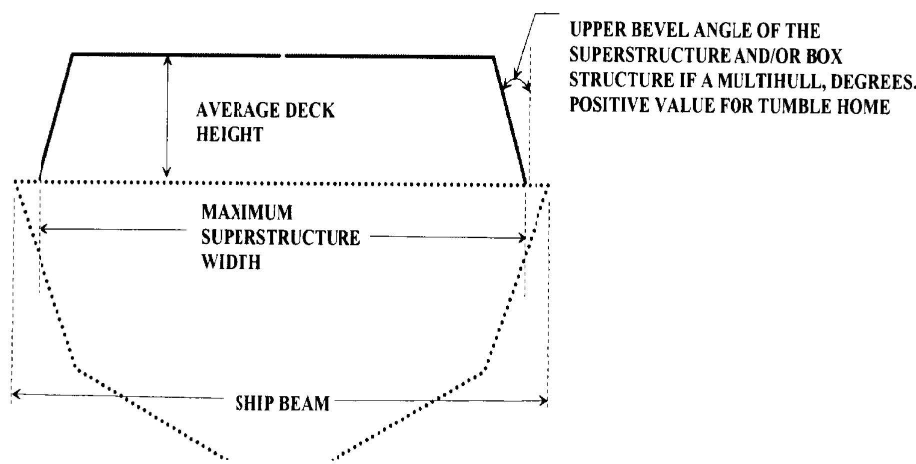


STRUCTURE PAGE

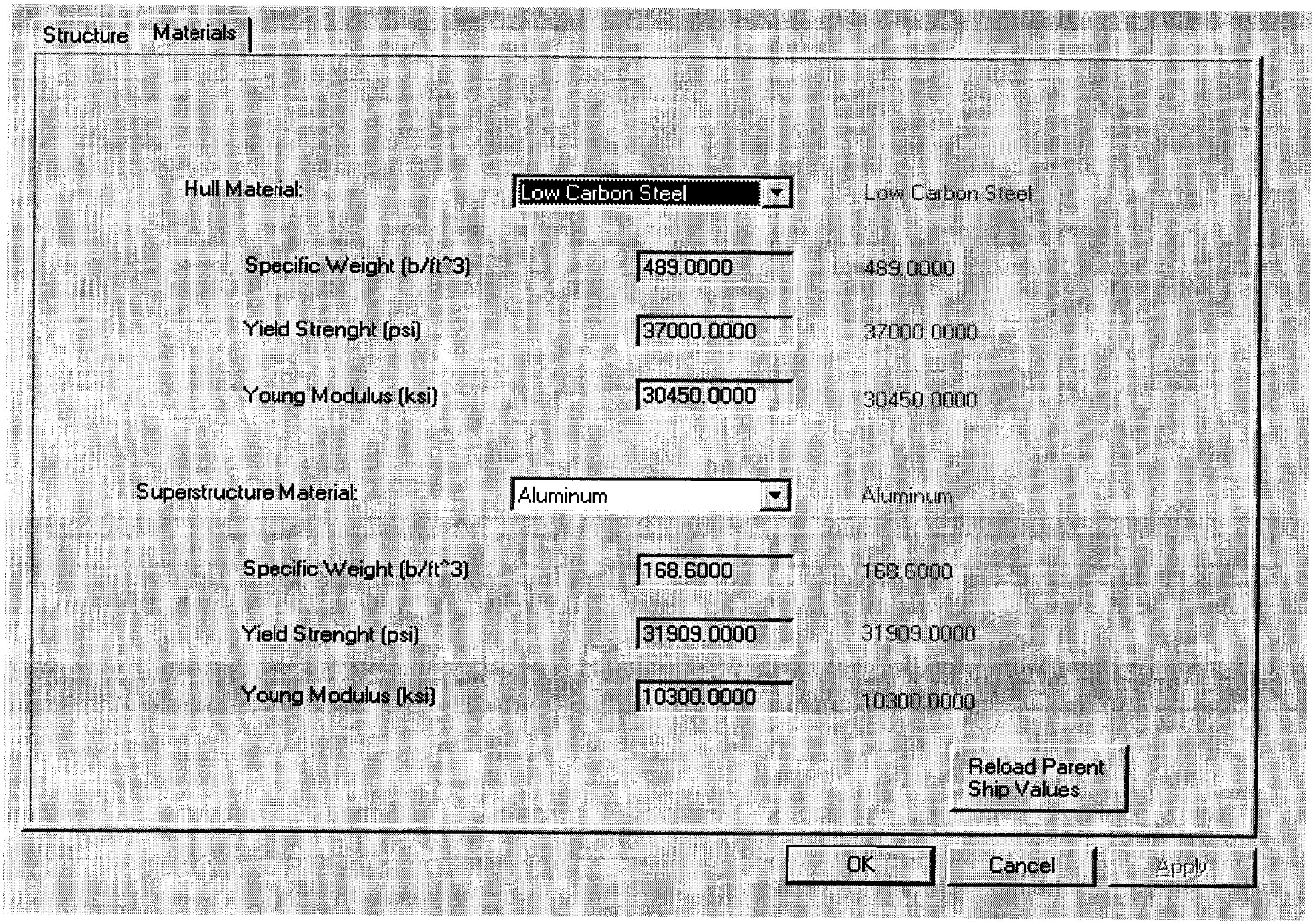


STRUCTURE DEFINITIONS

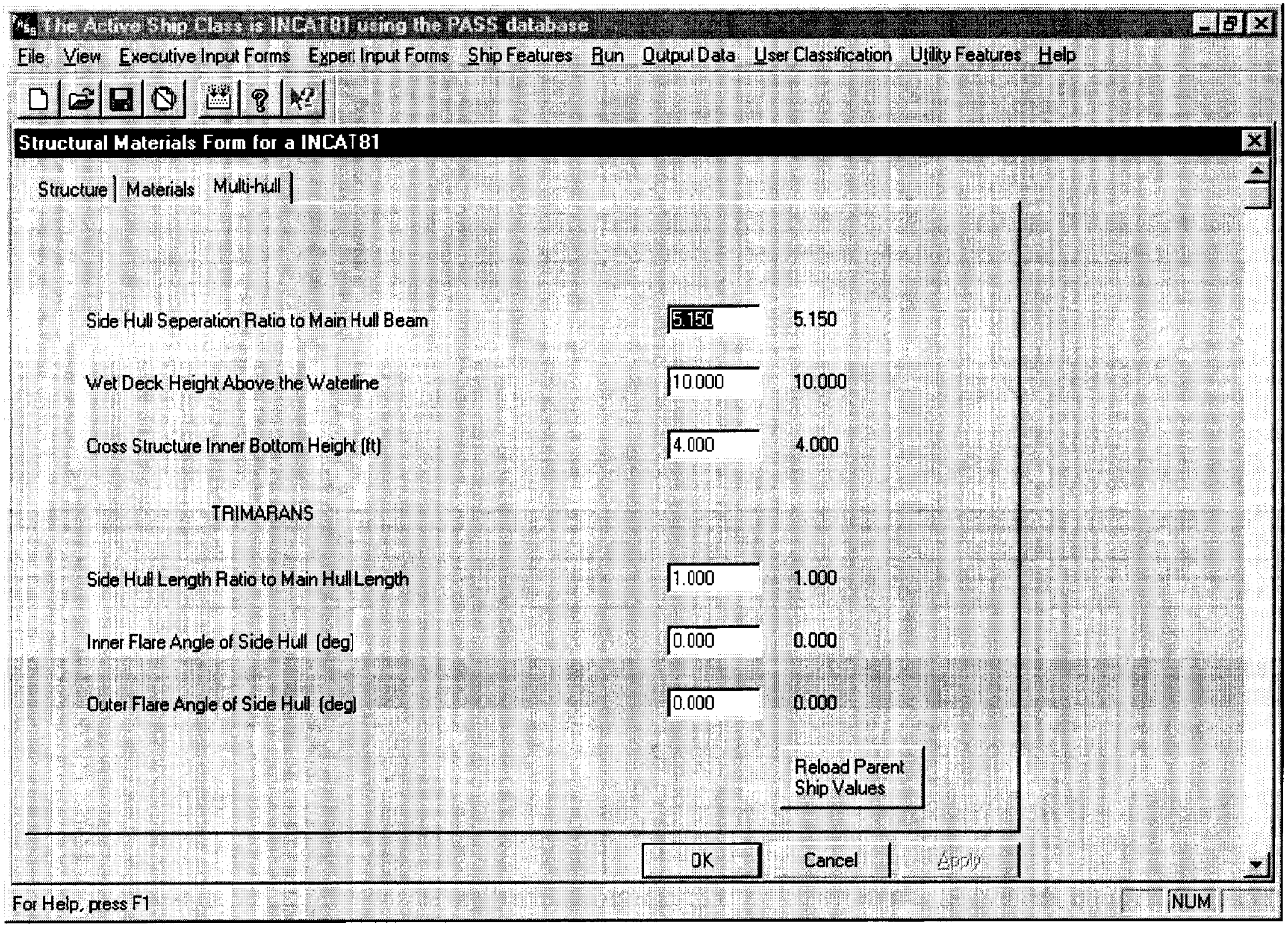




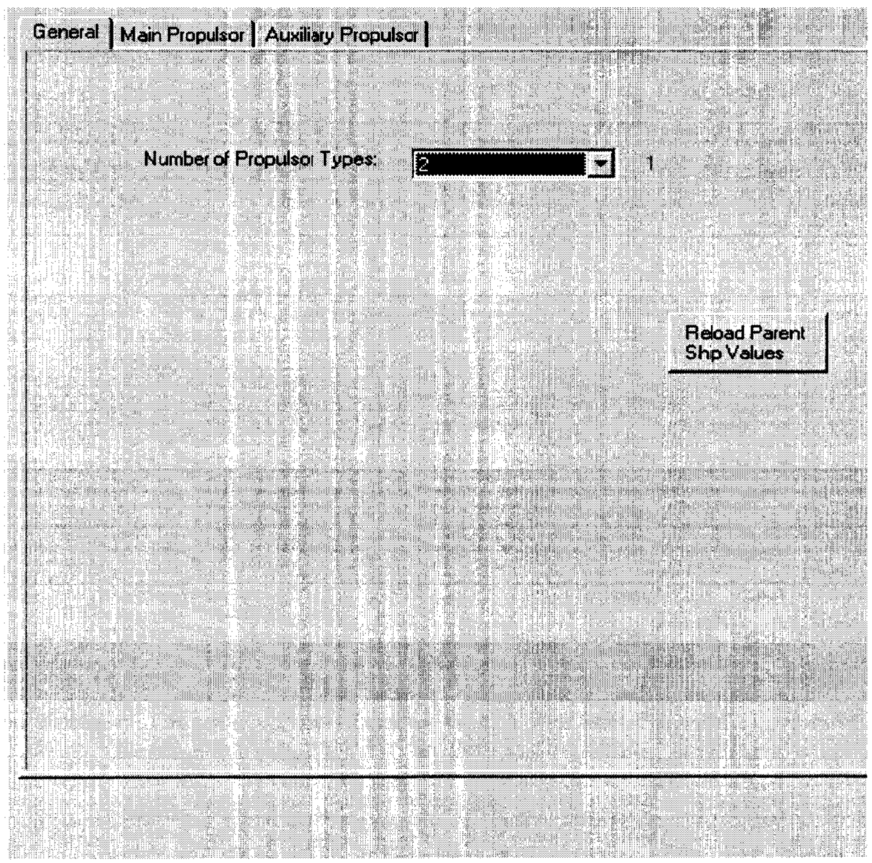
MATERIALS PAGE



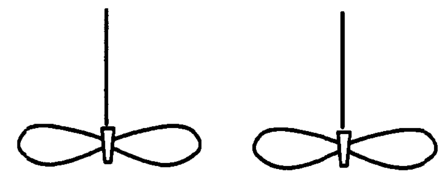
Multi-hull Page



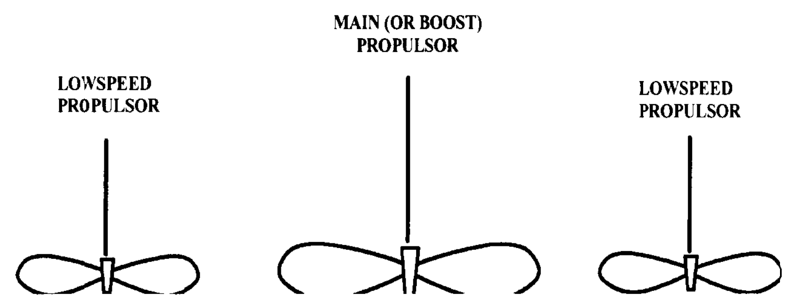
PROPULSOR DATA, GENERAL PAGE



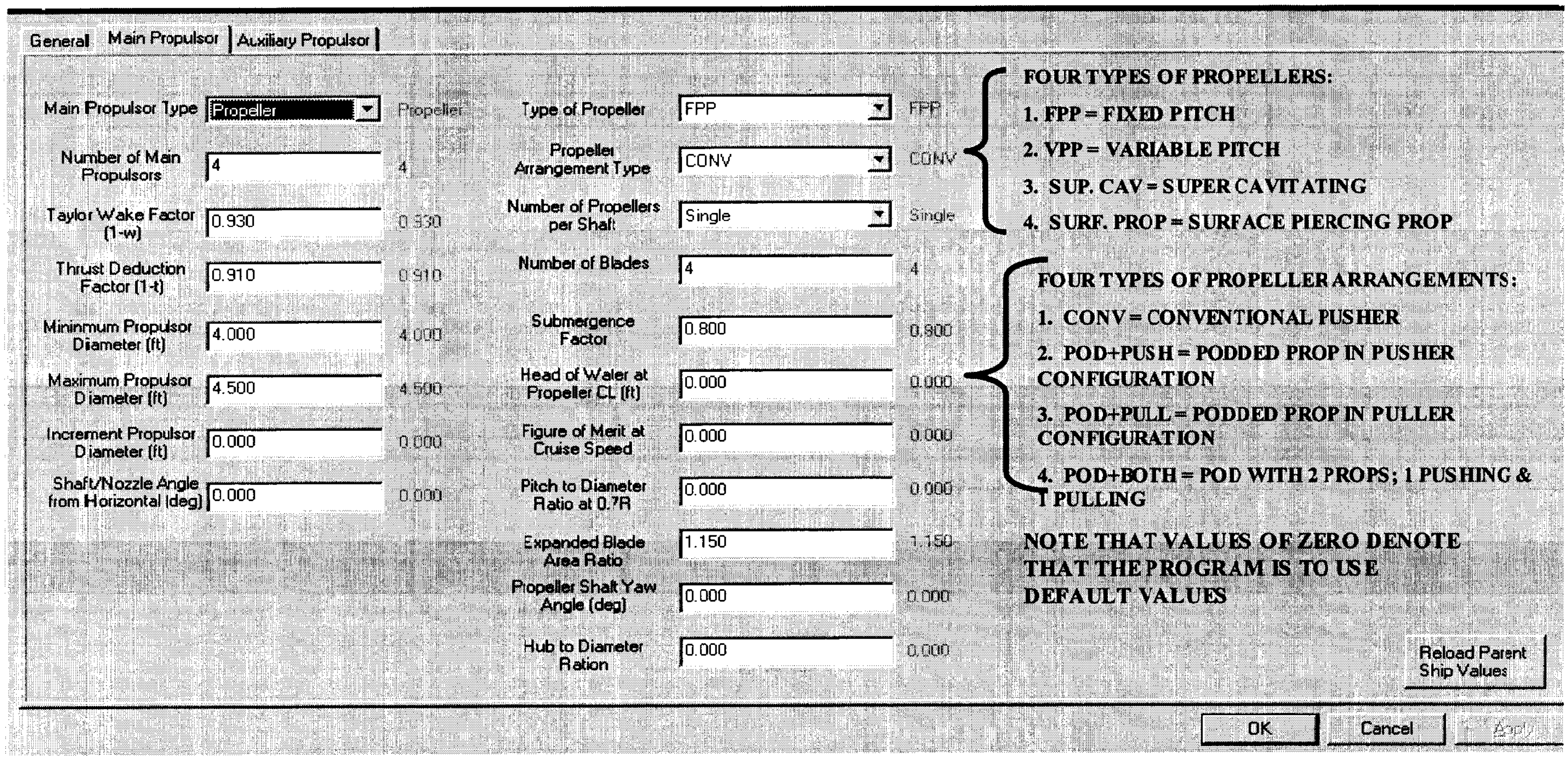
TYPICAL TWIN SCREW PROPULSOR CONFIGURATION NOTE THAT THIS IS A CONFIGURASTION THAT HAS ONE TYPE OF PROPULSOR SINCE BOTH PROPULSORS OPERATE ALL OF THE TIME



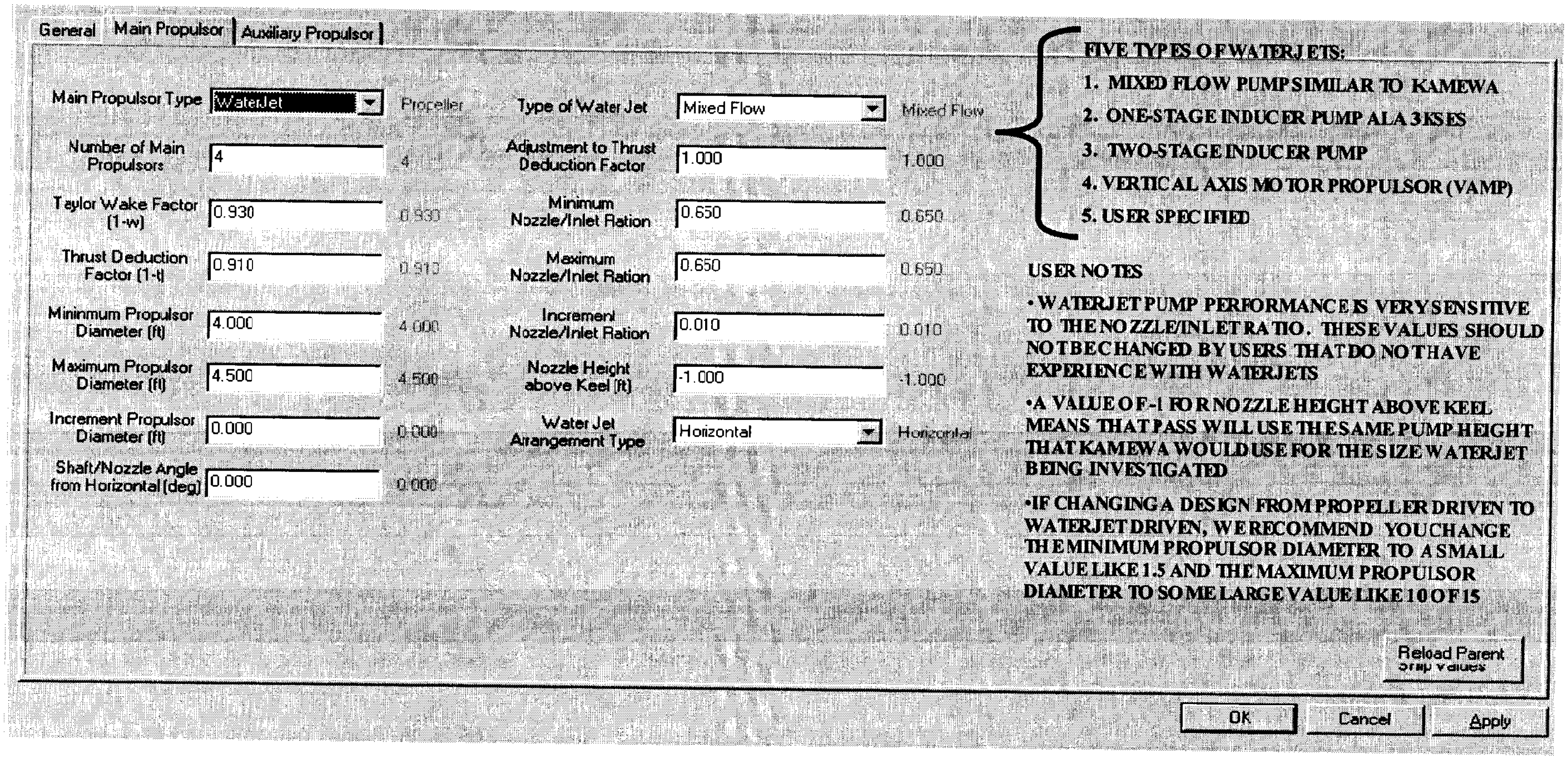
TYPICAL DUAL PROPULSOR CONFIGURATION WHICH COMBINES LOW SPEED PROPULSORS WITH A MAIN (OR BOOST) PROPULSOR. NOTE THAT THIS IS A CONFIGURATION THAT HAS 2 TYPES OF PROPULSOR



PROPULSOR DATA, MAIN PROPULSOR PAGE, PROPELLER

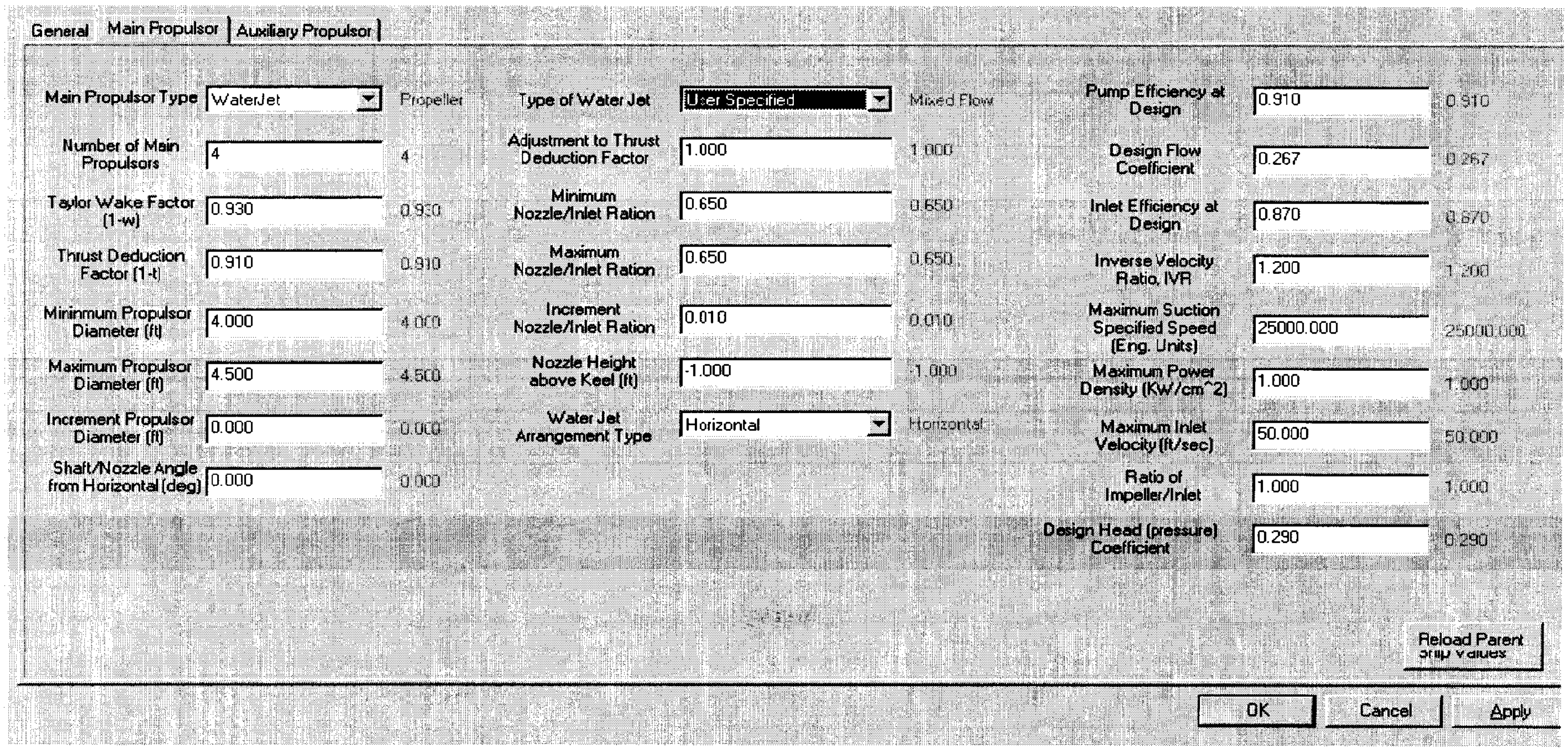


PROPULSOR DATA, MAIN PROPULSOR PAGE , WATERJET

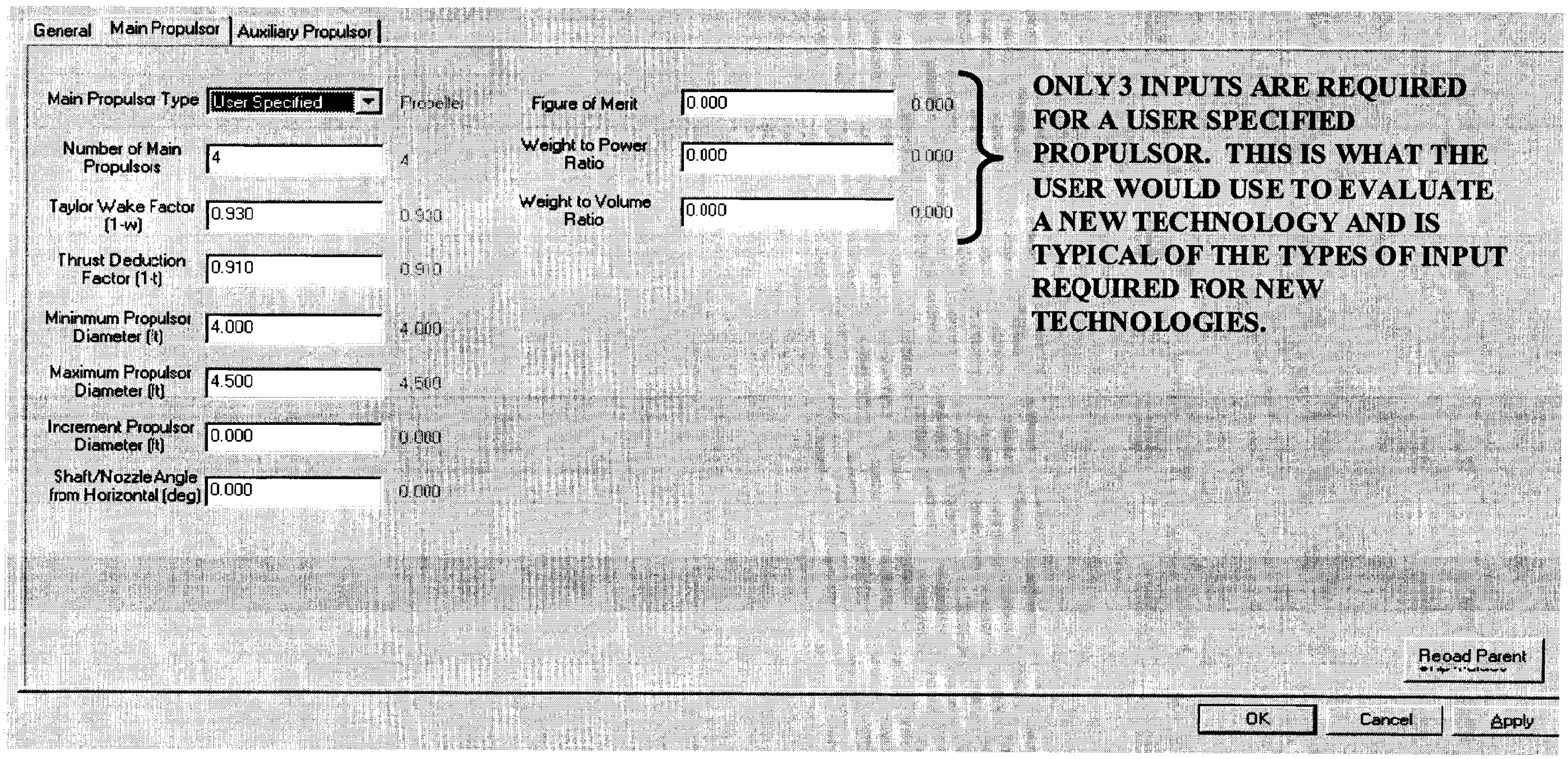


PROPULSOR DATA, MAIN PROPULSOR PAGE, USER SPECIFIED WATERJET

<u>THIS PAGE REQUIRES VERY SPECIFIC WATERJET DESIGN INFORMATION AND SHOULD ONLY BE USED UNDER THE SUPERVISION OF A WATERJET DESIGNER!</u>



PROPULSOR DATA, MAIN PROPULSOR PAGE, USER SPECIFIED PROPULSOR

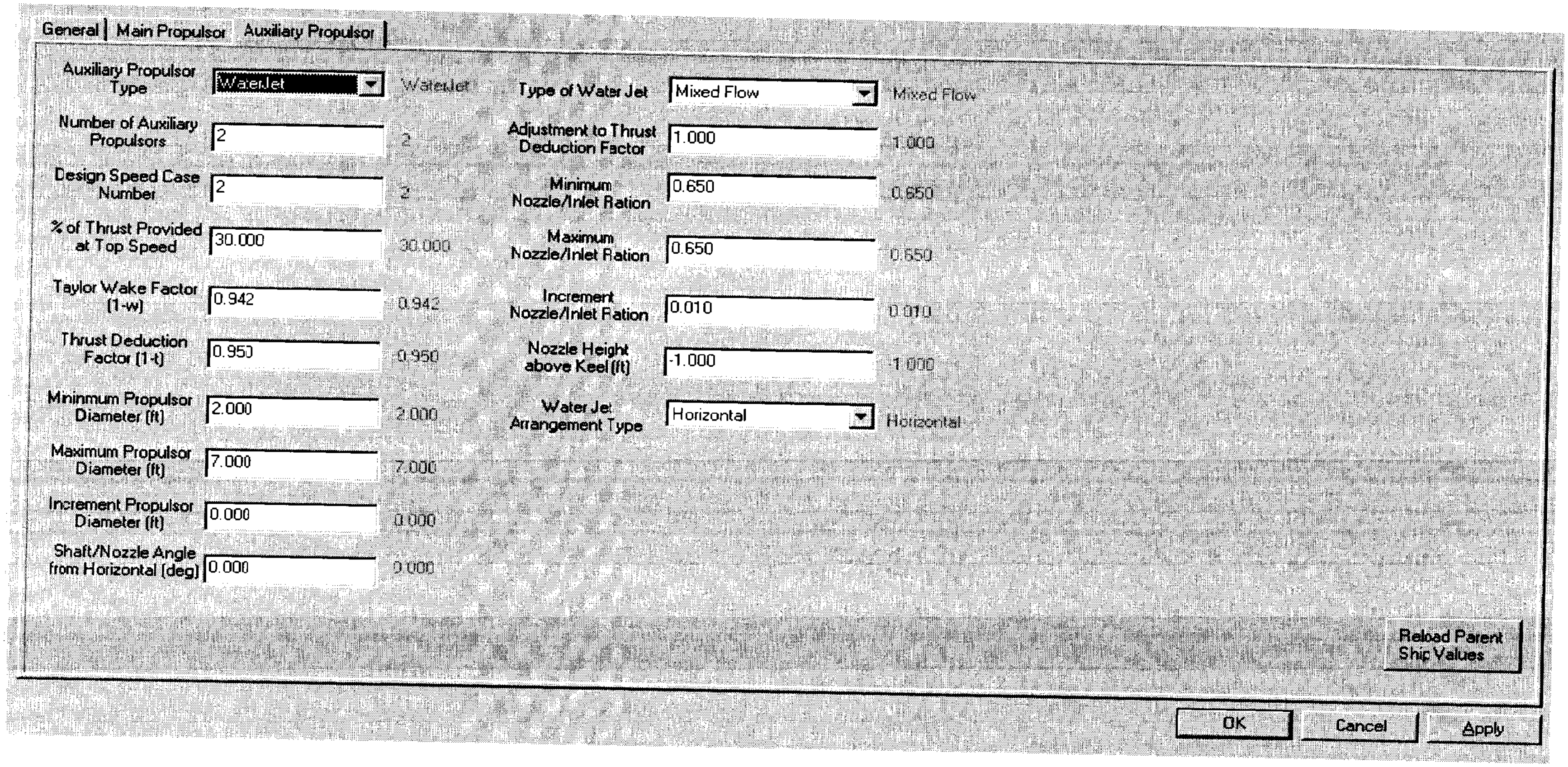


PROPULSOR DATA, AUXILIARY PROPULSOR INPUT

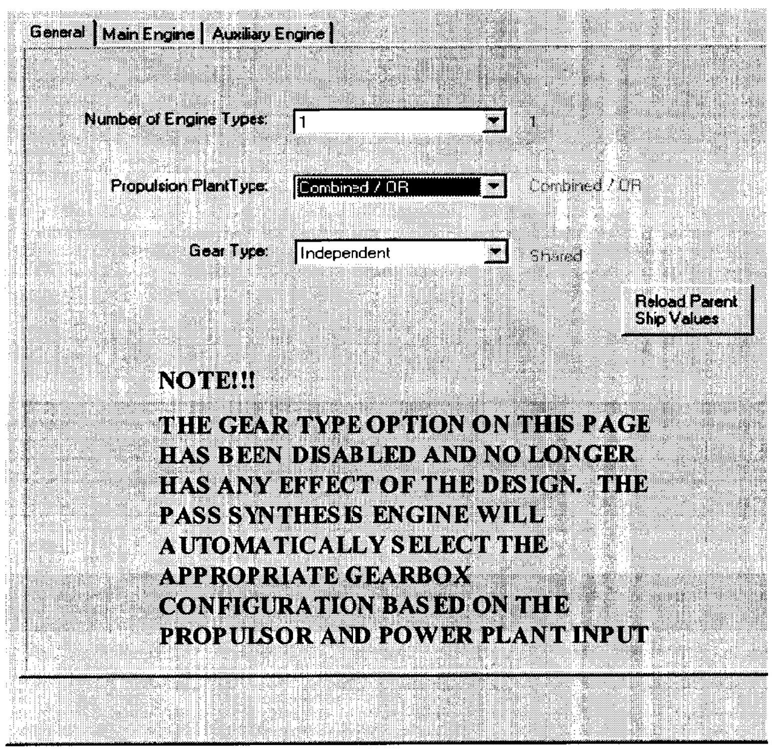
THE AUXILIARY PROPULSOR INPUT PAGE IS GENERALLY THE SAME AS THE MAIN PROPULSOR INPUT PAGE EXCEPT THAT IT INCLUDES TWO ADDITIONAL INPUT ITEMS:

- DESIGN SPEED CASE NUMBER WHICH IS THE SPEED CASE FROM THE PERFORMANCE REQUIREMENTS, SPEED PAGE AND IDENTIFIES THE SPEED/SEA STATE CONDITION TO BE USED TO DESIGN THE AUXILIARY PROPULSOR, AND
- % OF THRUST PROVIDED AT TOP SPEED WHICH IS THE PERCENTAGE OF THE TOTAL REQUIRED THRUST, AT THE MAXIMUM CRAFT SPEED, THAT THE AUXILIARY PROPULSOR MUST PRODUCE. THUS, THE MAIN PROPULSOR MUST MAKE UP THE REMAINING THRUST REQUIREMENT

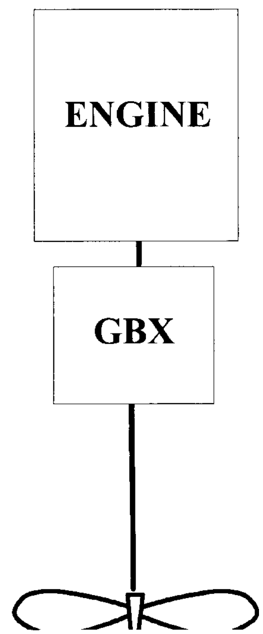
PROPULSOR DATA,AUXILIARY PROPULSOR PAGE



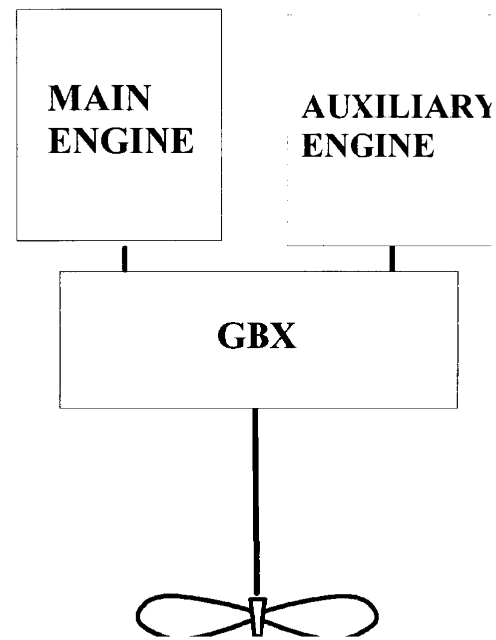
POWER PLANT DATA, GENERAL PAGE



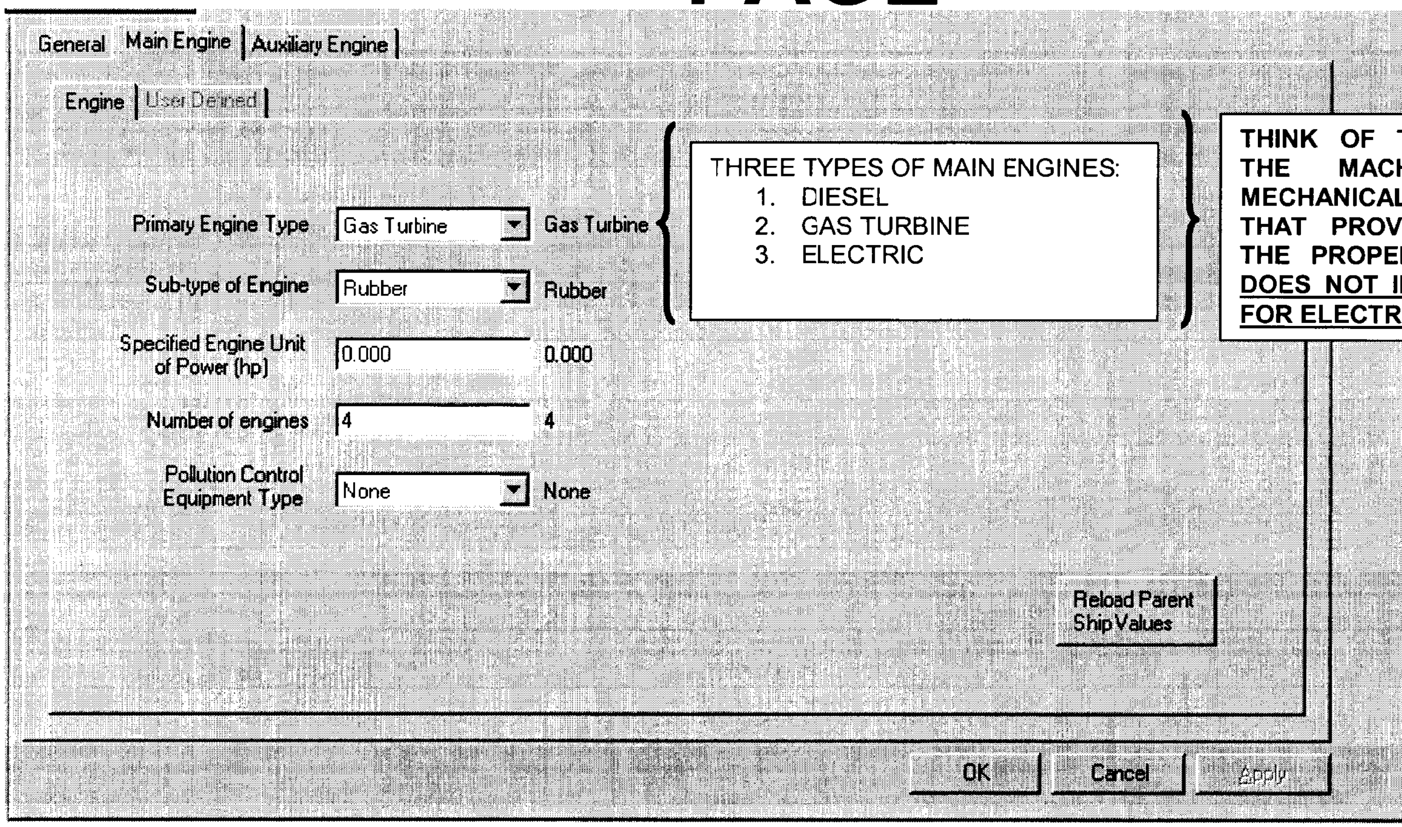
ONE ENGINE TYPE



TWO ENGINE TYPES



POWER PLANT , MAIN ENGINE PAGE



THREE TYPES OF MAIN ENGINES:
1. DIESEL
2. GAS TURBINE
3. ELECTRIC

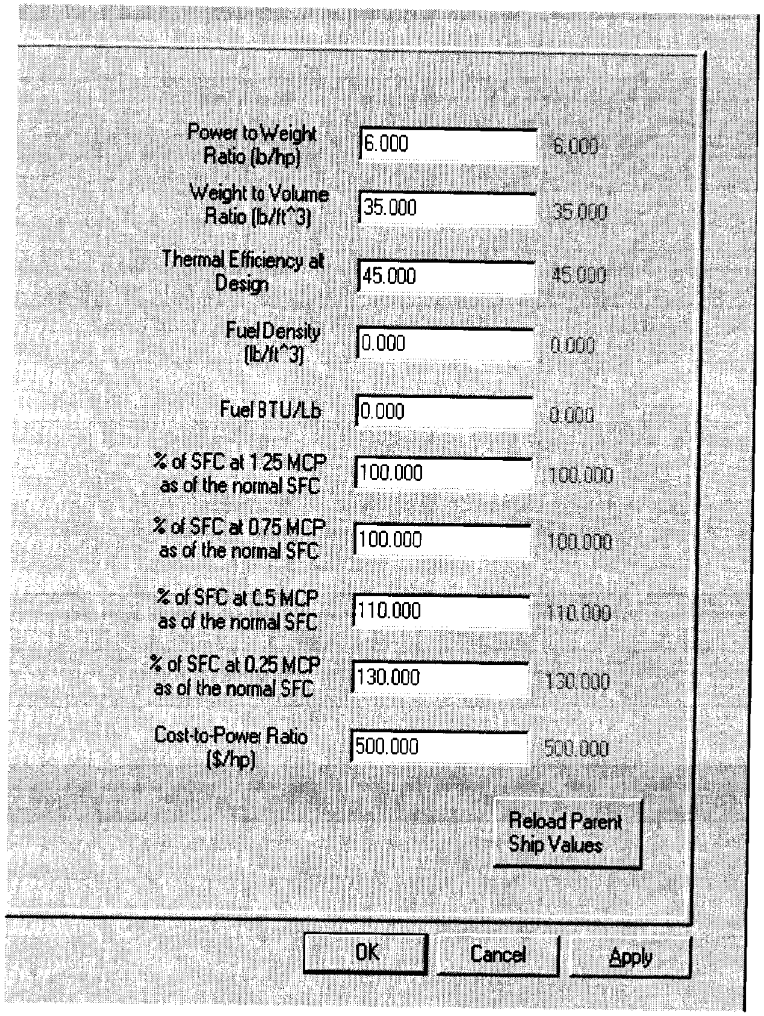
THINK OF THE ENGINES AS THE MACHINERY (EITHER MECHANICAL OR ELECTRICAL) THAT PROVIDES POWER OT THE PROPELLER SHAFT. IT DOES NOT INCLUDE GENSETS FOR ELECTRIC PROPULSION

POWER PLANTS

THERE ARE SEVERAL SUB-TYPES OF "ENGINES" WHICH DEPEND ON THE PRIMARY ENGINE TYPE.

1. IF DIESEL, THEN
   - RUBBER FOR CONTINUOUS SPECTRUM OF AVAILABLE POWER
   - Specific Engine Manufacturers
   - USER SPECIFIED FOR A NEW TECHNOLOGY ENGINE
2. IF GAS TURBINE, THEN
   - RUBBER FOR CONTINUOUS SPECTRUM OF AVAILABLE POWER
   - STEP INCREMENT TO STEP THROUGH THE POWER RANGE OF AVAILABLE ENGINES
   - ICR FOR AN INTERCOOLED, REGENERATIVE ENGINE
   - USER SPECIFIED FOR A NEW TECHNOLOGY ENGINE
3. IF ELECTRIC, THEN
   - AC MOTOR
   - DC PERMANENT MAGNET MOTOR
   - DC HOMOPOLAR MOTOR

POWER PLANT , USER SPECIFIED



FOR A USER SPECIFIED ENGINE, THE USER MUST PROVIDE:

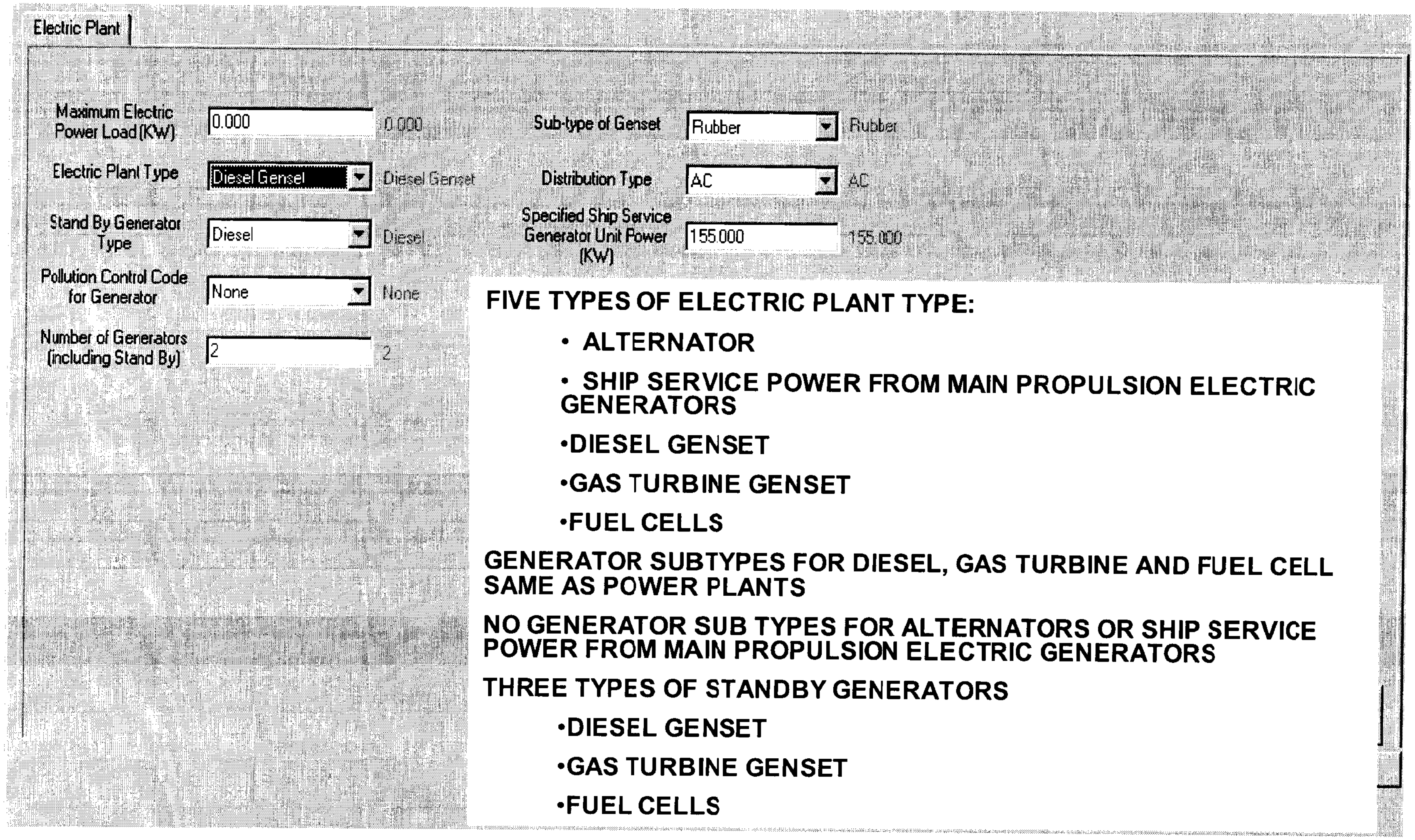
1. ENGINE WEIGHT-TO-POWER RATIO
2. ENGINE WEIGHT-TO-VOLUME RATIO
3 THE THERMAL EFFICIENCY OF THE ENGINE AT THE DESIGN POINT
4. THE DENSITY OF THE FUEL BURNED IN THE ENGINE
5. THE LOWER HEATING VALUE OF FUEL
6. AN SFC PROFILE FOR THE ENGINE AT OFF-DESIGN POWER LEVELS
7. AN ENGINE COST IN TERMS OF $/HP

THE ENGINE SFC AT THE DESIGN CONDITION IS CALCULATED BY THE PASS SYNTHESIS ENGINE USING AN ALGORITHM THAT IS A FUNCTION OF THE ENGINE THERMAL EFFICIENCY AT THE DESIGN CONDITION AND THE LOWER HEATING VALUE OF FUEL.

POWER PLANT , AUXILIARY ENGINE INPUT PAGE

- INPUT FOR THE AUXILIARY ENGINE IS IDENTICAL TO THE MAIN ENGINE INPUT

ELECTRICAL POWER DATA FORM



FIVE TYPES OF ELECTRIC PLANT TYPE:

- ALTERNATOR
- SHIP SERVICE POWER FROM MAIN PROPULSION ELECTRIC GENERATORS
- DIESEL GENSET
- GAS TURBINE GENSET
- FUEL CELLS

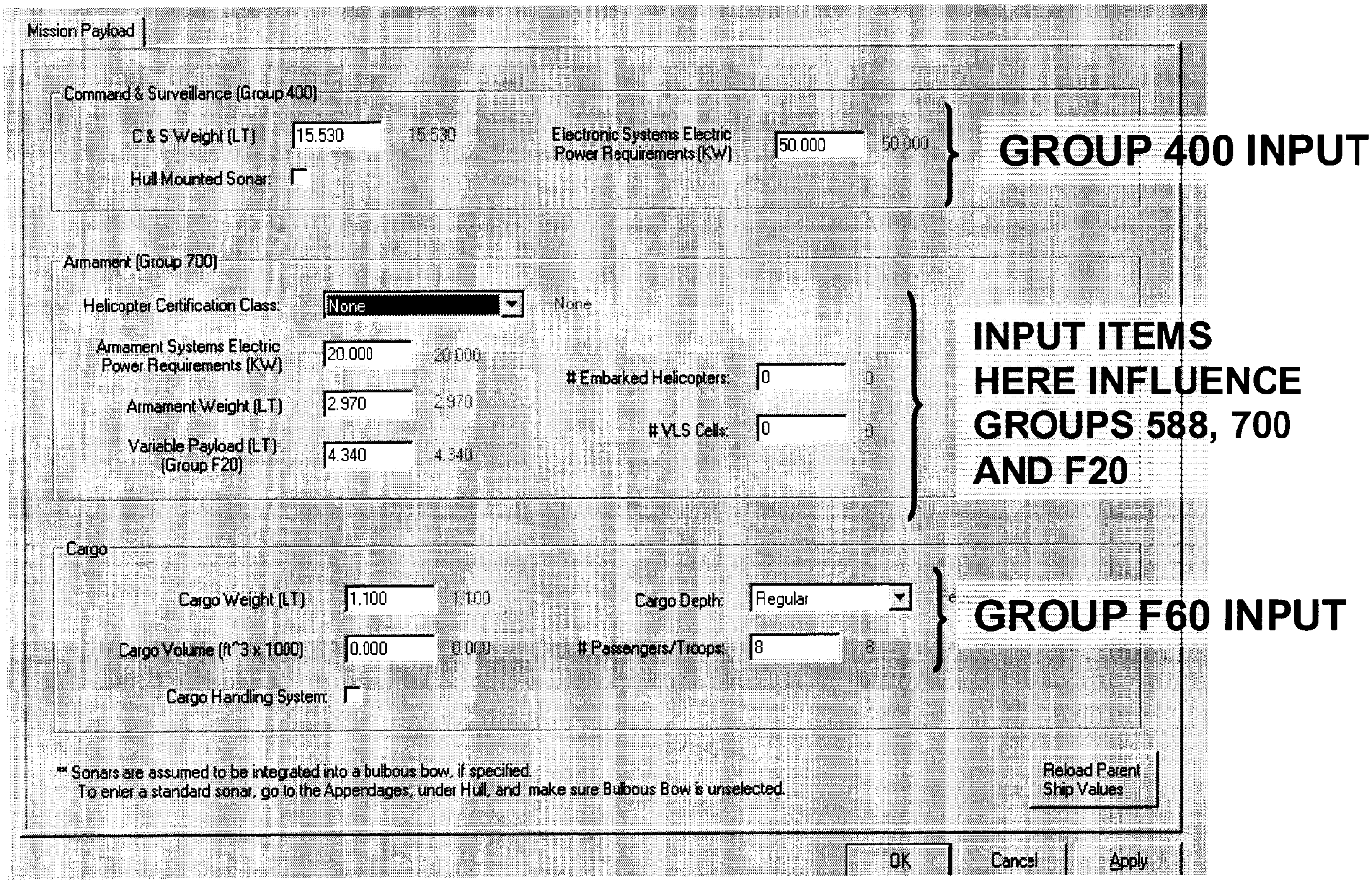
GENERATOR SUBTYPES FOR DIESEL, GAS TURBINE AND FUEL CELL SAME AS POWER PLANTS

NO GENERATOR SUB TYPES FOR ALTERNATORS OR SHIP SERVICE POWER FROM MAIN PROPULSION ELECTRIC GENERATORS

THREE TYPES OF STANDBY GENERATORS

- DIESEL GENSET
- GAS TURBINE GENSET
- FUEL CELLS

MISSION PAYLOAD PAGE



MISSION PAYLOAD

- HELICOPTER CERTIFICATION CLASS
  - NONE - NO HELICOPTER SUPPORT
  - LAND ONLY - DECK AREA WILL BE RESERVED FOR A LAMPS MK III SIZE HELO
  - LAND AND SERVICE - SAME AS LAND ONLY PLUS ADDITION OF JP-5 FUEL. JP-5 FUEL LOAD IS DEPENDENT ON ENDURANCE
  - LAND, SERVICE AND MAINTAIN - SAME AS LAND AND SERVICE PLUS ADDITION OF HANGAR SPACE FOR EACH EMBARKED HELO
- 19,480 LB OF WEIGHT IS ADDED TO GROUP 780 FOR EACH EMBARKED HELICOPTER
  - *<u>THIS WEIGHT IS ONLY USED FOR CG CALCULATIONS! THUS, USER MUST ALSO INCLUDE THE TOTAL WEIGHT OF HELICOPTERS IN THE ARMAMENT WEIGHT INPUT TO</u> CORRECTLY BE REFLECTED IN THE FULL-LOAD WEIGHT*

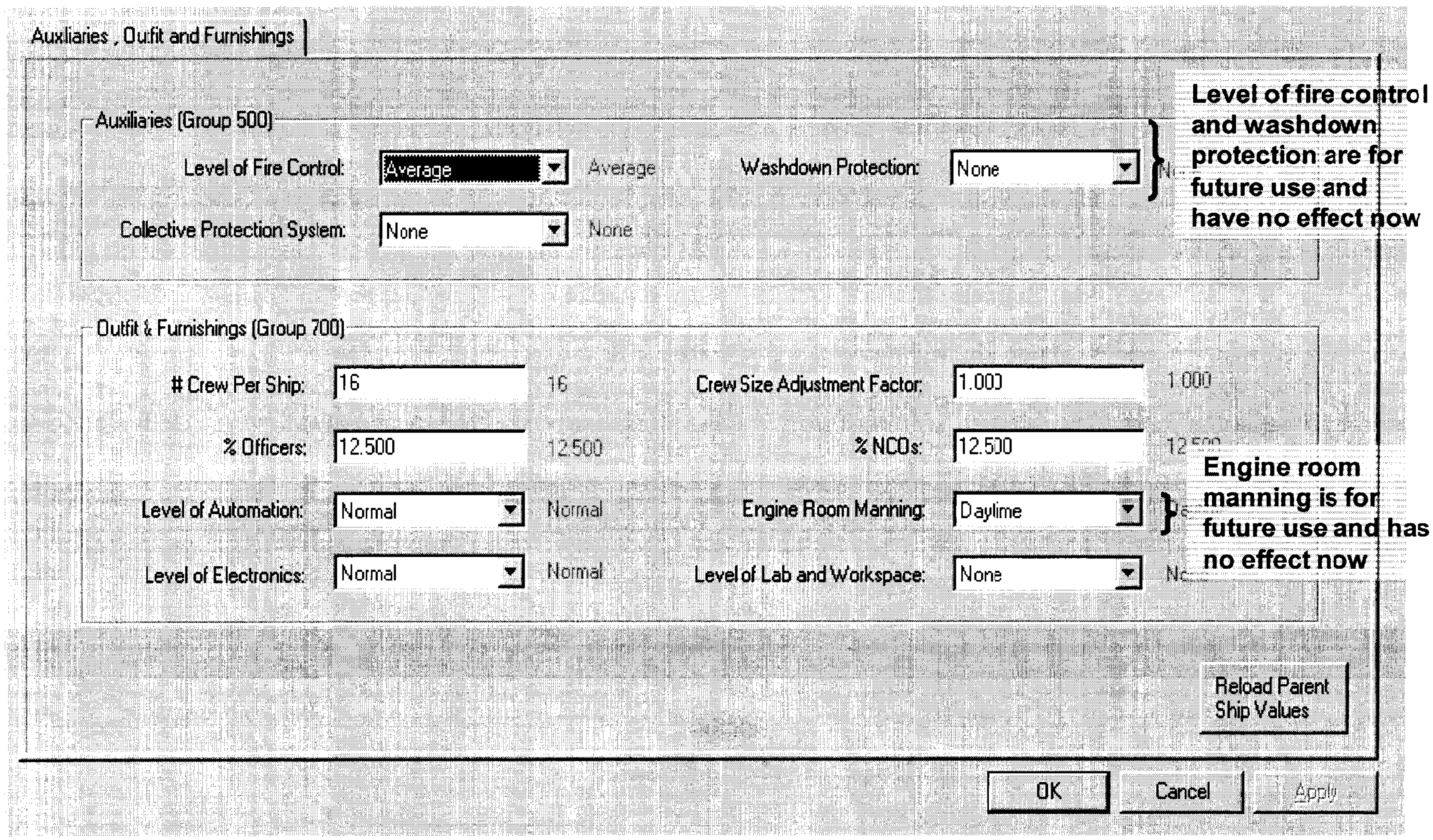
MISSION PAYLOAD

- VLS CELLS
  - INPUTTING A NUMBER FOR VLS CELLS RESERVES DECK AREA, VOLUME AND WEIGHT FOR A MK41 VLS CELL
    - 3360 LB OF WEIGHT IS ADDED TO SWBS GROUP 720 FOR EACH VLS CELL, BUT THIS WEIGHT IS ONLY USED FOR CG CALCULATIONS!
    - THUS, THE USER MUST ALSO INCLUDE THE TOTAL WEIGHT OF VLS CELLS IN THE "ARMAMENT WEIGHT" INPUT TO CORRECTLY REFLECT THE WEIGHT OF VLS CELLS IN THE FULL-LOAD WEIGHT OF THE SHIP

MISSION PAYLOAD (CON'T)

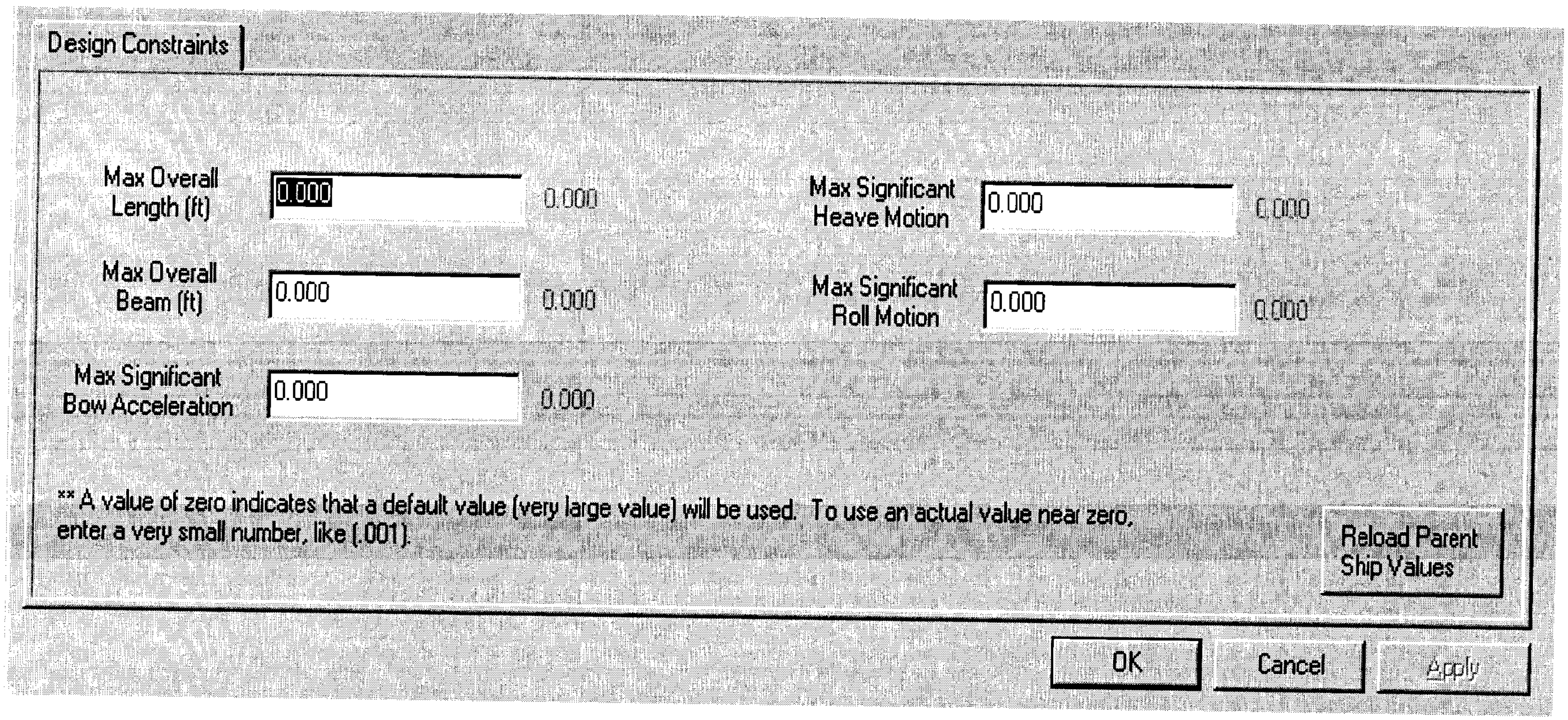
- CARGO
  - CHECKING THE BOX FOR CARGO HANDLING SYSTEM WILL ADD A NOMINAL WEIGHT TO GROUP 500 WHICH IS DEPENDENT ON SHIP TYPE

AUXILIARY, OUTFIT AND FURNISHING PAGE



DESIGN CONSTRAINTS PAGE

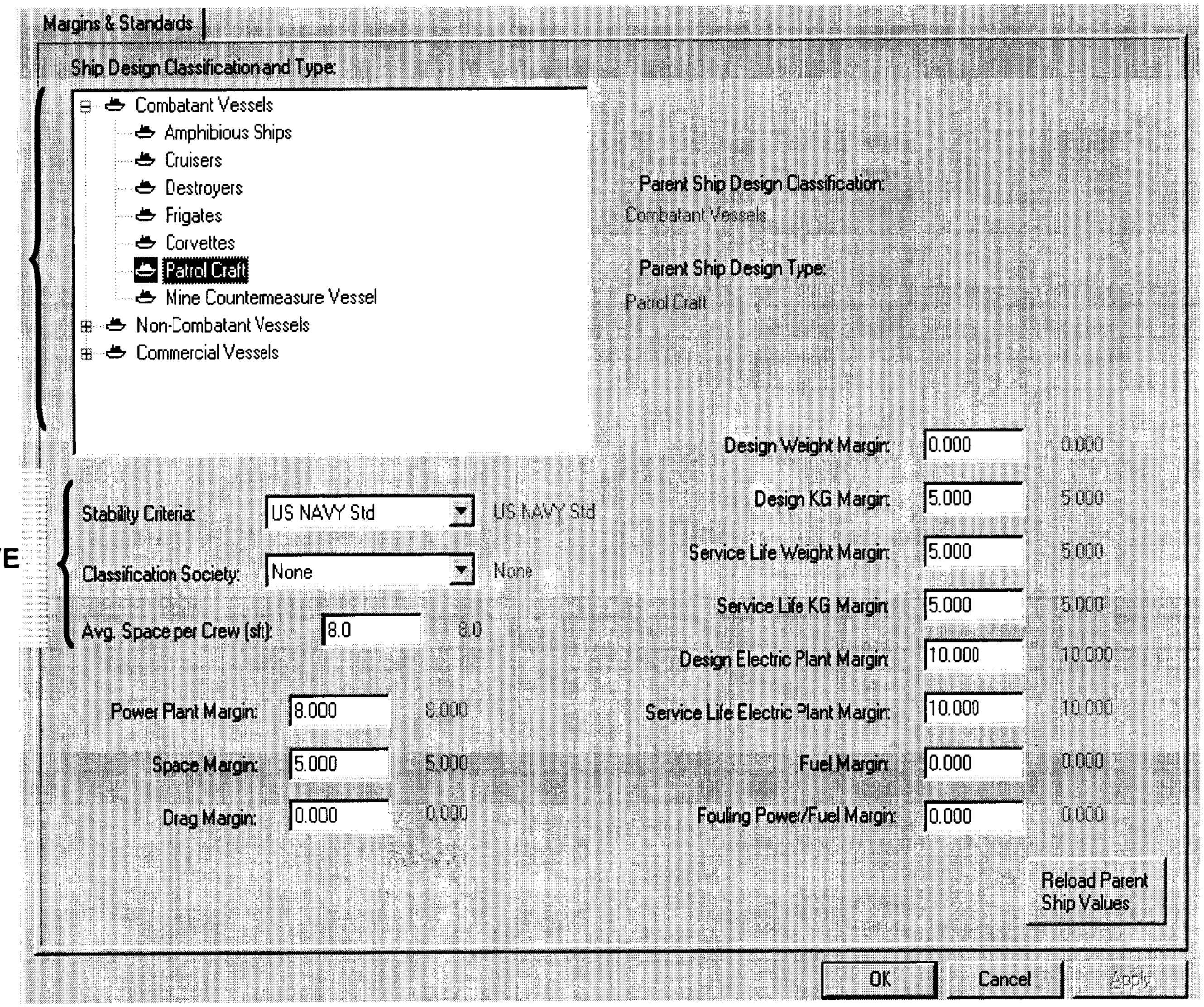
THIS PAGE IS IDENTICAL TO THE CORRESPONDING EXECUTIVE USER FORM AND IS USED TO CONSTRAIN THE SELECTION OF THE OPTIMUM DESIGN THAT PASS SELECTS FOR A PARAMETRIC RUN



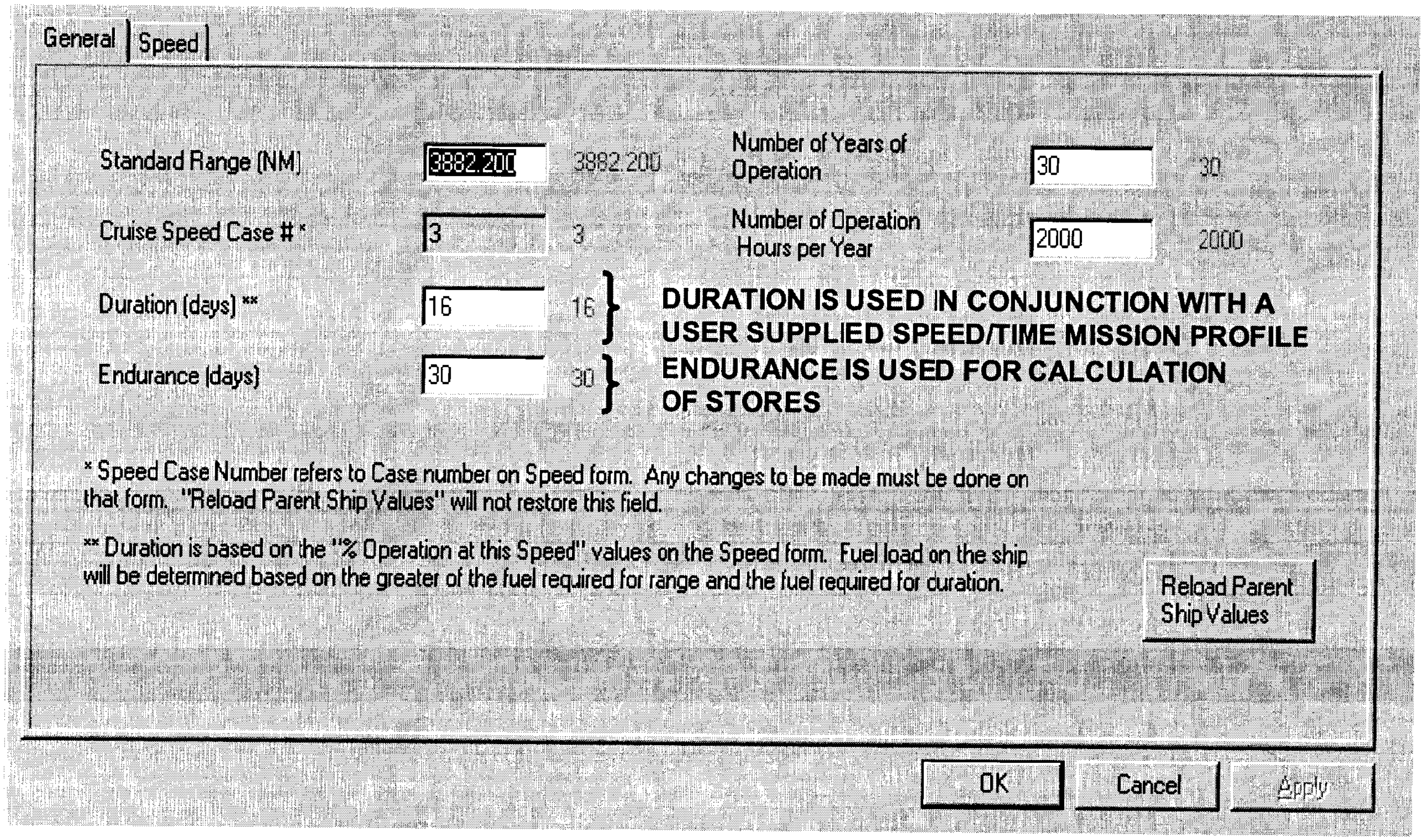
DESIGN MARGIN AND STANDARDS

THIS TREE VIEW DIALOGUE CAN BE USED TO CHANGE THE TYPE OF SHIP AND THUS, THE DESIGN STANDARDS AND ASSUMPTIONS (I.e. CHANGE A COMBATANT TO A COMMERCIAL FERRY)

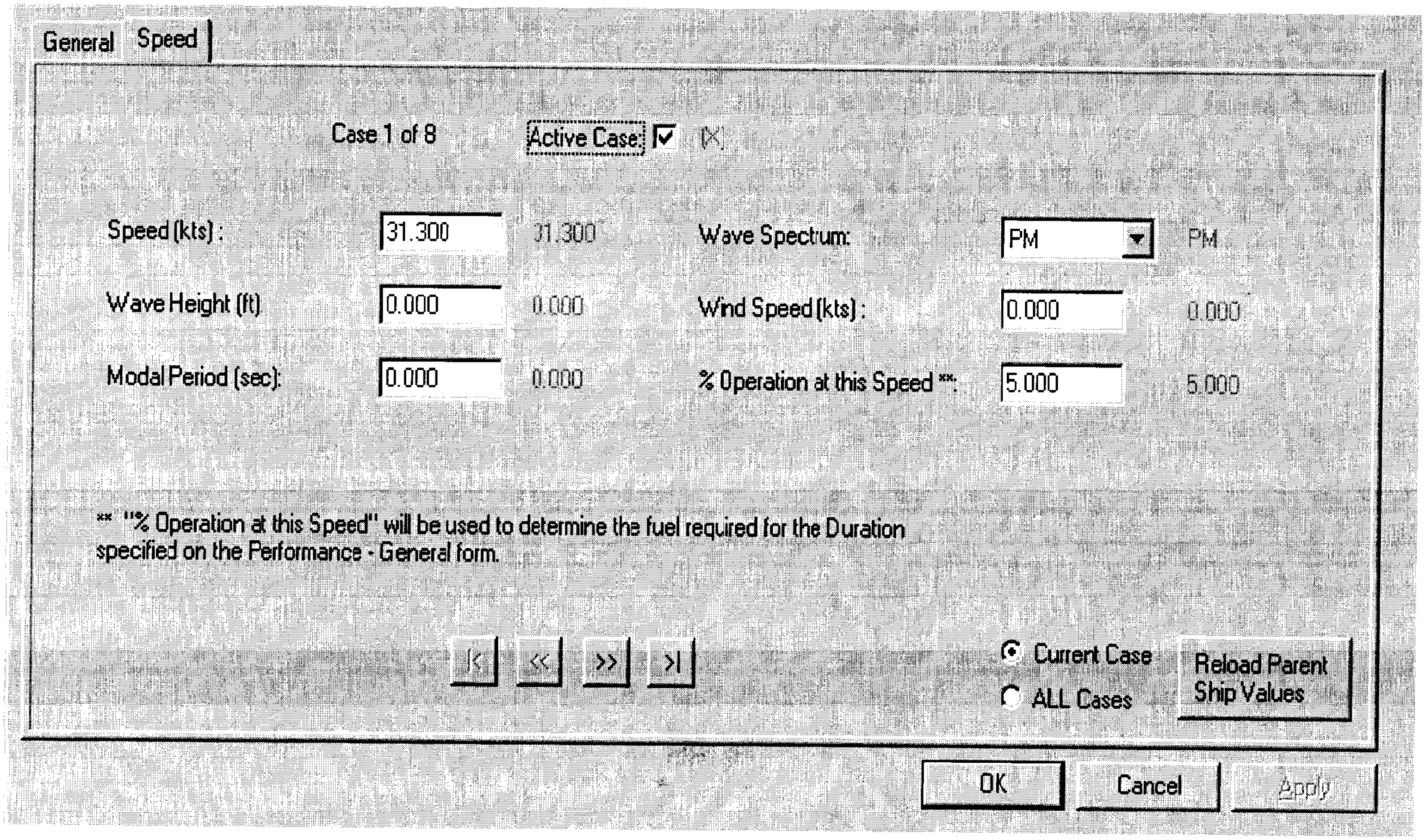
THESE THREE ELEMENTS ARE FOR FUTURE USE AND HAVE NO EFFECT AT THE PRESENT TIME



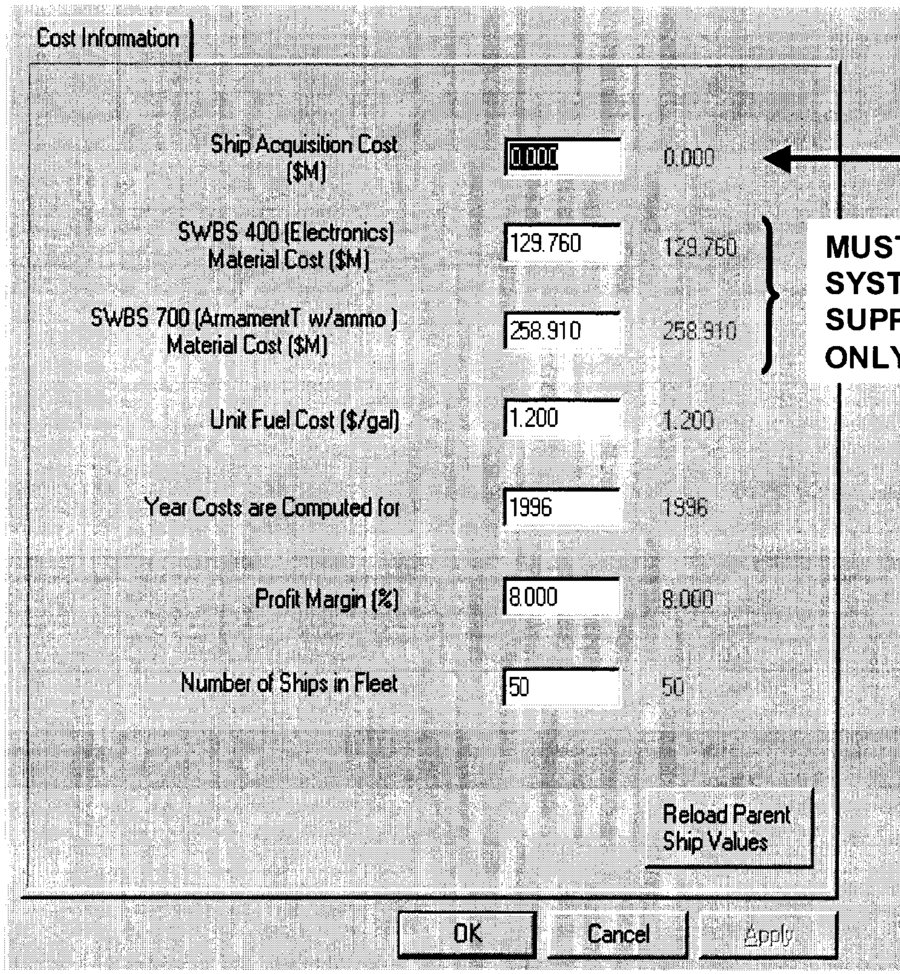
PERFORMANCE REQUIREMENTS, GENERAL PAGE



PERFORMANCE REQUIREMENTS SPEED INPUT PAGE 1 OF 8



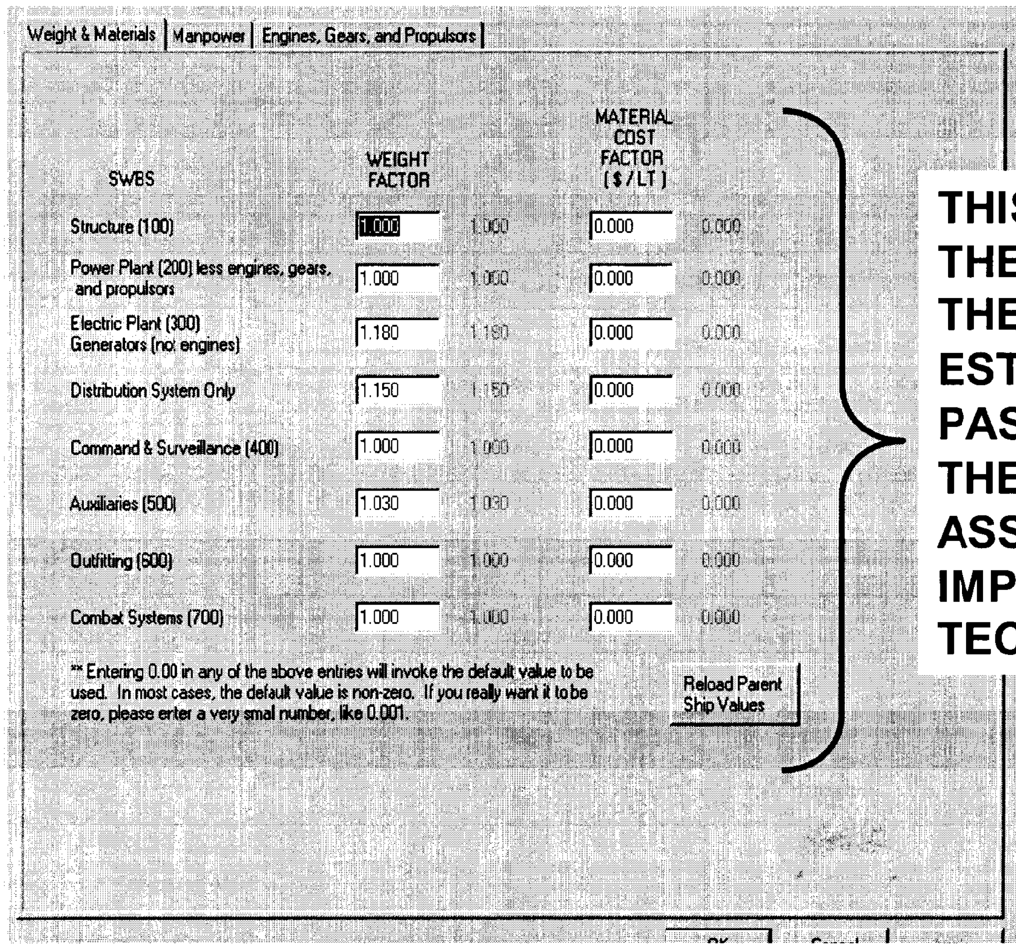
COST INPUT PAGE



USED TO OVERRIDE PASS CALCULATION OF ACQUISITION COST

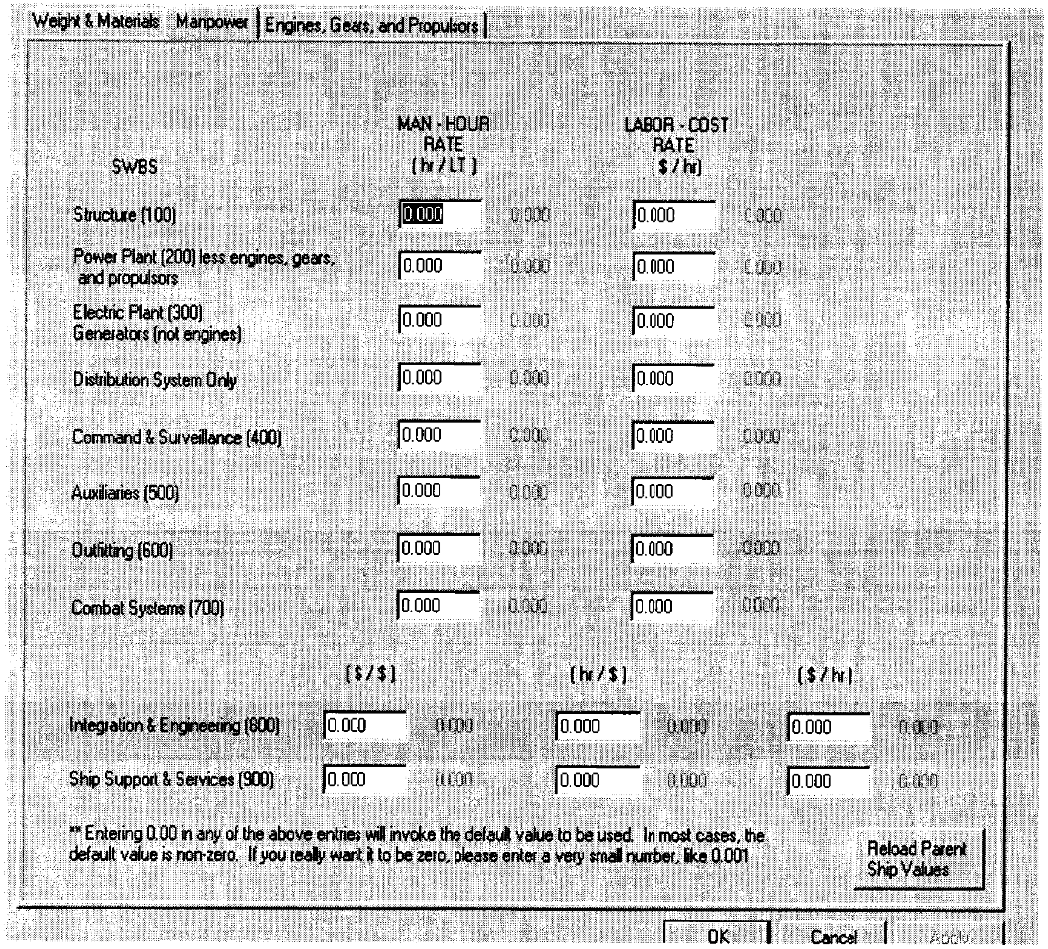
MUST BE SUPPLIED TO REFLECT COST OF COMBAT SYSTEM IN TOTAL ACQUISITION COST. IF NOT SUPPLIED, CALCULATED ACQUISITION COST WILL ONLY BE PLATFORM COST

WEIGHT AND COST ADJUSTMENT FACTORS, WEIGHT AND MATERIAL PAGE



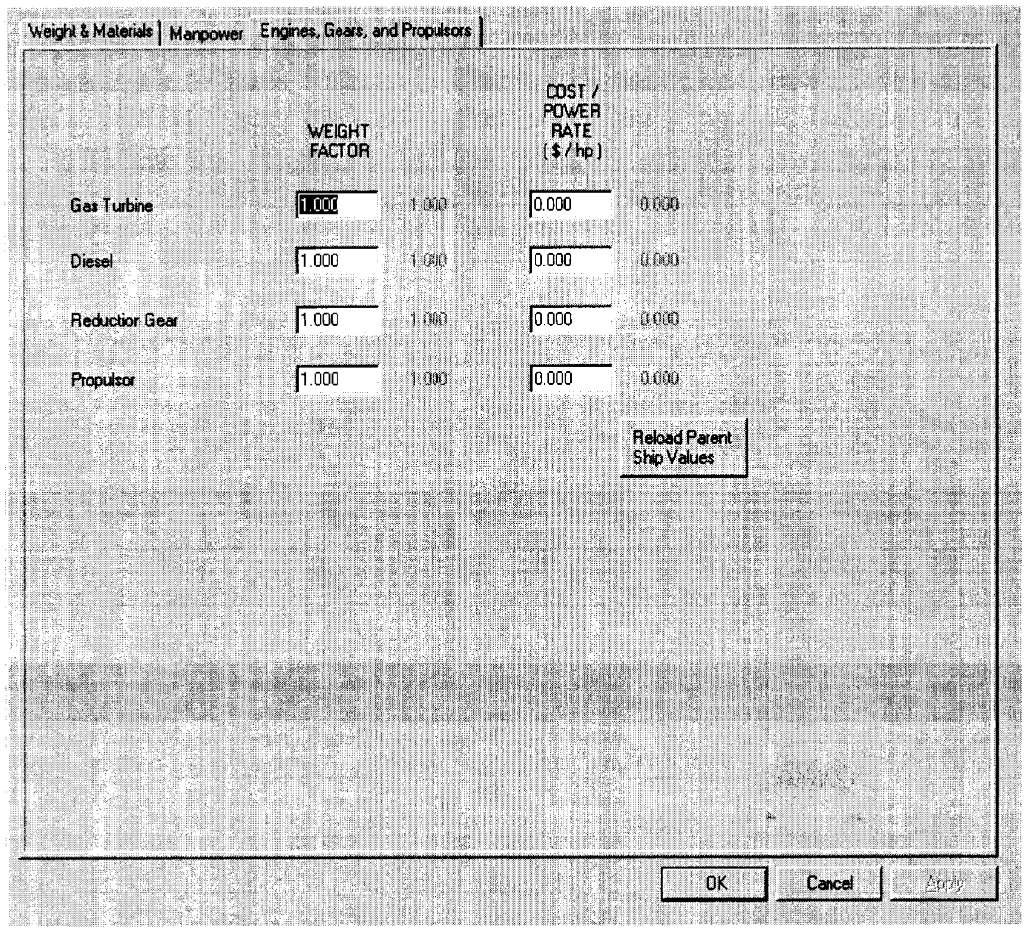
THIS PAGE IS USED TO MODIFY THE RESULTS OBTAINED FROM THE WEIGHT AND COST ESTIMATING ROUTINES IN THE PASS SYNTHESIS ENGINE. THEY ARE USEFUL FOR ASSESSING THE WHOLE SHIP IMPACT RESULTING FROM NEW TECHNOLOGY

WEIGHT AND COST ADJUSTMENT FACTORS, MANPOWER PAGE



THIS PAGE IS WHERE THE USER WOULD INPUT THEIR OWN LABOR COSTS INCURRED IN THE PRODUCTION OF A SHIP. THEY ARE FREQUENTLY USED TO REFLECT THE LABOR COSTS ASSOCIATED WITH A PARTICULAR SHIPYARD OR GEOGRAPHIC REGION

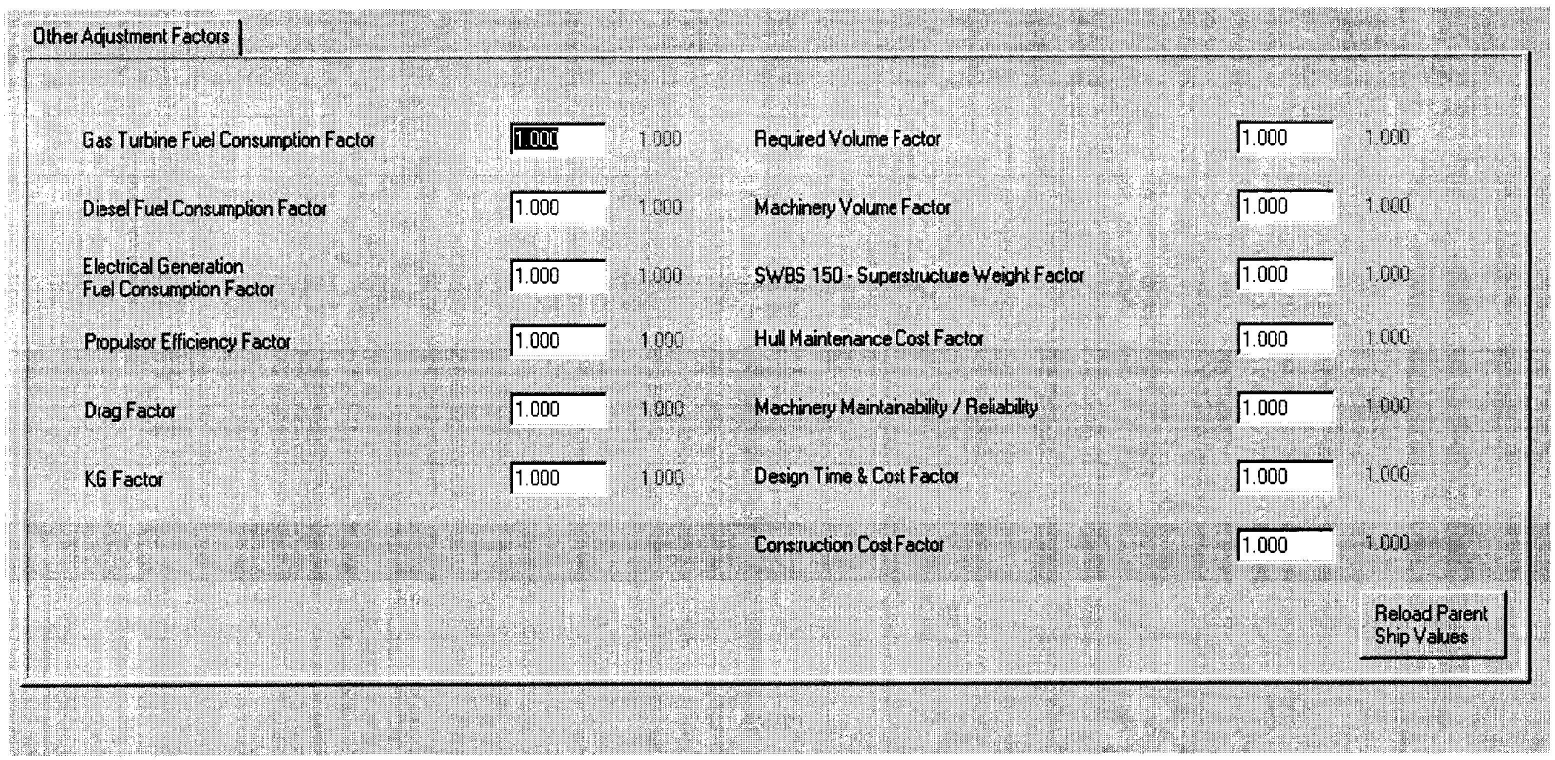
WEIGHT AND COST ADJUSTMENT FACTORS, ENGINES, GEARS AND PROPULSORS



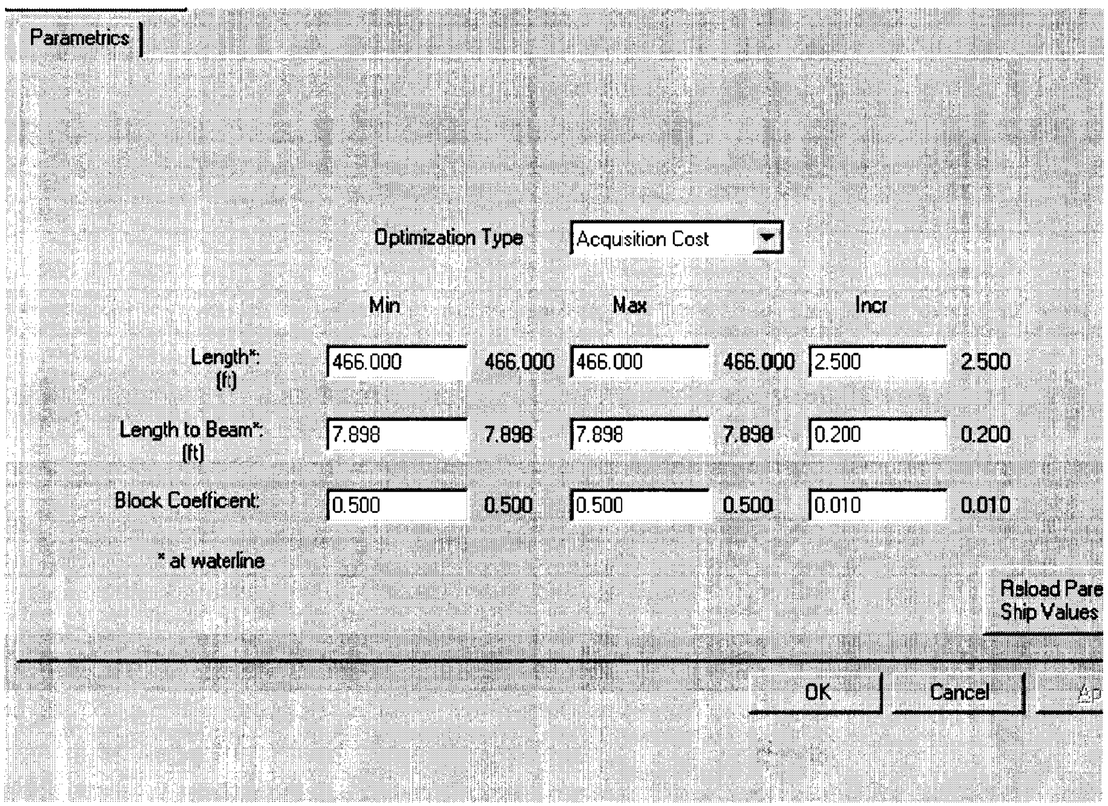
THIS PAGE IS USED TO OVERRIDE THE WEIGHT AND COST ESTIMATING RELATIONS FOR MAJOR PROPULSION MACHINERY. THEY ARE USEFUL IN EVALUATION NEW TECHNOLOGY

OTHER GENERAL ADJUSTMENT FACTORS

THIS PAGE INCLUDES ADDITIONAL ADJUSTMENT FACTORS TO TECHNOLOGY SPECIFIC ITEMS SUCH AS ENGINE SFC, SHIP DRAG, VOLUME REQUIREMENTS AND MACHINERY MAINTENANCE.



PARAMETRIC ANALYSIS PAGE



THIS IS THE PAGE WHICH CONTROLS THE NUMBER OF SHIP DESIGNS THAT ARE EXAMINED DURING EACH SEPARATE RUN OF THE PASS SYNTHESIS ENGINE. THREE DEPENDANT TERMS CAN BE SIMULTANEOUSLY EXAMINED DURING A PARAMETRIC ANALYSIS. FURTHERMORE, THE OPTIMIZATION PARAMETER AND THE NUMBER OF HULLS ARE CONTROLLED BY THIS PAGE

5.0 PASS TUTORIAL

5.1 Introduction

The baseline DDG51 in the PASS database is used in all the examples in this tutorial. It was compiled by the PASS developers through publicly available data sources. It may differ slightly from the real DDG51 of the U.S. Navy. However, the purpose here is not to reproduce the real DDG51, but rather to show you how PASS can be used for concept exploration.

First, we are going to run the baseline DDG51 without changing anything to demonstrate to the user how to run PASS and to highlight some of the basic PASS concepts.

In the second example, we are going to make some changes in the propulsion machinery of the baseline DDG51 by selecting a CODAG power plant. This is to illustrate how and why you may want to change a subsystem and how design requirements affect ship system design.

In the third example, we will evaluate the impact of a waterjet propulsion system on the whole ship design as opposed to the baseline's propeller system. You will see that a change in one subsystem may require subsequent changes in other subsystems. You will also learn how to troubleshoot when something goes wrong and be given general guidance to reduce the chances of problems.

In the fourth example, we will do some simple parametric variations. We will observe the process of platform optimization in PASS, what can be expected, and how to view and interpret the results. We will also see some limitations of PASS, why human interaction is needed, and how the engineering experience of the user is helpful.

5.2 Run PASS Through the Baseline DDG51 Design (Example 1)

This first example shows, among other things, how to run PASS, how it works, and how to view and manage its output data. Many important PASS concepts are also introduced in this section as they are encountered.

If you have previously used PASS, you may want to skip this section. However, it may be beneficial to the understanding of the examples that follow if you quickly review this example.

(1) Create a sub-directory to store the output files:

When you first installed PASS, you were asked to designate a directory (or folder) for PASS to reside in. If you did not specify, PASS resides in C:\programs\PASS by default. All the files generated by PASS will be in this directory. Unless you create a separate subdirectory, these files will be over-written every time you run the PASS synthesis engine. In order to save useful output data, you need to create a separate subdirectory for each of your designs and move all the PASS generated files from C:\programs\PASS (or wherever you specified) to this separate subdirectory (which we will call "the PASS working directory") once your design is finalized.

For the baseline DDG51, create a subdirectory (folder) named ***DDG51_baseline*** under the PASS directory, i.e., C:\programs\PASS.

(2) Start PASS:

In Windows 95, 98 or NT, you can run PASS from the ***Start*** bar under ***Programs***. If PASS is not put in your ***Programs***, you may run PASS by double-clicking the PASS icon from ***Windows Explorer***. In the PASS start-up window, check the ***Stop Wizard From Running at Startup*** (if you do not want to use the PASS Wizard) box and hit OK. This brings you to the PASS working window.

PASS has two running modes: ***Executive Mode* and *Expert Mode***. The executive mode offers only limited access to the input parameters. In expert mode, you are able to modify all the input information. Let's identify ourselves as experts: under main menu ***User Classification,*** click ***Expert User*** and make sure that it has a check before it. If you are too modest to call yourself a ship design expert, do not worry. When PASS was first designed, the goal was not only for naval architects but also for those less experienced to be able to use it successfully. However, if you are trying something that you are not quite sure about, you will face a higher risk of PASS returning unrealistic results.

In this tutorial, you may experience occasions where PASS is not running properly or not working at all. You will learn what to do if this happens.

(3) Select a model or baseline ship:

To facilitate the input preparation and relieve the burden of knowing every aspect of ship design, PASS has a collection of existing designs in its database ranging from surface combatants, paramilitary ships and commercial ships. This ***PASS Database*** is actually a Microsoft ACCESS file (default name: ship_def.mdb), which is, by default, in the PASS working directory. You can select a design model from the PASS database as your baseline or parent ship. You are not allowed to change any data in the PASS database file. PASS will save, or you may instruct PASS to save, your modified or created design in the ***Customer Database***. The customer database is also a Microsoft ACCESS file (default name: ship_cust.mdb; default directory: working directory) of exactly the same database structure as the PASS database.

You can view or change the database path and file name for both the PASS database and customer database. Under main menu ***Utility Features***, click ***Database Path Utility.*** You may then specify the path and file name for either database file. We will use the defaults throughout this tutorial. So, click ***Cancel*** and return to the main menu.

To view the database, click main menu ***File*** and then ***Open*** and a dialog box pops up. In the ***Ship Database*** combo box, choose ***PASS***. The tree structure of the PASS database opens up. You can click around to see the various PASS design models under different ship types and subtypes. We are going to work with DDG51. Click ***Combatant Vessels*** and then ***Destroyers,*** and you will see four baseline designs under this category. Choose ***DDG51*** and click ***OK.*** Now you are in the main menu again. You will notice ***The Active Ship Class is DDG51 using the PASS Database*** in the title bar of the main menu window. This reminds you that your baseline or starting point is DDG51 from the PASS database file.

(4) Surfing PASS input forms:

Input to PASS is done through input forms. There are 14 input forms under main menu ***Expert Input Forms***. Most of them have multiple tabs. ***Hull***, for example, has two tabs: ***Hullform*** and ***Appendages***. Under ***Hullform,*** there are 15 input parameters. Each has a text description, an edit box for inputting new values, and a static text box showing the value of the baseline ship. For parameters which have just a few options, all the options are listed in a combo box for you to choose from. ***Freeboard at Bow,*** for instance, could be ***Ocean*** standard, ***Coastal*** standard, or ***Specified Value***. For the first two options, PASS will calculate the value based on the standard. If you choose to specify a value, another parameter input box pops up for you to input your value.

For your input to be recorded, you need to click the ***OK*** or ***Apply*** button at the bottom of each form. If you cannot see these buttons, scroll the form/tab down or to the right. If you click the ***Cancel*** button, none of the changes you made in this form will be recorded. If you do not want to keep the changes you made in a particular form, go back to that form and click ***Reload Parent Ship Values***, which will cause all the parameters inside all the tabs of this input form to reset back to the baseline ship input values. Note that this ***Reload*** command only applies to the open form on your screen. Finally, click ***OK*** or ***Apply*** for them to take effect.

In addition to edit boxes and combo boxes, check boxes are also used for parameters with only two options: ***Yes or No***. If you do not want a bilge keel, for example, you can uncheck the ***Bilge Keel*** check box inside the ***Appendage*** tab. An edit box is used for ***Bulbous Bow***, even though it also has only two options, to allow more options to be added in the future to reflect more specially designed bulbous bows. Some of the inputs are inter-dependent. If you choose ***No Bulb***, for example, you will have the option to choose a ***Sonar Dome***. If you choose ***Regular Bulb***, however, PASS will assume that you can put your sonar (if any) inside the bulbous bow and the ***Sonar Dome*** check box disappears.

You can surf through other input forms and their tabs, but remember that we do not want to change any input yet. If you do change any DDG51 inputs from the baseline, PASS will ask if you want to save the changed model to your customer database before it runs. Use ***Cancel*** or ***Reload Parent Ship Values*** on each form so as not to record any changes you may have made. Alternatively, you can re-open DDG51 and choose NOT to save the current ship if asked to.

(5) Run the PASS design engine:

Now you have an idea how PASS input is edited and are ready to run the PASS design engine. From main menu ***Run***, choose ***PASS***. If you followed the above steps and PASS was installed properly, the PASS design engine should run without a problem. When the PASS engine runs, it opens a temporary DOS-look status window (buffer window) to let you know that the PASS design engine is running.

The PASS design engine requires a <u>**hardware lock**</u> to run. If you do not have that, it will not run and you need to contact Band, Lavis & Associates, Inc. (see Section 2, Technical Support).

Once the run completes, PASS will return to its initial (blank) screen.

(6) View PASS outputs:

PASS presents its output in three different modes, all available under main menu ***Output Data***. The first mode is ***Output Data Forms*** in which the summary of output data is listed in eight tabs together with the baseline data as comparison. In our present example, nothing has been changed. The data under the ***Current*** column should be the same as that under the ***Parent*** column, in which case the ***Changed*** column should be empty. If differences exist for a particular parameter between the ***Current*** and ***Parent*** (baseline) model, the corresponding spot in the ***Changed*** column will be checked.

The second mode of presenting the output is graphics. In order to use the graphics output, you need to have a <u>**special graphics license**</u>. This license is different from the PASS hardware lock. Without the graphics license, you will not be able to view the output graphically. However, this does not affect any other functions of PASS.

The third way of presenting PASS output is through various output files. PASS generates 16 ****.out*** files. ***Current.out*** is the general output file of PASS containing most of the important output with regard to geometry, structure, machinery, drag, propulsion, auxiliaries, outfitting, arrangement, stability, fuel consumption and seakeeping. PASS provides a text viewer to view all of these files, but you may use any other text editor or word processing software to view, edit or import these files into a report or spreadsheet.

(7) Store PASS output files:

Now you have successfully designed the baseline DDG51 using PASS and you have the 16 output files generated by PASS for this design. If you continue to do another design or modify DDG51, you will lose all the outputs for the baseline DDG51 (files will overwrite) if you do not store them somewhere else. You should move or copy them to the subdirectory ***DDG51_baseline*** you created in step (1) above. You may need to exit PASS if you choose to "move" these files instead of "copy" them to the desired directory.

53 Design DDG51 With a CODAG Power Plant (Example 2)

This example shows how to use PASS to redesign the power plant of DDG51. It illustrates what you would need to do and what you may expect if you want to create a new subsystem design.

(1) Review the baseline DDG51 power plant configuration:

The baseline DDG51 has two identical shafts with variable pitch propellers. Each shaft is driven by two gas turbines, each of 26500 HP. It has a total of four gas turbines and no diesels. The gas turbines are designed for the first speed case, i.e., 31.3 knots. You can view all this information by opening the baseline DDG51. First, go to the tabs in the ***Propulsor*** form. then the tabs in the ***Power Plant*** form, both under main menu ***Expert Input*** forms.

In this example, we are going to change the above power plant to a CODAG configuration. There will be two gas turbines and two diesels. All four engines will run to propel the ship to 31.3 knots. At 20 knots, the two gas turbines are shut down and only the two diesels will run.

(2) Review the performance requirements:

All the performance requirements are on the two tabs in the ***Performance Requirements*** form. DDG51 needs to run a ***Standard Range*** of 3882.2 NM without refueling at ***Cruise Speed,*** which is specified by ***Speed Case 3***. The other requirement is to carry enough fuel to run a ***Mission Profile*** of 16 days ***Duration***, 5% of which is running at 31.3 knots, 25% at 20.0 knots, 45% at 10.0 knots and 25% anchored at 0 knots. The more demanding case of the two (standard range or mission profile) will determine the amount of fuel the design has to provide. ***Endurance*** determines the amount of fresh water, food and stores the ship has to carry in order to support its crew for the specified number of days.

The speeds and mission profile percentage at each speed are specified on the ***Speed*** tab. You can use the **>>** button to view/edit the next speed case or **<<** button to view/edit the previous speed case. If the ***Active Case*** box is not checked, that particular speed case will be ignored by PASS and its mission profile percentage will not be counted. Speed case 1 is always the highest speed and has to be active. The cruise speed has to be checked as well. The sum of mission profile percentages of all the active speed cases has to be 100%.

For DDG51, the speed cases and mission profile are summarized in Table 5-1. For our CODAG design, we will use the same performance requirements.

Table 5-1

DDG51 Mission Profile

Speed case	1	2	3, cruise	4	5	6	7	8
Active or not	Yes	Yes	Yes	Yes	Yes	Not	Not	Not
Speed in knots	31.3	29.9	20.0	10.0	0.0	0.0	0.0	0.0
% Of operation	5%	0%	25%	45%	25%	0%	0%	0%

(3) Changing the power plant configuration to CODAG:

Go to the ***General*** tab of the ***Power Plant*** form, change the ***Number of Engine Types*** from 1 to 2, and change the ***Propulsion Plant Type*** from ***Combined/Or*** to ***Combined/And***.

Then go to the ***Main Engine*** tab, change the ***Specified Engine Unit Power*** to 0.0, and change the ***Number of Engines*** from 4 to 2. Setting the specified engine unit power to zero allows PASS to size the gas turbine based on power requirement.

Next go to the ***Auxiliary Engine*** tab, choose ***Diesel*** as the ***Auxiliary Engine Type***, ***Rubber*** for sub-type, 0.0 for specified unit power, 2 for number of engines, and 3 for speed case.

You have finished the necessary data input for a CODAG. Check the ***OK*** button to record all your changes. To make sure that your changes have been incorporated, go back to the tabs to double-check every entry.

(4) Run the PASS design engine:

You will be asked if you want to save the current design or not. We do want to save it. Choose ***yes*** and you will be prompted to give it a name. We will use "DDG51_CODAG" in this example. PASS will automatically put it under ***Destroyers, which*** is, in turn, under ***Combatants*** in the customer database. Click ***OK*** and the PASS design engine will run automatically.

In a successful run, PASS writes all the results into the output files. However, none of the results is recorded into the database yet. In both the input tabs/forms and the output data forms, the parent ship data is still that of the baseline DDG51. This is fine if you want to keep the comparison of the new design with the baseline. However, you may want to add a memo to the database to remind yourself in the future how the DDG51_CODAG design was developed. You can do so through ***Edit Memo*** under main menu ***Ship Features***. You may also change the name for this design. By doing so, you will modify the present DDG51_CODAG design. Use ***File Save*** to record these changes or you will be reminded to do so. Since the present design is considered as being modified, all the output in the ***Current*** column of the output data forms is flushed out and you need to re-run the PASS design engine. This happens every time you make a change through main menus ***Expert Input Forms, Executive Input Forms*** or ***Ship Features***.

If you want to record the DDG51_CODAG summary output into the database and use it as a parent ship in the future, you need to do ***File Save*** after a successful run of PASS design. PASS will ask you if you want to save it as a parent ship. If yes, all the parent ship data will be changed to that of the DDG51_CODAG. In the rest of this example, we still want to use the baseline DDG51 as the parent ship for the purpose of comparison, so click ***No***.

(5) Compare the CODAG design with the baseline DDG51:

Now go to the output data forms where you will see clearly the results of the CODAG design in comparison with the baseline. Changes are marked by blue checks. You will see that there have been several improvements: the displacement is down, so are the acquisition cost and the life cycle cost. How did this happen?

To view more detailed results, you need to go into the output files. Let us first create a new directory for the CODAG design and copy all the ****.out*** as well as ***current.dat*** into it. Using your favorite text viewer or editor, open the two ***current.out*** files (one from the baseline directory and the other from the CODAG directory).

Search for the string ***Lightship*** in both files. You will see the lightship weight of the CODAG is actually heavier than the baseline. However, the ***wloads*** (the total F00 group) of the CODAG is much smaller. To see the breakdown of the F00 group, search for the string ***F00*** and you will be brought to the F00 output section. All the loads are the same except for F40, which is the fuel load. The fuel load required by the CODAG design is much less than that required by the baseline design. Why is this?

The ***Drag*** section indicates that the drag of the CODAG design is a little bit less than that of the baseline because of the smaller displacement and shallower draft. The main reason for the significant reduction in fuel consumption lies in the more efficient use of the diesel engines at 20 knots. This speed case is very special because it is the cruise speed case and makes up 25% of the mission profile. In the ***Propulsor*** section, you will find that the total power required at 20 knots is close to 14000 HP (or 7000 HP each shaft) in both cases. For the baseline, it is provided by two gas turbines, each providing less than 7000HP, while their MCP is rated at 26500 HP. For the CODAG design, it is provided by two diesels, each providing less than 7000 HP running at 80% of their MCP (there is a 20% power plant margin). Engine rated power is in the ***Main Engines*** section. Because the diesels are operating around their optimum point, their specific fuel consumption is much better than the large gas turbines which are running at less than 30% MCP. The fuel consumption at different speed cases is listed in the ***Performance at Full Load Displacement*** section.

We have constructed the above example to show how to use PASS to modify a subsystem. To reach a conclusion on the merits of CODAG on DDG51 needs more careful study and a thorough investigation of every aspect. PASS, utilized by experienced personnel, would be a perfect tool for this purpose.

This concludes our example of DDG51_CODAG. For further practice, you may wish to design a CODOG power plant for DDG51. You could also use ***Rubber*** gas turbines instead of ***Step Increase***.

5.4 Design a DDG51 With Waterjet Propulsion (Example 3)

This example demonstrates the use of PASS to redesign the propulsion system of DDG51. You are strongly advised to go through the previous tutorial ***Design DDG51 with a CODAG Power Plant*** before you begin this example. Many baseline DDG51 propulsion and mission requirements are discussed in the previous example and are omitted herein.

In this example and the following example, we assume that you are already familiar with the PASS input forms and you are able to find the locations where changes will be made.

(1) The minimum changes you need to make for designing a waterjet:

Designing waterjets and pumps for DDG51 is no small effort. PASS is not going to design a pump or jet for you, at least not yet. What PASS is capable of doing is using existing waterjet technologies or reasonable projections (extensions) of existing technologies to predict the impact of possible systems on the whole ship system. The success of such a system also requires proper system integration, which involves work such as redesign of the aft hullform and transom to accommodate the inlet duct and nozzle outlet and optimization of the aft body flow. PASS does not go into details on all of these. What PASS assumes is a reasonable hull design for such a propulsion system.

In light of this, "designing" a waterjet system using PASS is relatively easy. Starting from the baseline DDG51, let us first simply change the ***Main Propulsor Type*** from ***Propeller*** to ***Waterjet*** (go to ***Main Propulsor*** tab in the ***Propulsion*** form) and then run PASS. The result is not so good: the total displacement is almost 50% more than the baseline.

(2) Some rudimentary troubleshooting:

What went wrong?

It turns out that it takes a little bit more than one change to properly design a waterjet propulsion. Go back to the ***Main Propulsor*** tab in the ***Propulsion*** form where you will see that the ***Propulsor Diameter*** has been fixed at 17.0 ft, which is carried over from the baseline propeller diameter. What is ***Propulsor Diameter*** for a waterjet? You can find this out from the tool tip for this parameter. The tool tip will come up if you put the cursor on the corresponding edit box. The tool tip can be turned off by unchecking the ***Tool Tips*** under the ***View*** menu. If the tool tip does not pop up, you should check that. For a waterjet, ***Propulsor Diameter*** means the ***Inlet Diameter*** and 17 ft is too large. Let us vary it from 5.0 ft to 11.0 ft by increments of 0.2 ft. Let us also vary the ratio of nozzle diameter over inlet diameter from 0.55 to 0.75 by increments of 0.01. Now run PASS and you will note that this time the total displacement is only about 2% less than that of the baseline.

Unless you are extremely versed at using PASS and you have very good knowledge of all aspects of ship design, situations like the above where PASS produces unrealistic results are possible, especially when you are trying something new and are unfamiliar with it.

To avoid making PASS produce unrealistic results, observe the following general rules:

- Choose the closest design in the database as parent ship.
- Understand the parent ship design, its geometry, subsystems, mission requirements, margins, adjustment factors, etc.
- Identify the parameters, systems or components you want to change. Understand and predict as much of the subsequent modifications required and their consequences as possible. For example, if you change the propulsor type, you need to check whether or not its sub-type is what you want, whether or not you need to specify its size, and whether or not you need to modify the geometry to accommodate a new system. If you are not sure about all the parameters that may be relevant, browse all the forms and tabs that may be related to a specific change.
- Modify one variable at a time. Do not run parametrics with unproven changes. Make one specific change (together with its required inter-dependent changes) at a time, and run PASS to see if it gives “believable” results.
- Consult an expert if you still have problems. You can also contact the program developer:

Band, Lavis & Associates, Inc.
Attn: Brian Forstell
Email: brian.forstell@cdicorp.com
Phone: (410) 544 2800
Fax: (410) 647 3411

When you contact Band, Lavis & Associates, Inc., please provide your input file and other information such as what you are trying to do and what went wrong. You do not need to send the customer data base file which contains all your present and past designs. You can generate a flat input file for a particular design. To do so, go to ***Utility Features*** and ***Export Ship to File***.

(3) Change the stern to improve the design:

Next, we are going to change a couple of geometry parameters to better accommodate the waterjet propulsion system. First, change the ***Transom Draft Ratio*** from 0.1 to 0.4. ***Transom Draft Ratio*** is on the ***Hullform*** tab under form ***Hull***. The other change is to increase the block coefficient from 0.484 to 0.494. ***Block Coefficient*** is on the ***Parametrics*** form. These aft body geometry changes bring the total displacement down about 1% by lowering the wave making drag.

(4) Browsing and comparing the results of the new design:

There may be other possible improvements to this waterjet version of the DDG51 design, but we will stop here and store all the output files to a separate directory. Compared with the baseline DDG51, you will find that the SWBS 200 group weight of the new design is about 300 LT more than the baseline. This is caused partly by the extra large size of the waterjet units. Each waterjet unit weighs around 137 LT, including the reversing and steering units, while each propeller in the baseline design weighs only 38 LT, not including the rudder. The gearbox and shaft weight are smaller due to a lower speed reduction ratio and a shorter shaft. The SWBS 290 group weight is much higher than the baseline thanks to the entrained water, which does not exist in the propeller propulsion system. The inlet size of the waterjet is 9.6 ft (293 cm), which is much larger than the biggest pump presently on the market. However, the SWBS 500 group weight is smaller than the baseline due to the absence of rudders in the waterjet design. The SWBS 100 weight is expectedly higher since the ship is larger.

For further practice, you may try 4 waterjet units, 2 smaller ones to drive the ship at 20 knots and 2 larger ones to help drive it up to a top speed of 31.3 knots. Each smaller unit is driven by a smaller gas turbine, while each large unit is driven by a larger gas turbine.

5.5 Find the Optimum Design by Running the Parametrics (Example 4)

This example shows how to run parametric variations on key parameters to determine the optimum design to fulfill a set of mission requirements.

(1) Varying the waterline length of the baseline DDG51:

As in the previous sections, we will continue to use DDG51 as our baseline ship. In the baseline DDG51, the total propulsion power is specified as four gas turbines, each at 26500 HP. If the propulsion power is specified by the user, PASS will not change it even if the power required is more than provided, in which case PASS simply outputs a warning message. For the baseline DDG51, the PASS calculated shaft total power at top speed is roughly 89583 HP, while the provided power (with 20% margin) is only: 26500 *x* 4 / 1.2 = 88333 HP.

However, specifying power is not desirable in the process of optimizing the hullform. In order for PASS to calculate the total installed power for an engine, the ***Specified Engine Unit Power*** input for the engine has to be set to zero. In addition, set the ***Sub-type of Engine*** to be ***Rubber*** instead of ***Step-Increase***.

Next, go to the ***Parametrics*** form; make the length vary from 426 ft to 486 ft by increments of 5 ft and ***Run PASS***. Notice that the ***Optimization Type*** is presently ***Acquisition Cost***. It will run through 13 different waterline lengths and takes a little longer to finish the run. After it finishes, go to ***Output Data***, click ***Open Output File*** and open ***param.out***. You will see that a much shorter length (431ft) is chosen instead of the baseline's 466 ft. However, even though the 431 ft design has the lowest displacement, its acquisition cost is only marginally smaller than other designs, including the baseline, but its life cycle cost is actually higher than the baseline and a few other designs. More importantly, its power requirement is one of the highest, while the baseline requires the least. Actually, if you go back and choose ***Power*** as the ***Optimization Type***, the baseline design will be picked. This seems to suggest that the baseline DDG51 hullform was optimized towards minimum drag or power requirement, which is very likely.

(2) Varying all three primary parameters:

We will continue by varying the Lwl/Bwl and Cb in addition to the previous waterline length variation. Vary Lwl/Bwl from 7.498 to 8.298 in increments of 0.2 and Cb from 0.46 to 0.54 in increments of 0.02. Limit the maximum draft to 21 ft (on ***Hullform*** tab under form ***Hull***). We have 13 length variations, 5 Lwl/Bwl variations and 5 Cb variations. This will generate 325 different combinations or designs. Depending on the processing speed of your computer, it may take quite a while for PASS to go through all these designs. You may want to set it up to run overnight. Note that PASS limits the number of designs to 500 at a time.

It is possible for PASS to stall in one "bad" design doing endless design spirals without convergence. During a typical concept exploration using PASS, you are advised to start from a single combination of length, beam and block coefficient first. Make sure that all the subsystems work and all the geometric parameters, structural parameters, mission profile and design requirements are reasonable. Then do a few small size parametric variations as a test to determine the working range of parameters. Finally, if everything works well, go ahead with a final and full range parametric run.

For this example, there should be no stall and PASS should run through the parametrics successfully.

(3) Viewing the results of the full range parametric run:

PASS automatically selects the optimum design which satisfies the draft limit you specified (or other design limits you may have specified). In our example, a hullform more slender than the baseline is selected. It has the same waterline length (466ft) as the baseline design, but smaller block coefficient (0.48 vs. 0.50) and larger length/beam ratio (8.298 vs. 7.898). The total displacement is 3% less and the acquisition cost is 1% less than the baseline design.

A one-line summary for each of the 325 designs is compiled in the file ***param.out*** as well as a summary description for the selected optimum design. Other results for the non-selected designs are not recorded in the output. All that is shown in the output files and forms are the results of the selected optimum design. As you go through the data in ***param.out***, you will see that there are other designs that have lower acquisition cost, lower life cycle cost, lower total weight and/or lower total power than the selected design. These designs were kicked out because their drafts exceed the specified limit. If the maximum draft limit is relaxed or eliminated, the conclusion will certainly be different. An even smaller and more slender but deeper platform will be selected. The total displacement and cost will also be further reduced.

However, the user must put the results and conclusions in perspective. A practical design may be subject to other restraints and limitations that we did not put into PASS or that cannot be recognized by PASS. It is also possible that PASS' drag routine has a bias towards a more slender hull. In a real conceptual exploration, more human intervention and the acute engineering judgment of the user is important to achieve a successful application of PASS. The purpose here is simply to show how a typical platform optimization works.

You may also graphically view the results of a parametric run. PASS GUI provides a 3D visualization, called a "carpet" plot, showing the results of all the designs that have been explored. Go to ***Output Data***, choose ***Output Graphs and Charts*** and then click ***Carpet Plot***. You will have the option to plot (Lwl+Beam, Lwl+Cb or Bwl+Cb) vs. (Acquisition Cost, Life Cycle Cost, Total Power or Total Weight). You may also print the graphs into a file of CGM format and insert them into your reports.

6.0 PASS ALERT Message and No Solution Indicators

If you got a message that says "ALERT NO OPTIMUM FOUND. LAST CONFIGURATION RUN ALERT" on the Summary Page of the Output Data Forms, one of two things occurred. Either the design(s) failed to meet the required Intact Stability criteria, or the Design Synthesis Engine failed to reach a solution in one of the design modules. You can determine which of the above two cases occurred and develop a strategy to overcome the problem by reviewing the PARAM.OUT file. To do this, select **OUTPUT DATA, OPEN OUTPUT FILE**. This will automatically start the Microsoft Editor. The PARAM.out File is the default file name as can be seen on the line prompting you for the file name. Press the **OPEN** button to start the Microsoft Editor and open the PARAM.OUT file.

The top portion of this file contains columnar output for each design that was generated during the last PASS run. Two of the columns are labeled "SOL/STAB". The first of these columns, the "SOL" column contains a solution indicator. A value of zero in this column indicates that the Design Synthesis Engine reached a solution in all of the design modules. A non-zero integer value in this column indicates that the Design Synthesis Engine failed to reach a solution in one of the design modules. The "No Solution" indicators that PASS will generate are shown below:

0 Solution Found

1 The Maximum Draft that was specified on the **Hull, Hull Form** page under the **Expert Input Forms** has been exceeded. Either increase the maximum allowable draft or change the hull form geometry to increase hull volume.

2 The Prismatic Coefficient has a value which is greater than 1.0. Either increase the **Midship Cross-Section Coefficient** on the **Hull, Hull Form** page under the **Expert Input Forms** or reduce the **Block Coefficient** on the **Prismatic** Page.

3 The Geometry Design Module could not find a solution. You must modify the input data on the **Hull, Hull Form** page.

4 The Arrangement Routine could not find a solution. This is a rare error that is not expected to occur.

5 The propulsion routine could not find a solution. This error most frequently occurs when the user has over constrained the design of the propulsor (see the **Executive Input Forms, Propulsion System, Propulsion** page or the **Expert Input Forms, Propulsion and/or Power Plants** pages).

6 PASS could not converge on a solution after 50 iterations. This error usually occurs when the user has inputted a series of design requirements that are conflicting with each other. It is suggested that you relax all user specified requirements (particularly performance and payload requirements) until you no longer get the ALERT message. The systematically start to increase the requirements you relaxed, one-by-one, to identify the requirement that is causing the problem.

The second of these columns, the "STAB" column contains a flag that indicates in the design(s) PASSed the intact stability requirement. A value of zero in this column indicates that the design PASSed the intact stability criteria. A non-zero integer value in this column indicates that design failed to satisfy the intact stability requirement. The user must take actions to increase the ship beam or reduce the height of the vertical center of gravity by increasing the enclosed hull volume below the main deck to correct this problem

PASS GLOSSARY

***AND/OR* Engine Configuration**

In ***AND*** configuration, the main engine and the auxiliary engine may run at the same time. In ***OR*** configuration, only the main engine or the auxiliary engine can be operating at one time.

Armament Weight

The SWBS 700 total weight. Weight of helicopters/VLS should be included in ***Armament Weight***. The number of helicopters/VLS will not affect the total group 700 weight. However, they will affect the vcg, area and volume requirements of the group.

Axial Pump

This type of pump has roughly the same diameter from inlet to impeller. Consequently, it requires relatively smaller hull beam to accommodate and may be lighter than a mixed flow pump. If properly designed, axial pumps may have comparable or the same efficiency as mixed flow pumps.

Baseline Ship

Before the users do anything with PASS, they will be asked to select a ship model from the database to serve as a ***Parent*** or ***Baseline*** ship. To achieve a desired design, choose a model that most closely resembles the one you are targeting. Any ship design stored in either the PASS database or the Customer database can be used as a parent ship.

In the process of preparing for PASS input, the values for the parent ship are available at all times for reference. If the user decides not to keep the changes made to a certain input form, he/she can go back to that form and click the ***Reload Parent Ship Values*** button. All the values on that form will be restored to the parent ship values.

Before running the PASS Design Engine, leaving PASS, or opening another model, the user will be reminded to save his/her design to the Customer database. If the parent ship is from the PASS database, a name has to be specified. The user may choose to overwrite the parent ship if the parent ship is one from the Customer database.

In case of an unfinished project, choose the previously saved model of the same name as the parent ship and replace it after the modifications have been made.

NOTE: Once you decide to save a ship design, the one just saved will be considered the ***Parent*** ship. If any changes from the parent input values were made, they will be overwritten and lost. If the current model was run through the design engine, the user has the capability to replace the baseline's output values as well. If you wish to keep all of the values of the parent ship for later use, you must save the current ship using the ***Save As...*** feature.

Bow Flare Angle

Bow flare angle refers to the flare angle at the bow.

Bow Rake Angle

Bow rake angle is the angle of the stem, measured in degrees from vertical, positive forward.

BTU

The British Thermal Unit - the quantity of heat needed to raise one pound of water one degree Fahrenheit. One pound equals 453.4 grams. One degree Fahrenheit temperature difference equals 5/9 degree Centigrade difference. 1 BTU = 778 Lb-ft = 251.9 Calories.

Calorie

The amount of heat needed to raise one gram of water one degree Centigrade. 1 calorie = 3.09 Lb-ft.

Customer Database

The user can store his/her own designs in the Customer database. All user accessible database interaction features, such as saving and deleting ships, work on this database alone.

NOTE: Since the Customer database is meant for the storage of user ship designs, any model already present in the database CAN be overwritten. If an existing model in the Customer database is used as the baseline ship, be careful not to choose ***Save*** and accidentally overwrite the baseline ship. To guard against this occurring, PASS will ask if the user wishes to proceed with this course of action.

Default Values

In many cases, PASS uses '0' not as a direct input but rather as an indicator to invoke the PASS defined default values. Different ships have default values for a particular parameter. Most likely, the default value is a function of other input and derived parameters. In cases where '0' is a valid input, PASS uses a negative number to invoke the default value.

Delete

The ***Delete*** capability is provided to allow the user to remove unneeded ship designs from the Customer database. Once a ship model is deleted, it cannot be recovered. Any additions or removals of ship models to the PASS database will be handled through Band, Lavis and Associates, Inc. If you have altered the PASS database in any unrecoverable fashion, or you have any questions or problems, please contact BLA using ***Support for PASS***.

Design Pressure Coefficient

Design pressure coefficient is the design head coefficient.

Design Constraints

Set limits for certain dimensions and performance parameters in ***Parametric Run***. PASS will not consider a design as valid if any one of the limits is exceeded. If 0.0 is given, the default value will be used. Use a very small number for real zero input.

Drag Curve Adjustment Factor

PASS will allow the user to specify the amount of drag the ship will experience during its deployment. If the user wishes to increase the amount of drag, increase the value to an amount greater than 1.0. Likewise, to decrease it, specify a value less than 1.0.

Duration (days)

Duration is the longest time the ship can be in operation according to the mission profile without re-fuelling and re-supply.

Enclosed Cargo Volume

Enclosed cargo volume is the size of the cargo that is below the main deck. If the ship is registered as a container ship, where part of the cargo may be exposed on the deck, the enclosed cargo volume could be significantly smaller than the total cargo volume.

Endurance (days)

Endurance is the longest time without re-supply of food and other supplies.

Engine Type

PASS allows two different types of engines in the power plant room. Two diesel engines with distinct MCPs are considered as two separate engine types.

PASS uses two digits to describe the engine type, the first digit for main type, the second digit for the subtype with the main type. Main types include: ***Diesel, Gas Turbine*** and ***Electric Motor***. Subtype varies with the main type:

Main Type Index	Main Type	Subtype Index	Subtype Name
1	Diesel	1	Rubber
			User Specified
2	Gas Turbine	1	Rubber
			Step Increase
			ICR
			User Specified
3	Motor	1	AC
			DC-permag
			DC-homop

Figure of Merit

Figure of merit is the ratio of the new-design propulsor efficiency over the maximum efficiency based on momentum theory. 0 for default, default = 0.75

Flare Angle

Flare angle is the angle of the sides above the waterline, measured in degrees from vertical, positive outboard.

Flow Coefficient

Flow coefficient in PASS is defined as Vs / Utip. Vs is the ship speed in ft/sec, Utip is the impeller tip speed.

Forward Sheer Angle

Sheer angle is the angle of rise of the main deck in the forward section, in degrees, from horizontal, positive up. If the entered value is <-10, the default value will be used. The aft part of the main deck is assumed to be level with no rise.

Fuel BTU Value (BTU/Lb)

The amount of heat (in BTUs) a pound of fuel can generate.

Gear Type

PASS index for gear type is defined as:

1) "SINGLE INPUT, SINGLE OUTPUT, ONE STAGE, OFFSET"
2) "SINGLE INPUT, SINGLE OUTPUT, ONE STAGE, OFFSET, WITH REVERSE"
3) "SINGLE INPUT, SINGLE OUTPUT, TWO STAGE, OFFSET"
4) "SINGLE INPUT, SINGLE OUTPUT, TWO STAGE, OFFSET, WITH REVERSE"
5) "DUAL INPUT, SINGLE OUTPUT, ONE STAGE, OFFSET"
6) "DUAL INPUT, SINGLE OUTPUT, ONE STAGE, OFFSET, WITH REVERSE"
7) "DUAL INPUT, SINGLE OUTPUT, TWO STAGE, OFFSET"
8) "DUAL INPUT, SINGLE OUTPUT, TWO STAGE, OFFSET, WITH REVERSE"
9) "SINGLE INPUT, DUAL OUTPUT, ONE STAGE, OFFSET"
10) "SINGLE INPUT, DUAL OUTPUT, ONE STAGE, OFFSET, WITH REVERSE"
11) "SINGLE INPUT, DUAL OUTPUT, TWO STAGE, OFFSET"
12) "SINGLE INPUT, DUAL OUTPUT, TWO STAGE, OFFSET, WITH REVERSE"

Genset Type

Similar to the ***Engine Type***, PASS defines ***Genset Type*** as follows:

Main Type Index	Main Type	Subtype Index	Subtype Name
1	Diesel	1	Rubber
			User Specified
2	Gas Turbine	1	Rubber
			Step Increase
			ICR
			User Specified
3	Fuel Cell	1	PEM
			MC
			PA
			SOC
			User Specified

Head Coefficient

In PASS, head coefficient is defined as:

g * H / Utip^2

Where:

H is the head rise in ft

Utip is the impeller tip speed in ft/sec

Inflation Rate

In calculating cost, PASS assumes an annual inflation rate of 3%.

Inducer Pump

Inducer pump is usually considered to be a type of axial pump. It has a unique blade design (inducer blade design) which is intended to have better cavitation performance and higher power density.

Input and Input File

PASS is an independent program, which will take inputs from a text file (current.dat) before each run of the PASS Design Engine. There are also ***Utility Features*** to write or import a ship data file.

Labor Cost Rate ($/hour)

The labor cost includes salary, benefit, tax and overhead, etc. If 0.0 is given, the default value will be used. Use a very small number for real zero input.

Man-Hour Rate (hour/LT)

The way PASS calculates labor cost is to determine the man-hours required by each SWBS group based on its weight. If 0.0 is given, the default value will be used. Use a very small number for real zero input.

Material Cost Factor ($/Lt)

Material cost for each SWBS group is calculated based on its weight and a given/default material cost factor. If 0.0 is given, the default value will be used. Use a very small number for real zero input.

Maximum Efficiency Based On Momentum Theory

= 2 / (2 + Thrust / (A*Vs^2)), A = □□R^2. R is the inlet diameter.

MCP

Maximum continuous engine power.

Mission Profile

Mission profile defines the percentage of operation at each speed case during the ship's duration period.

Mixed Flow Pump

Mixed flow pump is the dominant type presently on the market, with KAMEWA as one of the major suppliers. This type of pump has a much larger impeller diameter than its inlet. Therefore, it requires relatively bigger hull beam to host and is generally heavier than an axial pump.

One-Stage Inducer Pump

The type of inducer pump with only one row of inducer blades and one row of stator blades.

Outboard Flare Angle

Outboard flare angle refers to the flare angle at mid-ship.

Output and Output Files

Output is presented in three ways: ***Output Forms, Graphics*** and ***Output Files***. Output forms contain summary information and general information about each of the seven subsystems. Graphical output provides real modelling of the ship design in a manner that will aid in assessment. The user may reference the output files for a more detailed description of individual ship system designs. A viewer is provided from within PASS to allow easy access to such files. It can be found under ***Output Data***.

In total, there are fourteen output files:

1) ***current.out*** --- general output for the whole ship and each subsystem
2) ***param.out*** --- parametric run results
3) ***geometry.out*** --- geometry information, the hulls, cross structures (boxes) and super structure
4) ***propulsor.out*** --- all info for propulsors: hydrodynamic coefficients, size, weight, cost, rpm, etc.
5) ***power.out*** --- power plant info: power, weight, size, cost, rpm, SFC for engines, gensets and gears
6) ***elec.out*** --- electric plant output
7) ***struct.out*** --- structure design results
8) ***stability.out*** --- stability calculations and some hydrostatic characteristics
9) ***drag.out*** --- drag and drag breakdown at different speed case
10) ***cost.out*** --- acquisition cost and operational cost
11) ***offset.out*** --- simple offset file
12) ***swbs.out*** --- SWBS weight breakdown
13) ***arrang.out*** --- arrangement information
14) ***bend_mt.out*** --- longitudinal bending moment curve output

Parametric Run

In order to find the optimum design parameters for a ship model, the user can use the ***Parametric Run*** capability provided by PASS. The user may establish the ranges and increments for ***Length at Waterline, Length to Beam Ratio*** and ***Block Coefficient***. At the user's choice, PASS will find the combination that has the lowest weight, the lowest acquisition cost, the lowest life-cycle cost, or the lowest power requirements.

Parent Ship

See Baseline Ship.

PASS Database

The PASS database presently contains 18 ships in three categories: ***Combatant Vessels, Non-Combatant Vessels*** (paramilitary, Coast Guard ships) and ***Commercial Vessels***. Each category may contain sub-categories (e.g. Combatant Vessels' sub-categories include: ***Amphibious Ships, Cruisers, Destroyers***, etc.). Most of the models in the PASS database are replicates of actual ships. PASS does not allow the user to overwrite any of the ships in this database. Changes to these ships may be saved in the Customer database.

Power Density (Kw/cm^2)

Power density is the ratio of power absorbed (KW) over the inlet area (cm^2).

Propulsor Type

Propeller and waterjet are the two propulsion mechanisms that are built into PASS even though the user may use his/her own type by specifying a few parameters. Please note, according to PASS' definition, two propellers (or waterjets) of different size or subtype are considered to be two different types of propulsors. PASS allows up to two different types of propulsors.

Range

Range, in nautical mile, is the maximum distance the ship can travel without refueling at the specified cruise speed.

Rubber Engine

Rubber engine is the type of engine that has an unrestricted range of power rating to choose from. If an engine is of rubber type, its MCP will be the required power with margin. ***Rubber Engine*** is the opposite of ***Step Increase Engine***. For example, there are many diesel engine manufacturers offering different power levels of diesels on the market. Most of the time, one is able to find the right power level diesel for his/her design. In PASS, diesels are considered to be rubber engines.

Save and Save As

Save and ***Save As...*** will write the present design to the Customer database. If the specified name (while Saving As) already exists in the same category and sub-category, the user will be asked to verify if he/she wants to overwrite the existing ship model. Once overwritten, the model cannot be recovered.

SFC (Lb/Hp/Hour)

Specific Fuel Consumption.

Shared Gearbox

Shafts of the same type of propulsor may share a gearbox. If the gearbox cannot be shared, each shaft has its own gearbox. Shafts of different types of propulsors cannot share gearboxes.

Ship Classification for Design

Ship Classification for the purpose of design follows the same categories as in the PASS database, i.e., ***Combatants, Non-Combatants*** (paramilitary, Coast Guard ships) and ***Commercial Ships***. Different categories have different design standards and different cost calculation assumptions.

Ship Files and File Utilities

A ship file is a specially formatted flat data file which contains all of the input values of a specific ship design. PASS is equipped with file ***Utility Features***, which allow the user to read/write the formatted ship files into/out of the PASS/Customer databases.

The ***Export*** utility will take the current ship active in PASS and produce a ship file, allowing the user to specify the desired location and name for the file. This will allow the user to transfer a ship model from one computer to another without having to copy the entire database.

The ***Import*** utility will allow the user to read a ship model from the ship file into the Customer database. The name given to the ship is the same as the name of the file, without any extensions.

Ship Type for Design

Like sub-categories in the PASS database, there are different ship types under each of the three ship classes. For example, there are eight different ship types for Combatants: ***Aircraft Carriers, Amphibious Ships, Cruisers, Destroyers, Frigates, Corvettes, Patrol Craft*** and ***MCMs***.

Speed Cases

PASS' ***Expert Level*** forms provide the user the capability to specify up to eight different combinations of speed and sea conditions (***Wave Height, Wave Period*** and ***Design Wind Speed***). Each speed case has to be checked as active in order to be effective. The user needs to make sure that the speed cases used for the propulsor and engine designs are active.

NOTE: The cruise speed case has to be active as well.

Step Increase Engine

Step increase engine is the type of engine that has a limited number of power ratings to choose from. Most likely, the MCP of the engine is going to be higher than the required power with margin since it has to be rounded to the next higher power level. ***Step Increase Engine*** is the opposite of ***Rubber Engine***. For example, it is often not easy to find a gas turbine of the exact power level of one's design requirement. One may have to choose an engine of the next higher power level that is available. In PASS, one may choose rubber or step increase for gas turbines.

Stern Rake Angle

Stern rake angle is the angle of the stern, measured in degrees from vertical, positive aft.

Suction Specific Speed

In PASS, suction specific speed is defined as:

RPM * GPM / (NPSH^0.75)

Where:

RPM --- revolutions per minute

GPM --- the mass flow in gallons per minute

NPSH --- net positive suction head, in ft.

Thermal Efficiency

The relationship among fuel BTU_value, engine SFC, and engine thermal efficiency is as follows:

Work/hour done by an 1 Hp engine = 550 * 3600 Lb-ft

= SFC *BTU_Value * 778 * Thermal_Efficiency

Therefore,

Thermal Efficiency = 550 * 3600 / (778 * SFC * BTU_value)

= 2545.8 / (SFC * BTU_value)

Where:

SFC in Lb/Hp/Hour, BTU_value in BTU/Lb

Two-Stage Inducer Pump

The type of inducer pump with two rows of inducer blades and a row of stator blades. The first row of blades is called the kicker stage and the second row is called the inducer stage.

Weight Factor

PASS allows the user to adjust the SWBS group weights by specifying a factor to each SWBS group. The weight is going to be higher (lower) than the PASS calculation if this factor is greater (less) than 1.0.

PASS No Solution Indicators Found in PARAM.OUT file

If you got a message that says "ALERT NO OPTIMUM FOUND. LAST CONFIGURATION RUN ALERT" on the Summary Page of the Output Data Forms, one of two things occurred. Either the design(s) failed to meet the required Intact Stability criteria, or the Design Synthesis Engine failed to reach a solution in one of the design modules. You can determine which of the above two cases occurred and develop a stratigy to overcome the problem by reviewing the PARAM.OUT file. To do this, select **OUTPUT DATA**, **OPEN OUTPUT FILE**. This will automatically start the Microsoft Editor. The PARAM.out File is the default file name as can be seen on the line prompting you for the file name. Press the **OPEN** button to start the Microsoft Editor and open the PARAM.OUT file.

The top portion of this file contains columnar output for each design that was generated during the last PASS run. Two of the columns are labeled "SOL/STAB". The first of these columns, the "SOL" column contains a solution indicator. A value of zero in this column indicates that the Design Synthesis Engine reached a solution in all of the design modules. A non-zero integer value in this column indicates that the Design Synthesis Engine failed to reach a solution in one of the design modules. The "No Solution" indicators that PASS will generate are shown below:

- 0 Solution Found
- 1 The Maximum Draft that was specified on the **Hull, Hull Form** page under the **Expert Input Forms** has been exceeded. Either increase the maximum allowable draft or change the hull form geometry to increase hull volume.
- 2 The Prismatic Coefficient has a value which is greater than 1.0. Either increase the **Midship Cross-Section Coefficient** on the **Hull, Hull Form** page under the **Expert Input Forms** or reduce the **Block Coefficient** on the **Prismatics** Page.
- 3 The Geometry Design Module could not find a solution. You must modify the input data on the **Hull, Hull Form** page.
- 4 The Arrangement Routine could not find a solution. This is a rare error that is not expected to occur.
- 5 The propulsion routine could not find a solution. This error most frequently occurs when the user has over constrained the design of the propulsor (see the **Executive Input Forms, Propulsion System, Propulsion** page or the **Expert Input Forms, Propulsion and/or Power Plants** pages).
- 6 PASS could not converge on a solution after 50 iterations. This error usually occurs when the user has inputted a series of design requirements that are conflicting with each other. It is suggested that you relax all user specified requirements (particularly performance and payload requirements) until you no longer get the ALERT message. The systematically start to increase the requirements you relaxed, one-by-one, to identify the requirement that is causing the problem.

The second of these columns, the "STAB" column contains a flag that indicates in the design(s) PASSed the intact stability requirement. A value of zero in this column indicates that the design PASSed the intact stability criteria. A non-zero integer value in this column indicates that design failed to satisfy the intact stability requirement. The user must take actions to increase the ship beam or reduce the height of the vertical center of gravity by increasing the enclosed hull volume below the main deck to correct this problem

PASS Frequently Asked Questions

1. Why do some of the parameters have zero as input values while zero may not be a valid number for them? For example, '0' for maximum beam does not make any sense!

   In many cases, PASS uses '0' not as a direct input but rather as an indicator to invoke the default values. Different ships have default values for a particular parameter. Most likely, the default value is a function of other input and derived parameters. In cases where '0' is a valid input, PASS uses a negative number to invoke the default value.

2. PASS did not find any optimum solution when I ran a parent ship with a longer range or a larger payload?

   PASS may think that the combination of inputs is not practical. PASS has a simple error message handling mechanism. The error message may give you a hint where to change the input. A more sophisticated error message handling mechanism is planned for the future.

   You may try:

   a) Increase the Lwl range.

   b) Lower the lower limit of Lwl/bwl to make it fatter.

   c) Increase the upper limit of Cb to make it fuller.

   d) Increase your draft limit and beam limit, etc., to ease the restrictions a little bit.

   e) Check other geometry inputs to let them be consistent with the above changes.

   f) Check the range and duration requirements.

   g) The ***Ocean*** freeboard option also makes the ship bigger. If you know your freeboard, specify a number instead. Otherwise, try ***Coastal*** to see if the calculated freeboard is acceptable or not.

   h) Higher speed demands more power. A couple of knots may make a big difference. You may also try to lower the speed requirement a little bit. After you have something working, try to increase the speed again.

   i) You may also try to use a different type of engine or change the number of engines. ***Gas Turbines*** and ***Fuel Cells*** are lighter than ***Diesels***, but they use more fuel than diesels. Large, low speed diesel engines are much heavier than small/medium diesels.

   j) If your Lwl/Bwl is greater than 10 or smaller than 3.5, the drag routine may not work very well for you. If you are designing a Trimaran and Lwl/Bwl is between 13 to 15, Series-64 data will be used and you should be fine.

   k) If your ship is very small or very large or your number of engine is more than 4, you need to be very careful in using PASS and interpreting PASS' results. You are encouraged to contact the author of PASS to discuss your application.

   l) If you are designing NAVY auxiliary vessels intending to use commercial standards, you may want to run them both as a ***Paramilitary*** and ***Commercial*** applications to see the difference and make your own decisions. You may also try ***Military Sealift*** and compare.

3. What is the difference between ***Apply*** and ***OK*** in the input forms?

   If you press ***Apply***, the changes you made on the open form will be recorded and the form remains open for further editing. If you press ***OK***, the changes are recorded and the present form will be closed and you will be returned to the main menu.

4. What is the effective scope of ***Reload Parent Ship Values***?

   The scope of ***Reload Parent Ship Values*** is limited to the open form only. The values of the parent hull for inputs inside the present form will be brought back and all the changes on this form will be lost.

5. I have a CODOG power plant driven by only one type of propulsor. I want the gas turbines to run for only the highest speed. For the other two lower speeds, I want to run the diesels? How can I specify that?

   Well, you may not be able to specify it. However, it is not difficult to achieve what you want. First, make sure that your three speed cases are all active. Then, in the ***Auxiliary Engine*** input form, choose the ***Design Speed*** case to be the highest of the two low speeds where you want run the diesels. This way the gas turbines will be shut down for all the speeds equal to or lower than the diesel design speed.

6. I have a CODAG power plant driven by only one type of propulsor. How is the power is distributed?

   The auxiliary engines will be sized or designed first, based on the speed specified ***(Vaux)***. Second, the top or maximum operating speed ***(Vtop)*** is found if the main engine design speed is not specified. The main engines are designed to the power (with margin) required at the top speed less the power provided by the auxiliary engines at this speed. Third, PASS will find a speed ***(Vmain)*** at which the power required is the same as the main engine output. If the off design speed is ≤ ***Vaux***, only the auxiliary engines will be running. If the speed is ≥ ***Vtop***, both main and auxiliary engines will be running at full power. If the speed is between ***Vaux*** *and* ***Vmain,*** only the main engines will be running. If the speed is between ***Vmain*** and ***Vtop,*** the auxiliary engines will run at full power and the main engines will provided the remaining power.

7. How is the power is distributed in the case of two types of propulsors?

   In the case of two types of propulsors, the situation is much more complicated. First, you have to have two different types of engines and they will form a CODAG plant regardless of what you specify. In other words, the auxiliary engines drive the auxiliary propulsors while the main engines drive the main propulsors. They could operate simultaneously. Second, the auxiliary propulsors and engines are sized or designed based on the speed specified ***(Vaux)*** or the most demanding power output at all speeds (recall that, in the auxiliary propulsor inputs, there is a "percentage thrust at other speeds"). The auxiliary propulsors and engines are not allowed to be idle at any speed cases. The reason is that you do not want the auxiliary propulsors to create drag in any case. The design speed for the auxiliary engine will be ignored. Third, the thrust the auxiliary propulsors could provide at the top speed ***(Vtop)*** is determined. This power is normally less than the maximum power of the auxiliary engines. Fourth, the remaining thrust for the main propulsors to provide can then be calculated and the main engines are designed to this power. Finally, when calculating off design performance, the maximum thrust provided by the auxiliary propulsors at this speed is calculated first and the auxiliary engines will provide the power needed. The remaining thrust comes from the main propulsors for which the main engines provide the power needed.