CTX Mate Version 0.71

User's Manual

Jack Devanney

Sisyphus Beach

Tavernier, Florida

2007

Copyright © 2006, 2007 Jack Devanney

Permission is granted to copy, distribute and/or modify this document under the terms of the Gnu Free Documentation License (GFDL), Version 1.2 or any later version published by the Free Software Foundation; with no Invarient Sections, no Front-Cover Texts, and no Back-Cover Texts. A copy of the GFDL is available at `www.gnu.org`.

CTX Mate is distributed under the Gnu Public Licence and can be downloaded from www.c4tx.org. CTX Mate employs the immersed section area integration algorithm initially developed by Herreshoff & Kerwin, Inc. Halsey C. Herreshoff and Justin E. Kerwin have kindly allowed the Center for Tankship Excellence to use this algorithm in the CTX Mate package. However, CTX is solely responsible for the code that uses this algorithm.

Published by The CTX Press
212 Tarpon Street
Tavernier, FL 33070

Publishers's Cataloging-in-Publication Data
Devanney, Jack

CTX mate user's manual / Jack Devanney — Tavernier, Fla :
The CTX Press, 2006

p. : cm.
ISBN: 0-xxxxxxx-0-0
ISBN 13: yyy-0-xxxxxxx-0-z

1. Tankers – Design and Operations. 2. Tankers – Loading. 3. Tankers – Spill reduction. I. Devanney, Jack. II. Title

VM455.D38 2005
387.2/45—dc22 2005938363

Printed in the United States of America
10 09 08 07 06 • 5 4 3 2 1

Contents

0 Testing Mate **1**
0.1 Tolerances 1
0.2 Allowables 2
0.3 Test Conditions 4

1 Overview **7**
1.1 Capabilities 7
1.2 Limitations and Bugs 12
1.3 Basic Methodology 14
1.4 About this Manual 15

2 Getting Started **17**
2.1 From the desktop 17
2.2 From the command line 19
2.3 Mate Folders 22
2.4 Using Mate outside the Tanker File System 24

3 The Mainscreen **25**
3.1 The Five Sections 25
3.2 The Tank Table 30
3.3 The Summary 38
3.4 The Menubar 41
3.5 The Toolbar 50
3.6 The Titlebar 53
3.7 Preserving Liquid Mass 55

4 Liquid Parcels **59**
4.1 Editing Parcel Data 59

5 Point Loads **67**
5.1 Editing Point Load Data 67

6 The Load File **71**
6.1 Saving a Loading Pattern 71
6.2 The Loadfile Format 73

7 Saving Results **77**
7.1 Report Philosophy 77
7.2 The EXPORT Menu 78

8 Longitudinal Strength **83**
8.1 Shear Force and Bending Moment Plots 83
8.2 The Strength Screen Command Bar 85
8.3 Longitudinal Strength Reports 87

9 Stability **89**
9.1 Metacentric Height 89
9.2 Righting Arm Curves 90

10 Flooding **95**
10.1 The Downflooding Report 95

11 IMO Regulation 25 **99**
11.1 Invoking the Reg 25 Function 99
11.2 Discussion of IMO Reg 25 102

12 Sloshing Resonance **105**

13 Hotspot Stress Analysis **107**
13.1 Obigatory Warning 107
13.2 The Hotspot Screen 108

14 Cargo Survey Reports **111**
14.1 The Cargo Menu 111
14.2 Rounding 112
14.3 The OBQ Report 114
14.4 The After-Discharge or ROB Report 117
14.5 The Ullage Survey Report 119
14.6 The Ullage-FAOP Report 121
14.7 The Ullage-EOP Report 122

15 Auto Mode **127**
15.1 Entering Auto mode 127
15.2 Auto Mode functions 128
15.3 Gauging System Errors 129

16 Damage Mode **131**
16.1 The Damage Mode Mainscreen 131
16.2 Checking vessel survivability 139
16.3 Using Hotspot analysis to estimate loss of strength 140
16.4 Minimizing spillage whose source is uncertain 143
16.5 Minimizing spillage whose location is known 144
16.6 Entering Damage Data 146

17 Stranding **151**
17.1 Stranded Drafts and Heel Specified by User 151
17.2 Getting the Ship Off 154

18 Non-GUI Use of Mate **157**
18.1 Using Mate without a graphical interface 157
18.2 The `ctx_mate_cmd` 158
18.3 Embedding `ctx_mate_cmd` within a bigger analysis 159

19 Volume Correction factors **161**
19.1 Using the `ctx_vcf` Command 161

20 Single Tank Analysis **165**
20.1 The ctx_tank Command 165

21 Hull Hydrostatics **167**
21.1 The `ctx_hull` Command 167

22 Errors **173**
22.1 User Interface Problems 173
22.2 Missing or Inconsistent Input 174
22.3 Convergence Failure 174
22.4 Other Error 176
22.5 Bug Reports 176

A Mate XML Reports **179**
A.1 The Summary sub-report 179
A.2 The Options sub-report 184

A.3 The Header sub-report 186
A.4 The Parcel sub-report 187
A.5 The Tank sub-report 188
A.6 The Strength sub-report 191
A.7 The Stability sub-report 193
A.8 The Downflooding sub-report 196
A.9 The IMO Reg 25 sub-report 197

B Post-Processing **199**
B.1 Post-processing with Perl 199

List of Tables

1 Deadweight & Lightweight for DEMO ULCC 1
2 Tolerances 2
3 Maximum Discrepancies 2
4 Allowables 3
5 Test Loading Patterns 4

4.1 Simplified Parcel Screen 66

14.1 Sample OBQ Report 116
14.2 Sample ROB Report 118
14.3 Ullage Report, first page 120
14.4 Ullage Report, Second page 121

List of Figures

3.1 Simplified Normal Mode Mainscreen 29

6.1 Sample Loadfile (top) 75
6.2 Sample Loadfile (bottom) 76

9.1 Sample Righting Arm Table 94

11.1 Sample Reg25 Report 101

14.1 Excerpt from CTX style cargo survey report 126

A.1 Excerpt from Damage Mode Tank sub-report 190
A.2 Excerpt from Strength sub-report 192
A.3 Excerpt from Stability sub-report 195
A.4 Excerpt from Downflooding sub-report 196

Chapter 0

Vessel Data and Test Conditions

0.1 Vessel Particulars & Tolerances

For ease in updating, all vessel specific information required by the Regulations to be included in a Loading Program Manual have been collected here in Chapter 0. This data can be referred to as necessary. The manual proper really starts with Chapter 1. Unless you are running a CTX_Mate test condition or need to check vessel calculation tolerances, you may immediately move on to Chapter 1. If you are running a Mate test, see Section 0.3.

CTX_Mate uses the following summer deadweight and lightweight for this ship. An unusual feature of Mate is that the input files describing

Table 1: Deadweight & Lightweight for DEMO ULCC

SUMMER DEADWEIGHT (metric tons)	441561
LIGHTWEIGHT (metric tons)	67923
LCG_LIGHTWEIGHT (meters Fwd of Aft Perp.)	176.690

the ship which Mate *actually* uses are in human readable form, and can be examined — but not changed — by any user. All these files are in `/X/uldh/DATA/MATE`. Therefore, if you want to see what Mate is using, simply display the relevent file on you terminal or print it out. For example, for the set of vessel particulars used by Mate, see `/X/uldh/DATA/MATE/main.xml`.

For this ship, internally Mate uses the weight and moment tolerances

shown in Table 2. Since Mate uses a trial and error process in determining

Table 2: Weight and Moment Tolerances

	Intact	Fallback	dDamaged
Hull displacement (tons)	0.4	0.4	4.0
Longitudinal Moment (ton-meters)	1.3	1.3	1300.0
Transverse Moment (ton-meters)	0.2	0.2	21.0
Tank volume (cubic-meters)	0.2	0.5	12.5

the equilibrium drafts and heel, it is possible for the resulting solution to be slightly different for the same loading pattern if the starting trial condition is different. However, the discrepancies in the output should be no more than those shown in Table 3.

Table 3: Maximum Discrepancies

	INTACT	DAMAGED
Hull displacement (tons)	(+/-)10	(+/-)400
Draft (meters)	(+/-)0.002	(+/-)0.020
Trim (meters)	(+/-)0.002	(+/-)0.040
Heel (degrees)	(+/-)0.002	(+/-)0.040
Shear Force (tons)	(+/-)50	(+/-)500
Bending Moment (ton-meters)	(+/-)1500	(+/-)15000

0.2 Shear Force and Bending Moment Allowables

The shear force and bending moment allowables used by Mate for this ship are shown in Table 4. Mate computes the shear force and bending moment at all the longitudinal stations shown in `/X/uldh/DATA/MATE/frames.xml`. The allowables shown in Table 4 are translated to these stations by linear interpolation. To examine the lightweight distribution used by Mate for DEMO ULCC, display `/X/uldh/DATA/MATE/ltwt.xml`. The hull Moment of Inertia curve is in `/X/uldh/DATA/MATE/secmod.xml`.

Table 4: Allowables for DEMO ULCC
ALLOWABLES IN TONS (SHEAR FORCE) AND TON-METERS(BENDING MOMENT)

FRAME NAME	FRAME FWD OF AP	SHEAR AT SEA AFT UP	SHEAR AT SEA FWD UP	MOMENT AT SEA HOGGING	MOMENT AT SEA SAGGING	SHEAR PORT + AFT UP	SHEAR PORT - FWD UP	MOMENT IN PORT HOGGING	MOMENT IN PORT SAGGING
FR_17	14.450	7500	-7500	89400	-64600	8214	-8264	140825	-119634
FR_29	25.250	8750	-8750	156275	-112750	10257	-10363	264839	-228932
FR_41	36.050	12342	-12342	244500	-176450	14643	-14804	410203	-353781
FR_59	52.250	23000	-23000	500913	-361588	26490	-26736	752323	-630641
FR_65	57.650	23000	-23000	595600	-429900	26887	-27160	875580	-729528
FR_67	69.390	24000	-24000	801500	-600000	28733	-29066	1142428	-964853
FR_70	87.000	25500	-25500	1100300	-840000	30788	-31160	1544555	-1304729
FR_75	116.350	28000	-28000	1510100	-1090000	33200	-33538	2098630	-1719830
FR_80	145.700	27500	-27500	1510100	-1090000	31905	-31942	2252905	-1884931
FR_85	175.050	27000	-27000	1510100	-1090000	31307	-31307	2271951	-1905314
FR_90	204.400	28500	-28500	1510100	-1090000	32807	-32807	2271951	-1905314
FR_95	233.750	30000	-30000	1510100	-1090000	34934	-34797	2271951	-1905314
FR100	263.100	29500	-29500	1389100	-990880	35652	-35248	2009464	-1654779
FR105	292.450	29000	-29000	874400	-730100	35152	-34748	1318450	-1205312
FR110	321.800	22000	-22000	359800	-438767	27004	-26675	625359	-722962
FR115	351.150	15000	-15000	91900	-147400	16682	-16571	181145	-242908
FR129	363.050	5405	-5405	18236	-29281	5733	-5712	35650	-47917

0.3 Test Conditions

Mate can be tested at any time by running any of the following read-only test loading patterns and comparing the results with those shown on the following pages.

Table 5: Test Loading Patterns

lf_12_depscant
lf_13_arrscant
lf_05_depblst
lf_06_arrblst
lf_18_depseg3

There are three tables for each test loading pattern:

1. the first table displays the loading pattern and the overall results for that loading pattern,
2. the second table contains the longitudinal strength report, and
3. the third table showns the intact stability report.

These tables are explained in Chapters 7, 8, and 9 respectively. For each test loading pattern, your results must match the corresponding attached summary within the discrepancies shown in Table 3.

The test loading patterns are taken from the ship's Loading Manual. These test patterns are in the Read Only directory `/X/uldh/DATA/MATE/MAN`. These tests should be done on every Chief Mate handover in the presence of both mates and the results logged in the Chief Mate Handover Report. They should also be done any time the Master or Chief Mate is suspicious of Mate's results. The Class Surveyor will also run these tests for Survey purposes.

The procedure for running these tests is:

1. Change directory to `/X/uldh/V/TEST`.
2. Carefully issue the command `/X/uldh/DATA/MATE/MAN/ctx_mate_tests.sh`. This will delete any existing files in the `TEST` directory related to the above test patterns which were left over from previous tests. You may get some warning messages if these files don't exist. Ignore these messages. Next the read-only test loading patterns from `/X/uldh/DATA/MATE/MAN` will be copied into the `TEST` directory. You can tell that these test loading patterns have been freshly copied by using `ls -ltr` and looking at the modification times.
3. Then issue `mate` *loadfilename* where *loadfilename* is the first loadfile

name in Table 5 and generate the required reports for this loading pattern.

4. Repeat for each of the test patterns in Table 5.

Occaisionally, Surveyors will run a test pattern, change it and make a run, and then return to the original test pattern and run it again expecting to see exactly the same numbers as in the first run. They need to be aware of two things in making this test:

1. *You cannot change TANKOPT during this series of tests.* Suppose in the original loading pattern tank 1C had a TANKOPT of W, a Weight of 32345.1 tons, and an apparent percent full of 98.00%. Often the Surveyor will make the original run, switch to a TANKOPT of P, note the 98% full, change to a different percent and rebalance, and then "return" to 98.00% full. This looks like the same loading pattern from a percentage point of view; but, if you note the new tank weight carefully, you may find that it is as much as 2 tons different from the original. This is because in the original pattern the tank was not really 98% full but it might have been 98.004% full. The only way to be sure of getting exactly the same values back is to note the value in the input column for the original TANKOPT, change only that column, and then change it back to exactly the original value. You cannot change TANKOPT and expect to return to exactly the original loading pattern.
2. Even if the loading pattern on the second run is exactly the same, the results may be very slightly different. This is because Mate will be starting from a different initial drafts and heel than in the first run.[1] Often you cannot see the small differences in draft and heel since Mate only displays draft and heel to three decimal places.

Refer the Surveyor to Table 3 on page 2.

[1] This is true of any loading program that uses trial and error which as far as I know is all of them. Class's assumption that a loading program should return to exactly the same solution is just plain incorrect. Commercial loading programs use a number of devices to hide the fact that the results are not *exactly* the same.

Chapter 1

Overview of CTX_Mate

1.1 Capabilities

CTX_Mate is a combination tanker loading program, cargo survey report generator, and salvage and oil spill reduction package.

Loading Instrument Mate does standard tanker loading and longitudinal strength calculations based on shear force and bending moment allowables but more accurately reflecting impact of trim and heel on cargo location. Mate understands the difference between earth-vertical and ship-vertical and keeps all weight and buoyant forces earth-vertical regardless of the ship's trim and heel. Mate is not limited to symmetric loading patterns. Mate automatically estimates hull deflection.

Survey Report Generator Mate can prepare fully filled out cargo survey reports for each of the four standard cargo survey situations a tanker can face: 1) before load (OBQ), 2) after load, 3) before discharge, and 4) after discharge (ROB). Mate implements Tables 6A, 6B, 54A, and 54B, allowing a fairly full range of Volume Correction Factors. This saves ship and crew time and insures that all survey reports are free of calculation errors. These reports may be post-processed to obtain in-transit loss/gain, etc.

Mate's results are commercially accurate. Mate understands the difference between tank gauging systems that work in ship coordinates (radar, floats, etc) and systems that work in earth coordinates(surveyor tapes, UTI, pressure, etc). In the latter category, it understands the difference between systems that operate from a fixed point near the deck (surveyor tapes) and systems that operate from a fixed point

near the bottom (most pressure sensing). It also correctly handles arbitrarily (within reason) shaped sounding pipes. Most loading programs (and many tank tables) do not correctly handle these differences which limits them to low heel and trim situations, and even then these programs can generate commercially significant errors.

Mate is designed so that in the normal course of events the Mate should never need to pick up a calculator. For example, Mate allows multiple pre-programmed dipping points for each tank. There is no need to adjust a reading taken at one dipping point to another. The Mate's only responsibility is to insure that the raw data is entered correctly. Not only does this avoid calculation errors but it means that all calculations are consistent and completely documented.

Assuming the saab2ctx.pl script has been correctly installed on your ship. Currently only the Saab Radar protocol is implemented.

Auto Mode Mate has the capability of taking data directly from the tank ullaging system. This is known as Auto mode. The user may switch back and forth between Auto mode and Normal mode at will. The user may remove individual tanks from Auto mode on the fly. This may be necessary if the sensor for a tank is not operational or producing faulty readings.

Part of a Tanker Management System CTX_Mate is desiged to be an integral part of an overall Tanker Management Information system. The loading patterns, results, etc may be, and should be, stored in the same voyage folders as all the other reports and correspondence associated with that load/discharge.

Each saved loading pattern is a complete self-standing record of that particular run including not only the loading pattern itself and the parcel data, but also all options that were in effect at that time. If this file is sent to the office or elsewhere, the exact run can be replicated, both manually and by automatic post-processors which can combine and analyse multiple loading patterns. One use of this is an automatic pumping log generator.

Mate keeps track of variables it itself does not use, e.g. voyage number, leg, port, berth; but which may be critically important to the overall management system.

Intact Stability Mate computes both port and starboard righting arm curves and checks compliance with the IMO Code on Intact Stability A749. This can be crucially important for double hulls. It also displays the downflooding limits. Mate may be unique among loading programs

in that it calculates the roll radius of gyration. Double hull tankers roll like pigs, especially in ballast. The main cause of this is the high roll radius of gyration. Mate gives the crew the information they need to minimize this quantity.[1]

IMO Regulation 25 Mate checks compliance with IMO Regulation 25 on subdivision and stability.[2] This regulation requires that the Master of any tanker be satisfied that each loading pattern meets this rather complex set of requirements. In practice, this is rarely checked because of the inability to efficiently do the calculations. In the event of a casualty, the failure to make these checks could have massive legal implications. Mate also checks stability and flooding for the raking damage mandated by IMO Reg 13F.

Damage Mode If your ship experiences a casualty, you can convert Mate into a salvage program with a single click. This is known as Damage Mode. You may then enter the location and extent of the damage. Mate will immediately compute the equilibrium drafts and heel associated with this damage and the pre-damage loading pattern. Free surface effects are computed directly, not from estimates of waterplane inertia. These estimates can be grossly wrong in many tanker damage situations. In the case of the unusually shaped ballast tanks in double hull tankers, they can be grossly wrong without any damage. There is no difference between Mate's intact and damaged stability calculations. The user merely indicates which tanks are damaged and where and Mate then computes the righting arms correctly accounting for any flooding and/or run off. The user can obtain a list of all downflooding points sorted by distance above the water line.

Tank Grouping In Damage Mode, Mate allows tanks to be "grouped" on the fly. Tanks that are grouped are treated as if they were a single tank. This allows many forms of internal double hull damage to be well represented including the capture of cargo in the top of the wing ballast tanks. Tank grouping also allows us to analyse the strategy of purposely inter-connecting tanks in order to reduce spillage.

Spill Reduction As part of the damage calculation, Mate computes the equilibrium oil outflow from damaged tanks based on the vertical

[1] Mate also computes the pitch radius of gyration which can be useful input to vessel motions studies, SBM mooring analyses and the like.

[2] In this version, Mate checks only the final flooded condition, not the intermediate conditions.

extent of the damage and the results are automatically reflected in the hull balance, damaged stability, and strength calculations. Ullage space over/under-pressure is accounted for as is the change in ullage space pressure if the tank is sealed. Hydrostatic balance is integrated into the code. Equilibrium oil-water interfaces in the damaged tanks are computed so that the amount of cargo lost can be computed. Mate computes and displays both hydrostatic loss and exchange loss.

This capability can serve as a ship specific, hydrostatic balance trainer through which the crew can study a variety of potential damage scenarios and the outflow which result from alternative response strategies. Without such training, effective use of hydrostatic balance in a real spill is unlikely. With such training, the amount of spillage can often be reduced by a factor of three or more, and in some cases eliminated, by simply triming and heeling the ship properly.

Stranding Mate has a limited but useful grounding capability. For any given grounded situation, Mate will compute the ground reaction force and centers. All other calculations, including oil outflows, are available when grounded. The relationship between grounding and spillage can be crucial. For a given damage, oil spillage will generally be much larger in stranded situations than in unstranded especially if the tide is dropping. Mate always keeps track of the lowest point on the hull to alert the crew to potential grounding situations.

Immediately Available Damage and spill analysis is an extension of the normal use of CTX_Mate. There is no need to change to an unfamiliar, at best incompletely tested program in the middle of a crisis. There are no delay prone, error prone communication and data translation problems associated with using a totally different data format on a computer thousands of miles from the scene. Mate will be onboard which is the only place it can really do us any good in the event of a big spill. The loading pattern at the time of damage will already be on the computer, and ready to go.

And the crew will be using a program that it knows and trusts. Turning to a program the crew doesn't know and have rarely if ever used in the middle of a crisis simply won't work. Since Mate is an everyday tool, its use in a damaged situation is merely an extension rather than a whole new ball game at a time when the ship cannot afford to fight thru all sorts of learning and teething problems.

item[Hotspot analysis] The standard strength calculation based on Class approved allowables is appropriate only if both the structure is undamaged and the heel is small. For salvage situations, where this may not be the case, Mate also offers a calculation which adjusts the hull section modulus both for loss of steel and for heel, and identifies the points with the highest indicated stress to yield stress. We call this Hotspot analysis. This feature uses the same description of damage as that for the oil outflow calculations, so it requires only a single button push. This approach assumes classical beam theory. It has some very important limitations and must be used with a great deal of judgement. Read Chapter 13 carefully before using.

User Interface CTX_Mate is equipped with a user interface which is at least as easy to use as those associated with commercial packages. Almost all basic functions are accessible from a single *Mainscreen*, most with a single key or mouse click. The Mainscreen is scrollable vertically and horizontally so the system can be used on any sized monitor from a laptop on up. And the Mate retains the use of his computer for other purposes while running CTX Mate.

Having said this, CTX Mate is not a program that can be intelligently used or even learned by simply starting it and clicking away. Mate is a serious tool for professionals who are responsible for up to several hundred thousand tons of petroleum and more importantly thirty or more lives. It can only be learned by serious study including careful and repeated readings of this manual. For example, you must know exactly when Mate assumes no liquid has entered or left a tank and preserves the tank liquid mass, and when it assumes the amount of liquid in the tank has changed. See Section 3.7. In addition to use the Damage Mode spill calculations intelligently, you must understand the principles of hydrostatic balance. This subject is NOT included in this manual.

ctx_hull The Mate package includes a command, `ctx_hull`, which produces a standard hull hydrostatics table for any given heel and trim. Optionally, a table of bonjean curves may be produced as well. This can be used as a hull design tool like any other hydrostatic program. Since `ctx_hull` computes the hull properties using the same code as Mate, it can be used to quickly compare Mate's hull numbers with any standard hydrostatic table.

ctx_tank The Mate package includes a command, `ctx_tank`, which serves

as a computerized set of tank tables. No need for any interpolation or trim/heel correction. The program will correct for temperature by Tables 6A/6B/54A/54B if desired. Unlike normal tank tables, `ctx_tank`'s numbers are good even when the tank is almost dry and there is a great deal of trim (and heel). `ctx_tank` computes the tank volume and centers using exactly the same code as Mate. So it can be used to compare Mate tank volumes for a given ullage/innage (and trim and heel) with those of standard tables.

ctx_vcf The Mate package includes a command, `ctx_vcf`, which calculates VCF, WCF, and density for a given standard density (or API) and temperature according to API Tables 6A or 6B or 54A or 54B. Various rounding options are available.

ctx_secmod The Mate package includes a command, `ctx_secmod`, which calculates the section moduli and other cross-sectional strength numbers for any scantling cross-section given in the ship's Mate data base. This command is an integral part of the CTX Tanker Design Package.

1.2 Limitations and Bugs

Mate currently has at least the following limitations:

1. Mate does not attempt to model shear flow. Therefore, the shear allowable must be based on a worst case distribution of shear force between longitudinal bulkheads and side shell. Mate will claim that certain loading patterns violate shear requirements when in fact they do not. The program should modify shear allowables according to the transverse loading per Rule.
2. Although Mate correctly positions all loads and buoyant forces transversely as well as longitudinally, Mate currently does not have any transverse strength capability. The long range plan is to give Mate a Finite Element capability which will take advantage of this capability.
3. Mate is limited to trim and heel angles less than 80 degrees.
4. Mate assumes a rigid body. It estimates the vertical hull deflection longitudinally, but hull deflection does not affect the hydrostatic or oil outflow calculations. For the most part, this error is small and conservative. However, in conditions involving large hull deflection (e.g. sag of .2m or more), Mate will underestimate the outflow from the tank in the high portions of the deflection curve (the ends for sag) and overestimate the outflow for tanks in the low portions of the

deflection curves. This error can have a quite noticeable impact on equilibrium spillage.

5. In damaged situations, Mate computes the equilibrium spillage for the equilibrium rigid body hull orientation and divides it into hydrostatic and exchange flow. But Mate gives the crew no guidance as to how rapidly that spillage will occur. This spillage can often be reduced markedly by properly trimming and listing the ship. Mate will inform the crew of the reduction associated with any combination of ballasting and transfer of cargo, *but only under the assumption that the new trim and heel is implemented before any spillage takes place.* In situations in which spillage is rapid, this is not a useful approximation.
6. Mate does not compute outflow through tank P/V valves or vents which can occur at high trim and heel.
7. Even with tank grouping, certain forms of internal double hull damage are not well modelled. See Chapter 16.
8. In this version, Mate does not give the crew any information relating to sloshing resonance. This will be corrected in later version.
9. Hotspot analysis is based on classical beam theory which at best is approximately correct when the hull is undamaged, and may be wildly misleading when the structure is damaged. But the long range goal is to use finite element for this purpose.
10. It is possible for the program to fail to converge at extremely high trim or heel for very strange shaped tanks. Mate will identify the problem and issue an error message. In some cases, this could force the crew to treat a tank as a fixed load. To CTX's knowledge, this has never happened in over 80 ship-years of actual operation. But it is possible.
11. Occasionally, unexpected user input will generate inscrutable error messages. If the user does something from the keyboard or mouse that the program cannot figure out what to do with, a window will pop-up with an usually unhelpful error message. Most of the time this is a harmless nuisance which can be corrected by dismissing the error window and reentering the input. On rare occasion, it can force a user out of his Mate session.
12. Graphical output is limited to bending moment and righting arm curves, and 2-D tranverse views of selected sections. A 3-D visualization capability is in preparation.

1.3 Basic Methodology

The most important difference between Mate and most commercial programs is its basic methodology. Like most loading programs, Mate balances the hull via a trial and error process. That is, it guesses the ship's midship draft, trim, and heel, computes the hull buoyancy for this condition and the centers of that buoyancy. Mate then checks to see if this buoyancy and these centers match the weight and centers of the lightweight and all the liquids in the tanks and compartments. If there is a discrepancy, the program adjusts the depth, trim, and heel and repeats the process. This continues until the buoyancy and the weights and the longitudinal and transverse centers of the hull and the weights match, or the program gives up with an error message.

Where Mate differs from most loading programs is in the way it handles liquid loads. For each trial in the trial and error process, Mate recomputes the volume of liquid in each tank and the centers of that volume directly from the tank offsets and the ullage/innage/pct volume/etc. This process is known as *direct integration*. Every time it needs a tank volume or moments, it re-does the calculation that produced (or should have produced) the corresponding tank tank table entry. In so doing, it treats each tank as a little ship and calculates the volume and moments of that little ship up to the current liquid level in the tank. The fact that a hull displaces liquid and a tank or compartment retains it is almost irrelevant to Mate. It uses the same code to compute the volumes and moments of the volume under the current hull/tank waterlines in both cases.[3]

This computationally costly procedure has at least four big advantages.

1. There is no limit on heel and trim as long as they are less than 80 degrees. Mate's computations are as accurate at very high heel and trim as they are at zero heel and trim. Most commercial programs do not even adjust tank centers for trim. In fact, many assume the

[3] CTX offers a companion program called CTX_Surveyor which can use tank tables for its volume calculations. The purpose of this program is to satisfy cargo surveyors who insist on using tank calibration table figures in survey reports. For small trim and heel, there's usually a slight difference (normally less than a cubic meter) between the tank table numbers and Mate's more accurate direct calculations for the same tank readings, draft, trim and heel. Both CTX_Mate and CTX_Surveyor use the same format for loading pattern files which allows loading patterns to be passed back and forth. The cargo survey reports that are generated use the same format, so post-processing software can handle either. And they both have a similar user interface. ***However, CTX_Surveyor is not a Loading Instument.*** It cannot check strength. It cannot check stability. The drafts and heel need not be consistent with the loading pattern. CTX_Surveyor merely automates the calculations that a cargo surveyor does. In a rational world, CTX_Surveyor would be completely unnecessary.

LCG of a tank is the same regardless of ship orientation and tank ullage. Gravitational forces remain earth vertical regardless of the ship's orientation.

2. For intact tanks, the shift in the tank liquids and its effect on trim and stability are computed directly. There is no need to make any assumptions about the form of the free surface. This is important because the normal assumptions based on waterplane moments can be grossly wrong at the high heels and trims that may be encountered in a damage situation and for the unusually shaped ballast tanks of a double hull tanker. With double hulls, intact tanker stability is once again a real issue and the normal treatment of free surface can be fatally in error.
   It also implies that Mate's computations in no way depend on the bottom of the tank being totally flooded (nor the top of the tank being totally dry). The "wedge problem" does not exist.
3. For damaged tanks, the program can adjust the liquid volume to the assumed draft and trim and heel and correctly compute both the flooding/runoff, and the amount of oil outflow at hydrostatic balance in the tanks, and then feed the effect of this change into the determination of the equilibrium draft, trim and heel. The amount and composition of liquid in a damaged tank or compartment is not fixed but depends on the ship's draft and trim and heel and in turn helps determine what that draft, trim and heel will be. Mate's brute force approach allows it to handle the fact that tanker loads are not fixed but rather both depend on and determine the ship's orientation.
4. Important numbers such as the roll and pitch radii of gyration, which are crucial to the ship's dynamic response to a particular set of sea conditions come almost for free. A standard loading program cannot compute these numbers.

1.4 About this Manual

This manual can be displayed on your terminal by seleting Manual from the Help menu. It is in PDF format. After you have displayed the manual, you can search for a particular phrase, or print out all or a portion, using the tools on the display window.

This manual has several companion documents:

The Physics of Tank Spillage Understanding this CTX Technical Report is essential to handling damage in a manner that minimizes oil

spillage. It can be accessed on-line from the Mate Help menu.

Not yet available.

CTX_Mate Designers Manual This manual is aimed at users who are employing CTX_Mate as a design or evaluation tool, rather than a Loading Instrument.

CTX_Mate Ship Data Preparation Guide This document describes the procedure for generating and testing the ship specific data files that Mate requires in order to be able to perform its functions for a particular ship. However, it is also the source for a description of these files and is easily readable by any deck officer. A copy should be on-board and studied by deck officers interested in deepening their knowledge of Mate and their ship.

CTX_Mate Installation and Administration This document describes how to install or re-install Mate. This may be required not only for upgrades but in the event of a hardware failure. A copy of this document must be on board every Mate equipped ship and at least one crew member familiar with and capable of performing these procedures.

Not yet available.

CTX_Mate Programmer's Manual This document is aimed at personnel who are responsible for maintaining and improving Mate. But it also contains a great deal of information on basic methodology which could be useful to anybody using the program, especially those who have a little computer experience.

Chapter 2

Getting Started

There are two ways of starting CTX Mate:

1. Clicking on the Mate icon (the ugly capital M) on the desktop.
2. Typing a `mate` command into a terminal window.

Using the command line is more flexible and often quicker, especially when you are repeating similar runs. But for untrained people clicking on the icon is easier. Section 2.1 describes the icon method; section 2.2the command line method. If you don't have a Mate icon on your desktop, you will have to turn to Section 2.2.

2.1 Launching Mate from the Desktop Icon

When you double click on the Mate icon, you will be presented with the Mate `start-up form`.[1] This form allows you to choose a fleet, a ship, a voyage (or TEST), and an initial loading pattern.

Mate attempts to pre-select these values in a manner such that most of them should already be the ones you want. For each such variable, you can check out the alternatives via clicking on the arrow. When you do this a list of the possibilities will drop down and you can select one of these by clicking on it. The following values need to be selected.

Fleet Select a fleet from the drop down list. In most on-board cases, you will have only one choice, the fleet to which your ship belongs,

[1] On most systems, the icon can be drag and dropped onto the panel (or dock). Then it is always visible and you can launch Mate with a single click.

in which case you can ignore this box.

Ship Select a ship from the drop down list. In most on-board situations, you will have only one choice, your own ship, in which case you can ignore this box.

Voyage Number This variable determines the voyage (or `TEST`) folder in which the Mate calculations will take place and the reports will be filed. That folder will be `/`*F*`/`*ss*`/V/`*NNN*`/CARGO` where *F* is your fleet code, *ss* is your ship code, and *NNN* is the three digit voyage number. See Section 2.3 for what little you need to know about Mate's filing system. The voyage number must be exactly three digits. The ship's seventh voyage has a voyage number of `007`, not `7`. Initially, Mate will display the ship's current voyage (or `TEST` if none exists).

The list will show all the ship's past voyages, plus `TEST` and `NEXT`.[2] `TEST` should be used for Mate testing and training to avoid conflicts with the real voyages. If `NEXT` is selected, Mate will create a new voyage directory whose number is one greater than the largest voyage number which already exists.[3]

Loading pattern Select an initial loading pattern from the drop down list. This is the loading pattern from which the Mate calculations will commence. Initially, Mate will display the voyage's most recently modified loading pattern in this field. Attempt to pick a pattern that is as close to the one you expect to end up with as possible. However, you will be limited in your choices to the patterns already in the selected voyage directory. If you want a more complete choice of initial patterns, you will have to work from the command line.

If there are no load files in the selected directory, Mate will put a small number of standard loading patterns in the directory.

After you are satisfied with the start up form, click on the MATE button and, after a short delay, a large window, the Mate Mainscreen, will pop up.[4] You will also get a background window entitled Mate_Log_File. This background window will keep track of warning

[2] And possibly `DEMO`. `DEMO` applies only to the CTX Mate demonstration ships.

[3] Some owners restrict the creation of new Voyage directories in which case an attempt to make a new voyage directory from the Mate start-up form will raise an error. In this case, ask your Captain or other authorized personnel to create the new directory for you.

[4] Provided you have the proper permissions, and Mate's self-test is successfully completed. If you don't get a Mainscreen, check the launch window for error messages. To

messages and, God forbid, abnormal errors. It will be almost entirely obscured by Mate's Mainscreen. If Mate is not responding the way you think it should, move the Mainscreen to the right to read the Log File. With luck, it will explain what the problem is. In the rest of this manual, the Log File is referred to as the *launch window*.

It is possible and easy to run multiple Mate sessions at the same time. Simply click on the Mate icon more than once. However, if you do this, we strongly recommend that you put each Mate session on a different desktop For example, you might have one session monitoring a discharge in Auto mode (taking readings directly from the ullaging system) on one desktop and another Normal mode planning session where you are working out your post-discharge ballasting pattern on another desktop. Multiple Mate sessions on the same screen can get confusing.

Now turn to Chapter 3 for instructions on manipulating the Mainscreen.

2.2 Starting Mate from the command line

Starting Mate from a desktop icon is convenient but limiting. To obtain the full power and flexibility of Mate, it must be started from the command line. And ***with practice*** you will find that the command line method is not only more powerful, but where multiple runs are involved — as they almost always are — can be quicker and easier. However, command line use (and this section) assumes that you know how to bring up a terminal window, copy and move files, and move around the file system using the change directory command (`cd` or equivalent).

Mate should always be used from the proper directory which for normal operations is `/`*F*`/`*ss*`/V/`*NNN*`/CARGO` where *F* is your fleet code, *ss* is your ship code, and *NNN* is the three digit voyage number. See Section 2.3 for what little you need to know about Mate's filing system.[5] All

run Mate, you must have Read permission on the ship's Mate data directory and Write permission on the voyage directory you are working in. See Section 2.3.

[5] For training purposes and only for training purposes, run Mate from the `/`*F*`/`*ss*`/V/TEST` directory. Load files in `V/TEST` cannot be protected. Any work you do in `V/TEST` will eventually be over-written and lost.

In non-operational environments – for example, when Mate is being used as a tanker design or evaluation tool – Mate may be run in non-voyage directories. See Section 2.4.

the documents for this voyage's load/discharges should be filed in this directory.

You will need a *loadfile* containing an initial loading pattern. If a file containing a suitable such pattern does not already exist in the current directory, copy one in. Usually the initial loading pattern will be a loading pattern similar to the one you intend to use; but it can be any loading pattern that has all the tanks that you will be using. If no other pattern exists, you may copy `/`*F*`/`*ss*`/DATA/MATE/lf_ltwt`. Then to run Mate simply issue

```
mate lf_ltwt &
```

And a large window called the Mainscreen will appear. To repeat, to run Mate:

1. Switch to the directory appropriate for the load/discharge to be analyzed.
2. Type
   `mate` *loadfile* `&`
   where *loadfile* is the name of a loading pattern file which must be in the same directory.

That's all there is to it. The window in which you type the `mate` command is called the *launch window*. The ampersand at the end of the above command is optional but it allows you to be able to use the launch window while you are running Mate. If you do not have the proper permissions, or Mate detects an unrecoverable error in the input or encounters other unusual problems, it will print an error message to the launch window and (sometimes) abort. If things appear amiss, check the launch window for error messages, and then refer to Chapter 22.

The above example assumes that the fleet code and ship code has been properly set for the ship of interest. On-board this will always be the case. In the office, where we have to deal with a number of different ships, Mate uses the environment variable FLEET to keep track of the fleet code and the environment variable SHIP for the ship code. On some systems, these two environment variables are automatically set whenever you switch to a particular ship's directory, which is normally exactly what you want. These two variables can also be set manually by issuing

`mate --fleet=`*F* `--ship=`*ss* *loadfile*

where F is the desired fleet code and ss is the desired ship code You will only need to reset the FLEET or SHIP variables when you change fleet or ship.

Finally, you can include `--voy=`*NNN* in the command line to both switch you to particular voyage directory and set the VOY environmental variable. For example,

```
mate --fleet=A --ship=em --voy=TEST lf_selftest
```

will run Mate on `lf.selftest` in the `V/TEST` directory of `A` fleet ship `em`.[6] Once again you will only have to reset VOY when you change voyages.

Notice that Mate's loading pattern files start with `lf_`, that's ell-eff. If you create a load file manually, always follow this convention. Conversely, files that are not Mate loading patterns should never start with `lf_`.

[6] `-f` is shorthand for –fleet=. `-s` is shorthand for `--ship=`. `-v` is shorthand for –voy=. So the shorthand form of this command is `mate -fA -sem -vTEST lf_selftest`.

2.3 The CTX Mate Folders

Mate is designed to be very easy to use, ***but not without some preliminaries***.[7] Before you can begin to use CTX Mate, you must understand the file folder system Mate uses.

Mate assumes that the Tanker File System (TFS) is broken down by fleet and within fleet by ship.[8] Each fleet (there may only be one in your case) is given a one character *fleet code*, and a top level directory whose name is the fleet code.[9] Thus, if your owner or manager is responsible for three fleets: they might be assigned fleet codes: `A`, `B` and `C`. And there will be three top level fleet directories: `/A`, `/B` and `/C`.[10] If your ship is in the `B` fleet, then you will probably only have the `/B` directory on your on-board computer.

Within each fleet, each ship is given a two to four character *ship code*. For example, if fleet `A` consists of the ships, Alhambra, Orpheum and Tara. These ships might be given ship codes of `al`, `or`, and `ta`. And each such ship will be given a sub-directory in the `A` fleet directory whose name is the ship code. In this case, there will be three ship directories `/A/al`, `/A/or`, `/A/ta` in the `/A` fleet directory. On-board, you will probably only have your own ship's ship directory.[11]

All of the information pertaining to a particular ship should be filed somewhere in that ship's ship directory. If your owner follows the CTX Tanker Filing System (TFS), the complete description of where all this data must be filed is given in The CTX Tanker Filing System Manual**??** which runs to several hundred pages. Fortunately, for Mate purposes, only a very small portion of the TFS is relevent or necessary. In fact, we only need to deal with the following folders.

---

[7] Commercial programs on the other hand are designed to easy to start up without any preliminaries. Commercial vendors know this is an important selling point. The cost of this is that it is extremely difficult to integrate the loading program within an overall tanker management system.

[8] This is hardly a CTX invention. Almost all owners and ship managers do this, but often the system is not fully enforced across the organization.

[9] For the purposes of this manual, folder and directory are synonyms.

[10] Some owners use fleet code `X` for ships they have interest in but don't actually own; for example, a ship they are considering purchasing.

[11] The ship code need only be unique within a fleet. In the preliminary design context, the fleet code often signifies a project ID and the ship code becomes a varient design, eg `/A/0021/`, might be the 21st varient in a project to design an Aframax tanker. In the newbuilding contest, fleet code often is really a yard code, and ship code becomes a hull number.

***/fleet/ship*/DATA/MATE** This is the read-only folder where all the ship's data Mate needs is stored. This includes, the ship particulars, hull offsets, tank descriptions, lightweight distribution, allowables, etc. For a typical tanker, this directory contains some 60 files. In order to use Mate, you must have Read permission on this directory. All the data is in human readable, self-identifying form. You can examine any of these files (for example, with an editor); but you cannot change them.

***/fleet/ship*/V/*voy*/CARGO** Each voyage is given its own folder in the TFS. This folder, whose name is the *voyage number* is in the ship's V directory. The voyage number is three digits, sequential including the leading zeros: `001`, `002`, and so on. The cargo related data for each voyage is filed in that voyage's, `CARGO` folder. If your ships is currently on her 19th voyage, then everything to do with cargo handling on this voyage, should be in */fleet/ship*`/V/019/CARGO`. This is where Mate's loading patterns for the 19th voyage should be filed. In order to use Mate operationally, you must have Write permission on the CARGO sub-directories.

***/fleet/ship*/V/TEST** `V/TEST` is a special directory where you can play around with Mate without affecting any of the "real" loading patterns in the voyage CARGO folders. It is intended for training and testing only. Never use `V/TEST` for real loading patterns. Files in this directory cannot be protected and will eventually be over-written and lost.

2.4 Using Mate outside the Tanker File System

It is possible to use Mate without accepting any part of the CTX Tanker File System. This can be useful is some non-operational applications; but is almost always a terrible idea on-board in actual tanker operations.

You may specify the three folders that Mate needs directly via issuing the following command

`mate --ship_dir=`*xxxx* `--load_dir=`*yyyy* `--rep_dir=`*zzzz* *loadfile*

where *xxxx* is the full pathname of the directory containing Mate's ship data, *yyyy* is the full pathname of the directory containing the intial loading pattern file, *zzzz* is the full pathname of the directory where you want the reports to be filed, and *loadfile* is the initial loading file name. If you delete the `--rep_dir` option, Mate will assume that the report directory is the same as the `load_dir`. These options will override the current FLEET, SHIP and VOY variables. You must have Read permission on `ship_dir` and `load_dir` and Write permission on `rep_dir`.

This form of the Mate command can be used if you want to base a Mate report on a loading pattern which is in a directory for which you do not have Write permission. For example, an owner may elect to put the loading patterns that are sent in from the ships in folders which are read-only for office personnel to prevent the office from inadvertantly (or otherwise) changing these patterns.

Tha real intended use of this form of the Mate command is in non-operational applications where the /fleet/ship/voyage breakdown is not appropriate. But it can used operationally by owners who for whatever reason do not think this is a logical structure. However, if they do so, they will not be able to launch Mate from the desktop.[12]

[12] Unless they write a specialized start-up script. This is not a big job. See the Mate Programmer's Manual.

Chapter 3

The Mainscreen

3.1 The Five Sections

When you start Mate either by clicking on Go in the start-up form or with a `mate` command, it will take Mate a few seconds to read in all the hull and tank offsets and then balance the ship for the initial loading pattern. If all goes well, Mate will then display a large window. which is known as the *Mainscreen*. Figure 3.1 show a highly simplified Mainscreen. [1] To see the Mainscreen in all its glory, fire up a Mate session. The Mainscreen will stay on your terminal until you end this Mate session. To activate the Mainscreen, the mouse must be somewhere in this window.

The Mainscreen consists of five sections:

Titlebar Along the top of the window, you will find a *Titlebar* which shows the ship's name and the key options being used in this run including the name of the current loading pattern. These somewhat cryptic options are explained in Section 3.6. You can use the Titlebar to move the Mainscreen around, resize it, and iconify it – just like any other window.

Menubar Just below the Titlebar, you will find the *Menubar*, from which all Mate functions can be accessed via dropdown menus. The individual menus are discussed in Section 3.4.

[1] Figure 3.1 shows Mate in Normal mode. In Damage and Auto modes, the Mainscreen will look a little different. These differences are discussed in Chapters 16 and 15 respectively.

Tank Table Most of the Mainscreen is taken up by the *Tank Table*. The Tank Table contains one row for each tank/compartment.[2] You probably cannot see all the tanks at once. Fortunately, the Tank Table is scrollable. One of the cells in the Tank Table is highlighted. The *highlighted* cell is shown in a different color from the other cells and it contains a blinking editing cursor. You can change the highlighted cell with the arrow keys moving about the Tank Table at will. When you attempt to move the highlighted cell off the table, the table will scroll if the table extends beyond that edge. Therefore, if you want to scroll the table up, move the highlighted cell down to the bottom with the DOWN-ARROW key. When it hits the bottom line of the Tank Table, the next DOWN-ARROW press will scroll the table up one line, if lines at the bottom are currently obscured. You can also move about the table with the mouse by positioning the mouse pointer over a cell and clicking on it. The highlight will move to the cell that you just clicked on. But you can't scroll the table with the mouse. The Tank Table also scrolls horizontally via the LEFT-ARROW and RIGHT-ARROW keys but this is usually necessary only in damage calculations.

At the bottom of the Tank Table, there will be one row for each *point load*. Point loads are weights that count against deadweight but are not treated as liquid. These include such things as crew, stores, fluids in engine room piping, and possibly very small tanks.

It is by making changes to the Tank Table that you will create new loading patterns to study. This process is described in Section 3.2.

Summary The fourth section of the Mainscreen is the *Summary*. This area displays the main results from the most recent recomputation of the hull balance. Most of the entries are self-explanatory. However, if in doubt, check the Glossary for a complete set of definitions. The Summary is described in Section 3.3. You cannot change any part of the Summary section directly.

If you change the loading pattern by editing the Tank Table, the Summary will not change until you rebalance the ship. Until this

[2] Mate's "tanks" include all the major compartments in the hull. As far as Mate is concerned, an Engine Room or a Pump Room is a perfectly good "tank" and such tanks can be crucially important in damaged situations. Howvever, as we shall see, an empty/dry tank/compartment may be *hidden*, in which case that compartment will not be displayed in the Tank Table unless the proper `show_hidden` option is ineffect.

is done, the Summary will not be consistent with the Tank Table loading pattern. When this happens the background color of the Summary will switch to yellow to warn you of that fact.

Toolbar The final section of the Mainscreen is a *Toolbar* that runs along the bottom. It contains 12 buttons which match the 12 Function keys at the top of your keyboard. The most common and/or critical Mate functions can be accessed with a single click via the Toolbar. You may tell Mate which Toolbar function you want by either clicking on that button in the Toolbar or by hitting the corresponding Function key. The Toolbar is discussed in Section 3.5.

You can exit a Mate session several ways:

1. Selecting Quit from the File menu or directly from the Toolbar.
2. Hitting Shift-F12.
3. Clicking on the X button in the Title bar.
4. Typing Cntl-C in the Launch window.

In the first case, you will be warned if the current loading pattern has not been saved. Mate will ask if you really want to quit. Hitting Shift-F12 ends the Mate session without asking for confirmation. ***The current loading pattern will be lost unless you save it first.*** Quit will not work until Mate finishes whatever it is doing. If you start a very long computation that you want to abort, or you just get hopelessly messed up, you can always get rid of the current Mate session by hitting Cntl-C (Hold down the Control key and hit C) with the cursor in the launch window. Of course, you will lose the current loading pattern unless you have already saved it.

Leaving Mate via Cntl-C has another, more important purpose. Mate automatically maintains a Log File of all its operations in a particular session. Normally, this Log File together with a number of other temporary files is deleted at the end of the session.[3] But if you exit Mate by hitting Cntl-C, these files are not deleted. If you think Mate is not functioning properly, use Cntl-C to quit; and you will have a history of the session in the Log File which should be emailed to CTX together with your comments. See Chapter 17 for details.

One drawback of using Cntl-C is that these temporary files will have to be removed manually.

[3] If Mate thinks that something is amiss, the Log File will be saved automatically.

The Mate Mainscreen is simply one more window on your monitor. By moving the mouse off the Mainscreen, you can do anything you want in other windows (including starting up another Mate session). Thus you can be looking at an Mate run while you prepare a telex or email into which you insert some of the information on the Mate screen. Conversely, unless the mouse pointer is somewhere on the Mate screen, the screen where it is will receive all your input not Mate. So you can activate and deactivate the Mate screen by moving the pointer on and off of it.

While the Mainscreen is showing, anyone who has access to the keyboard can use any of these commands, potentially wiping out a valuable file. If the Chief Mate leaves the keyboard, he should move the mouse off the Mainscreen to make this a little more difficult. Of course, if the Chief Mate is going to leave the Cargo Control Room, he should save the current loadfile and log off. Otherwise, not just Mate but the entire portion of The File System to which working group `CMATE` has access is open to anyone who wanders into the CCR. It will only take a few seconds to bring Mate back, when he returns.

If you haven't done so already, start a Mate session and play around with the above commands. Do this in `/`*fleet*`/`*ship*`/V/TEST` to avoid interfering with the "real" loading patterns.

Figure 3.1: Simplified Normal Mode Mainscreen

```
CTX MATE 0.40-BASE using AT SEA, API/SG .01/.0001, F/C .1/.01, 0_Inn/Wedge for HELLESPONT TARA on /X/uldh/V/DEMO/lf.al98dep

File   Edit   View   Export   Cargo   Reports   Mode   Options   Rounding   Sort                                                Help

  TANK  |O|PT|CGO| API | TEMP|  SG  |ULLAGE|INNAGE|%FULL | VOLUME | WEIGHT |FREEWTR|NONLIQ|  GSV   | Wtrvol | Nonvol |  GOV   | OFF    |

1C      |P|UL|AL| 34.56| 60.0|0.8502|26.301| 6.549| 20.00|   51752|  6995.3|    0.0|   0.0|   51752|    0.0 |    0.0 |   51752|        |
2C      |P|UL|AL| 34.56| 60.0|0.8502| 1.140|31.716| 98.00|  299519| 40485.9|    0.0|   0.0|  299519|    0.0 |    0.0 |  299519|        |
3C      |P|UL|AL| 34.56| 60.0|0.8502| 1.138|31.710| 98.00|  299518| 40485.9|    0.0|   0.0|  299518|    0.0 |    0.0 |  299518|        |
4C      |P|UL|AL| 34.56| 60.0|0.8502| 1.147|31.716| 98.00|  299518| 40485.9|    0.0|   0.0|  299518|    0.0 |    0.0 |  299518|        |
5C      |P|UL|AL| 34.56| 60.0|0.8502| 1.205|31.657| 98.00|  271983| 36764.0|    0.0|   0.0|  271983|    0.0 |    0.0 |  271983|        |
1P      |P|UL|AL| 34.56| 60.0|0.8502| 1.122|31.284| 98.00|  137464| 18581.0|    0.0|   0.0|  137464|    0.0 |    0.0 |  137464|        |
1S      |P|UL|AL| 34.56| 60.0|0.8502| 1.118|31.281| 98.00|  137464| 18581.0|    0.0|   0.0|  137464|    0.0 |    0.0 |  137464|        |
2F_P    |P|UL|AL| 34.56| 60.0|0.8502| 1.518|30.885| 98.00|   93801| 12679.1|    0.0|   0.0|   93801|    0.0 |    0.0 |   93801|        |
2F_S    |P|UL|AL| 34.56| 60.0|0.8502| 1.404|30.905| 98.00|   93801| 12679.1|    0.0|   0.0|   93801|    0.0 |    0.0 |   93801|        |
2A_P    |P|UL|AL| 34.56| 60.0|0.8502| 1.595|30.862| 98.00|   93801| 12679.1|    0.0|   0.0|   93801|    0.0 |    0.0 |   93801|        |
2A_S    |P|UL|AL| 34.56| 60.0|0.8502| 1.505|30.888| 98.00|   93801| 12679.1|    0.0|   0.0|   93801|    0.0 |    0.0 |   93801|        |
3P      |P|UL|AL| 34.56| 60.0|0.8502| 1.353|31.042| 98.00|  187601| 25358.0|    0.0|   0.0|  187601|    0.0 |    0.0 |  187601|        |
3S      |P|UL|AL| 34.56| 60.0|0.8502| 1.345|31.064| 98.00|  187601| 25358.0|    0.0|   0.0|  187601|    0.0 |    0.0 |  187601|        |
4F_P    |P|UL|AL| 34.56| 60.0|0.8502| 1.510|30.885| 98.00|   93801| 12679.1|    0.0|   0.0|   93801|    0.0 |    0.0 |   93801|        |
4F_S    |P|UL|AL| 34.56| 60.0|0.8502| 1.485|30.909| 98.00|   93801| 12679.1|    0.0|   0.0|   93801|    0.0 |    0.0 |   93801|        |
4A_P    |P|UL|AL| 34.56| 60.0|0.8502| 1.541|30.853| 98.00|   93801| 12679.1|    0.0|   0.0|   93801|    0.0 |    0.0 |   93801|        |
4A_S    |P|UL|AL| 34.56| 60.0|0.8502| 1.523|30.877| 98.00|   93801| 12679.1|    0.0|   0.0|   93801|    0.0 |    0.0 |   93801|        |
5P      |P|UL|AL| 34.56| 60.0|0.8502| 1.599|30.854| 98.00|  130263| 17607.6|    0.0|   0.0|  130263|    0.0 |    0.0 |  130263|        |
5S      |P|UL|AL| 34.56| 60.0|0.8502| 1.565|30.879| 98.00|  130263| 17607.6|    0.0|   0.0|  130263|    0.0 |    0.0 |  130263|        |
SLOP_P  |P|UL|AL| 34.56| 60.0|0.8502| 1.617|31.011| 98.00|   41112|  5557.1|    0.0|   0.0|   41112|    0.0 |    0.0 |   41112|        |
SLOP_S  |P|UL|AL| 34.56| 60.0|0.8502| 1.559|31.074| 98.00|   40061|  5415.0|    0.0|   0.0|   40061|    0.0 |    0.0 |   40061|        |
1FO_P   |P|UL|f1|0.9876|15.00|0.9876| 2.576|23.551| 90.92|  3458.2|  3415.4|    0.0|   0.0|  3458.2|    0.0 |    0.0 |  3458.2|        |
1FO_S   |P|UL|f1|0.9876|15.00|0.9876| 2.797|23.239| 90.92|  4150.8|  4099.3|    0.0|   0.0|  4150.8|    0.0 |    0.0 |  4150.8|        |
2FO_P   |P|UL|f1|0.9876|15.00|0.9876| 1.666|14.156| 90.92|  1240.8|  1225.4|    0.0|   0.0|  1240.8|    0.0 |    0.0 |  1240.8|        |
2FO_S   |P|UL|f1|0.9876|15.00|0.9876| 1.157|13.752| 90.92|   805.9|   795.9|    0.0|   0.0|   805.9|    0.0 |    0.0 |   805.9|        |
3FO_P   |P|UL|f1|0.9876|15.00|0.9876| 1.396|12.328| 90.92|   603.0|   595.5|    0.0|   0.0|   603.0|    0.0 |    0.0 |   603.0|        |
3FO_S   |P|UL|f1|0.9876|15.00|0.9876| 1.300|12.211| 90.92|   603.0|   595.5|    0.0|   0.0|   603.0|    0.0 |    0.0 |   603.0|        |
FO_SET_P|P|UL|f1|0.9876|15.00|0.9876| 7.819|11.804| 90.92|   250.1|   247.0|    0.0|   0.0|   250.1|    0.0 |    0.0 |   250.1|        |
FOSRVSTP|P|UL|f1|0.9876|15.00|0.9876| 7.489|11.810| 90.92|   250.1|   247.0|    0.0|   0.0|   250.1|    0.0 |    0.0 |   250.1|        |
FO_SRV_P|P|UL|f1|0.9876|15.00|0.9876| 7.461|11.850| 90.92|   190.8|   188.5|    0.0|   0.0|   190.8|    0.0 |    0.0 |   190.8|        |
CREW    | |  |  |      |     |      |      |      |      |        |     5.0|       |      |        |        |        |        |        |

DWT     412129  29432 LT Sdwt  DRAFTMID  23.240  AL 2964525 TOV  2964525 GSV  400715 MT  BLINDZONE     365  LOW_PT   -26.76  DRAFT MARKS
CARGO   400715 TPC      231.8  DRAFT AP  26.892                                          MANI_HT_S  12.457  DEPTH    100.00  AftP 26.641
BLLST        0 MTC       6098  DRAFT FP  19.588                                          MANI_HT_P  12.318  MIN_FLOOD  5.26  AftS 26.548
BFO      11409 WETTED   36332  TRIM      -7.304                                          DISPLCMENT 480052  AT        FR013  MidP 23.497
OTHER        5 SEA_SG  1.0234  HEEL      -0.136                                          MAX SHEAR   19843  LCB      186.66  MidS 23.336
MAX %SHEAR  -70.7% at   FR040  PROP IMM  15.000                                          MAX BEND -1614795  TCB        0.04  FwdP 19.950
MAX %BEND  -148.1% at   FR090  GM corr    8.802                                          MAX HOG    -0.416  VCB       12.24  FwdS 19.866

   REDO     PARCELS    SAVE_LD    PRINT          BEND.       STAB.      FLOOD      DAMAGE        VISUAL   REG_25     UNUSED        QUIT
```

3.2 The Tank Table

3.2.1 Editing the Tank Table

Making changes to a loading pattern via the Tank Table is straightforward.

1. When the Mainscreen first appears, the highlighted cell will be in the top row of the Tank Table. Move the highlight to the cell you want to change either by clicking on the desired cell or by using the arrow keys. You may have to use the arrow keys to scroll to the cell you want to change.
2. Once the highlight is on the right cell, simply type in the new value. As soon as you start typing, the old value will disappear. By hitting Escape before leaving the cell, you can make it reappear. You can Backspace over any mistakes. A blinking cursor indicates where you are in the cell.
   You can overwrite individual letters or numbers by hitting the Insert key. The blinking cursor will change color and become fatter. While in this mode, any (legal) character you type in will overwrite the character under the cursor. To move the blinking cursor without destroying anything, use Ctrl-Left (Hold the Control key down and press LEFT ARROW) and Ctrl-Right. To revert to the normal mode, hit the Insert key again.
   Mate will reject entries which it can see are illegal – for example, a letter in a cell which should be a number. In this case, it will beep and ignore your entry. It will reject any attempt to enter data into a column which is display only and sometimes will automatically move you to what it thinks is the proper column. For example, if you have specified tank option U (user enters ullage) and you attempt to change the Innage column for that tank, Mate will reject the entry and move to the Ullage column.[4]
3. When you are satisfied, leave the cell either by hitting Return (labeled Enter on some key boards) or by using the arrow keys. *The change has no effect until you leave the cell or hit one of the commands that rebalance the ship.* When you leave a changed

[4] Sometimes Mate will move to a column which is not in the currently visible portion of the Tank Table. This is a nuisance for it will appear that you have lost the highlighted cell. Either click on another cell or scroll the table sideways until the highlighted cell appears. We hope to fix this in future versions of Mate.

cell, the cell will change color for a moment. This tells you that the new value has been accepted. Until you see the color flash, the old value is in effect. If you leave a cell and then decide you made a mistake and want the old value back, you must make the cell all blanks, leave it, rebalance, and the old value will be restored. Obviously, it's simpler to hit Escape before leaving the cell. *Also, if you want to set a cell to zero, you must type in a zero, not blanks.*

Both the Down Arrow key and the Return (aka Enter) key will move you down one row. But there is an important and useful distinction. If you leave a cell by hitting Return, Return will remember that entry. If you hit Return again upon entering another cell, the new cell's value will be replaced by the last cell you left via Return. Say you want to change a whole bunch of tanks to the same value, say 98% full.[5] Go to the top of the `%FULL` column, change the value to 98.0 and hit Return. Then just keep hitting Returns and each tank in turn will be changed to 98.0. This only works for Return, so if you want to skip one or more tanks (not change them to 98), use the Down Arrow to move over those rows. And this only works if Return is the *first* key you hit upon entering a cell. To repeat: *if Return is the first key press in any cell, that cell will be immediately changed to the same value as the last cell which was left by hitting Return.* This can be a big time-saver in the early stages of searching for the best loading pattern.

3.2.2 The Tank Table Columns

Making changes is easy; but what are we changing? Here starting from the left are the columns in the Tank Table and their meanings:[6]

TANK The leftmost column contains the tank/compartment code. You cannot change the tank code column.[7] This means that you cannot add a tank or compartment that is not already in the initial loading pattern from the Main Screen. To do this you must either select the SHOW_HIDDEN option from the View

[5] This example assumes that OPT has been set to `P` for all these tanks, but the same trick works for ullages and innages provided the OPT is properly set.

[6] These are the Normal and Auto mode columns. Damage mode has a somewhat different set of columns. See Chapter 16.

[7] But you can re-order the tanks via the Sort menu.

menu (See Section 3.4 or edit the loadfile directly (See Chapter 6).

At the bottom of the Tank Table, most loading patterns will have one or more "tanks" for which the CGO (third column) is `fi`. Each such row is not a tank but a *point load* that is regarded as fixed in space. Such loads include stores, crew and effects, minor tanks which are not explicitly included in the tanks listed in the loading pattern, etc.

OPT The second column is labeled OPT. This is a very important column by which the user specifies which tank OPTion to use for each tank. His possible choices and their meanings are:

U Tank is intact, user wishes to specify ullage.[8]

I Tank intact, user wishes to specify innage

P Tank intact, users wishes to specify percent full (volumetrically)

V Tank intact, users wishes to specify volume directly

W Tank intact, users wishes to specify weight directly

E Tank is intact and empty.

H Tank is intact and empty and hidden.

F Tank is free flooding, started out empty

D Tank is damaged, user wishes to specify damage location and ullage space pressure (often 0 gage for a vented tank).

S Tank is damaged and sealed. In this case, Mate's uses the perfect gas law to estimate the equilibrium ullage space pressure. This OPT can be chosen only in Damage mode.

G Tank is to be grouped with another tank, that is, this tank should be treated as if were part of the tank with which it is grouped. This OPT can be chosen only in Damage mode. This option is used to model certain kinds on internal damage or purposely connecting two tanks in order to reduce outflow. See Chapter 16 for details.

OPT can be entered in either upper or lower case, but lower case will be converted to upper. Notice the tank option is a single

[8] If you have specified a pressure sensing, `H` type gauging system (see PT below), ullage has no real meaning. Therefore, Mate will not accept an OPT of `U` for tanks with H type gauging systems. In this case, Mate will change the OPT to `I` with a warning telling you why it had to make this change.

character and there are only a few legal values. Anything else will be rejected. *Depending on the value of OPT, only changes in certain columns have any impact on the rebalance.* If OPT is `U`, only ullage counts and changes in the INNAGE, %FULL, VOLUME, and WEIGHT columns will have no effect and are rejected. Similarly, if opt is `P`, then only %FULL counts and changes in ULLAGE, INNAGE, VOLUME, and WEIGHT are rejected. In short, always check the OPT column when making a change to a particular tank. If you want to change the %FULL and OPT is `U`, you must change OPT to `P` (or `p`) before entering the percent full.

For point loads, OPT has no meaning and is blank.

PT The third column contains a two character code specifying the Gauging Point/Measurement System which was used in making the reading. Mate allows each tank to have multiple dipping points/measurement systems which means you must specify which one you are currently using. The code must match one of the dipping points in the tank's CTX file. Case is important: `WH` and `wh` are different. If you try to enter a dipping point code that does not exist for a particular tank, Mate will reject it and give you an error message which include the list of legal codes.

why not allow lower case input, easier to type, less mistakes

The conventional dipping point coding is:

UL Ullage lid (and in most case the official tank table gauging point)

WH Whessoe Gauge

SA Saab Radar

D1 UTI point 1

D2 UTI point 2

But this is just a convention which can be altered by owner or yard policy. Notice a dipping point is a combination of both a location and a method. As far as Mate is concerned, a tank could have multiple radar gauges each with its own location. The advantage of multiple dipping points is that the Chief Mate never has to compute a trim (or heel) correction as he moves from one dipping point/measuring system to another.

The Dipping Point code performs one other function. Some gauging systems work in earth coordinates, that is, they point downward toward the center of the earth regardless of the ship's trim

or heel. A surveyor's tape will do this provided it doesn't hit any structure. Other systems are tied to the ship and their idea of down is really parallel to the ship's bulkheads. Whessoe gauges and Saab radars fit into this category (as does reading draft marks). Still others, such as sounding pipes, follow a wiggly path while pressure sensors work in earth coordinates but the fixed point is near the bottom of the tank rather than the top. The PT code tells Mate which category the gauging system fall into.

Another example of this nitpicking is the difference between draft and depth. Mate reports the draft as measured by the ship's draft marks, which are parallel to the ship's transverse bulkheads. Mate reports depth, for example the hull's `LOW_PT`, as measured by a plumb bob. Therefore, if the ship has substantial heel and/or trim, the maximum draft might be 22 m and the low point might be -21.8 m (21.8 m below waterlevel). For normal heel and trim, the difference is usually negligible, but in damage situations the difference can be very significant.

For point loads, Mate ignores ithe PT column.

CGO The fourth column is the tank's parcel code which must be one of the two-character codes in the first column of the loading pattern's Parcel Screen (see Section 4.1), or `sw` if the tank liquid is sea water whose density is the same as the external sea water.[9] Blanks are allowed in this column only if the tank is empty, hidden, or free-flooding. This column tells Mate which liquid is in each tank. If you want to switch parcels around, simply change the corresponding parcel codes. Case is important. The *Parcel Screen* screen is the only way the user can specify a parcel density. For example, if the charterer wants to load two batches of "Arab Light" with differing API's, there must be two lines in the Parcel Screen, one called say `A1` and another say `A2` and Mate will handle the situation correctly. For damaged tanks, this column must be the pre-damage parcel or `sw` if the tank was empty prior to damage.

[9] If this is your first experience with Mate, click on the Parcels button in the Toolbar. This will pop up a window which displays all the liquid parcels in the current loading pattern. Each tank's CGO code must match one of the parcel codes in the left most column of the Parcel Screen (or `sw`). Return to the Mainscreen by clicking the Return button on the Parcel Screen.

If you need to add a new parcel that is not already showing on the Parcel Screen, you must add it to the Parcel Screen before entering that parcel code on the Mainscreen. Conversely, if you wish to delete a parcel entirely, you must remove that parcel code from all tanks on the Mainscreen before removing that parcel from the Parcel Screen.

API API is a read only column which shows the tank liquid's density at standard conditions as given on the Parcel Screen. If the parcel's *method* as shown on the Parcel Screen (2nd column) is `C` (Table 6A) or `F` (Table 6B), the standard density will be shown in API degrees at 60F. Otherwise, the standard density will be shown as specific gravity. API's are shown to two decimal points, specific gravities to three decimal points. You can not change the standard density of a parcel on the Mainscreen. To change the API or specific gravity of a parcel, you must edit the Parcel Screen. See Section 4.1.

TEMP This column contains the average tank temperature. If the parcel's method as shown on the Parcel Screen is `C` (Table 6A) or `F` (Table 6B), the temperature will be shown in Fahrenheit degrees to a tenth of a degree. Otherwise the temperature will be shown in degrees Celsius to one hundreth of a degree. The user may change the temperature as desired within reasonable limits but temperature will only affect the density of those liquids whose parcel method is `C`, `F`, `c`, or `P`.

DENSITY This is a read only column showing Mate's computed density for each tank. For parcel's whose method is C, this will be computed by using Table 6A. For parcel's whose method is F, this will be computed by using Table 6B. For parcel's whose method is c, this will be computed by using Table 54A. For parcel's whose method is P, this will be computed by using Table 54B. For other parcel methods, the density is fixed and independent of temperature and this column will simply show the density given on the Parcel Screen.

Be aware that the computed density can be affected by the rounding options that are in effect at the time. Mate implements a number of different rounding options with respect to VCF, standard density/API, and temperature. These are described in Section 14.2. Regardless of the rounding options, Mate shows the standard density/API and temperature as the user entered them.

ULLAGE This column displays the tank ullage in meters. Changes to this column have no effect on the rebalance unless OPT is `U` or `u`.

INNAGE This column displays the tank innage in meters. Changes to this column have no effect on the rebalance unless OPT is `I` or `i`. When you switch from ullage to innage in the last stages of discharge, make sure you change OPT.

%FULL This column displays the ratio of tank TOV (Total Observed Volume) to the nominal capacity of the tank at 100%. Changes to this column have no effect on the rebalance unless OPT is `P` or `p` or the tank is damaged in which case it refers to the pre-damage situation. %FULL is the normal way of trying out loading patterns when you are planning the voyage. %FULL is also often used in design studies.

VOLUME This column displays the TOV of the tank. If the tank parcel's method is C (Table 6A) or F (Table 6B), the volume will be shown in barrels to the nearest barrel. Otherwise it will be displayed in cubic meters to the nearest tenth of a cubic meter. The diffence in the decimal point tells you which unit is being used for a particular tank.[10]

Changes to this column have no effect on the rebalance unless OPT is `V` or `v`. `V` is often used in entering bunker and engine room tank data.

WEIGHT This column displays the tank weight in metric tons. Changes to this column have no effect on the rebalance unless OPT is `W` or `w`. Point loads weights are entered in this column.

FREEWTR This column displays the free-water innage in cm. This number should be the distance from the sounding plate to the oil-water interface. The free-water volume that will be calculated is the tank volume at this innage less any non-liquid volume. Remember blank means use old number. If you want to change to zero, you must type in a zero; not a blank.

NONLIQ This column displays the non-liquid (often called unpumpables) innage in cm. In computing non-liquid volume, Mate assumes the non-pumpables flow sufficiently so that the top of this material is

[10] The user can force Mate to always display cubic meters via the use_metric option in the Options menu.

parallel to the sea surface. For near-zero trim, this can underestimate sediment volume if NONLIQ is based only on dips at the aft end of the tank. In such situations, it will be more accurate to use an average of the non-liquid innages measured at various points in the tank.

Mate also assumes that any free-water always lies on top of the non-pumpables. Therefore, the free-water innage in each tank must always be at least as large as the non-liquid innage. To handle a tank with non-pumpables but no free-water, make the free-water innage the same as the non-liquid innage.

GSV This read-only column displays the tank Gross Standard Volume. This is the GOV (see below) corrected back to the parcel's standard temperature.

WTRVOL This read-only column displays the free water volume in the tank.

NONVOL This read-only column displays the non-liquid (unpumpables) volume in the tank.

GOV This read-only column displays the Gross Observed Volume in the tank. This is the TOV less WTRVOL less NONVOL.

OFF This column controls whether a tank is *offline* during Auto mode. Normally, it is blank; but, if a tank's auto-ullaging system is not working properly, you can set this tank's ullage/innage manually, by putting a `Y` in this column. See Chapter 15 for details. This column has no effect in Normal or Damage modes.

While Mate can immediately reject some nonsensical entries, Mate does not do a full check of the validity of your changes until you call for a rebalance. It then does a rather comprehensive set of checks. If an entry is rejected, Mate will ask for a correction with a pop-up window. Enter the corrected value and Return or you can go back to the old value by hitting Escape.[11]

[11] In some cases, the old value will no longer be legal in which case Mate will force you to enter a new, legal value.

3.3 The Summary

The Summary section is read-only. It is only updated on a hull re-balance. If the you have made changes to the tank data (or parcel data) and have not yet re-balanced, the Summary background color will switch to yellow to alert you of that fact. Otherwise it will be the normal gray.

The Summary Section is nearly self-explanatory. In the upper left-hand corner, the deadweight is compared with the Summer (`Sdwt`), Tropical (`Tdwt`) or Winter deadweight (`Wdwt`) at user option. See Section 3.4 on how to control the loadline option. All deadweight figures are in metric tons. The deadweight is broken down into cargo (including slops and freewater in cargo tanks), ballast (BLLST), bunker fuel oil (BFO), and everything else (OTHER).

TPC is tons per centimeter immersion and MTC is the moment to trim one cm in ton-meters. WETTED is the hull wetted surface in square meters. SEA_SG documents the assumed sea water specific gravity. MAX_%SHEAR shows the worst case shear force relative to the allowable and the longitudinal location of this maximum. MAX_%BEND is the worst case bending moment relative to the allowable and its longitudinal position.

Draft is given at midships, the Aft Perpendicular and the Forward Perpendicular. (Draft marks are rarely at the AP or FP and never on the centerline so these numbers need not match the readings. Mate displays the rigid body draft marks numbers on the far right of the Summary.) Trim by the stern is negative. All these numbers are in meters. Heel is in degrees, positive to starboard. PROP_IMM is the water depth at the top of the propeller. If negative, the tip of the propeller is above the waterline. GM_Corr is the Metacentric Height corrected for free surface in meters.

The Parcel Summary in the center shows the the Total Observed Volume and the Gross Standard Volume of up to seven cargo parcels. This allows the Chief Mate to see immediately the impact of any changes in loading pattern on parcel quantities, so that he can quickly arrive at a loading pattern which best matches the voyage instructions which are usually in terms of GSV. Mate operates exclusively in metric units, with the exception that cargo volume and temperature will be shown in barrels and degrees Farenheit if the parcel VCF method is `C` (Table

6A) or `F` (Table 6B).

On the right side of the parcel section, the Summary shows the blind zone in front of the bow in meters, the vertical distance above the waterline of the starboard and port manifolds, the Displacement, the maximum absolute vertical shear force (excess buoyancy aft is positive), the maximum absolute bending moment (hogging is positive), and the maximum hull deflection (hog is positive, sag is negative).

In the next column, the top row displays the depth of the lowest point on the hull.[12] The second row shows the user specified water depth. If the top row is larger than the second row, the ship is aground. The converse is not necessarily true. You will need some margin. Mate's low point does not account for hull deflection, squat, or wave action.

The third and fourth rows display the distance above the waterline of the lowest downflooding point and the name of that downflooding point. If the distance is negative, then the ship is subject to progressive flooding. In NORMAL mode, you are shown only the lowest downflooding point. To see all the downflooding points, click on the Flood Button. The final three rows show the LCB, TCB and VCB of the hull in ship coordinates.

In Normal and Auto modes, the rightmost column displays the "drafts" at the six draft marks, that is, what a person looking at the draft marks will read. If a draft mark is completely submerged, Mate will show `ALL_WET`.[13] If a draft mark is completely out of the water, Mate will show `ALL_DRY`.[14] Mate, unlike most Trim and Stability Booklets, correctly handles non-zero heel in converting from the drafts at the Forward and Aft Perpendiculars to the draft marks.[15] However, Mates's numbers are NOT adjusted for sag, hog, or any hull deflection. Thus, the difference between Mate's numbers and those taken from careful

[12] Mate is very precise about depth and draft. Depth is in the direction of gravity. Draft is in the direction of the ship's aft perpendicular. Thus, in cases where the ship has significant trim or heel, the depth of the hull low point may be smaller (say 21.8 m), than the larger draft (say 22.1 m).

[13] Mate extends the draft marks all the way to the deck, so it is possible that Mate's draft mark number is larger than the highest number actually painted on the hull.

[14] Mate extends the draft marks all the way down to the baseline, so it is possible that Mate's draft mark number is smaller than the lowest number actually painted on the hull.

[15] Draft marks are wiggly lines on the hull. Unless the ship is at zero heel, there is no simple relationship between the drafts at the AP and FP (two numbers that can't be measured directly), and the drafts that will be read off the draft marks. Few programs correctly account for this fact.

readings at the draft marks can be used to estimate hull deflection. Your ship may not have this option implemented in which case the draft marks fields will show `CANT_DO`. Be aware that no remote draft gauging system of which we are aware correctly corrects for heel in converting from the readings at the gauging system points to draft at either the perpendiculars or the marks.

If a Summary value is illegal, the background for that field switches to red.[16] You cannot change any part of the Summary section directly.

[16] There is no legal maximum on trim. However, if the trim is such that it would cause serious problems in the Engine Room – controlling boiler water level, for example – Mate will show the trim in red. This should be regarded as a warning.

3.4 The Menubar

In Normal mode, the menubar at the top of the screen has 12 menu buttons:

The FILE menu The FILE menu has four options:

- **Rebalance** This option will re-balance the hull, bringing the Summary up-to-date with the Tank Table. This is the same as the Redo function in the Toolbar.
- **Save Load** Selecting `Save Load` will rebalance the ship and save the current loading pattern in CTX Mate's native XML format. See Section 6.1 for details..
- **Print Screen** Selecting `Print Screen` will rebalance the hull and print out a hardcopy of the current Mainscreen. This is the same function as the Print button in the Export menu. See Section 7.2.
- **Quit** Selecting the `Quit` button will exit your CTX Mate session. If you have not saved the current loading pattern, then you will be warned that that is the case, and asked if you want to quit anyway. If the loading pattern on the screen has been saved, Mate will exit immediately.

The Edit Menu The EDIT menu has two options: Edit Parcels and Edit Point Loads. Selecting Edit Parcels will pop-up a window within which you can change information relating to the liquid parcels on-board. See Section 4.1 for how to go about doing this. Selecting Edit Point Loads will pop-up a window within which you can add, delete, or change the location of point loads. Point loads are loads that count against deadweight, but are not treated as liquid. See Section 5.1. On some ships, this function is de-activated per owner policy; but you can always change the weight of an existing point load on the Mainscreen.

The View Menu The VIEW menu determines whether "hidden" tanks and compartments, that is, spaces whose OPT is H, are displayed on the Mainscreen and on most reports. It controls the `Show_Hidden` option. There are only three choices.

- **Hide Hidden** This is the usual choice in which all tanks/compartments with a tank OPT of `H` are not displayed. Nor will they appear on any reports.

Show Hidden Tanks If this button is selected, then all tanks, that is, all non-V type compartments are displayed. And they will show up on most reports as empty tanks, even if their OPT is `H`.[17]

Show Hidden All If this button is selected, then all tanks and all compartments, are displayed even if their OPT is `H`, and they will show up on most reports.

This option has two main uses:

1. On many voyage legs, only a subset of the tanks are of interest. On a loaded leg, all or almost all the ballast tanks are known to be empty and expected to remain so. These empty tanks clutter up the Mainscreen unnecessarily. Similarly on ballast legs, all or almost all the cargo tank are of little interest. Getting rid of these unnecessary tanks, allows you to see more of the interesting tanks without scrolling and shortens all the reports based on that loading pattern.[18]
2. For damage situations, you must have access to all the compartments, not just the tanks. The Engine Room is of little interest in normal cargo loading patterns; but can be critically important in damaged situations. The Show_Hidden option allows us to display these compartments when we need to, and only when we need to.

To hide a tank or compartment, you set its OPT to `H`. But you can only do this if the tank or compartment is already marked as Empty. That is to hide a tank/compartment, you must first set its OPT to `E` ***and rebalance***. Only then will Mate allow you to change that tank's OPT to `H`. This is to make it difficult for you to inadvertantly hide a tank you shouldn't. When you hide a tank or compartment, it's parcel code is set to `sw` (ambient sea water).[19] This means if you hide a cargo tank and then bring it

[17] Any normally dry compartment on your ship will have been assigned a type of `V`. `V` is short for Void, but it applies to any non-tank hull compartment. Some cargo survey reports are based on cargo parcels. To ensure that a formerly hidden tank appears on these reports, you must change the tank OPT to E (Empty) and assign the tank one of the cargo parcels.

[18] Some charterers require explicit documentation that a tank is empty, in which case you will have no choice but to set the empty tanks' OPT to `E`.

[19] Mate must do this because it cannot be sure that the tank's old parcel will still be on-board when the tank is unhidden. But it also has the advantage of properly pre-setting the parcel code for damage situations.

back, you will almost always have to reset the parcel code. When a tank is marked Empty on the other hand, the parcel code does not automatically change.

To unhide a tank or compartment, select the relevent Show_Hidden option from the VIEW menu, and then reset that tank's OPT on the ensuing Mainscreen to something other than H. You can then reset the Show_Hidden option to Hide Hidden, to get rid of the tanks/compartments you don't need to see.

Repeated use of this process can result in the tanks ending up in a strange and/or confusing order. You can correct this by using one of the SORT tank options. See the SORT menu below.

The Export Menu Mate has the capability of savings its results in a variety of different formats. See Chapter 7 for your options.

The Cargo Menu Mate has the capability of automatically preparing a number of different cargo survey reports. The reports are accessed via the Cargo menu. They are described in Chapter 14. All these reports are available in a variety of formats. Each of these menu items brings up a window which allows you to select the desired format.

The Reports Menu In addition to rebalancing the ship, Mate has the capability of doing the following technical analyses which can be accessed via the Reports menu:

Longitudinal strength This report does the standard shear force and bending moment calculations. The results will be compared with the ship's allowables. Vertical hull deflection is also computed. See Chapter 8. This calculation is done whenever the ship is re-balanced, but the Mainscreen will only show the worst case values. This menu item allows you access to the detailed strength report which may be saved in a number of formats.

Stability This report computes both the port and starboard right arm curves and compares the results with the IMO A.749 requirements. See Chapter 9 for details. This analysis is ***not*** done automatically, but must be explicitly called for either by selecting this menu item or the Stability button on the tool bar. Be aware that this calculation can take as long as 30 seconds. This menu item covers both intact and damage stability.

Sloshing Resonance This report estimates the natural periods of longitudinal and transverse sloshing in each slack tank and compares these numbers with the ship's natural pitch and roll periods for the current loading pattern. This report is not implemented in this version of Mate.

Downflooding This report computes the height above waterline of all the downflooding openings and sorts them for lowest to highest. A negative number means the opening is underwater. See Chapter 10. This report is done every time the ship is rebalanced but the Mainscreen only shows the lowest point.

IMO Reg 25 This report does the flooding and damage stability analysis required by IMO Regulation 25 (and 16C raking) for the current loading pattern. This analysis is based on a series of hypothetical damage scenarios. See Chapter 11 for details. These hypothetical and not very realistic scenarios have nothing to do with CTX Mate's Damage mode, which is based on the specific damage entered by the crew.[20] The IMO Reg 25 analysis is ***not*** done automatically, but must be explicitly called for either by selecting this menu item or the Reg 25 button on the Toolbar. Be aware that this calculation can take as long as a minute.

All these reports are available in a variety of formats. Each of these menu items brings up a window which allows you to select the desired format.

Hotspot Selecting Hotspot will determine the point with the maximum stress to yield at each frame for which the scantlings are given. You may view the results of these calculations for the worst such section in either ship coordinates (up is parallel to the Aft perpendicular) or earth coordinates (up is perpendicular to the sea surface). See Chapter 13 for details. Be aware that the Hotspot calculations are based on classical beam theory, and must be used with considerable judgement.

Mode This menu allows you to move from Normal to either Auto mode (input from automatic ullaging system) or Damage mode. From Damage mode, it allows you to move only to Normal and then only if no tanks are marked damaged. See Chapter 16 for a

[20] In fact, Mate will not allow you to do the IMO Reg 25 analaysis in Damage Mode.

complete description of Damage mode. In Auto mode, this menu allows you to move only to Normal mode. In Auto mode, this is the only menu that will appear on the Menubar. In Auto mode, you must first return to Normal mode, in order to have access to all of CTX Mate's functions. See Chapter 15 for a full description of Auto mode.

Options This menu allows you to change a number of miscellaneous but important options.

Allowables This option allows you to select either AT-SEA or HARBOR allowables. Obviously, unless you are in well-protected water, you must choose AT-SEA.

PCT/ABS BM/SF This option allows you to choose beteen displaying shear force and bending moment as a fraction of the allowable, or in absolute terms. This option can also be controlled from the Strength Screen. See Section 8.1.

Loadline This option controls which loadline (Summer/Tropic/Winter) will be shown in the Summary.

Force Metric This options allows you to force Mate to display all volumes in cubic meters and all temperatures in Celsius, even for Table 6A and 6B parcels. Most design applications prefer all metric. This options will automatically be in effect in Damage mode.

Zero Innage/Zero Volume This option controls how Mate handles the ambiguity associated with a zero innage and a heel and trim such that the zero innage point is not the lowest point in the tank. See Section 14.3.

Design Wave Hotspot analysis requires that you specify a longitudinal wave profile, for which the longitudinal stresses are computed. See Chapter 13 for details.

Show Cargo This option controls whether the current loading pattern is shown in the tank plan drawing. See Drawings below.

Show Wide This option controls whether the tank plan drawing is artifically broadened to allow more information to be included. See Drawings below.

Show Text This option controls the amount of textual informations which shows up on certain drawings. See Drawings below.

Show Grid This options controls whether certain drawings are displayed with a grid or not. See Drawings below.

Rounding In order to comply with the range of cargo surveyor practice, Mate implements a number of different rounding options with respect to parcel standard density, tank temperature, and VCF. This menu allows you to control these options. They are discussed in Section 14.2

Sort This menu allows you to change the order of the tanks on the Mainscreen. Your options are:

Sort by Tank Type, Cargo First
Sort by Tank Type, Ballast First
Sort by Parcel then Tank Type, Cargo first

Within each sort category, the tank and compartments are sorted by tank name. The cargo parcels will be sorted in the same order that they appear on the Parcel Screen.

Drawings This menu allows you to create and display a number of drawings. Your options are:

Section Ship This produces an outline of the hull and tank boundaries for a selected frame with the flat bottom horizontal. It is used mainly for checking hull and tank offsets during ship data preparation.

Section Earth Same drawing as Section Ship except the horizon is horizontal. Not very useful by itself.

Section with Liquids This is a very useful drawing especially in damage situations. It is the same drawing as Section Earth except that it shows the tank liquids including any flooding in the case of damage. Petroleum is shown in a tan color. Non-petroleum (usually sea water) in a blue color. It also shows the damage box provided the damage straddles the frame. This is the best way Mate has of visualizing damage. In addition, this drawing has a little table showing key data for the compartments in the drawing.

If the frame displayed includes damaged tank(s) but the frame is forward or aft of the damage box, you won't see any damage. However, the key damage level for each damaged tank — top of the damage in the tank, if all the damage is below ship's waterline — will always show in the little table on the drawing. All the distance numbers in this little

table are relative to sealevel. 3.456 is 3.456 meters above sea level in the direction of gravity. -9.876 is 9.876 meters below sea level. If the damage is all below sea level, the difference between the Live Bottom (the oil/sea water interface) and Damage Key (the highest point of damage) is the cushion you have against leakage due to current or wave action.

Worst Section If you select any of the top three Drawings options, Mate will popup a list of all the ship's frames and ask you to select a frame from that list, after which it will display the drawing for that frame. If you select Worst Section, Mate will attempt to guess the worst case frame, and display the Section with liquids drawing for that frame. Often Mate's guess is not very good in which case you must manually select the frame(s) of most interest. To make this a little easier, Mate remembers the last frame you displayed, and pre-selects it. So if you want to see the same frame again, simply click on OK on the list of frames.

Walk Thru Thus is perhaps the most useful of the drawing buttons. Clicking on the Wazlk Thru button will prepare a set of transverse section drawings, all with the the tank liquids displayed, and the sea level horizontal. The actual set will depend on how your ship's data was set up. But if your ship was set up per CTX recommendations, there will be at least one drawing for each set of cargo tanks across. Each such drawing will show the section one frame forward from the aft end of those tanks, which is normally close to the main gauging points for those tanks. The drawings will be arranged from forward to aft. You can click through these drawings with the forward arrow on the pop-up window (and go backward with the back arrow.) Thus you can quickly "walk thru" through each set of tanks checking the situation fairly close to the ullaging point.

Tank Plan CTX Mate has a limited ability to prepare loading pattern plans. Clicking on the TankPlan button will generate a plan view of the ship slightly below the deck level.[21]

The contents of this drawing will depend on the following Options (which are set via the Options menu)

Show Cargo If this option is set to N, the tank plan will

[21] The TankPlan button is not available in Damage mode.

simple show an outline of the ship and the bulkheads.
If this option is set to T (tank type), the cargo tanks and only the cargo tanks will all be fully colored.
If this option is set to Y, a portion of each cargo tank will be colored. That portion is proportional to the tank's percent full. Thanks to a bug in preparing this drawing, for certain tank arrangements, a line will extend from one tank into a neighboring tank. Fortunately, it's pretty obvious what's happening.
Each parcel has its own color. The color is chosen by Mate on the basis of the parcel's standard density. Lighter cargos are lighter and more yellow. Heavier cargos are darker and more purple. Mate tries to pick colors that will show up differently even if the parcel densities/APIs are nearly the same, as is often the case, This means that the colors of ***all*** the parcels will change if you change ***any*** of the parcel densities/API's.[22] Despite this, if the APIs/densities are close enough, it can still be difficult to see the difference in colors. In this case, choosing the Verbose option in the Options Menu will display the parcel code on each tank. You may need to also choose the Expand Beam option to keep the text for each tank within the tank boundaries.

Show Wide If this option is Y, the beam dimension will be trebled relative to length. This can be useful if you are putting a lot of text onto the drawing, or using it as a scratch pad.

Show Text This option controls the amount of text which will be shown on the tank plan.

- N No text will be displayed
- S Tank codes will show on the drawing
- Y If Show Cargo is T, the 100% full volume of each tank will be displayed.
  Otherwise the current Total Observed Volume in the tank will be displayed.
- V If show Cargo is V, both the TOV and the tank's parcel code will be displayed.

[22] It also means that there is no fixed relationship between density and color. If an API 30 crude is the heaviest parcel on-board, it will show up in an orange-purple. If the same crude is the lightest parcel on-board, it will show in yellow.

All these drawings are actually PDF files, you can print out or save these files by clicking of the Printer icon on the drawing window.

Help This menu gives you on-line access to this manual and a number of other administrative tasks. The options are:

manual Selecting this option will display this manual as a PDF document. You can navigate about the manual, using either the table of contents on the left, or the links. You may also search, print, zoom, etc using the display window tools.

about_CTX Selecting this option will display a little blurb about the Center for Tanker Excellence.

License Selecting this option will display the license under which CTX_Mate is released. as a PDF document. You can navigate about the manual, using either the table of contents on the left,

In Damage Mode, there will be a twelfth button labeled Grounded, which controls Mate's stranding capability. See Chapter 17.

Whenever you call for any Menubar or Toolbar function (except Quit and Help) or any Mate report or analysis, Mate will scan the Tank Table and re-balance the ship. You will see the Tank Table momentarily turn red when it does this. Thus, you can be sure that any such report or analysis is based on the up-to-date equilibrium drafts and heel.

3.5 The Toolbar

The Toolbar allows single click access to Mate's most common functions. But it has a more important purpose. It is essential that all critical Mate functions be accessible from the keyboard. The reason is that the mouse is by far the most failure prone computer component. Tankers which may be at sea for seven or eight weeks cannot be at the mercy of such a device. The Toolbar allows all of Mate's critical functions to be accessed even if the mouse is not working.

The contents of the Toolbar will depend on the mode. However, there will always be 12 buttons on the Toolbar, and each button always matches the corresponding function key on the top row of the key board. Hitting a function key is equivalent to clicking on the corresponding Toolbar button. In some cases, the Toolbar button will be marked Unused in which case clicking on this button or hitting the corresponding function key does nothing.

3.5.1 The Normal Mode Buttons

Left to right the Normal mode Toolbar buttons are:

Redo Scan the Tank table and re-balance the ship. Same as Rebalance from the File menu.

Parcels Pop-up the Parcels Screen to make changes to the Parcel data. See Section 4.1. The sea water density and depth can also be changed from this screen. This is the same function as Edit Parcels from the Edit menu.

Save Ld Re-balance and then save the current loading pattern. See Section 6.1 for instructions. Same as Save Load from the File menu.

Print Rebalance the hull and print out a hardcopy of the current Mainscreen. This is the same function as the Print button in the Export menu.

Bend. Rebalance and display the plot of shear force and bending moment. This window also allows access to all the strength reports. This is the same function as Longitudinal Strength from the Reports menu. See Chapter 8 for more information.

Stab. Rebalance and display the plot of port and starboard righting arms. This window also allows access to all the stability reports. This is the same function as Stability from the Reports menu. See Chapter 9 for more information.

Flood Rebalance and display all the downflooding openings sorted in order of height above sea level, lowest first. If the height is negative, then the opening is immersed. This is the same function as Downflooding from the Reports menu. See Chapter 10 for more information.

Damage Rebalance and then switch to Damage mode (Chapter 16). There is a slight difference between the Damage Toolbar button and the Damage Function Key (F8). The Damage Function Key forces the Show_Hidden option to ALL, so all tanks and compartments appear on the Tank Table. Mate does this since it is possible that any space might be damaged and, without a mouse, there is no way to change Show_Hidden. The Damage Toolbar button forces the Show_Hidden option to TANKS so all tanks appear on the Tank Table, but any hidden non-tank compartments will remain hidden. For most damage situations, this is all you will need. If even this is overkill, you can go to Damage mode via the Mode menu. Of course, once in Damage mode, you can change the Show_Hidden options as required.

Visual Display a 3-D Model of the ship. This function is not implemented in this version.

Reg 25 Rebalance and then do the IMO Regulation 25 analysis. This is the same function as IMO Reg 25 from the Reports menu. See Section 11.1 for more information.

Walk Thru Rebalance and prepare the Walk Thru section drawings. This is the same function as the Walk Thru button on the Drawings Menu. See Section 3.4 for more info.

Quit End Mate sessions. Warns only if current loading pattern is not filed. Same function as Quit from the File menu.

3.5.2 The Damage Mode Buttons

The Damage Mode buttons are the same as Normal mode except

1. The Damage button is replaced by the Hotspot button which accesses CTX_Mate's Hotspot Stress capability. See Chapter 13.

2. The Visual button is replaced by the Section button which will display a transverse view of the situation at Mate's guess at the worst case frame. The drawing will be in earth coordinates (with the horizon level). The drawing is actually a PDF file. You can print it out or save it via clicking on the Printer icon on this window. This button is the same as the Worst Section option on the Drawings menu. Frequently, Mate's guess at the worst case frame is not very good, in which case you should pick out the frame(s) you really want to see via the Section with liquids option from the Drawings menu.
3. The Reg_25 button is replaced by Unused. Since the assumptions underlying IMO Regulation 25 are inconsistent with CTX_Mate's Damage mode, Mate will not allow you to do Reg 25 analysis while in Damage mode.

3.5.3 The Auto Mode Buttons

In Auto Mode the Redo button is replaced with Normal which will switch you back to Normal mode. The Print, Bend., Stab., and Quit buttons function like they do in Normal mode; but be aware that long-running calculations (e.g. Stab.) will interrupt the standard Auto mode update, until they are complete. All the other buttons are marked Unused. If you need to do anything unusual, go back to Normal mode first. You can always return to Auto mode as soon as you have finished whatever you need to do.

3.6 The Titlebar

For Mate, the Titlebar is more than decoration. It is the only way that the user can be reminded of which options are in effect. Unfortunately, to save space the description of the options is awfully cryptic. Here's how to read the Titlebar.

- The Titlebar starts with the Mate Version and Variant. This is important documentation for Class surveyors.
- The next word "using" begins a lists of options. The first option is either `AT SEA` or `HARBOR` indicating which set of allowables is being used. If the ship has no allowables assigned, this option will be missing. This must never happen when Mate is used as a Loading Instrument.
- The next option, labeled `API/SG`, indicates the standard density rounding option in effect. The possibilities are

  .01/.0001 API rounded to nearest hundreth of a degree. kg/m3 rounded to nearest tenth of a kg.

  .1/.0005 API rounded to nearest tenth of a degree. kg/m3 rounded to nearest fifth of a kg.

  .5/.0005 API rounded to nearest half of a degree. kg/m3 rounded to nearest fifth of a kg.
- The next option, labeled `F/C`, indicates the temperature rounding option in effect. The possibilities are

  .1/.01 Fahrenheit rounded to nearest tenth of a degree. Celsius rounded to nearest hundreth of a degree.

  .1/.05 Fahrenheit rounded to nearest tenth of a degree. Celsius rounded to nearest twentieth of a degree.

  .5/.05 Fahrenheit rounded to nearest half of a degree. Celsius rounded to nearest twentieth of a degree.
- The next option will be either `VCF_4` or `VCF_5`. The former indicates that the VCF (Volume Correction Factor) has been rounded to four decimal places; the latter says the VCF has been rounded to five decimal places. See Section 14.2 for a discussion of all these rounding options.
- The next option will be either `O_Inn/O_Vol` or `O_Inn/Wedge` The former indicates that zero or negative innage tanks should be assumed to be empty. The former indicates that zero or negative innage tanks should be assumed to be full up to the given innage.

This option applies to situations where the zero innage point is not the lowest point in the tank. See Section 14.3 for a discussion of this issue.

- The remainder of the Titlebar displays the ship name and the full path name of the current loading pattern ***if that pattern has been filed***. Otherwise, the Titlebar will end with `UNFILED!`. This is supposed to warn you that you have not yet saved the current loading pattern. See Section 6.1.

3.7 Mate's rules for preserving liquid volume and mass.

Mate has one disconcerting feature until you get used to it. The program is very precise about the meaning of ullage and innage. It recognizes that as the ship heels and trims, the observed ullage and innage will change even though the liquid volume in the tank stays the same. When you change an ullage or innage, Mate will adjust the volume to match the new ullage or innage ***at the new trim and heel***. Normally, this is what you want only if you have just changed the ullage or innage.[23]

However, if you didn't change Tank A's ullage or innage between the last balance and this balance, Mate assumes no liquid has been loaded into or discharged from this tank.[24] In this case, the weight of the liquid in the tank did not change. But if you made a change in some other tank(s) that changes the ship's trim or heel, the ullage and innage in Tank A will in general change. In short, you will see the ullage and innage move around in tanks for which OPT is I or U even though you have not changed the ullage or innage. The basic rule is: ***if you've changed the ullage (innage) since the last balance, Mate will adjust the amount of liquid to that ullage (innage). If not, Mate keeps the weight of the liquid in the tank constant.***

A very important implication of this rule is that, if the tank temperature changes for a U or I tank ***but nothing else***, then Mate preserves mass rather than ullage or innage. Once again Mate assumes no liquid has entered or left the tank.

Once in a very rare while the "new" ullage is the same as the old. This will happen if the change in the ullage due to the change in the amount of liquid in the tank just happens to be matched by the change

[23] If you measured the ullage/innage at an "old" trim and heel (or any trim and heel other than the new trim and heel), then Mate's resulting tank volume will be wrong. This could happen if there was a delay between the actual measurement and Mate calculations and other tank operations were taking place in the interim. This is the reason cargo surveyors insist that no cargo/ballast operations take place during a survey. Whenever you manually enter an ullage or innage, it is your responsibility to insure that the reading is up-to-date, that is, there were no significant changes in the loading pattern beteen the time of the measurement and when it was entered into Mate.

[24] This rule does not apply to Auto mode. In Auto mode, Mate assumes every ullage and innage read in from the automatic gauging system is a "new" ullage/innage, even if it is the same as the last ullage/innage.

in ullage due to the change in heel and trim and/or temperature. In this case, Mate can't tell that the "new" ullage is a new ullage by comparing it with the "old" ullage. This will probably happen no more than a couple of times in your career. But Mate has a way of handling this. If you set the tank's OPT to `Y` (or `y`), Mate will keep the ullage constant even if the ullage hasn't changed since the last balance. It will also reset OPT to `U` when it is finished rebalancing the ship.

The special tank OPT, `N` (or `n`) handles the same situation with respect to innage. By the way, keeping innage constant does not necessarily imply that ullage will be constant or vice versa. For ullaging systems such as a surveyor's tape, the vertical distance between the ullage point and the tank bottom will change with trim and heel. If you measured ullage, set the tank OPT to `U`. If you measured innage, set the tank OPT to `I`. ***Do not do the innage to ullage conversion yourself.***

The same sort of thing happens with volume and percent volume. If you do not change a tank volume (for OPT equals `V`) or percent volume (for OPT equals `P`), Mate assumes that no liquid has entered or left the tank since the last balance, that is, it keeps the weight of liquid constant. This means that, if you change the temperature but not the volume (for OPT equal V) or the percent volume (for opt equal P), the volume (percent volume) will change to keep the weight constant. This is almost always what you want and makes handling temperature changes very easy. If nothing has happened except the temperature has changed, simply enter the new temperature regardless of the value of OPT.[25] Mate will do the right thing.

Mate's view of the right thing changes a bit if you have ***just*** changed a tank's parcel code or the parcel's type or standard density on the Parcel screen. "just" in this context means "since the last rebalance". In this case, Mate assumes that you do want to preserve innage, ullage, volume and volume percent if that is what the tank's OPT is. In this situation, the mass of liquid in the tank will change. If you don't want that to happen, you must set the tank OPT to `W` before changing the

[25] The situation in which OPT is set to `V` or `P`, and liquid is removed or added while the temperature changes, and the change in mass just happens to match the change in density is so astronomically unlikely that Mate does not have a special OPT to handle this case. However, you can change V to P and P to V (see below) and volume will be preserved. The practical reality is that, if the amount (mass) of liquid in the tank is changing, the tank's OPT should be set to U or I.

tank's parcel or the parcel's characteristics.

Finally, if you have changed the tank OPT to U, I, V or P, since the last rebalance, then Mate assumes that you did this because you want to preserve the corresponding measurement. In this situation as well, the mass of liquid in the tank will change.

Chapter 4

Liquid Parcels

CTX Mate and its associated commands deal with liquids. Mate thinks of each of these liquids as a *parcel*. A parcel may be a cargo, a bunker fuel or other engine room liquids, or ballast. Each such parcel will at a minimum have a standard density. If the liquid is a petroleum, in most cases it will also have a *method* for adjusting the standard density for temperature. And in some cases, such as bunker stems, the liquid will have a number of other attributes as well including Vapor Pressure, Sulfur, Ash and Water content.

4.1 Editing Parcel Data

Every Mate loading pattern has its own set of parcel data. Selecting Edit Parcels from the Edit menu — or clicking on the Parcels button in the Toolbar — will pop-up the Parcels Screen. You can change the parcel data by editing the Parcel Screen and clicking on Change. If ***and only if*** you subsequently save the loading pattern, the next time that loading pattern is read in, it will be read in with the new parcel data.

If you change a loading pattern's parcel data during a session, this is logically the same as changing an ullage or innage in the loading pattern. Therefore, until you actually save the loading pattern with the new parcel data, Mate will mark all the output reports as UNFILED! in exactly the same way it treats an unfiled change in tank data. It will not put the loading pattern's name on any such reports. Therefore,

if you see an Mate report that does have a loading pattern name on it, you can be confident that, if you ran that loading pattern file as it stood as of timestamp, you will get the same results. In other words, the situation with respect to parcel data is exactly the same as it is with tank data.

There are two basic rules when it comes to changing parcels:

1. In adding a parcel, add the parcel in the Parcel Screen ***before*** assigning any tank that parcel on the Mainscreen. Mate will not allow you to give a tank a parcel code that is not in the current parcel data (except for the predefined parcel code `sw`.
2. In deleting a parcel, delete that parcel from all tanks on the Mainscreen ***before*** deleting that parcel from the Parcel Screen. Mate will not allow you to delete a parcel from the Parcel Screen if that parcel is still being used by any tank in the loading pattern.

The Parcel Screen looks something like Table 4.1. The top line allows you to change the ambient sea water density. This is the density of the water outside the hull. It will also be the density of the water in any tanks whose parcel code is `sw`. It is also the density that is used in flooding calculations. Sea water does not necessarily mean salt water. If the ship is floating in fresh water, then `SW_DENSITY` should be close to 1.000. Simply type in the desired specific gravity.

You may also change the water depth in the top line by typing in the desired value in meters. The figure 99.999 means that the depth is unlimited. The only role of Water Depth is to warn you if the hull low point is below this depth. But nothing else happens. Mate still acts as if the ship is afloat. To activate Mate's grounding capability, you must manually select the proper option from the Grounded menu while in Damage mode. See Chapter 17.

The rest of the Parcel Screen contains a row for each parcel. You are allowed up to 20 parcels. However, at most seven ***cargo*** parcels will show up on the Mainscreen Summary. The columns in the Parcel Screen are:

PARCEL CODE The first column is a two character code. Mate has one predefined parcel codes `sw`. If you specify a parcel code of `sw` for a tank, then that tank will be given a parcel whose density is the current sea water density. ***Be aware that the density of this "parcel" changes if you change the sea water density.***

In many cases, it is better to specify a fixed ballast density. For example, if you ballast off Pascagoula where the sea water density is about 1.015, and then move to the Red Sea where the sea water density is about 1.030, you will be making a signficant mistake unless you create a ballast parcel with a density of 1.015, — you might give this parcel a code of `bw` or maybe `bP` — and then give the tanks that are ballasted with Pascagoula ballast this parcel code.

Mate will not accept a parcel code of `sw` on the Parcel Screen.[1] With this exception, you can use any two character parcel code you like, provided it is different for each parcel on the screen. *Whatever code you choose, this code must match the parcel code in the Mainscreen of any tank which contains this particular liquid.* Typically ships try to come up with meaningful parcel codes, for example, `AL` for Arab Light. But if you have two physically different Arab Light parcels on board then you must give them different codes, for example `A1` and `A2`. Some owners reserve the codes F1, F2, F3 etc for bunker fuel oil stems, D1, D2, ... for diesel fuel, and L1, L2 for lubes. But as far as Mate is concerned, this is matter of preference.

What is important is that the Name and Comments columns contain a reasonable description of the parcel. You may remember what `bP` means but the next mate will not. So in the Name column put something like "Pasc ballast" and the Comment column should say why you chose the density that you did.

The requirement for uniqueness applies only to a particular voyage. The Arab Light with a code of `AL` on voyage 005 can be quite different from the Arab Light on voyage 006 even if it has the same (or different) parcel code. But be aware that Mate can't check that the `AL` in one loading pattern's parcel data is the same as the `AL` in another loading pattern's parcel data, ***even if both loading patterns are on the same voyage***. Usually what happens as the voyage progresses is that you will modify an existing loading pattern (the last) — but not the parcel data — and then save the modified loading pattern into a new file. If you haven't changed the parcel data, then all the parcel data in the new loading pattern will be the same as in the old, which is

[1] Internally, Mate treats `sw` as just another parcel. The main difference is that this parcel is always available.

normally what you want. But Mate allows you to change parcel data, so you can change the API of say `AL` in the new loading pattern. If so, you will end up with two different `AL`'s on the same voyage, which is almost always a mistake.

Parcel Method The second column in the Parcel Screen is a single character parcel *method* code which must be either `C`, `F`, `c`, `P`, `N`, or `B`. This code specifies the Volume Correction Table to be used for this liquid, that is, how the parcel density varies with temperature.

C indicates a crude oil using Table 6A.

F indicates a petroleum product using Table 6B.

c indicates a crude using Table 54A.

P indicates a petroleum product using Table 54B.

N means the density is fixed but the liquid is petroleum,

B means the density is fixed, but the liquid is not petroleum (usually a sea water or fresh water).

The distinction between parcel methods `N` and `B` is critical in spillage and Effective Oil Spill number calculations. Note case is important here.

In actual petroleum tanker operations, you should not use method `N` parcels except possibly for minor engine room tanks. Some owners make this policy, in which case your CTX Mate will not accept `N` in the method column.

Mate allows you to mix parcels based on English units (methods `C` and `F`) with parcels based on metric units. In fact, thanks to the backward state of our industry, this is normally required if you want to have both cargo densities and bunker fuel densities corrected for temperature. But don't mix ***cargo*** parcels with different units unless you absolutely must. If you do, MATE will not be able to prepare an ROB report.

DENSITY AT STANDARD TEMPERATURE The third column contains the parcel density at standard temperature. If Parcel method is either `C` or `F`, the standard density must be in API degrees at 60F. If Parcel method is either `c` or `P`, the standard density must be specific gravity at 15C.[2] If Parcel type is `N` or `B`,

[2]Mate accepts API to a hundreth of an API degree and specific gravities to 0.1 kg/m3. An API of 34.567 will be rounded to 34.57. An SG of 0.87654 will be rounded to 0.8765.

then the density must be in specific gravity, and the temperature field on the Mainscreen will be ignored.

COLOR The fourth column contains a two character color code which MLOAD uses in coloring certain output reports, such as the tankplan. Currently, this is not implemented and you can ignore this column.

NAME The fifth column is a descriptive name for the parcel which can be up to 14 characters. The name can be as simple as "Basrah Light". Mate makes no use of this name other than to put it on certain reports if given. This field also helps the crew to remember which parcel has which code. Mate will accept all blanks in this field; but this is a very bad idea. Two character parcel codes by themselves are often close to meaningless. Without a good name, confusion and mistakes will result.

Sulfur Content The sixth column contains the sulfur content in percent mass. If this is not known, leave it blank.

Ash Content The seventh column contains the ash content in percent mass. If this is not known, leave it blank.

Water Content The eigth column contains the water content in percent volume. If this is not known, leave it blank.

Reid Vapor Pressure The ninth column is the parcel's Reid Vapor Pressure (RVP) in bar absolute. This is needed by the S tank opt (tank damaged and sealed). If you do not enter a value here and a tank containing that parcel is damaged and sealed, Mate will silently and incorrectly assume that the parcel has zero vapor pressure, which could generate a significant under-estimate in the amount spilled. Make a practice of looking up and entering the RVP whenever you receive a new cargo parcel. Reid Vapor Pressure is the vapor pressure as measured by a particular laboratory procedure at a particular temperature. Reid Vapor Pressure has been measured and tabulated for just about all the world's crudes. Mate will convert this to true vapor pressure (TVP) at the tank temperature for you.

Comment The tenth column is a freeform comment which can be up to 30 characters. MATE makes no use of this field and will accept all blanks in this field. You may use or not use this field however you see fit. One common use of this field is to document where the standard density came from. In the case of most cargos, this

can be done by giving the Bill of Lading number. For bunker fuels, it might be the FOBAS test ID or equivalent.

Currently, only the `ctx_chief` command makes real use of the Sulfur, Ash and Water fields (to compute the NCV of bunker stems). However, your company policy may require you to enter this data for all cargo parcels in order to implement a proper Tanker Management System.

You edit the Parcel Screen in almost the same way that you edit the Mainscreen. Move around with the arrow keys and simply type in the changes. Insert and Overwrite mode works the same way as in the Mainscreen. However, there are three important differences:

1. If you want to delete a parcel, then blank out the parcel code. Mate will not allow you to delete a parcel that is in the current loading pattern. Therefore, in order to delete a parcel, you must first make sure that no tank is currently using that parcel.
2. If you reduce a parcel's standard density, be aware that the current loading pattern may become infeasible. If a tank containing this parcel has a tankopt that conserves mass, such as `W`, the increase in volume associated with the decrease in density may result in the tank becoming overfilled. You will only catch this when you return to the Mainscreen. At that point, you will be forced to reduce the tank's weight, go back to the Parcel Screen, correct the density, and then go back to the Mainscreen and restore the tank to the original weight. This is a pain, so be careful in reducing parcel densities. Fortunately, a tankopt of `W` should rarely if ever be used for liquid loads in normal tanker operations.
3. You can add another parcel by simply typing a code in any blank line in the Parcel Screen. You must add a parcel to the Parcel Screen before you can assign that parcel's code to any tank on the Mainscreen.

The Parcel Screen had three buttons at the bottom.

TEST After you have entered parcel data, you can test the validity of the data by clicking on the `TEST` button. This will check that the data is all within range, and make sure that you have not deleted a parcel that is being used. It does not check for overfilling of constant weight tanks. TEST does nothing other than make these checks. The loading pattern's parcel data has not yet

been changed. But it is always a good idea to use `TEST` before using the `CHANGE` button.

CHANGE This button will do the same checks as `TEST` and, if the data looks OK, it will also change the attached parcel data for the current loading pattern. ***This change will not be permanent until you save the loading pattern.*** When you do this SAVE, the old parcel data attached to this loading pattern will be lost unless you have previously saved it under a different loadfile name.

RETURN The only way of leaving the Parcel Screen and returning to the Mainscreen is via the RETURN button. When you click on RETURN, you will immediately be put back to the Mainscreen and any changes you made to the Parcel Screen since the last CHANGE will be lost. Until you hit RETURN, you will not be able to do anything in the Mainscreen. When you hit RETURN — but not before — Mate will recalculate the loading pattern. If any of the tanks have become overfilled as a result of a reduction in density, Mate will incorrectly blame the problem on the tank data, not the parcel data. You will have to reduce the weight in any tanks that have been "over-filled", go back to the Parcel Screen, correct the density, and then come back to the Mainscreen and restore the weight.

Remember to save any new parcel data, you must Save the loading pattern after returning to the Mainscreen.

Table 4.1: Simplified Parcel Screen

Adjust parcel data as required. All blanks in first column will delete									
SW_DENSITY			1.025		Water Depth				99.999
liQ	M	DENS	CO	NAME	SULFUR	ASH	WATER	VAP PR	COMMENT
fw	N	0.9999		special fwater					
fo	N	0.9300		std dsme hfo					
do	N	0.9300		std dsme mdo					
lo	N	0.9300		stf dsme lo					
F1	N	0.9300		aaa					Orig sg was 0.9704
F2	P	0.9300		aaa	2.6040	0.0500	0.0750		Orig sg was 0.9634
D1	P	0.9300		aaa					SAW is guess
D2	P	0.9300		aaa					SAW is guess
CO	P	0.9300		aaa					density from castrol manual
SO	P	0.9300		aaa					density from castrol manual
TEST				CHANGE			RETURN		

Chapter 5

Point Loads

5.1 Editing Point Load Data

Point loads are weights that count against deadweight but are not treated as liquid. Mate regards such loads as being concentrated at a single point in 3-D space. Point loads are used for such things as crew weight, stores, liquids in engine room piping, and possibly very small tanks. You can change the weight of an existing point load on the Mainscreen by altering the point load's Wt column. But you cannot add or delete point loads, nor change their location on the Mainscreen. Do do this you much choose Edit Point Loads from the Edit menu.[1]

When you select Edit Point Loads, a five column window, the Point Load Screen, will appear. The columns are:

NAME The name of the load as it will appear on the Mainscreen and in the reports. This must be no more than 8 characters and no less than 2 with no embedded blanks (use underscores). Each point load must have a different name.

WT The weight of the point loads in tons.

XS The longitudinal position of the load forward of the Aft Perpendicular in meters. Aft of the AP is negative.

YS The transverse position of the load. This is distance off the centerline in meters. Port of centerline is positive; starboard is negative.

[1] Some owners have a policy of allowing crews only to change the weight of existing point loads, in which case the Change button (see below) will be disabled.

ZS The height of the load above the baseline in meters.

There is one row in the table for each point load. You edit the Point Load Screen in almost the same way that you edit the Mainscreen. Move around with the arrow keys and simply type in the changes. Insert and Overwrite mode works the same way as in the Mainscreen. However, there are two important differences:

1. If you want to delete a point load, simply blank out the point load name.
2. You can add a new point load by typing a name in any blank line on the Point Load screen. You can have as many point loads as there are rows on the Point Load screen; but in most tanker contexts, you should not need more than three or four point loads. Otherwise the reports get cluttered up with insignificant detail.[2]

The Point Load Screen has three buttons at the bottom.

TEST After you have entered point load data, you can test the validity of the data by clicking on the `TEST` button. This will check that the data is all within range. TEST does nothing other than make these checks. The loading pattern's point load data has not yet been changed. But it is always a good idea to use `TEST` before using the `CHANGE` button.

CHANGE This button will do the same checks as `TEST` and, if the data looks OK and site policy allows point load editing, it will also change the point load data for the current loading pattern. *This change will not be "permanent" until you save the loading pattern.* When you do this SAVE, the old point load data attached to this loading pattern will be lost unless you have previously saved it under a different loadfile name.

If your owner's policy is to not allow adding or deleting point loads or changing their location, when you try to use the CHANGE button, you will get a warning message, but no changes will be made. In this case, you can still change the weight of an existing point load from the Mainscreen.

[2] Mate's point load capability is effectively unlimited. Mate may be configured to accept an effectively unlimited number of point loads. To Mate, a containership is simply a tanker with thousands of point loads (the containers) and a small number of tanks. But in normal tanker applications, you should keep the number of point loads to a small handfull.

RETURN The only way of leaving the Point Load Screen and returning to the Mainscreen is via the RETURN button. When you click on RETURN, you will immediately be put back to the Mainscreen and any changes you made to the Point Load screen since the last CHANGE will be lost. Until you hit RETURN, you will not be able to do anything in the Mainscreen. When you hit RETURN – but not before – Mate will recalculate the loading pattern.

Remember to save any new point load data, you must Save the loading pattern after returning to the Mainscreen.

Chapter 6

The Load File

6.1 Saving a Loading Pattern

Selecting `Save Load` from the File Menu or the Save Ld button on the Toolbar will save the current loading pattern in CTX Mate's native XML format. This is known as the *loadfile*. Files saved in this format can be used as input to CTX Mate anywhere. For example, you can email this saved file to the office, and assuming they have CTX Mate and the ship data properly installed, they can replicate not only the run but produce any of the reports, and the results will be exactly the same as those produced on the ship.[1] Except for legalties, it is unnecessary to send anything other than the loadfile to the office or anywhere else that has CTX Mate capability for your ship. The load file alone is a complete record of the situation. The load files are reasonably compact so transmission and memory requirements are almost negligible. Despite this compactness, the loadfiles are self-identifying and human readable. See Figures 6.1 and 6.2 for a sample loadfile.

When you select `Save Load`, a pop-up form will be displayed requesting a load file name, two title lines, a loading pattern type, a voyage number, a leg code, a port name, and a berth name. All these fields will be filled in with whatever was in the last loading pattern. Mate only requires the file name. ***If you don't change the file name, the old loading pattern file will be over-written and lost forever.***[2]

[1] This also avoids any possibility of a *stale* report. See Section 7.1.

[2] Normally, Mate will not allow you to over-write a loadfile that was created by someone

Mate silently enforces the rule that load file names always start with `lf_` by replacing the first three characters of whatever name you enter with `lf_`.

For actual loading patterns in operational environments, you should fill in all the other values according to your owner's rules. Mate does not need these variables, but any good Tanker Management System does.

In the CTX Tanker Management System, the voyage number is a three digit integer with leading zeros: that is: 001, 002, and so on.[3] The leg code is of the form *ppppn* where *pppp* is the leg's four digit FAOP port code, and *n* is the leg index with the initial leg of the voyage having an index of `0`, the next leg `1`, and so one. See the CTX Tanker Filing System Manual**??** for details. The berth field can either be the berth number or name (eg SBM203) or the name of a lighter or mothership. The loading pattern type is one of

OBQ Arrival at load port. There should be exactly one of these for each load port.

Load Intermediate loading pattern.

FAOP Departure from load port. There should be exactly one of these for each load port.

EOP Arrival at discharge port. There should be exactly one of these for each discharge port or lighter.

Dsch Intermediate discharging pattern.

ROB Departure from discharge port. There should be exactly one of these for each discharge port or lighter.

B_BFO Before Bunkering.

A_BFO After Bunkering.

NOON Noon Report.

None Unspecified. This type should be used only in non-operational contexts.

Pick the appropriate type via the spinbox.

---

else. If you run into this situation, you will have no choice but to use a different file name. Loadfiles in the V/TEST folder do not have this protection.

[3] Or TEST. Each voyage has its own sub-directory. The TEST "voyage" is used for training and Class survey tests.

You can cancel the pop-up with Alt-C in which case the loading pattern will not be saved.

Mate does not automatically save loading patterns. If you change a loading pattern and don't save it, that loading pattern will be lost when you change the loading pattern again or when you end your Mate session, whichever comes first.

6.2 The Loadfile Format

Strictly speaking, understanding of this section is not needed to use CTX Mate. But knowing just what is in the load file will make you a better tanker officer. Figures 6.1 and 6.2 show an abbreviated example of a loading pattern file. All the left and right arrows take a little getting used to, but basically the file is self-identifying and with a little practice fairly easy to read. Throughout the loadfile, each variable is given in a *name*="*value*" fashion where *name* is the name of the variable and *value* is its value in this loading pattern. The variable names for the most part are self-explanatory, and the same names that we use in this manual.

The first four lines simply identify the file and the Mate version that was used to create it. The rest of the file consists of seven sections;

The Header Section This section contain a bunch of variables that Mate itself does not really use, but which can be critically important to a good Tanker Management System. See Section A.3 for details.

The Options Section The Options section shows the user options that were in effect when the loading pattern was saved. This little paragraph is pretty cryptic, so see Section A.2 for the definitions. See

The Tilt Section The Tilt section shows the ship's draft (meters) and heel (degrees). If the loadfile was saved from CTX Mate and the ship is not stranded, this will be the equilibrium drafts and trim. If the loadfile came from somewhere else (e.g. CTX Surveyor), it need not be.

The Bottom Section The Bottom section contains only one variable, the water depth in meters. 99.999 is effectively unlimited.

The Parcels Section The Parcel section contain one "line" for each liquid parcel on-board. where a "line" is everything between the <ctx_Parcel and the next />. The first "parcel" is always ambient sea water, `sw`, even though it doesn't show up that way on the Parcel Screen. Otherwise, the variables are exactly the same as those on the Parcel Screen. See Section A.4.

The Dips Section The Dips section contain one "line" for each non-hidden tank and compartment. Each "line" starts with <ctx_Dip. The variables are very similiar to those on the Tank Table except that the meaning of `read` depends on the value of `opt`. If `opt` is `U`, `read` is an ullage in meters. If `opt` is `I`, `read` is an innage in meters. If `opt` is `P`, `read` is a fraction full. If `opt` is `V`, `read` is a volume in cubic meters. If `opt` is `D`, `read` is intact fraction full. Internally Mate always stores volumes in cubic meters and temperatures in degrees Celsius, even for Table 6A and Table 6B parcels. `wtr` (free water innage) and `nonliq` (non-liquid innage) are stored in meters. If the user has specified a damage location (the high and low points of the damage) in a particular tank or compartment, this is stored as well. If the user has grouped a tank or compartment with another space, the lead tank in the group is given by the `grp` variable.

The Spikes section The Spikes section contains one line for each point load. The variables are name of the load, weight in tons, and the load's longitudinal, transverse and vertical position on the ship.

That is all there is to a loadfile. But it is everything that is needed to completely document the loading pattern. If you send this file to any site that has the same version of Mate and the ship's data installed, they will be able to replicate any Mate report or analysis based on this loading pattern.

Figure 6.1: Sample Loadfile (top)

```
<ctx_Load path="/cfs/ctx/job/mate/0.18/ld.al98dep"
    mate_version="0.18.0" mate_varient="BASE"
    ship_dir="/U/al/DATA/MATE"
    scant_dir="">
    <ctx_Header
        fleet="U" ship="al" shipname="Hellespont Alhambra" imo_number="9224752"
        voy_num="" leg="" type="X" port="xxxx" berth=""
     title1="this is a template for loading pattern files as used by 0.25 and later."
     title2="based on /tfs/u/NLOAD/1.92/LF.al98dep."
     mod_time="2006-06-14T14:43:30Z" author="root">
    </ctx_Header>
    <ctx_Options
        mode="D"       use_si="N"       use_harbor="N"      zero_inn_zero_vol="N"
        loadline="S"   rigid="Y"        bend_mom_pct="Y"    phony_vertical="N"
        exact_vcf="N"  round_temp="N"   round_api="N"       show_hidden="N"
        grounded="N"   low_grnd="N">
    </ctx_Options>
    <ctx_Tilt draft_fp="23.961" draft_ap="24.932" heel_deg="-0.139">
    </ctx_Tilt>
    <ctx_Bottom depth="99.999">
    </ctx_Bottom>
    <ctx_Parcels>
        <ctx_Parcel code="sw" method="s" density="1.0234" color="" name="test sea water" sulfur="0.0000" ash="" water="" rvp="" comment=""/>
        <ctx_Parcel code="AL" method="C" density="34.56"  color="" name="test arab ligh" sulfur="0.0000" ash="" water="" rvp="" comment=""/>
        <ctx_Parcel code="f1" method="P" density="0.9876" color="" name="test 54b" sulfur="" ash="" water="" rvp="" comment=""/>
    </ctx_Parcels>
```

Figure 6.2: Sample Loadfile (bottom)

```
    <ctx_Dips>
        <ctx_Dip tank="1C      " grp="1P      " opt="P" dip="UL" par="AL" read="0.980000" deg=" 15.56" wtr="      " nonliq="      " igs="  510
        <ctx_Dip tank="2C      " opt="P" dip="UL" par="AL" read="0.980000" deg=" 15.56" wtr="      " nonliq="      " igs="  510"/>
        <ctx_Dip tank="3C      " opt="P" dip="UL" par="AL" read="0.980000" deg=" 15.56" wtr="      " nonliq="      " igs="  510"/>
        <ctx_Dip tank="4C      " opt="P" dip="UL" par="AL" read="0.980000" deg=" 15.56" wtr="      " nonliq="      " igs="  510"/>
        <ctx_Dip tank="5C      " opt="P" dip="UL" par="AL" read="0.980000" deg=" 15.56" wtr="      " nonliq="      " igs="  510"/>
        <ctx_Dip tank="1P      " opt="P" dip="UL" par="AL" read="0.980000" deg=" 15.56" wtr="      " nonliq="      " igs="  510"
 dam_hi_xs="300.000" dam_hi_ys=" 30.100" dam_hi_zs="10.000" dam_lo_xs="300.500" dam_lo_ys=" 25.350" dam_lo_zs=" 3.300"/>
        <ctx_Dip tank="SLOP_P  " opt="P" dip="UL" par="AL" read="0.980000" deg=" 15.56" wtr="      " nonliq="      " igs="  510"/>

         ..... more tanks ......

        <ctx_Dip tank="FO_SRV_P" opt="P" dip="UL" par="f1" read="0.909200" deg=" 15.00" wtr="      " nonliq="      " igs="    0"/>
        <ctx_Dip tank="DO_TK_S " opt="E" dip="UL" par="sw" read="        " deg="  0.00" wtr="      " nonliq="      " igs="    0"/>
        <ctx_Dip tank="DO_SET_S" opt="E" dip="UL" par="sw" read="        " deg="  0.00" wtr="      " nonliq="      " igs="    0"/>
        <ctx_Dip tank="DO_SRV_S" opt="E" dip="UL" par="sw" read="        " deg="  0.00" wtr="      " nonliq="      " igs="    0"/>
        <ctx_Dip tank="FW_P    " opt="E" dip="UL" par="sw" read="        " deg="  0.00" wtr="      " nonliq="      " igs="    0"/>
        <ctx_Dip tank="FW_S    " opt="E" dip="UL" par="sw" read="        " deg="  0.00" wtr="      " nonliq="      " igs="    0"/>
    </ctx_Dips>
    <ctx_Spikes>
        <ctx_Spike name="CREW    " wt="    5.00" xs=" 35.000" ys="  0.000" zs="40.000"/>
    </ctx_Spikes>
</ctx_Load>
```

Chapter 7

Saving Results

7.1 Report Philosophy

Mate is designed to be integrated into an overall Tanker Management System.[1] Mate is based on the proposition that the information created by a CTX Mate run is not a dead-end. It can and should be post-processed; ***but Mate must dictate neither the post-processor functions nor the software required to perform those functions.*** For example, the reports created by Mate during a discharge can be combined to evaluate the ship's discharging performance, create a pumping log, defends cargo claims, prepare freight invoices, compute bunker's received, etc, etc. Truly useful output is merely input to the next stage in an information processing system. But Mate cannot say what that next stage is, nor lock-in Mate users to any particular information processing system. To this end, Mate has the capability of preparing reports in a variety of formats.

Whenever you call for a Mate report, Mate will scan the Mainscreen and re-balance the ship which insures that all the results are consistent with the loading pattern currently on the screen. ***However, that loading pattern is not automatically saved.***

If there have been any changes to either the tank data or the parcel data since the last time you saved the loading pattern per Section 6.1, the current loading pattern will be *unfiled*. If the current loading

[1] It is also designed to be integrated into tanker design and evaluation packages, in which case Mate results are almost always post-processed.

pattern is unfiled, it has no name. In this case, Mate will make up a report filename of the form *type_nnnnn.fmt* where the *type* prefix indicates the kind of report, *nnnnn* is the process ID number, and the *fmt* extension indicates the report format.[2] These isn't must point in keeping reports based on unfiled loading patterns, so Mate regards any such files as temporary. ***Such files will be automatically deleted when you quit your Mate session.***

If there have been no changes to either the tank data or the parcel data since the last time you saved the loading pattern per Section 6.1, then the current loading pattern on the screen will be properly filed in the loadfile named on the Titlebar. In this case, Mate will make up a report filename of the form *type_load.fmt* where the *type* prefix indicates the kind of report, *load* is the name of the current loading pattern file without the leading `lf_`, and the *fmt* extension indicates the report format. Thus, if your current loading pattern is filed as `lf_rast1_faop`, the reports based on that loading pattern will be named, *type*`_rast1_faop.`*fmt*. The loadfile name without the leading `lf_` is called the *loadname*. Such report files are not deleted when you quit the Mate session.[3]

Normally, all of Mate's reports are filed in the same folder where the loadfile upon which the report is based resides. See Section 2.3. However, if the user has specified the `--rep_dir` command line option, the reports will be filed in that directory. See Section 2.4. Onboard, in actual tanker operations, use of the `--rep_dir` option is almost always a bad idea.

7.2 The EXPORT Menu

The EXPORT menu allows you to select a report and a format for your overall results. The choices are:

[2] The Process ID is an essentially meaningless five digit number produced by the operating system, which Mate uses to keep one Mate user's temporary files from overwriting another users.

[3] This system can be fooled. Suppose you create a report based on a properly filed loading pattern, then change the loading pattern, re-file it again under the ***same*** loadfile name, but don't redo the report. The report is no longer consistent with the loading pattern in the report's file name. This is called the *stale* report problem. In this situation, you must either file the new loading pattern under a different name, or redo all the reports based on that loading pattern. Post-processors may catch the fact that the loadfile and report file timestamps don't match, but you can't count on that.

Print This button will print out a hard-copy of the current Mainscreen. This is not a complete report, since it does not contain all the parcel data nor all the options in effect. It is intended to be an aid for the crew, rather than a formal report. This format is not useful for post-processing.

This is the same function as the Print item in the File menu and the Print button in the Toolbar.

Latex This button will generate a copy of the Mainscreen in the Latex mark-up language. This is useful for including a snap-shot of the Mainscreen within other reports that use this mark-up language. The CTX documentation of Mate and and CTX technical reports which include Mate output are created in this manner. The file is called `out_`*load*`.tex` where *load* is the current load name if this loading pattern has been filed or the Process ID number if not. This format can be post-processed, but only with difficulty.

PDF This button will generate a copy of the Mainscreen in Adobe Page Description Format. The file is called `out_`*load*`.pdf` where *load* is the current load name if this loading pattern has been filed or the Process ID number if not. This format can be useful in communicating with third parties which do not have XML capability. Just about every web browser and email reader can display PDF. However, this format is useless for computerized post-processing.

Full XML Mate's native output language is a dialect of XML. XML combines human readability with easy, sure computer post-processing.[4] The details of this XML dialect are discussed in Appendix A. The Full XML report combines a timestamp, a full description of the loading pattern and all the results on the Mainscreen. The file is called `out_`*load*`.ctx` where *load* is the current load name if this loading pattern has been filed or the Process ID number if not.

This file can be emailed to any entity that has XML processing capability.[5]

[4] Most of CTX's post-processors are written in Perl. Perl has the ability to convert an XML report to a Perl data structure in a single line of code. Any value in the report can then be extracted by simply referencing that variable's name. See Appendix B. This is made possible by the self-identifying nature of XML. Every useful programming language has similar XML tools. So post-processor writers can work in just about any language they like.

[5] If that entity has CTX Mate and the ship data installed, it is simpler and more

Full XML with Beam This report is the same as Full XML but the frame by frame results of the longitudinal strength calculations are also included.[6] Design applications are often interested in this information.

Full XML with Arms Same as Full XML but the results of the righting arm calculations are included.

Full XML with Floods Same as Full XML but the details of the downflooding calculations are included.

Full XML with Reg25 Same as Full XML but the results of the IMO Regulation 25 calculations are included.

Full XML with All The is the same as Full XML but the results of all four of the above calculations are included.

Summary XML In some situations, the user of CTX Mate results is not interested in the details of the individual tank calculations; but only in the information that appears in the Summary section of the Mainscreen. The individual tank calculations were only a means to an end. This is often the case when Mate is being used as a tanker design or evaluation tool. The Summary XML report is the same as Full XML but without the individual tank data. It contains the information shown in the Summary section of the Mainscreen, plus Options and Header data. The file is called `sum_`*load*`.ctx` where *load* is the current load name if this loading pattern has been filed or the Process ID number if not.

Summary XML with Beam The is the same as Summary XML but the frame by frame results of the longitudinal strength calculations are also included,

Summary XML with Arms The is the same as Summary XML but the results of the righting arm calculations are included.

Summary XML with Floods The is the same as Summary XML but the details of the downflooding calculations are included.

---

flexible to send that entity the loading pattern file (which is also in XML). They can then regenerate whatever results they need. This also avoids the possibility of a stale report. But even here legalities may require that the ship's calculations be "frozen" in which case the ship will need to use the Export function and send the output as well as the input.

[6] One of XML's strengths is that it allows reports to be nested. The actual Full report is made up of a series of sub-reports with the user selecting which sub-reports should be included.

Summary XML with Reg25 The is the same as Summary XML but the results of the IMO Regulation 25 calculations are included.

Summary XML with All The is the same as Summary XML but the results of all four of the above calculations are included.

Chapter 8

Longitudinal Strength Analysis

8.1 Shear Force and Bending Moment Plots

When you select Strength from the Reports menu or the BEND. button on the toolbar, Mate will rebalance the hull, compute shear force, longitudinal bending moment, and hull deflection curves, and then display then as a plot on the screen. The curves will be displayed in a window that pops up and will partially obscure the Mainscreen. Your may move and resize this pop-up window, the Strength Screen, with the normal mouse commands.[1] The window shows shear force (green), bending moment (red) and hull deflection (thin black line). Shear force is positive/negative if excess buoyancy is aft/forward. A positive bending moment implies hogging; negative implies sagging. Similarly, positive deflection is hog and negative is sag.

At user option, Mate will plot shear force and bending moment either as a fraction of the allowable at each longitudinal position or it will display the absolute shear force and bending moment together with the absolute allowables.[2] The relative plot is much cleaner and easier

[1] All Mate pop-up windows disappear when you change the loading pattern and rebalance the hull. This prevents a left-over pop-up screen which is inconsistent with the loading pattern.

[2] In preliminary design applications, allowables for the ship may not yet be available. After all they are an output of the design process. In this case, only the absolute plot will be available and it will not show any allowables. Similarly, early in the design process,

to read; the absolute plot contains more information. The user can switch back and forth as he desires. See Section 8.2 on controlling this option.

The allowables in question may be either the At Sea condition allowables or the Harbor condition allowables at user option. This option is controlled from the options menu, Section 3.4. The currently selected condition is shown in the top left corner of the screen.

The relative plot shows the the ***ratio*** of the actual shear force and the actual bending moment to the allowable shear force and bending moment at each station. If the absolute value of that ratio is larger than 1.00 at any point — above the 1.00 line or below the -1.00 line on the plot — then the loading pattern is illegal. This plot extends only over that portion of the ship for which the allowables are actually assigned, normally the pump room to the aft end of the forepeak tank. When using this plot, remember that a jump in either curve may be the result of a change in the allowable, not necessarily a change in shear force or bending moment.

The absolute plot shows both the absolute value of the bending moment (ton-meters) and shear force (tons) and their allowables (if available). The allowables are shown as broken lines on this plot — dots for shear force and squares for bending moment. The allowables extend only over that portion of the ship for which allowables are actually defined; but the shear force and bending moment curves extend over the entire length of the ship. The dots on the shear force curve and the squares on the bending moment curve indicate the points at which Mate has actually computed the numbers. Because of the way, Mate handles shear force you may see some minor wiggles in the shear force curve. These are probably artificial, but they won't cause any problems and can be ignored.

The hull deflection numbers shown in the plot must be used with judgement. Mate assumes a rigid body in doing its hydrostatics. Thus in general it is not true that the actual draft is the drafts shown in the Summary plus the deflection curve. For example, if the ship is sagging with zero trim, the actual draft will be slightly less than draft shown in the Summary plus the sag because Mate has not adjusted for the additional volume immersed as a result of the sag. In this case, the

the hull moment of inertia curve may not be available, in which case the deflection curve will not be displayed. Neither situation applies to an operating tanker.

draft plus the sag will be conservative in estimating the water depth required by ther vessel. However, if the ship is hogging, the draft at the ends of the ship will be larger than that obtained by simply adding the deflection curve to the Summary drafts. In this case, a conservative estimate can be obtained by adding the maximum hog to the draft at the deepest end of the ship.

Be aware that, while Mate handles very high trim and heel correctly from the point of view of hydrostatics and stability, the standard longitudinal strength calculations can be misleading for high angles of heel. The loads are correct but the stresses associated with these loads are different from those upon which the shear force and bending moment limits were based. This is due to the shift in neutral axis and the fact that the mostly highly stressed fibers (the gunnel on the high side and the bilge on the low side) are farther away from the neutral axis when the ship is heeled. These effects can increase the max fiber stress by 15% for 15 degrees heel. If the heel is more than 5 degrees and the stresses are near the allowable, you should probably perform a Hotspot stress analysis. Hotspot analysis will give you the maximum fiber stress accounting for both the actual distance to the neutral axis and the shift in the earth vertical section moment of inertia with heel. See Chapter 13.

8.2 The Strength Screen Command Bar

The command bar along the top of the Strength Screen offers five options:

ABS/PCT This button allows you to toggle between the absolute and fractional displays. If the screen is showing the absolute shear force and bending moment curve: then selecting this button will flip you to the fractional, and vice versa.

PLOT Selecting PLOT will print out a hard copy of the Strength Screen.

Short Table Selecting Short Table will display a pop-up showing the actual shear force and bending moment numbers at the ship's major frames (tranverse bulkheads, AP, FP, etc) as well as the frames at which the shear force and bending moment obtained their absolute maximum and their fraction of the allowable maximums. All the frames at which Class requires that the shear

force and bending moment be checked are included in this table. These are also the frames that are marked on the strength plot. The command bar along the top of this screen allows you to save this table in a variety of formats. See Section 8.3.

The strength table contains eight columns:

Frame The Frame name.

Actual Shear Force The shear force at that frame in tons. Plus implies excess buoyancy forward.

Shear Force Allowable The relevent shear force allowable.[3] The column header indicates whether this is the At Sea or Harbor allowable.

Percent of Allowable The ratio of the actual shear force to the allowable as a percent.

Actual Bending Moment The bending moment at the frame in ton-meterss. Plus implies hog; negative sag.

Shear Force Allowable The relevent bending moment allowable. This will be the hog allowable if the bending moment is positive and the sag allowable if the bending moment is negative. The column header indicates whether this is the At Sea or Harbor allowable.

Percent of Allowable The ratio of the actual to the allowable as a percent.

Deflection The vertical hull deflection in meters.

The rows marked with an asterisk are the absolute and fractional maximums. These maximums are repreated at the bottom of the table.

On the line summarizing the Maximums, you will find two numbers labeled `err=`. These are the shear force and bending moment imbalances. These numbers should always be less than 0.5% of the allowable. If not, contact the office.

Long Table Selecting Short Table will display a pop-up showing the actual shear force and bending moment numbers at all the ship's frames. In Mate, a big tanker will have as many as 200 frames, so this is probably overkill for any operational situation. For almost all operational purposes, the short form is sufficient. But the long

[3] Rarely ships will have different shear force allowables for positive and negative shear force. If so, Mate will pick the correct one. However, Mate does not have the capability of modeling shear flow.

table can be useful in design applications. The layout of the long table and the report format options are exactly the same as for the short table. Mate always calculates and plots the shear force and bending moment at every frame regardless of which table is selected. That's why the maximal frames in the Short table need not be one of the bulkheads or other major frames.

Dismiss Selection Dismiss will destroy the Strength Screen. Or you can simply click on the Mainscreen.

8.3 Longitudinal Strength Reports

The command bar along the top of either the short table or long table window offers six choices:

XML Selecting XML will produce a strength report in CTX's XML format. This format is discussed in detail in Section A.6. It is ideally suited for computerized post-processing but also human readable. If the Short Table is showing and you have made no changes since last saving the loading pattern, the report will be filed in `mom_`*load*`.ctx` where *load* is the current load name. It will contain the strength results at only the major and maximal frames. If the Long Table is showing and you have made no changes since last saving the loading pattern, the report will be filed in `moml_`*load*`.ctx`. It will contain the strength results at every frame. If the current loading pattern is unfiled, then *load* will be replaced by the process ID number. This report will be included in the overall XML report in the Export menu if BEAM or ALL is sleclected.

LATEX LATEX produces a strength report in Latex markup. This format produces reasonably good looking tables and can be used to include a strength report within other documentation that uses the Latex markup language. It is not well suited for computerized post-processing. The short/long and file naming conventions are the same as for the XML reports except the file extension is `.tex`.

PDF Produce a PDF strength report. This can be useful for sending a report to third parties without XML capability. It is useless for post-processing. The short/long and file naming conventions are the same as for the XML reports except the file extension is `.pdf`.

TROFF Produce a strength report in Troff markup. This format produces the best looking tables. It can be post-processed but requires non-standard tools. The short/long and file naming conventions are the same as for the XML reports except the file extension is `.trf`.

PRINT Print out a short or long strength report depending on whether the short or long table is being displayed.

DISMISS Clicking on DISMISS will destroy the strength table screen. You will then have to DISMISS the strength plot window as well. Or you can destroy both windowns at once by clicking anywhere on the Mainscreen.

Chapter 9

Stability

9.1 Metacentric Height

Whenever you rebalance the hull, Mate automatically computes the metacentric height corrected for free surface effect, `GM_corr`, and displays that number in the Summary. If `GM_corr` is less than the legal minimum of 0.15 meters, the figure will be highlighted with a light red background. In intact situations, the loading pattern is illegal and cannot be used.

This 0.15 meter figure is much more than a legality. If you allow the metacentric height to go much below this during load or discharge, then you are taking a substantial risk that it will go negative as the load/discharge continues. Once that happens you are in a lolling situation from which it is nearly impossible to recover without a major lolling casualty.[1]

However, even if `GM_corr` is above 0.15 meters, the loading pattern still may fail to meet the IMO Intact Stability Code. Before actually using any loading pattern, you must compute the righting arm curves and check the results against the requirements of the IMO Intact Stability Code. This is done by selecting Stability from the Reports menu, or the STAB. button on the Toolbar. We repeat: Mate does not do this check automatically. You must explicitly ask for it.

[1] In many cases, your best chance is to reverse whatever you did to get into this situation; but this will only be possible if the terminal is willing to reverse flow.

9.2 Righting Arm Curves

If you select Stability from the Reports menu or the STAB button from the Toolbar, Mate will compute the port and starboard righting arm curves. It will then display these curves in a window which will partially obscure the mainscreen. You may move, resize, iconify, etc., this window using the Window Manager. The port righting arm is shown in red; the starboard in green. A summary of stability statistics is also shown on each side, and compared with the IMO Intact Stability Code. If a value does not comply, it will be shown in red.

It is possible that the heels assumed in this calculation will immerse one of the points through which flooding could occur. The angle at which this first occurs is called the *downflooding angle*. If this is the case, the downflooding angle(s) will also be displayed. The righting arm curve for angles of heel higher than the downflooding angle are highly suspect for it is based on the assumption that no such flooding takes place. In many tanker cases, the downflooding angles will be a larger problem than stability itself.

The calculations required to prepare these curves are quite extensive. Be prepared to wait as long as a minute for this window, during which time the cursor will switch to a watch. Normally, Mate will compute each righting arm in 2.5 degree increments, up to fifty degrees either side of equilibrium heel. At each assumed angle of heel, Mate must rebalance the ship with respect to draft and trim, taking into account the transverse and longitudinal shifts in tank liquids. Mate's calculation of the righting arm curves automatically includes free surface effects. Occaisionally, the calculations will fail to converge usually because the ship has become unstable, in which case the righting arm curve will not extend out the full fifty degrees. If the ship is damaged (see Chapter 16), then the righting arm analysis will correctly flood the tanks/compartments that have been breached. Thus, the Stability report button can be used to compute stability in both the intact and damaged situations.

The command bar at the top of rhe righting arm window has seven buttons: PLOT, REPORT, SAVE, DISMISS.

PLOT Clicking on the PLOT button or hitting the Alt-G key with the cursor in the righting arm window will print a hardcopy version of the graph.

PRINT Clicking on the Print button or hitting the Alt-P key with the cursor in the righting arm window will print a tabular summary of the righting arm calculations such as Figure 9.2.

LATEX Clicking on the Latex button will file the stability report in the Latex mark-up language. If the loadfile name matches the current loading pattern – there have been no changes to the loading pattern since you last saved the loadfile – then the stability report will be filed in `arm_`*load*`.tex`. where *load* is the load name. Otherwise the report will be filed as `arm_`*nnnnn*`.tex`

Troff Clicking on the Troff button will file the stability report in the Troff mark-up language. If the loadfile name matches the current loading pattern – there have been no changes to the loading pattern since you last saved the loadfile – then the stability report will be filed in `arm_`*load*`.trf`. where *load* is the load name. Otherwise the report will be filed as `arm_`*nnnnn*`.trf`

PDF Clicking on the Troff button will file the stability report in PDF (Adobe Page Description Format). If the loadfile name matches the current loading pattern – there have been no changes to the loading pattern since you last saved the loadfile – then the stability report will be filed in `arm_`*load*`.pdf`. where *load* is the load name. Otherwise the report will be filed as `arm_`*nnnnn*`.prd`

XML Selecting XML will produce a stability report in CTX's XML dialect. See Section A.7 for a detailed description of this format. This report is designed for post-processing. It is included in the EXPORT menu reports if ARMS or ALL is selected.

DISMISS Clicking on the DISMISS button or hitting the Alt-D key with the cursor in the righting arm window will wipe out the righting arm window.

Some of the numbers in the Stability Report require explanation. The top table shows the port and starboard righting arm curves in tabular form. The Heel is in degrees and the table starts at the equilibrium heel which need not be zero. The righting arm itself is in the GZ column. This is the transverse distance (in earth coordinates, hence horizontal) between the Center of Buoyancy and the Center of Weight. A positive number implies positive stability. The column labeled AREA is the area under the righting arm curve in meters-radians up to that heel. This is a measure of the energy that would be required to heel the ship to that angle. Under IMO Rules, area beyond the downflooding

angle is not counted. Thus, this number will be constant from the downflooding angle on, a warning that this portion of the righting arm curve is highly suspect.

MARGIN is the vertical distance between the lowest ***non-closable*** downflooding point and the waterline. If this number is negative, then at least one of the non-closable downflooding points would be submerged at that heel. You should be aware that, when Mate artificially heels the ship to compute the righting arm curves, any potential downflooding point that can be closed watertight is assumed to be closed. Thus, watertight doors, self-closing tank vents, and P/V valves are all assumed to be watertight and non-flooding in the righting arm computation. If this is not the case, the righting arm curves will be optimistic. In contrast, in determining flooding at equilibrium draft, trim and heel, Mate makes the much more conservative assumption that any potential downflooding opening that can be left open is open. See Chapter 10 for a discussion of this issue.

In intact situations with a perfectly symmetric loading pattern including fuel, lube and distilled water tanks, etc. port and starboard righting arms will be the same. But frequently this will not be the case, if only because the downflooding points are not symmetric, and both righting arms must be checked.

The lower table in the report compares the overall results with the IMO Code on Intact Stability. If a value does not comply it will be followed by an asterisk. The first row shows the area under each curve between equilibrium and 30 degrees heel for which the IMO minimum is 0.055 m-radians. The second row shows the area under the curves between equilibrium heel and the lesser of 40 degrees and the downflooding angle to that side for which the IMO minimum is 0.090 m-radians. The third row shows that area between 30 and 40 degrees (or the downflooding angle if less) for which the IMO minimum is 0.030 m-radians. The fourth row shows the port and starboard righting arms at 30 degrees for which the IMO minimum is 0.20 meters. The fifth row shows the maximum of the righting arm curves and the sixth row shows the heels at which those maxima occurs. IMO requires that the location of the maximum must be at 25 degrees or higher. Any loading pattern for which either righting arm violates any of these minimums must be rejected.

There are certain very unusual situations in which Mate's A749 area

numbers are misleading. Thanks to an overly literal reading of IMO A749, Class requires that the area numbers to 30/40 degrees be based on absolute heel, rather than 30/40 degrees either side of equilibrium heel. Mate computes the righting arm curve for up to 50 degrees either side of equilibrium. Therefore if you have more than 10 degrees heel, the righting arm on the high side will not be calculated out to 40 degrees absolute. In this case, Mate will report area numbers for the high side which are smaller (possibly zero for 30 to 40) than actual. As a practical matter, we are only interested in the righting arm on either side of equilibrium, especially if we have 10 or more degrees of heel. In these situations, ignore the A749 high side areas and focus on the righting arm curves in the top half of the report, which are correct.

The seventh line contains the Metacentric Height, GM, uncorrected for free surface. The eight line contains the GM corrected for free surface. This correction is based on the conventional assumption that the effect of the free surface is equivalent to raising the liquid in the tank by the ratio of the tank waterplane moment of inertia to the hull displaced volume. This is usually an accurate assumption but can be over-conservative if the tank is nearly full. The ninth line, labeled `GM_Corr 1`, is the metacentric height computed by dividing the righting arm at +/- 1 degree heel by the sine of 1 degree. This calculation assumes the righting arm curve is linear or nearly so between 0 and 1 degree, which will almost always be the case. Usually, in intact situations, there will be nearly no difference between `GM_Corr` and `GM_Corr 1`. However, if the tank is full or nearly full, `GM_Corr` may be somewhat lower than `GM_Corr 1`. This is an indication that the free surface effect is actually smaller than that based on the tank waterplane due to the fact that the tank is so full that the liquid is not free to flow from one side of the tank to the other. In such cases, `GM_Corr 1` will be more accurate. However, in intact situations, you may not legally use a loading pattern for which `GM_Corr` is less that 0.15m.

In damaged situations, the IMO 749 requirements do not apply; the righting arm curve itself is the key. In such situations, Mate correctly accounts for flooded spaces, so the righting arm curves represent the residual stability.

Figure 9.1: Sample Righting Arm Table

DEMO ULCC IMO Number: 9235268
CTX_MATE 0.40-BASE STABILITY REPORT

LOAD PATTERN	lf_al98dep	HEEL	-0.14	DATE	2006-10-19T17-27-16Z
DRAFT fwd/aft	19.59/26.89	TRIM	-7.30	PORT	xxxx
VOYAGE/LEG	DEMO/	AUTHOR	root	BERTH	

PORT				STARBOARD			
HEEL	GZ(m)	AREA	MARGIN	HEEL	GZ(m)	AREA	MARGIN
-0.14	0.000	0.000	12.311	-0.14	0.000	0.000	12.311
-2.64	0.387	0.008	12.403	2.36	0.386	0.008	11.951
-5.14	0.785	0.034	12.484	4.86	0.783	0.034	11.566
-7.64	1.198	0.077	12.548	7.36	1.194	0.077	11.166
-10.14	1.624	0.139	12.594	9.86	1.618	0.138	10.752
-12.64	2.063	0.219	12.618	12.36	2.056	0.219	10.319
-15.14	2.516	0.319	12.618	14.86	2.507	0.318	9.866
-17.64	2.961	0.439	12.556	17.36	2.954	0.437	9.364
-20.14	3.365	0.577	12.394	19.86	3.363	0.575	8.769
-22.64	3.705	0.731	12.130	22.36	3.710	0.729	8.079
-25.14	3.977	0.899	11.778	24.86	3.988	0.897	7.307
-27.64	4.190	1.077	11.347	27.36	4.206	1.076	6.464
-30.14	4.353	1.263	10.845	29.86	4.373	1.263	5.559
-32.64	4.473	1.456	10.278	32.36	4.497	1.457	4.597
-35.14	4.551	1.653	9.651	34.86	4.578	1.655	3.587
-37.64	4.582	1.852	8.975	37.36	4.614	1.855	2.537
-40.14	4.563	2.051	8.260	39.86	4.600	2.056	1.460
-42.64	4.495	2.249	7.514	42.36	4.535	2.256	0.364
-45.14	4.382	2.443	6.741	44.86	4.426	2.320	-0.745
-47.64	4.232	2.630	5.946	47.36	4.278	2.320	-1.863
-50.14	4.048	2.811	5.128	49.86	4.096	2.320	-2.988

IMO A.749 CODE ON INTACT STABILITY

Requirement	Minimum	Actual Port	Actual Stbd
Area to 30 (m-radians)	0.055	1.253	1.274
Area to 40/downflood (m-radians)	0.090	2.040	2.067
Area 30 to 40/downflood (m-radians)	0.030	0.787	0.793
GZ at 30 (meters)	0.200	4.344	4.380
Max GZ (meters)		4.582	4.614
Location of Max GZ(degrees)	25.0	37.64	37.36
GM (meters)	0.150	9.874	9.874
Free Surface Correction		1.073	1.073
GM Corr. (meters)	0.150	8.802	8.802
GM Real @ 1 (meters)		8.821	8.814
Downflooding Angle		Unreached	43.2

Chapter 10

Flooding

10.1 The Downflooding Report

If you select Downflooding from the Reports menu or the FLOOD button from the Toolbar, Mate will rebalance the hull and display a scrollable window showing all the ship's downfooding openings sorted by distance above sea level, lowest first. The columns in this little table are:

Opening The name of the downflooding opening.

U or C Mate and the regulations recognize two kinds of downflooding openings: Unprotected and Closable. This column will show a U if the opening is Unprotected and a C otherwise. The downflooding report shows all openings regardless of kind. So is quite possible that the lowest openings are closed and watertight; but it is your responsibility to confirm this. However, in doing righting arm and IMO Reg 25 stability calculations, Mate only considers Unprotected openings: that is, Mate assumes that the Closable openings are closed and watertight. If this is not the case, then Mate's righting arm and IMO Reg 25 downflooding angles will be optimistic, quite possibly very optimistic.

Abv Waterline The height above waterline of the opening in meters. If this number is negative, the opening is immersed. Mate models a downflooding opening as a point. Real openings are not points but areas; and in the case of such openings as engine room hatches can extend over a considerable area. Hopefully, the person who

prepared the ship's data did a good job of putting the lowest point of the opening into the ship's Mate database. However, be aware that the lowest point of the opening when the ship is at zero trim and heel need not be the lowest point when the ship is trimmed or heeled, in which case the height may be optimistic.

Longitudinal Position The position of the opening forward of the Aft perpendicular in meters.

Transverse Position The distance of the opening off the centerline. Port is positive; starboard is negative.

The last two columns are aimed at identifying the opening in the unlikely case that the opening name is not meaningful or ambiguous. Thus, these two numbers are in ship coordinates. However, the height above waterline is measured in the direction of gravity, and will be quite different from the vertical location of the opening above the baseline when the ship is at even keel.

The command bar at the top of rhe righting arm window has six buttons:

XML Selecting XML will produce a downflooding report in CTX's XML format. See Section A.8 for details. This report is designed for post-processing. It is included in the EXPORT menu reports if FLOODS or All is selected. If the loadfile name matches the current loading pattern — there have been no changes to the loading pattern since you last saved the loadfile — then this downflooding report will be filed in `flood_`*load*`.ctx`. where *load* is the load name. Otherwise the report will be filed as `flood_`*nnnnn*`.ctx` where *nnnnn* is the process ID number.

LATEX Clicking on the Latex button will file the flooding report in the Latex mark-up language. The file naming rules are the same as for the XML report except that the file extension will be `.tex`.

Troff Clicking on the Troff button will file the flooding report in the Troff mark-up language. The file naming rules are the same as for the XML report except that the file extension will be `.trf`.

PDF Clicking on the PDFf button will file the flooding report in PDF (Adobe Page Description Format). The file naming rules are the same as for the XML report except that the file extension will be `.pdf`.

PRINT Clicking on the Print button or hitting the Alt-P key with the cursor in the downflooding window will print out the sorted list of openings.

DISMISS Clicking on the DISMISS button will destroy the downflooding window or you can simply click on the Mainscreen.

Chapter 11

IMO Regulation 25

11.1 Invoking the Reg 25 Function

All tankers delivered after 1979-12-31, are subject to the IMO Regulation 25 damage stability and flooding requirements. If the user selects IMO Reg 25 from the Reports menu or Reg25 on the Toolbar, Mate will perform the IMO Regulation 25 damage stability and flooding check for the current loading pattern. The analysis involves considering a number of hypothetical damage scenarios. For each such scenario, Mate treats the damaged tanks/compartments as free flooding, and determines if the IMO damaged stability requirements with respect to heel, flooding, and righting arm are met. Your ship may require checking as many as 100 scenarios, so the calculation can take as long as 5 minutes. It need be done only on the final EOP and FAOP loading patterns.

When you invoke this function, a window will pop up and display a one-line summary for each scenario as it is computed. If the scenario results in a violation of Regulation 25, the reason will be displayed in the column labeled PROBLEM. If that column is blank, the scenario does not result in a violation of Regulation 25. If the PROBLEM column is non-blank for any of the scenarios, then the loading pattern must be adjusted. If your ship is a double hull, this function also checks the bottom raking damage specified in Regulation 13F. Until the computation is finished, your Mate window will be locked. (You can use Cntl-C in the launch window to abort this calculation; but, if you do, you will lose the current Mate session including the loading

pattern unless you have already saved it.)

After Mate is finished, you may scroll thru the Regulation 25 window with the scroll bar The command bar at the top of rhe righting arm window has six buttons:

XML Selecting XML will produce a Regulation 25 report in CTX's XML format. See Section A.9. This report is designed for post-processing. It is included in the EXPORT menu reports if Reg25 or All is selected. If the loadfile name matches the current loading pattern — there have been no changes to the loading pattern since you last saved the loadfile — then this downflooding report will be filed in `reg25_`*load*`.ctx`. where *load* is the load name. Otherwise the report will be filed as `reg25_`*nnnnn*`.ctx` where *nnnnn* is the process ID number.

LATEX Clicking on the Latex button will file the Reg 25 report in the Latex mark-up language. The file naming rules are the same as for the XML report except that the file extension will be `.tex`.

Troff Clicking on the Troff button will file the Reg 25 report in the Troff mark-up language. The file naming rules are the same as for the XML report except that the file extension will be `.trf`.

PDF Clicking on the PDFf button will file the Reg 25 report in PDF (Adobe Page Description Format). The file naming rules are the same as for the XML report except that the file extension will be `.pdf`.

PRINT Clicking on the Print button or hitting the Alt-P key with the cursor in the Reg25 window will print out the Reg 25 report

DISMISS Clicking on the DISMISS button will destroy the Reg 25 window or you can simply click on the Mainscreen. This window must be dismissed before you can do anything else.

If you ship is double hull, this function will also check the IMO Regulation 16 Raking Requirement. However, the current version of Mate does not check stability at intermediate stages of flooding.

IMO Reg 25 analysis has nothing to do with and is inconsistent with Mate's Damage mode (see Chapter 16). You cannot do Reg 25 analysis in Damage mode. An attempt to do so will pop up an error message.

Figure 11.1: Sample Reg25 Report

DEMO ULCC IMO Number: 9235268
CTX_MATE 0.40-BASE IMO REG 25 REPORT

LOAD PATTERN	lf_al98dep	HEEL	-0.14	DATE	2006-10-19T17-27-16Z
DRAFT fwd/aft	19.59/26.89	TRIM	-7.30	PORT	xxxx
VOYAGE/LEG	DEMO/	AUTHOR	root	BERTH	

Scen-ario	OK ?	Reason	Heel deg	Draft FP	Draft AP	Min. Margin	Where	Area to 20	Max GZ	FLOODED SPACES
00001	Y		-0.1	19.91	26.71	5.26	S/G_VENTP	0.576	3.36	FPVOID,FOCSLE
00002	Y		-0.1	20.77	26.26	5.26	S/G_VENTP	0.572	3.34	FP,FOCSLE
00003	Y		2.7	21.39	26.06	5.47	3FOS_VENT	0.560	3.12	1B_S
00004	Y		3.6	20.99	26.57	5.47	3FOS_VENT	0.566	3.13	2B_S
00005	Y		3.7	20.40	27.17	5.47	3FOS_VENT	0.567	3.13	3B_S
00006	Y		3.6	19.77	27.76	5.47	3FOS_VENT	0.567	3.13	4B_S
00007	Y		3.4	19.10	28.45	5.31	S/G_VENTS	0.561	3.10	5B_S
00010	Y		-0.1	19.48	27.13	5.26	S/G_VENTP	0.579	3.37	PR
00011	Y		-0.1	17.71	30.72	5.26	S/G_VENTP	0.551	3.06	ER,ER_DBLBM
00021	Y		-0.1	21.12	26.06	5.26	S/G_VENTP	0.572	3.34	FPVOID,FOCSLE,FP
00051	Y		-0.1	24.78	24.40	5.76	2FOP_VENT	0.554	3.17	FPVOID,FOCSLE,FP,1C
00101	Y		14.0	26.60	25.68	10.42	5B_S_VENT	0.341	1.54	FOCSLE,FPVOID,FP,1B_S,2B_S,3B_S,4B_S
00102	Y		-0.1	31.19	25.50	5.76	2FOP_VENT	0.421	2.15	FOCSLE,FPVOID,FP,1B_S,2B_S,3B_S,4B_S,1B_P,2B_P,3B_P,4B_P
00201	Y		1.6	22.29	25.51	5.47	3FOS_VENT	0.514	2.86	FOCSLE,FPVOID,FP,1B_S,1S
00202	Y		4.9	22.02	26.05	5.47	3FOS_VENT	0.453	2.34	1B_S,1S,2B_S,2F_S
00203	Y		5.9	21.50	26.79	5.47	3FOS_VENT	0.439	2.25	2B_S,2A_S,3B_S,3S
00204	Y		6.1	20.40	27.94	5.47	3FOS_VENT	0.437	2.24	3B_S,3S,4B_S,4F_S
00205	Y		6.9	19.29	29.38	5.47	3FOS_VENT	0.438	2.30	4B_S,4A_S,5B_S,5S
00206	N	Flooding	4.2	15.57	35.56	5.72	FW_P_VENT	0.439	2.26	5B_S,SLOP_S,1FO_S,PR,ER,ER_DBLBM,AP,SG_ROOM,3FO_S,2FO_S,
01206	N	Flooding	4.2	15.57	35.56	5.72	FW_P_VENT	0.439	2.26	5B_S,SLOP_S,1FO_S,3FO_S,PR,ER,ER_DBLBM,AP,SG_ROOM,2FO_S,
00207	Y		-0.0	16.84	32.32	5.40	3FOP_VENT	0.523	2.87	2FO_S,3FO_S,ER,ER_DBLBM,FW_S,AP,SG_ROOM
00301	Y		2.8	27.22	23.25	13.94	2B_S_VENT	0.469	2.39	FOCSLE,FPVOID,FP,1B_S,1S,1C
00302	Y		6.2	25.84	24.20	5.83	2FOS_VENT	0.405	1.91	1C,1S,1B_S,2C,2F_S,2B_S
00303	Y		4.5	19.06	26.85	5.47	3FOS_VENT	0.482	2.57	2C,2A_S,2B_S,3C,3S,3B_S
00304	Y		5.2	19.52	27.01	5.47	3FOS_VENT	0.480	2.52	3C,3S,3B_S,4C,4F_S,4B_S
00305	Y		6.1	19.40	28.02	5.47	3FOS_VENT	0.462	2.40	4C,4A_S,4B_S,5C,5S,5B_S
00306	Y		-0.1	17.18	31.74	5.26	S/G_VENTP	0.541	2.96	PR,ER,ER_DBLBM,AP

11.2 Discussion of IMO Reg 25

Any tanker delivered after 1979 is subject to IMO Regulation 25. Under this regulation, the ship must be able to survive a range of hypothetical damage scenarios without progressive flooding, without exceeding a heel of 25 degrees (30 degrees if the deck is not immersed), and with a residual righting arm curve which is positive for another 20 degrees, has a maximum GZ of at least 0.1m and an area of at least 0.0175 meter-radians. This requirement applies only to loaded conditions.

Each IMO 25 damage scenario can be translated into a combination of breached tanks or compartments. For example, one such combination might involve breaching 1P, 1C, 2P and 2C. The complete range of IMO damage scenarios can be translated into very roughly fifty such combinations of flooded tanks. For each ship, the combinations of flooded tanks which must be checked are listed in the file, `imoreg25.xml`, in the ship's Mate data folder. This is a read-only file which was approved by your ship's Classification society.

IMO 25 requires that, in performing the check for each flooded tank "it shall be assumed that the contents are completely lost from that compartment and replaced by saltwater up to the level of final plane of equilibrium". This is not always good physics — in many cases, a breached tank will reach hydrostatic balance — but it certainly simplifies the calculations for this is precisely what Mate calls "free-flooding". When you call for the IMO25 calculation, Mate marches through `imoreg25.xml` and, for each combination of breached tanks/compartments, temporarily marks the breached spaces as free-flooding, and then computes the equilibrium heel and drafts, the corresponding minimum downflooding margin, and the righting arm curve in the directionof heel, and checks those against the Reg 25 minimums. The output is one line per damage scenario. Sixty scenarios take about two minutes on an older PC. During that time, you will be locked out of Mate. This check must be made and filed only for the FAOP and EOP loading patterns for each loaded leg.

Figure 11.1 shows a portion of sample output of the IMO 25 check. Each line represents one combination of flooded tanks and has ten fields. The rightmost column indicates the tanks that were assumed to be flooded, the leftmost is the index of that combination of tanks in `imoreg25`. If the check reveals no problems, the second column (OK)

will be Y and the third column (Reason) will be blank. If there is a problem, the second column will be N, and the third column will be one of:

FLOODING At least one downflooding point is immersed at the post-flooding equilibrium draft, trim and heel. Progressive flooding could occur. For the purposes of this calculation, all the ship's downflooding openings are considered open, even if they can be made watertight and are normally closed. However, downflooding points which flood the spaces that are already assumed to be flooded are ignored.

HEEL_TOO_HIGH Heel at equilibrium is greater than 30 degrees or heel at equilibrium is greater than 25 degrees and the deck edge is immersed.

NEGATIVE_GZ The regulation requires that the flooded righting arm have a positive GZ for at least 20 degrees on either side of flooded equilibrium. `NEGATIVE_GZ` indicates this is not the case.

LOW_ARM_AREA Righting arm area between equilibrium and 20 degreese is less than the IMO REG 25 mimimum of 0.0175 meter-radians.

LOW_GZ Righting arm maximum is less than the IMO REG 25 mimimum of 0.1 meters.

UNPROTECTED An unprotected downflooding point would be immersed by a heel of 20 degrees or less from equilibrium. For the purpose of this calculation, all downflooding points which can be closed are regarded to be closed. Also points which flood the spaces that are already assumed to be flooded are ignored.

This is an entirely different criterion from that labeled FLOODING. FLOODING has to do with openings that will be immersed at the damaged equilibrium draft, trim and heel. The UNPROTECTED criterion has to do with openings that would only be immersed at the non-equilibrium heels which Mate artificially induces in order to calculate the righting arm curve.

NO_CONVERGENCE Mate was unable to converge, probably because the ship is unstable.

The remaining columns in Figure 11.1 in order are

Heel Equilibrium Heel in degrees after Flooding, + is too starboard. It is possible that the ship will heel away from the damage. If a

fully loaded cargo tank is regarded as free-flooding, the weight of the liquid in the tank after flooding is often less than the weight before.

Draft_FP Flooded draft at the Forward Perpendicular

Draft_AP Flooded draft at the Aft Perpendicular

Min_Mgn The lowest vertical distance between a downflooding point and sea level at equilibrium. If this number is negative, progressive flooding can occur. However, remember that for the purposes of this calculation closable downflooding points are regarded to be open.

Where The label of the worst case downflooding point.

Area The area under the flooded righting arm curve up to 20 degrees from equilibrium in the direction of heel.

Max_GZ The maximum of this righting arm curve within the 20 degree range.

If a flooded condition fails to meet more than one of the IMO REG 25 requirement, Mate will state ***only one*** of the reasons in the Reason column. The other columns may reveal other problems.

Chapter 12

Sloshing Resonance

Sorry. Tank sloshing analysis is not implemented in this version of Mate.

Chapter 13

Hotspot Stress Analysis

13.1 Obigatory Warning

CTX Mate has the capability of estimating longitudinal stress via classical beam theory. This is known as *hotspot* analysis. The name comes from the fact that the analysis focuses on the points with the highest tensile and compressive stress and the point with the highest stress to yield. If the ship has a a great deal of heel (more than 5 degrees), then the worst case stress can be considerably higher than that assumed by the Classification Society in determing the allowables. Thus, in this case it is a good idea to use hotspot analysis to check the worst case stress.

Hotspot analysis can also be used to get a rough idea of residual strength, that is, the remaining strength after damage. To do this, CTX Mate removes all structure within the damage box and then recalculates the stresses assuming classical beam theory.

In either case, the results must be viewed with suspicion and used with a great deal of judgement. For one thing, the assumptions made by classical beam theory are at best approximately correct when the hull is undamaged, and can be wildly incorrect in way of damage.

Even more importantly, in double bottom tankers the design of the bottom structure is not driven by longitudinal stress, but rather by local pressure forces. Very roughly a tanker double bottom will have about twice as much steel as required by longitudinal stress. Thus, a relatively low longitudinal stress in the double bottom structure, does

not necessarily mean that the structure will not fail, since longitudinal stress is only one component of the stresses. And in a tanker double bottom, it is usually not even the most important component.

Nonetheless, used carefully hotspot analysis can be helpful in certain situations as we shall see. It can also be used as a design tool.

13.2 The Hotspot Screen

You can access hotspot analysis by selecting Hotspot from the Reports Menu, or in Damage Mode via clicking on the toolbar button labeled hotspot.

In either case a screen will pop-up showing a curve of worst case stess to yield over a range of frames. Hotspot analysis requires a detailed description of the scantlings at a frame. Normally, this data is not available for the full length of the ship. Often, the scantling data is only available for the parallel midbody.[1] In any event, the max stress to yield will be displayed only for those frames for which the necessary scantling data has been prepared.

The screen will also show some tabular data for the worst of the worst, that is, the hotspot numbers for the frame which has the highest stress to yield. And it indicates which wave bending moment was used in calculating the stresses.

The hotspot screen has six buttons:

WAVE This button allows you to change the longitudinal wave bending moment which CTX Mate will assume in computing the stresses. It is exactly the same as the Design Wave option in the Options Menu. Your choices are

Full Design Wave This is the standard IACS at-sea design wave bending moment upon which the allowables are based. If the tensile hot spot is on or near the bottom — below the neutral axis — the IACS sagging wave bending moment will be used. If the tensile hot spot is on or near the deck — above the neutral axis — the IACS hogging wave bending moment will be used. If the ship is not damaged, hotspot analysis

[1] In many cases, no scantling data is available at all in which case attempts to do hotspot analysis will produce only a warning message to that effect.

with the design wave incorporated should replicate a portion of the analysis which produced the ship's bending moment allowables.

0.8 Design Wave This is the standard JTP design wave bending moment except the wave height is 80% of the JTP wave. Some Classification Societies call this the Short Voyage or Short Sea wave.

0.5 Design Wave This is the standard JTP design wave bending moment except the wave height is 50% of the JTP wave. Some Classification Societies call this the Harbor or Protected Waters wave.

Calm Water Zero wave bending moment.

Profile This option allows you to directly enter a longitudinal wave profile. It is not implemented in this version of Mate.

In this version of Mate, this button is not implemented. You can only change the wave bending moment via the Design Wave option in the Options menu.

PLOT Clicking on this button will simply print out a hardcopy of the hotspot screen.

Earth Section Clicking on this button will popup a screen showing a drawing of the worst case frame. The drawing will be in earth coordinates, that is, with the sea level horizontal. The drawing also contains some tabular data on the results for that frame. The drawing is actually a PDF file. You can print out a hardcopy or save this file by clicking on the printer icon.

Ship Section Clicking on this button will popup a screen showing a drawing of the worst case frame. The drawing also contains some tabular data on the results for that frame. The drawing will be in ship coordinates, that is, with the ship flat bottom horizontal. The drawing is actually a PDF file. You can print out a hardcopy or save this file by clicking on the printer icon.

Table Clicking on this button will pop-up a large table. This table will contain a row for each frame for which scantling data has been given. Each row contains the key data for three points on that frame:

1. The point with the largest ratio of tensile stress to material yield stress.
2. The point with the largest tensile stress.

3. The point with the largest compressive stress.

The buttons at the top of this screen allow you to save this table to a file in various formats, and to print it out. If the loadfile name matches the current loading pattern — there have been no changes to the loading pattern since you last saved the loadfile — then this report will also be filed in `hot_`*loadname.ext* where *loadname* is the loadfile name without the leading `lf_` and the extension matches the format is the usual manner. Otherwise *loadname* is replaced by the process ID number.

Dismiss Clicking on the Dismiss button will destroy the hotspot screen, returning you to the Mainscreen.

Chapter 14

Cargo Survey Reports

14.1 The Cargo Menu

A nice feature of Mate is that preparing cargo survey reports is nearly effortless. Once the survey ullages, innages, and temperatures are entered, you are done. You can immediately produce the required cargo survey report with a couple of clicks. Since Mate uses the tank offsets and surveyors generally insist on using a combination of the generally less accurate tank tables and the almost always inaccurate "wedge method", there will be differences between Mate's numbers and the surveyor's calculations.[1] But in most cases, as long as Mate and the surveyor are using the same trim and heel, these differences will be small enough to be acceptable to both parties. And when they are not you should consider issuing a Letter of Protest if the surveyor's errors are not in the ship's favor.

The Cargo menu gives you access to Mate's cargo survey reports. There are six choices: OBQ, ROB, Ullage, Ullage-FAOP, Ullage-EOP, CTX-XML. The first five are aimed at aping industry practice; the last should be used in a true tanker management system. Normally, you should prepare one of the first five for the cargo surveyor, and the last for your office.

[1] Make sure you are using the same density, temperature, and VCF rounding options as the surveyor. See Section 14.2.

14.2 Rounding

Before we can talk about cargo survey reports, we need to talk a little bit about rounding. Industry practice is to round VCF, API (or kg/m3), and temperature. Unfortunately, there is a great deal of inconsistency in surveyor's rounding policy. Mate does the best it can to cater to these idiosyncracies.

The rounding options are accessed thru the Rounding menu. With respect to temperature, Mate offers three possibilities.

Round F/C to 0.1/0.01 degrees If this option is chosen, Mate will round Fahrenheit (Table 6A and 6B parcels) to the nearest 0.1 degree. Celsius will be rounded to the nearest 0.01 degrees. Few surveyors use this policy, but this in Mate's default. Internally Mate stores all temperatures as Celsius to the nearest hundreth of a degree.

Round F/C to 0.1/0.05 degrees If this option is chosen, Mate will round Fahrenheit (Table 6A and 6B parcels) to the nearest 0.1 degree. Celsius will be rounded to the nearest twentieth of a degree. This is the ASTM recommendation and the policy used by most surveyors.

Round F/C to 0.5/0.05 degrees If this option is chosen, Mate will round Fahrenheit (Table 6A and 6B parcels) to the nearest half of a degree. Celsius will be rounded to the nearest twentieth of a degree. Some American surveyors round Fahrenheit to the nearest half of a degree. This is completely inconsistent with and makes a mockery of their attempts to compute volumes to six or more (sometimes 9) decimal places. If you run into a surveyor who uses this strange policy, run the numbers both with F rounded to 0.1 and 0.5 degrees. If the error associated with 0.5 degrees works against the ship, the CTX recommends issuing an LOP.

On the Tank Table, Mate always shows Fahrenheit to the nearest tenth of a degree, and Celsius to the nearest hundreth of a degree, regardless of the currently selected rounding policy.

The API/density rounding options are similar.

Round API/SG to 0.01/0.0001 If this option is chosen, Mate will round API (Table 6A and 6B parcels) to the nearest 0.01 degree. kg/m3 will be rounded to the nearest 0.1 kg/m3. Few surveyors

use this policy, but this in Mate's default. Internally Mate stores API's to the nearest hundredth of a degree and specific gravity to the nearest 0.0001.

Round API/SG to 0.1/0.0005 If this option is chosen, Mate will round API to the nearest 0.1 degree. kg/m3 will be rounded to the nearest 0.5 kg/m3. This is the ASTM recommendation and the policy used by most surveyors.

Round API/SG to 0.5/0.0005 If this option is chosen, Mate will round API to the nearest 0.5 degree. kg/m3 will be rounded to the nearest 0.5 kg/m3. Some American surveyors round API to the nearest half of a degree. This is completely inconsistent with and makes a mockery of their attempts to compute volumes to six or more (sometimes 9) decimal places. If you run into a surveyor who uses this strange policy, run the numbers both with API rounded to 0.1 and 0.5 degrees. If the error associated with 0.5 degrees works against the ship, the CTX recommends issuing an LOP.

On the Tank Table, Mate always shows API to the nearest hundreth of a degree, and SG to the nearest 0.0001.

There are two options with respect to VCF.

Round VCF to 5 decimal points ASTM calls this the VCF for "calculation" purposes.

Round VCF to 4 decimal points ASTM calls this the VCF for "printed" purposes. And in fact, the printed VCF tables are to four decimal places. This again is inconsistent with attempts to compute volumes to five or more significant figures. Since most surveyors now use laptops, they should be rounding to 5 decimal places. But some surveyor's programs don't. Once again, if this is the case, run the numbers both ways, and consider an LOP if the error works against the ship.

See Chapter 19 for further discussion of these issues.

14.3 The OBQ Report

Selecting OBQ will pop-up a window displaying a simplified version of the OBQ (before any loading) report for the current loading pattern.[2] This window has a command bar running across the top which allows you to file this report in a variety of formats. The choices are:

Latex Selecting Latex will produces a file containing the OBQ in the latex mark-up language. This format makes reasonably pretty hard-copy and allows the OBQ report to be included in a larger document which uses Latex.[3] report in Mate's native XML format. (See Appendix A.) If the loadfile name matches the current loading pattern – there have been no changes to the loading pattern since you last saved the loadfile – this report will be filed in `obq_`*load*`.tex` where *load* is the current load name, ***overwriting any existing file of the same name***.

If you have changed the loading pattern without updating the loadfile, then the report will be saved as `obq_`*nnnnn*`.tex` where *nnnnn* is the five digit process ID number. There is little point in preparing Survey reports for unsaved loading patterns, so Mate regards all such reports as temporary files, which it will delete when you exit the Mate session.

troff Selecting troff will produces a file containing the OBQ report in troff mark-up. This produces the best looking tables, and allows the OBQ report to be included in a larger document that uses troff.[4] The file naming conventions and rules are the same as for Latex except the file extension is `.trf`.

PDF Selecting PDF produces a file containing the OBQ report in PDF (Adobe Page Description Format). This is a good format for sending to third parties, since just about everybody has the capability of displaying and printing PDF.[5] It is useless for post-processing.

[2] The OBQ report is a simplified report used by surveyors only when the ship is empty of cargo or nearly so. This is different from the OBQ load pattern type which applies to any arrival at a load port, including situations where the ship is already partially loaded. The proper report in the latter case is Ullage.

[3] Such as this manual. Some sites may not have a Latex capability, in which case you will get a pop-up saying can't produce Latex report.

[4] Some sites may not have troff capability, in which case you will get a pop-up saying can't produce troff report.

[5] The PDF report is actually based on the troff report if troff is available. If not, it

Print Selecting Print will print out the OBQ report.

Dismiss Selecting Dismiss will wipe-out the OBQ window. You can also destroy the window by clicking on the Mainscreen.

Table 14.1 shows a sample OBQ report. Only cargo tanks will be shown. The OBQ report simply summarizes the liquid oil, freewater, and non-liquid by tank. The Glossary contains definitions of the various cargo related volumes. The OBQ report follows industry practice for a nearly empty ship and does no temperature correction. Therefore, it is not appropriate to situations where the ship is already partially loaded upon arrival.

The last column contains a `D` or `Z`. It is often the case that the point of zero innage for a particular dipping point is not the lowest point in the tank. This is especially true if the ship has significant trim or heel. Since the ullaging system can't measure below zero innage, we don't know if the wedge below this point is empty, full, or somewhere in between. Mate offers two choices. `D` indicates the volume was calculated by Mate's normal direct integration method which takes the given innage at its word, and assumes the real tank waterline is at this innage level. In other words, it assumes the wedge is full.[6] However, if you set the the Zero_Innage_Zero_Volume option in the Options menu, Section 3.4, Mate will assume that any tank that has a non-positive innage is Empty. This is the normal cargo surveyors' convention.[7] For positive innages, there is no difference between D and Z. The OBQ report always reports TOV (Total Observed Volume) in cubic meters.

will be based on the Latex report. If neither troff nor Latex are available at your site, you will get an error message saying unable to produce PDF report.

[6] Don't be fooled by the word "wedge". Mate never uses the so-called Wedge Method which some surveyors use to estimate the liquid volume in a nearly empty tank. The Wedge Method arbitrarily assumes a tank geometry which may have nothing to do with the actual shape of the tank. It can be and often is highly inaccurate.

[7] Mate cannot be inconsistent. If the Zero_Innage_Zero_Volume option forces the tank volume to zero, then Mate will show a negative innage which is consistent with the lowest point in the tank. All this means is that no liquid showed on the dip stick or equivalent.

Table 14.1: Sample OBQ Report

HELLESPONT TARA IMO Number: 9235268
CTX_MATE 0.37-BASE OBQ REPORT

Temp rounded to nearest 0.1F. API rounded to nearest 0.01 degrees.

LOAD PATTERN	lf_al98dep.zero_inn	HEEL	-0.14	DATE	2006-10-02T17-22-02Z
DRAFT fwd/aft	18.48/27.38	TRIM	-8.91	PORT	xxxx
VOYAGE/LEG	DEMO/	AUTHOR	root	BERTH	

TANK	DIP	TOV		FREE WTR		NON-LIQ		GOV	W
CODE	PT	CM	BBLS	CM	BBLS	CM	BBLS	BBLS	?
1C	UL	-48.5	0	0.0	0	0.0	0	0	Z
1P	UL	3137.9	137464	0.0	0	0.0	0	137464	D
1S	UL	3137.5	137464	0.0	0	0.0	0	137464	D
2A_P	UL	3089.5	93801	0.0	0	0.0	0	93801	D
2A_S	UL	3092.1	93801	0.0	0	0.0	0	93801	D
2C	UL	3073.0	289463	0.0	0	0.0	0	289463	D
2F_P	UL	3092.3	93801	0.0	0	0.0	0	93801	D
2F_S	UL	3094.2	93801	0.0	0	0.0	0	93801	D
3C	UL	3178.3	299518	0.0	0	0.0	0	299518	D
3P	UL	3112.2	187601	0.0	0	0.0	0	187601	D
3S	UL	3011.7	181303	0.0	0	0.0	0	181303	D
4A_P	UL	3088.4	93801	0.0	0	0.0	0	93801	D
4A_S	UL	3090.7	93801	0.0	0	0.0	0	93801	D
4C	UL	3073.0	289463	0.0	0	0.0	0	289463	D
4F_P	UL	3092.3	93801	0.0	0	0.0	0	93801	D
4F_S	UL	3094.7	93801	0.0	0	0.0	0	93801	D
5C	UL	3171.0	271983	0.0	0	0.0	0	271983	D
5P	UL	3086.8	130263	0.0	0	0.0	0	130263	D
5S	UL	3089.3	130263	0.0	0	0.0	0	130263	D
SLOP_P	UL	3099.2	41112	0.0	0	0.0	0	41112	D
SLOP_S	UL	3106.0	40061	0.0	0	0.0	0	40061	D
TOTALS			2886365		0		0	2886365	

SURVEYOR _____ CHIEF OFFICER _____

14.4 The After-Discharge or ROB Report

Selecting ROB from the Cargo menu will pop up a window and display a simplified version of Mate's ROB (Remaining On Board) report. The window will have a command bar with the same report format choices as for the OBQ report. This is a standard pattern for Mate reports. When you select a report type, you will be shown a snapshot of the report in a window which will allow you to select a specific format for saving that report.

The naming conventions for the ROB report are the same as for the OBQ except that the report file names start with `rob_` rather than `obq_`.

The ROB report is normally used only after the final discharge, but in many respects it is the most useful and flexible of all the standard industry cargo survey reports. Table 14.2 shows a sample ROB report.

The ROB report is similar to the OBQ report except that it uses the tank temperatures to convert any remaining observed oil volumes to standard volumes and summarizes the results by parcel. Because of the format used, Mate cannot prepare an ROB report for loading patterns that have both English and Metric unit cargo parcels. If you try, you will get an error message to this effect.

The cargo survey reports are the only Mate functions which make use of the FREEWTR and NONLIQ columns on the Mainscreen. All the other functions include the FREEWTR and NONLIQ quantities in the cargo. Mate assumes the Non-Liquid (sometimes known as Unpumpables) quantity underlies the free water. Mate further assumes the top of the non-liquids is parallel with the ocean. This implies that the free water innage must be at least as great as the non-liquid innage. An attempt to enter a free water innage which is smaller than the non-liquid innage will be rejected by Mate. This means that free water and non-liquid innages must usually be entered in that order. Mate computes the free water volume based on the difference between the free water and the non-liquid innage. If there is no free water above the non-pumpables, then the freewater innage must be the same as the non-liquid Innage.

Table 14.2: Sample ROB Report

HELLESPONT TARA IMO Number: 9235268
CTX_MATE 0.37-BASE ROB REPORT

Temp rounded to nearest 0.1F. API rounded to nearest 0.01 degrees.

LOAD PATTERN	lf_al98dep	HEEL	-0.14	DATE	2006-06-14T14:43:30Z
DRAFT fwd/aft	24.02/24.91	TRIM	-0.89	PORT	xxxx
VOYAGE/LEG	/	AUTHOR	root	BERTH	

TANK CODE	CGO	DIP PT	TEMP F	TOV CM	TOV BBLS	FREE CM	WTR BBLS	NON-LIQ CM	NON-LIQ BBLS	GOV BBLS	GSV BBLS	W ?
1C	AL	UL	60.0	3143.9	253583	0.0	0	0.0	0	253583	253583	D
2C	AL	UL	60.0	3144.5	299519	0.0	0	0.0	0	299519	299519	D
3C	AL	UL	60.0	3144.4	299518	0.0	0	0.0	0	299518	299518	D
4C	AL	UL	60.0	3144.5	299518	0.0	0	0.0	0	299518	299518	D
5C	AL	UL	60.0	3144.9	271983	0.0	0	0.0	0	271983	271983	D
1P	AL	UL	60.0	3095.3	137464	0.0	0	0.0	0	137464	137464	D
1S	AL	UL	60.0	3095.6	137464	0.0	0	0.0	0	137464	137464	D
2F_P	AL	UL	60.0	3074.5	93801	0.0	0	0.0	0	93801	93801	D
2F_S	AL	UL	60.0	3076.5	93801	0.0	0	0.0	0	93801	93801	D
2A_P	AL	UL	60.0	3074.0	93801	0.0	0	0.0	0	93801	93801	D
2A_S	AL	UL	60.0	3076.7	93801	0.0	0	0.0	0	93801	93801	D
3P	AL	UL	60.0	3076.2	187601	0.0	0	0.0	0	187601	187601	D
3S	AL	UL	60.0	3078.7	187601	0.0	0	0.0	0	187601	187601	D
4F_P	AL	UL	60.0	3074.5	93801	0.0	0	0.0	0	93801	93801	D
4F_S	AL	UL	60.0	3077.0	93801	0.0	0	0.0	0	93801	93801	D
4A_P	AL	UL	60.0	3074.1	93801	0.0	0	0.0	0	93801	93801	D
4A_S	AL	UL	60.0	3076.6	93801	0.0	0	0.0	0	93801	93801	D
5P	AL	UL	60.0	3082.7	130263	0.0	0	0.0	0	130263	130263	D
5S	AL	UL	60.0	3085.6	130263	0.0	0	0.0	0	130263	130263	D
SLOP_P	AL	UL	60.0	3109.7	41112	0.0	0	0.0	0	41112	41112	D
SLOP_S	AL	UL	60.0	3114.4	40061	0.0	0	0.0	0	40061	40061	D
TOTALS			60.0		3166356		0		0	3166356	3166356	

CGO	API	TOV	GOV	F	GSV	WCF	WEIGHT
AL	34.56	3,166,356	3,166,356	60.0	3,166,356	0.13517	427,996.4
Totals		3,166,356	3,166,356	60.0	3,166,356		427,996.4

SURVEYOR _____ CHIEF OFFICER _____

14.5 The Ullage Survey Report

The industry uses OBQ or ROB reports for empty or nearly empty ships. The rest of the time it relies on Ullage reports. Selecting Ullage will pop-up a window and display a simplified version of the Mate's Ullage report for the current loading pattern. The window will have a command bar with the same report format choices as for the OBQ report. The only difference is that the file names of the Ullage reports start with `ulp.` rather than `obq`.

The Ullage report has one page for each cargo parcel. Tables 14.3 and 14.4 show a sample two parcel After Loading report. If the parcel VCF method is `C` (Table 6A) or `F` (Table 6B), the volume units will be barrels and the temperature units will be Fahrenheit degrees. Otherwise cubic meters and degrees Celsius will be displayed. The page title for each parcel indicates which temperature correction table was used and the rounding policy.[8] Be aware that the rounding policy used with respect to API/standard density, temperature, and VCF can result in differences of the order of several hundred cubic meters (up to 2000 barrels) for a large parcel.

Since Mate never has to "correct" an ullage for trim or heel, Mate makes no use of the Ullage Corr. column. It's in the report so that CTX_Surveyor can use the same report format, and because cargo surveyors expect to see such a column.

In producing an ullage report, Mate assumes that the non-liquid innage is zero. This is consistent with industry survey practice in which no attempt is made to measure the non-liquid volume for loaded tanks. If you ask for an Ullage report and one or more of the non-liquid innages is greater than zero, Mate will refuse to do the report and ask for a correction.

Mate bases the average temperature of each parcel on the GSV of each tank.

[8] The VCF rounding policy is indicated by the word immediately below VCF in the column headers. It will either be Print (rounded to 4 decimal places), Calc (rounded to 5 decimal places), or Exact (unrounded, actually truncated to 8 significant figures).

Table 14.3: Ullage Report, first page

HELLESPONT TARA IMO Number: 9235268
CTX_MATE 0.37-BASE ULLAGE REPORT

Temp rounded to nearest 0.1F. API rounded to nearest 0.01 degrees. Using Table 6A

PARCEL test arab ligh API 60F 34.56 TYPE None
LOAD PATTERN lf_al98dep.2parcel HEEL -0.14 DATE 2006-10-05T16-08-49Z
DRAFT fwd/aft 24.01/24.91 TRIM -0.89 PORT xxxx
VOYAGE/LEG DEMO/ AUTHOR root BERTH

TANK CODE	PT PT	ULLAGE OBS	Corr	TOV BBLS	Free CM	Water BBLS	GOV BBLS	TEMP F	VCF Print	GSV BBLS	W ?
1P	UL	1.447		137464	0.0	0	137464	60.0	1.0000	137464	D
1S	UL	1.437		137464	0.0	0	137464	60.0	1.0000	137464	D
2F_P	UL	1.652		93801	0.0	0	93801	60.0	1.0000	93801	D
2F_S	UL	1.537		93801	0.0	0	93801	60.0	1.0000	93801	D
2A_P	UL	1.710		93801	0.0	0	93801	60.0	1.0000	93801	D
2A_S	UL	1.620		93801	0.0	0	93801	60.0	1.0000	93801	D
3P	UL	1.627		187601	0.0	0	187601	60.0	1.0000	187601	D
3S	UL	1.616		187601	0.0	0	187601	60.0	1.0000	187601	D
4F_P	UL	1.644		93801	0.0	0	93801	60.0	1.0000	93801	D
4F_S	UL	1.619		93801	0.0	0	93801	60.0	1.0000	93801	D
4A_P	UL	1.646		93801	0.0	0	93801	60.0	1.0000	93801	D
4A_S	UL	1.628		93801	0.0	0	93801	60.0	1.0000	93801	D
5P	UL	1.620		130263	0.0	0	130263	60.0	1.0000	130263	D
5S	UL	1.583		130263	0.0	0	130263	60.0	1.0000	130263	D
SLOP_P	UL	1.525		41112	0.0	0	41112	60.0	1.0000	41112	D
SLOP_S	UL	1.483		40061	0.0	0	40061	60.0	1.0000	40061	D
TOTALS				1742235		0	1742235	60.0		1742235	

GROSS STANDARD VOLUME (G.S.V) 1,742,235 BBLS
FREE WATER + 0 BBLS
TOTAL CALCULATED VOLUME (T.C.V) = 1,742,235 BBLS

SURVEYOR _____ CHIEF OFFICER _____

Table 14.4: Ullage Report, Second page

HELLESPONT TARA IMO Number: 9235268
CTX_MATE 0.37-BASE ULLAGE REPORT

Temp rounded to nearest 0.1F. API rounded to nearest 0.01 degrees. Using Table 6A

PARCEL	test arab hvy	API 60F	29.00	TYPE	None
LOAD PATTERN	lf_al98dep.2parcel	HEEL	-0.14	DATE	2006-10-05T16-08-49Z
DRAFT fwd/aft	24.01/24.91	TRIM	-0.89	PORT	xxxx
VOYAGE/LEG	DEMO/	AUTHOR	root	BERTH	

TANK	PT	ULLAGE		TOV	Free Water		GOV	TEMP	VCF	GSV	W
CODE	PT	OBS	Corr	BBLS	CM	BBLS	BBLS	F	Print	BBLS	?
1C	UL	2.459		245069	0.0	0	245069	60.0	1.0000	245069	D
2C	UL	2.459		289463	0.0	0	289463	60.0	1.0000	289463	D
3C	UL	2.452		289463	0.0	0	289463	60.0	1.0000	289463	D
4C	UL	2.466		289463	0.0	0	289463	60.0	1.0000	289463	D
5C	UL	2.461		262853	0.0	0	262853	60.0	1.0000	262853	D
TOTALS				1376311		0	1376311	60.0		1376311	

GROSS STANDARD VOLUME (G.S.V)		1,376,311 BBLS
FREE WATER	+	0 BBLS
TOTAL CALCULATED VOLUME (T.C.V)	=	1,376,311 BBLS

SURVEYOR _____ CHIEF OFFICER _____

14.6 The Ullage-FAOP Report

The Ullage-FAOP report is designed to be used on completion of load, that is, departure from the load port. The Ullage-FAOP report is exactly the same as the Ullage report except that in the summary section for each parcel the TCV received is calculated and displayed. In order to do this calculation, Mate needs to know each parcel's pre-loading OBQ. Unfortunately, currently Mate does not know this number. When you select Ullage-FAOP, Mate will pop-up a little form asking you to fill in the needed OBQ's. The prefix for the Ullage-FAOP report is `ull_`.

14.7 The Ullage-EOP Report

The Ullage-FAOP report is designed to be used on arrival at the discharge port. The Ullage-EOP report is exactly the same as the Ullage report except that in the summary section for each parcel the apparent In-Transit Gain/Loss is calculated and displayed. In order to do this calculation, Mate needs to know each parcel's FAOP TCV. Unfortunately, currently Mate does not know this number. When you select Ullage-EOP, Mate will pop-up a little form asking you to fill in the needed TCV's. The prefix for this Ullage-EOP report is `uld_`.

14.7.1 The CTX Cargo Survey Report

All of Mate's cargo survey reports ape industry practice, except one, the Tank report. This report is designed to be post-processed. It contains all the information required to generate any of the preceding cargo survey reports, as well as the information to prepare freight invoices, defend cargo claims, prepare bunker receipts, and a hundred other uses. It is a totally complete record of the condition of each tank (bunkers as well as cargo) at the time of the cargo survey. The idea is that each post-processor will extract the data it needs to do its particular function.

When you select Tank from the Cargo menu, the Tank report will be displayed in a scrolling window. The Command bar on this window has only two options, Save and Dismiss. If the load pattern has been filed, Save will save the report with a file name of `tank_`*load*`.ctx` where *load* is the current load name, the load file name without the leading `lf_`. Otherwise, the report will be placed in a temporary file `tank_`*nnnnn*`.ctx` where *nnnnn* is the process ID.

Figure 14.7.1 shows an abbreviated Tank report. The format is in self-identifying XML and follows the same rules as for the loadfile, Section 6.2.[9]

The Header, Options, Tilt and Parcels sub-sections are exactly the same as for a loadfile.

The difference is the Tanks sub-section where the report contains a little paragraph for each non-hidden tank and compartment, everything between CON<ctx_Tank and `</ctx_Tank>`. Within that paragraph is just about everything you need to know about that tank, especially when combined with the parcel data.

The `ctx_Tank` variables are:

name The tank/compartment name.

type The tank/compartment type which will be one of C/G/S (Cargo, Gale Ballast, Slops) which are all treated as cargo tanks, B (ballast), f (Heavy fuel oil), d (Diesel oil), c (Cylinder oil), s (other lube oil), w (fresh water), L (liquid, not specified), V (non-tank compartment).

[9] The format is also the same as the `ctx_Tanks` section in the Full report from the Export menu, Section 7.2. The only difference is that in the Tank report the post-processor can (but need not) assume the tank is undamaged.

par The parcel code, which will match one of the codes in the `ctx_Parcels` sub-section.

dip_pt The currently selected dipping point/gauging system..

opt Same as OPT on the Tank Table.

temp Average tank temperature in degrees Celsius to one-hundreth of a degree. This number is prior to any temperature rounding called for by the `round_temp` option.

sg The calculated specific gravity of the tank liquid at the tank temperature excluding free water and non-pumpables. This will be shown to five significant figures, but may have only been calculated to four depending on the rounding options.

vcf The computed Volume Correction Factor. This will be shown to five significant figures, but may have only been computed to four. See the Options sub-section.

wl_ze The height of the top of the tank liquid above sea level in meters. Height in this case is always measured in the direction of gravity.

ullage The tank ullage as measured by the selected dipping point/gauging system in meters. The direction will depend on the dipping point type.

innage The tank innage as measured by the selected dipping point/gauging system in meters. The direction will depend on the dipping point type.

freewater_m The freewater innage as measured by the selected dipping point/gauging system in meters.

non_liq_m The non-liquid innage as measured by the selected dipping point/-gauging system in meters.

freewater_v The calculated freewater volume in cubic meters.

nonliq_v The calculated non-liquid volume in cubic meters.

tov The total observed volume in cubic meters.

gov The gross observed volume in cubic meters. This is the TOV less freewater and non-liquid volume.

gsv The gross standard volume in cubic meters. This is the GOV converted back to the parcel's standard temperature.

wt The weight of the GOV liquid in the tank in tons.

lcg_xe The longitudinal center of gravity of all liquids in the tank in earth coordinates.

tcg_ye The transverse center of gravity of all liquids in the tank in earth coordinates.

vcg_ze The vertical center of gravity of all liquids in the tank in earth coordinates.

moi_m4 The transverse waterplane moment of inertia.

The last four variables are used only in tanker design applications and may be ignored in tanker operations. Notice that internally Mate stores temperature and volume in metric units, even for Table 6A and Table 6B parcels.

Figure 14.1: Excerpt from CTX style cargo survey report

```
<ctx_Report opts="HOtPT" time="2006-10-08T16-12-45Z" version="0.37" varient="BASE"
  path="/X/uldh/V/DEMO/obq.ld.al98dep.xml"
  ship_dir="/X/uldh/DATA/MATE"
  scant_dir="">
  <ctx_Header
    fleet="U" ship="al" shipname="Hellespont Alhambra" imo_number="9224752"
    voy_num="" leg="" type="None" port="xxxx" berth=""
    title1="this is a template for loading pattern files as used by 0.25 and later."
    title2="based on /tfs/u/NLOAD/1.92/LF.al98dep."
    mod_time="2006-06-14T14:43:30Z" author="root">
  </ctx_Header>
  <ctx_Options
      mode="N"       use_si="N"       use_harbor="N"      zero_inn_zero_vol="N"
      loadline="S"   rigid="Y"        bend_mom_pct="Y"    phony_vertical="N"
      exact_vcf="N"  round_temp="N"   round_api="N"       show_hidden="N"
      grounded="N"   low_grnd="N">
  </ctx_Options>
  <ctx_Tilt draft_fp="24.01539" draft_ap="24.90727" heel_deg="-0.13887">
  </ctx_Tilt>
  <ctx_Parcels>
      <ctx_Parcel code="sw" method="s" density="1.0234" color="" name="test sea water"
                  sulfur="0.0000" ash="" water="" vp="" comment=""/>
      <ctx_Parcel code="AL" method="C" density=" 34.56" color="" name="test arab ligh"
                  sulfur="0.0000" ash="" water="" vp="" comment=""/>
      <ctx_Parcel code="f1" method="P" density="0.9876" color="" name="test 54b"
                  sulfur="" ash="" water="" vp="" comment=""/>
  </ctx_Parcels>
  <ctx_Tanks mode="N">
      <ctx_Tank name="1C      " type="C"   par="AL" dip_pt="UL" opt="P"
          temp=      " 15.56" sg=       "0.85019" vcf=      "1.00000"
          wl_ze=    " 10.576" ullage=   "  1.404" innage=   " 31.439"
          freewtr_m="  0.000" non_liq_m="  0.000" freewtr_v="    0.0" non_liq_v="    0.0"
          tov=      "40316.4" gov=      "40316.4" gsv=      "40316.4" wt=       "47420.3"
          lcg_xe=  " 318.138" tcg_xe=   "  0.050" vcg_xe=   " -5.128" moi_m4=   "  60247">
      </ctx_Tank>

         .... more tanks ....

      <ctx_Tank name="1FO_P   " type="f"   par="f1" dip_pt="UL" opt="P"
          temp=      " 15.00" sg=       "0.98760" vcf=      "1.00000"
          wl_ze=    "  8.516" ullage=   "  2.472" innage=   " 23.650"
          freewtr_m="  0.000" non_liq_m="  0.000" freewtr_v="    0.0" non_liq_v="    0.0"
          tov=      " 3458.2" gov=      " 3458.2" gsv=      " 3458.2" wt=       " 3501.7"
          lcg_xe=  "  44.948" tcg_xe=   " 21.638" vcg_xe=   "  0.132" moi_m4=   "   5944">
      </ctx_Tank>

         ..... more tanks .....
  </ctx_Tanks>
</ctx_Report>
```

Chapter 15

Auto Mode

15.1 Entering Auto mode

Many modern ullaging systems have the capability of exporting their measurements. If the Auto button on the Mode menu is not disabled, your Mate has the capability of reading in those measurements.[1] This is done in Auto mode.

To enter Auto mode, select Auto from the mode menu. You must do this from Normal mode. You cannot go directly from Damage mode to Auto mode. As soon you do this, Mate will start taking tank input (ullages, innages, temperature, ullage space pressure) from the gauging system, and it will ignore whatever data you enter on the Tank Table, including data for those tanks that are ***not*** connected to the gauging system.

You can tell you are in Auto mode, because the Tank Table will have a blue background, rather than the normal grey. Every so often, usually about every 10 seconds, the Tank Table will flash all red. This tells you that Mate has just updated itself by reading in the data from the

[1] Mate uses a separate process whose job is to convert the gauging system output to an intermediate CTX XML file which is then read by Mate. This separate process is ***not*** a CTX responsibility. It is not automatically included when Mate is installed on your computer. Because of the idiosyncracies of different ullaging systems this process usually has to be customized to match the characteristics of the gauging system on each ship or at least each Class of ship. CTX does not do this, although it offers detailed templates and instructions for systems using the Saab Radar protocol. See CTX Mate System Adminstrator's Manual **??**. Unless someone has installed the separate process on your ship, you will not have a functioning Auto mode.

gauging system. Everytime this is done, the Summary section will change accordingly.

You may also see some new tanks on the screen. Mate ensures that all tanks that are connected to the automatic gauging system are unhidden. And it changes the OPT of each of those tanks to U or I depending on whether the gauging system reports ullage or innage for the tank. Finally, all tank temperatures are in Celsius and all volumes in cubic meters, even for Table 6A and Table 6B parcels.

15.2 Auto Mode functions

You will also notice that the Menubar and Toolbar have changed drastically. In Auto mode, the menubar contains only one Menu: Mode, and that menu will allow you to do only one thing: switch back to Normal mode.

On the Toolbar, the Redo button is now labeled Normal. Selecting this button, will switch back to Normal Mode. Most of the other buttons are now labeled Unused.

Auto mode is a very limited mode. You cannot enter any data to the Tank Table. Even tanks which are not connected to the gauging system cannot be changed in Auto mode. You cannot save a loading pattern. You cannot do IMO REG25 or sloshing analysis. You cannot even balance the ship; the ship will automatically be rebalanced every time new data is obtained from the gauging system.

You can only do the following:

1. Go back to Normal mode.
2. Print a snapshot of the Mainscreen by selecting the Print button on the Toolbar.
3. Pop up the bending moment and shear force window.
4. Pop up the righting arm curve window. Be aware that Mate will not update from the gauging system until the righting arm calculations are done.

As a practical matter, these limitations are not a problem. If you need to do something else, for example, save the current loading pattern or change a number for one of the tanks not connected to the ullaging system, simply switch back to Normal mode, do whatever you need to do, and then switch back to Auto.

Numerically, there is no difference between Mate's calculations in Auto mode and in Normal mode. If you save a loading pattern that was generated in Auto mode, and then send it to the office which runs that pattern in Normal mode, all the results will be exactly the same.

15.3 Gauging System Errors

Automatic ullaging systems tend to be fragile and error prone. Mate attempts to handle these problems gracefully or at least as well as it can.

- If Mate cannot connect to or loses contact with the ullaging system it will automatically switch you to Normal mode, and the background color of the Tank Table will change back to gray.
- If Mate cannot read data for an individual tank, it will stay in Auto mode and color the tank's row either red or yellow. (In most ***but not all*** cases, the tank will also show up pink or red on the gauging system monitor.) In either case, Mate will use the last ullage/innage it knows about ***which is probably not the correct ullage/innage***. The most common situation where this happens, is if a tank is 100% full or nearly 100% full. In this case, the gauging system often will not produce a reading for that tank. If the last reading indicates the tank is full or nearly full, Mate will act as if the tank is full and color that tank's row yellow. If Mate cannot get a reading from the ullaging system for an individual tank and the last reading indicates the tank is not nearly full, Mate will use the last known ullage/innage and color the tank's row red. ***Any tank row which shows red or yellow must be closely monitored and, if the actual ullage/innage becomes significantly different from that which Mate is using, you must switch to Normal Mode.*** Mate cannot do this for you.
- If too many tanks are showing red or yellow, Mate will automatically switch you back to Normal mode. When Mate switches back to Normal mode, the red or yellow will be retained until you rebalance the ship but only until then. This is a one time warning that you should check this tank's ullage/innage. The definition of "too many" is set by your owner's policy for the ship, but it should be less than 15% of the number of tanks connected to the

ullaging system.

The most effective way of handling individual ullaging system errors is to take a tank *offline*. If the gauging system for a particular tank is not functioning or the readings for that tank are known to be wrong, then switch to Normal mode, and put a `Y` in the `OFF` column for that tank. Also set the ullage or innage or whatever of that tank to the correct numbers.

When you return to Auto mode, that tank's row will remain gray. Mate will ignore whatever the ullaging system says about that tank. Rather it will use the numbers you manually entered. Of course, it the numbers for an offline tank change significantly, you will have to go back to Normal mode and enter the new numbers. As long as a tank is marked offline, Mate will act as if that tank is not connected to the auto-ullaging system. You can put a tank back on-line by going to Normal mode and blanking out the Y in the OFF column.

Chapter 16

Handling Damage

16.1 The Damage Mode Mainscreen

Mate has extensive damage analysis and salvage capabilities. The most straightforward way to invoke these capabilities is by selecting Damage from the Mode menu. You can only do this from Normal mode. If you are in Auto mode, you must switch to Normal mode first. You can also select Damage from the Normal mode Toolbar, but this will also unhide all tanks and compartments.[1] Normally, this will be overkill in which case using the Mode menu is the better alternative. Once in damage mode, you can then set any tank or compartment to damaged by setting the tank option for those tank(s) to `D` or `d`. Notice that the current loading pattern, presumably the loading pattern just prior to damage, is already loaded and ready for analysis.

Why

If a loading pattern is saved while in Damage mode, and you ask for that loading pattern when beginning your Mate session, you will automatically be in Damage mode on start up. If tanks or compartments which are not in the current loadfile are or may be damaged, then you must select the correct SHOW_HIDDEN option from the View Menu, so that you can include those spaces in the analysis.

Mate's damage mode is totally different from and incompatible with the hypothetical flooding scenarios called for by IMO Regulation 25 which is treated in Chapter 11. Mate's damage analysis is aimed at analysing actual specific damage and the resulting spillage, and testing

[1] This is insurance against a mouse failure.

means for minimizing and recovering from that damage. In that sense, it is a salvage program.

Parts of this chapter and the next assume the reader is familiar with the principles of hydrostatic balance. For example, you should know the meaning of the terms Hydrostatic Flow and Exchange Flow. See for example the CTX document, The Physics of Tank Spillage **??**. Mate's damage mode spill calculations are of almost no use unless you understand what Mate is calculating and why.

In Damage Mode, the Mainscreen will extend to the right of the normal Mainscreen and contains the additional columns shown on the next page. You will have to scroll the screen to see all these columns. In this case, 1P and 2P have damage extending 10 m up the side shell. Notice that the FREEWTR column has been replaced by a column labeled IGS_mm and the NONLIQ column has been replaced with a column called HBL_m. You cannot generate cargo survey reports when in Damage Mode. All the other commercially oriented columns (GSV, GOV, etc) are gone as well. In damage mode all temperatures are Celsius and all volumes cubic meters, even for Table 6A and Table 6B parcels.

The new columns are:

IGS_mm Unless tank Opt is S (Damaged Sealed) this column contains the unsealed ullage space gas pressure in millimeters of water gage for each tank. Normally for cargo tanks, this will be the inert gas pressure. If a tank is vented (either by design or by damage), then set this entry to zero. If tank Opt is S, this column contains the initial (pre-damage) ullage space pressure. Normally for cargo tanks, this will be the inert gas pressure.

HBL_m This column shows the degree of hydrostatic over/under balance at the tank bottom. This column applies only to tanks which have not been marked as damaged. This is particularly useful when you are unsure which tank(s) are leaking and the damage is believed to be on or near the flat bottom. If a tank is known to be damaged and marked as such, then other columns apply as we shall see, and HBL_m column will show a zero. Otherwise, if the number is positive, it implies that the tank is hydrostatically over-balanced and leakage from bottom damage would occur. If the number is negative, it implies that the tank is hydrostatically under-balanced and leakage from bottom damage would not oc-

cur. The figure is a rough estimate of the change in innage in meters that would be required to bring the tank to hydrostatic balance. A tank whose HBL_m is +3.0 would need to be drawn down roughly 3 meters to reach hydrostatic balance on the bottom; a tank whose HBL_m is -2.0 could be filled up roughly 2 meters before it reached hydrostatic balance on the bottom. If a tank has a comfortably negative HBL_m — anything more negative than -0.5 meters — then it cannot be leaking from flat bottom damage and may be ruled out as a possible flat bottom damage culprit. Only tanks with positive or near-positive HBL_m are possible sources of flat bottom leakage. Moreover, you can safely transfer cargo into tanks with comfortably negative HBL_m and be sure that as long as these tanks have a negative HBL_m, they will not be sources of bottom leakage.

ULL_m This column shows the equilibrium ullage space pressure in meters water gage. Unless tank Opt is S, this will be the same as IGS_mm except it will be in meters rather than millimeters. If tank Opt is S (tank is damaged and sealed), it will be less than IGS_mm (in meters) for tanks with net outflow, reflecting the vacuum created in the top of the tank. If tank Opt is S and there is net inflow, then ULL_m will be higher than IGS_mm. In this case, at least from a spill reduction point of view, it is normally a good idea to (partially) vent the tank.

TANK_WL The equilibrium level of the top of the liquid in each tank relative to the sea after any leakage. 0.000 in this column indicates that the top of the liquid in the tank is at sea level, plus means the level in the tank is higher than sea level, and -5.000 would indicate that the level in the tank is 5 meters below sea level.

INTRFACE For damaged tanks, this column contains the level of the oil-water interface in the tank relative to sea level after the tank has become hydrostatically balanced and all exchange flow has taken place. If there is no oil in the tank at equilibrium, this number will be the same as TANK_WL.

HYDROOUT For damaged tanks, this column contains the amount of hydrostatic outflow required for the tank to become hydrostatically balanced, that is the pressure at the critical damage level (KEYLEVEL) in the tank is the same as the pressure outside the tank. This value is in cubic meters.

EXCHGOUT This column contains the amount of exchange flow in cubic meters required to bring the oil-water interface up to the highest level of damage if the highest level is below the waterline.

KEYLEVEL In damage situations, the critical damage level or KEYLEVEL is the highest point of damage if the highest point is below the waterline, the lowest point of damage if the lowest point is above the waterline, and 0.000 (sealevel) otherwise. In the last case, the tank is essentially free flooding. Highest and lowest in this case are in earth coordinates.

GROUP In Damage mode, Mate has an important capability called *tank grouping*. This feature allows any tank to be *grouped* with a damaged tank, in which case the grouped tank is treated as if were part of the damaged tank. This allows Mate to model certain forms of internal damage, for example, between a double hull ballast tank and a neighboring cargo tank. It also allows Mate to model situations in which two or more tanks are purposely connected in order to reduce spillage. Grouping is discussed in some detail in Section 16.6. To group a tank, you use the GROUP column. Normally, the column will contain the tank's own code, that is, the tank code at the far left of each row. But you may enter the code of any damaged tank in this column in which case this row's tank or compartment will simply become part of the damaged tank. The tank whose code is entered into the Group column is known as the *lead tank* of the Group. You must first mark a tank as damaged (D or S) before it can become a lead tank. When you re-balance after grouping, the grouped tank's OPT will switch to `G`. You un-group a tank by putting its own code in the Group column and then you can reset the tank's OPT. Any damage location specified for a grouped tank is ignored.

OUTER Grouping does a good job of modelling certain forms of internal damage but not others. Grouping assumes the two tanks act as a single tank. This will happen if the internal damage is high in the tank or the internal flows are much faster than the external ship to sea and sea to ship flows. This is known as inside-out flow. However, if the internal damage is low in the tanks and the external flows are faster than the internal flows, grouping will usually over-estimate spillage. In the extreme case, the external tank will reach equilibrium with the sea before there is any significant internal flows. This is knows as outside-in flow. Mate

models inside-out damage and outside-in damage but nothing in between. Inside-out flow is handled by grouping as we've seen. If you wish to use outside-in flow to model internal damage, then you must put the tank code of the external tank in the Outer field. For example, if there is damage between 2P cargo and 2B_P ballast low in the inner side, put 2B_P in the Outer field of the 2P row, and enter your estimate of the inner side damage location just as if it were external hull damage (see below). As long as the internal damage is all below the waterline, the key is the high point of this damage. In outside-in flow, Mate calculates the hydrostatic balance in the interior tank just as it were facing seawater pressure externally. The only difference is that any oil outflow is directed into the external tank. Mate then computes the hydrostatic balance in the external tank. Any oil outflows are treated as spillage.

An inside tank in outside-in flow cannot be grouped, nor can it be an outside tank for some other tank. The outside tank in outside-in flow must be either not grouped or the lead tank of a group.

Hi F&A The longitudinal position of the high point of the damage in this tank forward of the Aft Perpendicular. If the tank is marked damaged, `OPT` is `D`, `d`, `S` or `s`, then this and the next five columns must have entries. Otherwise, this and the next five columns are ignored.[2]

Hi P&S The transverse position (distance off centerline) of the high point of the damage in this tank. Positive is port, negative starboard.

Need to re-write, once we implement ys_from_xs_and_zs

Hi Vert The vertical position of the high point of the damage in this tank, above the baseline.

Lo F&A The longitudinal position of the low point of the damage in this tank.

Lo P&S The transverse position of the low point of the damage in this tank.

[2] You may enter damage location numbers for tanks that are not marked damaged. Also Mate remembers the current damage location numbers if a damaged tank is changed to undamaged. In both cases, the damage location numbers will be checked to see if they are reasonable but otherwise ignored. This often saves some typing when exploring the effects of hypothetical damage.

Lo Vert The vertical position of the low point of the damage in this tank, above the baseline. Zero means on the flat bottom.

Normally you will have to scroll horizontally to see these columns by repeatedly pressing the RIGHT-ARROW key. All the columns from HBL_m through KEYLEVEL are output only. Changing them from the Mainscreen has no effect on the next rebalance. The key determinant of damage is the damage location (high and low points for each tank) in the rightmost six columns. The IGS_mm and rightmost six columns can be changed in the normal fashion but entries for non-damaged tanks will be ignored until the tank is marked damaged.[3]

The %FULL column has a special meaning for damaged and grouped tanks: it is the ***pre-damage*** percent full. This is the way you enter changes to the pre-damage situation. It's as if all damaged/grouped tanks have a hidden `OPT` of `P`. The ullage, innage and absolute volume columns are simply output for damaged tanks and correspond to the equilibrium ***after-damage*** situation. Thus for damaged tanks, the %FULL column will not match the ULLAGE, INNAGE, and VOLUME columns.

Grouped tanks basically lose their identity. Any liquid in a grouped tank in the post-damaged situation shows up in the lead tank's row. Thus, most of a grouped tank's columns are blank. However, you can change the pre-damage sitation in a grouped tank by changing the parcel code, the temperature, and the %FULL.

When you switch a tank to Damaged or Grouped, Mate remembers the last percent volume that was in the tank (or the initial volume when read in if the tank is listed as damaged/grouped in the loadfile) and assumes that that is the pre-damage percent volume. Thereafter, every time the ship is rebalanced, it starts off with the pre-damage volume (not the damaged volume in the tank at the last balancing). This makes the comparison of the last set of oil outflows with the next (another possible response, say more ballast) meaningful. If you want to study changing the pre-damage volume for a damaged/grouped tank, you do so by changing %FULL for that tank. However, the spillage

[3] If you enter a damage location value for a tank that has no been marked damaged, the value will be checked for reasonableness just as if the tank were marked damaged. And the value will be saved if the loading pattern is saved. But no use of that value will be made, until that tank's `OPT`is set to `D` or `d`. This can be useful in situations in which you are not sure where the damage is.

results will be accurate only if that change is made very quickly, prior to significant outflow/flooding.

Undamaged tanks can be manipulated in the normal fashion, but be careful. In damaged situations, the pre-damage and post-damage heel and trim can be quite different. If you work with ullages or innages in the undamaged tanks, Mate always assumes that each new ullage or innage was taken at the new heel and trim. If the ullage actually corresponds to the pre-damage situation, big errors can result. In severe damage situations, it's usually best to work in volume or percent volume for the undamaged tanks. The easiest way to do this is to simply take the pre-damage sitation, set OPT for all undamaged tanks to `P`, and proceed.

The Summary section contains three new columns containing.

HYDROLOSS The total hydrostatic outflow, the sum of the HYDROOUT column in the Tank Table.

EXCHGLOSS The total exchange flow, the sum of the EXCHGOUT column in the Tank Table.

GRNDFORCE The upward Grounding Reaction in metric tons assuming a flat bottom and a rigid hull and sea bottom. The point of application of this force is GRNDxs (distance forward of midships) and GRNDys (distance off centerline, positive to starboard). This location is given in ship coordinates.

DISPLACEMENT The total buoyancy of the hull envelope assuming it is empty and watertight in tons. The total weight of everything within the hull envelope including the lightweight. is DISPLACEMENT plus GRNDFORCE.

MAX_BEND The absolute maximum longitudinal bending moment in ton-meters. This may not occur at the same location as MAX_%_BEND.

MAX_SHEAR The absolute maximum shear force in tons. This may not occur at the same location as MAX_%_SHEAR.

MAX_HOG The maximum hull deflection in meters. Hog is positive; sag is negative.

LOWxs and LOWys The longitudinal and transverse location of the lowest point on the hull are shown in LOWxs and LOWys respectively. In grounded situations, these numbers should match GRNDxs and GRNDys but may not for reasons which are discussed in Chapter 16.

Centers The Summary also contains the longitudinal, transverse, and vertical centers of all the buoyant forces (including grounding) and those of all the weights. These values are given in ship coordinates (forward of midships, off centerline (positive to starboard), and above baseline where up is parallel to the ship's bulkheads). In situations with significant trim and heel, LCB and TCB in these coordinates will not be the same at LCG and TCG despite the fact that the ship is afloat and in balance. For example, assume the normal case: the VCG is above the VCB and the ship is trimmed by the stern. Gravity works in earth coordinates (see Chapter 18) and in earth coordinates the LCG and LCB are equal (as are the TCB and TCG), that is they are lined up on "top" of each other as far as the earth is concerned. But someone measuring in ship coordinates will find the (lower) LCB is closer to the aft perpendicular than the (higher) LCG if a ship is trimmed by the stern. A plumb bob dropped from the LCG points aft (in ship coordinates) as it drops down (in earth coordinates) to the LCB. Mate displays everything in the Summary except WATER_DEPTH, LOW_PT, and PROP_IMM in ship coordinates.

DEPTH The sea water depth in meters.

MIN_FLOOD The vertical distance between the lowest downflooding point and the waterline in earth cordinates. If this number is negative, then at least this downflooding point is submerged. For the purposes of this calculation, all downflooding points are considered open, even if they are normally closed. The name of the lowest opening is shown to the right of MIN_FLOOD.

In Damage mode, the Menubar contains an extra drop-down menu labeled Grounded. This menu allows you access to Mate's grounding capabilities. See Chapter 17.

There are two broad categories of casualties:

1. A casualty involving extensive damage, possibly threatening the survival of the ship.
2. The much more common situation involving damage where the major concern is limiting the amount of spillage. In many cases, this situation is combined with uncertainty as to the location of the damage.

Sections 16.2 and 16.3 deal with (1) while Sections 16.4 and 16.5 treat (2).

16.2 Checking vessel survivability

If the damage is so severe that there is concern that the vessel may founder or capsize, switch to Damage mode and set `OPT` ***for the breached tanks/compartments to*** `F`***, that is, treat these spaces as free-flooding. Don't worry about trying to type in the location of the damage. Then check the min margin point and the righting arm curves. As long as you have positive margin (allowing for wave action) and both righting arm curves have a positive GM and an area in excess of 0.02 meter-radians, then neither capsize nor flooding should be a problem.*** If the margin number is negative, then progressive flooding is a very real concern. But remember that this computation was done assuming that all potentially open downflooding points are open. If the immersed points are actually closed and watertight, then this will be overly conservative. The name of the worst case downflooding point is shown on the Summary. This will point to the area where shoring up efforts should be focused. If this opening is actually watertight for the depth shown, then at least this point is not an actual, immediate concern. Next check the rest of the flooding points using the FLOOD button. Keep in mind the space which each opening floods. If it's small, already nearly full or flooded, then that opening in itself may not represent a big problem.

Depending on the amount of heel and trim, consider counter-flooding. If a righting arm curve has an area less than 0.01 meter-radians or the calculation won't converge, stability is a very real concern. Counter-flooding should be considered and tested. The drafts resulting from this check can be used to assess grounding potential.

This free-flooding check, which ignores hydrostatic balance, will usually not be very accurate. In particular it will slightly under-estimate the vertical center of the liquids in loaded tanks which reach hydrostatic equilbrium. And it will usually be completely wrong and misleading for the purposes of minimizing cargo spillage. However, it will almost always be close enough for survivability concerns.

Mate can give no indication of how rapidly the flooding will occur. Depending on the extent of the damage, it may take minutes or hours or even days to reach the indicated equilibrium situation. The Master will have to use his own judgement as to how much time he has to affect counter-measures.

16.3 Using Hotspot analysis to estimate loss of strength

If the Section 16.2 checks indicate that the ship is not in danger of loss by flooding or capsize, but the structural damage is extensive, then enter the location of the damage in each damaged tanks or compartment per Section 16.6 and then return here.

In Damage Mode, the Toolbar will contain a button labeled HotSpot (F6). Clicking on this button or selecting Hotspot from the Reports menu will pop-up the HotSpot window which will show a plot of the worst case ratio of tensile stress to material yield stress at each frame for which Mate has been given the necessary structural data. See Chapter 13 for details including how to change the wave bending moment option. If the ship is in semi-protected waters, then it will normally be OK to use the Harbor bending moment. If conditions are really calm with no swell, then go ahead and use the No Wave option.

If the worst case stress is comfortably below the material yield stress using the wave bending moment appropriate to the situation, then it is probable that progressive structural failure is unlikely. However, hotspot analysis must be used with a great deal of judgement. The following caveats apply.

1. Hotspot analysis uses classical beam theory to estimate the the worst case stress. It models structural damage by removing longitudinal stiffeners and plating within the damage rectangle at each frame, recomputing the section moments of inertia and the neutral axis, and then assuming all the assumptions of beam theory apply. In fact, even an intact ship's hull is not well modeled as a beam. The stress pattern is more complicated than beam theory assumes. The more extensive the damage is the larger the errors associated with the beam theory assumptions. For obvious example, the stress concentrations generated at the sharp edges of the damage are not modeled.
   Therefore it is very important to compare the damaged characteristics of a section with the undamaged. If the loss in section moment of inertia is small, say less than 5% and the worst case stress is well below yield, then further tensile failure is indeed unlikely. The larger the change in section moment of inertia, the larger the margin required to be comfortable that this is the case.

Fortunately, in may tanker casualties, you will find that although the damage appears extensive, in fact the relative loss in section moment of inertia is 10And if there is little or no wave bending moment which is the case in most near-shore casualties, the margin between max stress and yield is often quite large or can be made so by proper cargo transfers and/or ballasting.

2. Mate's hot spot analysis accounts for the impact of trim on both the earth vertical section characteristics and the maximal fiber distance to the neutral axis. In this regard, hot spot analysis is far superior to the standard analysis based on bending moment allowables. However, currently the analysis does not account for transverse (in earth coordinates) forces or moments. The only moment that is applied to the structure is the earth vertical longitudinal moment.
3. If your tanker has a double bottom, and the ship is in sagging condition, which will normally be the case for a ship damaged near midships in the loaded condition, then the max stress to yield number are close to useless. In a double bottom tanker, the double bottom design is driven by local pressure rather than longitudinal stress. Very roughly, the double bottom will contain about twice as much steel as would be required just by longitudinal stress. Thus, low stress to yield in the double bottom does not mean that there will be no structural failure. In this case, the structure is nost likely to fail by buckling of the deck. Mate's hot spot analysis shows the amount and location of the largest compressive stress at each frame but offers almost no insight as to whether or not that stress will cause buckling. This requires knowledge of the local panel characteristics which your version of Mate does not have.
4. Currently, Mate's hot spot analysis does not worry about shear force. The damaged and undamaged section areas are shown. A very rough approximation is to increase the shear force as given by the normal strength calculations by the ratio of the undamaged to damaged area. If the result is still well below the allowable, then shear force is probably not a problem.
5. Mate bases the damage at each frame on the damage description outlined in Section 15.1, that is, Mate knows only the longitudinal, transverse, and vertical position of the highest point of the damage in each tank and the same information for the lowest point. At each frame, it eliminates all steel between the highest

and lowest point and between the inboardmost and outboardmost point of the damage. Normally, this is conservative but there are cases where it is not. Consider a diamond shaped hole in the side shell. Mate will treat this as a vertical crack at the midpoint of the diamond missing the loss in structure fore and aft of this crack.

Even in this case, Mate will correctly model the frame at the middle of the diamond which will normally be the worst point, ***provided the user makes sure the longitudinal positions of the high and low point straddle at least one frame***. However, if the user wants to be sure to be conservative, then he can do so by putting the high point at say the aft end of the damage in the tank and the low point at the other end. This will generate an error in the spill outflow calculations. The issue here is which is more important: further structural failure or minimizing outflow? Once you are confident that structural failure is not imminent, use the spill oriented description. If spillage not an issue, perhaps because we've already spilled whatever we are going to spill, then use the stress oriented description.

6. Mate can only do hot spot analysis for the frames for which it has been given the necessary information. The data required is quite extensive. It includes the location, scantlings, and type of each longitudinal stiffener and the location and thickness of each strake of shell and longitudinal bulkhead plating at the section. Normally, the only such section for which such data in provided is the midship section which is applicable only to the parallel midbody. If the damage is not located within the frames for which this data is available, hot spot analysis is not much use. The hotspot plot will show a red dot for every frame for which it was able to do hot spot analysis. ***If there is no red dot at a frame, it means that no analysis could be done.*** Similarly, the line on the hot spot tabular report for that frame will be blank. The missing dots and the blank lines most certainly do not mean that there is no problem. They only mean no information.

Despite all these dire warnings, hot spot analysis can be useful. In most real real-world situations, it will reveal that, even allowing for the above errors, progressive structural failure is not a problem and the crew can concentrate on minimizing spillage.

16.4 Minimizing spillage whose source is uncertain

Tankers, especially loaded tankers, can usually sustain a remarkable amount of damage and survive. In almost all damage situations, the primary concern will be minimizing oil spillage. There are two situations here:

1. the location of the leak is uncertain, usually because it's on the bottom somewhere,
2. the location of the damage is known.

In the first case, call for a diver and switch to Damage mode with the current loading pattern. Make sure the IGS_mm column is correct. Examine the HBL_m column. Any tank whose HBL_m number is comfortably negative cannot be the source of bottom leakage. Concentrate on the tanks with positive HBL_m. If the IGS pressure is positive and it is prudent, vent these tanks or at least drop the IGS pressure as far as you prudently can. It then may be a good idea to seal off these tanks if you can in an attempt to generate a vacuum in the tank that is leaking.

Start ballasting the ship down (see next section) and begin transferring from the tank most likely to be the source to any tank either known to be undamaged or having a comfortably negative HBL_m. Continue until the HBL_m of the tank being drawn down goes negative — it is not holed on the bottom — and then switch to the next most likely. If at any time in this process the leakage stops, the tank that was being drawn down at the time is the source of the leak.

If you have enough pumps and space, you may choose to draw down more than one tank at a time. The trade off is possibly halting the leakage sooner but then being left with some uncertainty as to which tank is leaking. You can accomplish both goals by staggering the drawdown, that is, drawdown multiple tanks at once but make sure that the drawdown is uneven, so that when the leakage stops a minimum number of tanks (hopefully only one) have an HBL_m that has just gone from positive to negative. That tank is the culprit.

Pay almost no attention to where the oil seems to be coming up. I have been involved in three cases of a leak whose location was uncertain. In all of these the apparent location of the leak was misleading. Oil leaking on the bottom gets caught by the bilge keels and then gets

pushed forward or aft by the current and the flow under the hull. The result is that HBL_m numbers are far more important that the apparent source of the leak.

16.5 Minimizing spillage whose location is known

As soon as the the location of the damage is known, proceed as follows:

1. If the ullage pressure is positive, vent the damaged tank(s) or at least lower the IGS pressure as far as you prudently can. If the pressure is negative, do your utmost to seal off these tanks to maintain the vacuuum. Enter the Mate IGS pressure for these tank(s) accordingly.
2. Go to Damage mode. Using the current loading pattern, change tank OPT for the externally damaged tanks to `D` for the externally damaged tanks that you are unable to seal off and to `S` for the externally damaged tanks that you are able to seal off.
3. Enter the high point and the low point of the damage in each externally damaged tank. See Section 16.6 for details.
4. If there is sufficient internal damage between two tanks, so they are effectively communicating, then group the non-externally damaged tank with the externally damaged
5. If you are sure the internal damage is low in the ship and have an estimate of how high that damage extends, the instead of grouping, use outside in flow, entering the location of the internal damage and the external tank (Outer) in the internal tank row.

The key numbers are HYDROLOSS and EXCHGLOSS. The sum of HYDROLOSS and EXCHGLOSS is the total amount of oil lost to the sea at equilibrium for the given loading pattern and damage location. Your job will be to manipulate the loading pattern to minimize some combination of these values without causing further damage to the ship. You must be familiar with the principles of hydrostatic balance. See for example the CTX Paper, The Physics of Tank Spillage (CTX PTS), **??**.

The basic strategies are:

1. Transfer oil from the damaged tanks to bring the Live Bottom up if damage is low or to minimize runoff if the damage is high.
2. If the top of the damage is well below the waterline, ballast the ship down to bring the Live Bottom up. If the bottom of the dam-

age is high enough so that it can be raised above the waterline, deballasting the ship will markedly reduce exchange flow.

3. The same effect as in (2) can be obtained by trimming the ship aft if low damage is aft or by heeling the ship toward the damage if it is on one side. If the damage is near or above the waterline, consider trimming or heeling the ship away from the damage. Heeling can be surprisingly effective at reducing spillage if sideshell damage is all high (heel away from the damaged side) and if sideshell damage is all low (heel toward the damaged side).

Normally, the worst thing you can do for low damage is discharge cargo from intact tanks or deballast the ship unless the decrease in draft is more than compensated by the increase in trim or heel at the damage. See CTX PTS**??** for a complete discussion. The point is, whatever loading pattern you choose to examine, Mate will immediately tell you what the results will be at equilibrium. Sometimes these spill numbers can be counterintuitive so playing with the program in hypothetical damage situations is highly recommended.

Unfortunately, Mate can tell you almost nothing about how rapidly this equilibrium will be reached. Mate doesn't know the extent of the damage, only the high point and the low point in each tank. Obviously, if the damage is a thin crack extending from that high point to that low point, the flow rates will be much, much smaller than if the damage is a rectangle, in which the high point and low point represent the ends of the rectangle's diagonal. Take soundings to get an idea about how fast things are progressing. In so doing, remember that the Hydrostatic Outflow will occur much faster, usually an order of magnitude faster, than the Exchange flow.

Also it is very important to remember that ***in coming up with a number for Hydrostatic Outflow and Exchange Loss, Mate is comparing a pre-damage intact situation (your input loading pattern) with the situation at full equilibrium (after all spillage has completed).*** If you change things in between, Mate's numbers may not be correct. Remember Mate assumes whatever changes you make to the loading pattern, they were actually made immediately after the damage, i.e. before any substantial outflow has occurred. If the outflow rates are large or you are slow, the spillage figures may be wrong. Be quick.

Finally, be aware that your version of Mate does not know anything about *deckloss*. Deckloss is outflow through the tank P/V valves which will occur if the top of the oil in the tank is far enough above the top of the P/V valve. You can also have deckloss through ballast tank vents if there is internal damage between a cargo tank and the ballast tank. Usually, deckloss requires an extreme amount of trim and heel. To obtain a very rough check on the possibility of deckloss, click on the Section button. This will show you the section in way of the top of the damage with the horizon level. If the oil level in the damaged tanks is comfortably below the deck or at least the level of the vents, then you probably don't have to worry about deckloss.

16.6 Entering Damage Data

There are a number of things to keep in mind in telling Mate the damage location.

Unusual Tanks In a damage situation, you must ensure that all the compartments that are or could be involved in the damage situation are included in the loadfile. Your normal loadfiles will not include such tanks as the Engine Room, the Pump Room, etc. Flooding in these spaces can be critical to the situation. If so, use the `SHOW_HIDDEN_ALL` option to include all compartments.

The Free-Flooding Option, F ***Tank option*** `F` ***must be used only for tanks or compartments which are vented and were empty prior to the damage (e.g. the Engine Room) and for which the damage is such that you can be sure that the waterline in the tank at equilibrium will be at the sea level no matter what you do.*** For example, if the damage is high in the Engine room and by trimming the ship by the bow you might be able to get the low point of the damage above the waterline, `F` would be inappropriate. Use `D` or `d` and put the damage location in. If you use the Free flooding option for a cargo tank, then Mate will assume the tank started out Empty, is vented, and will calculate neither the hydrostatic balance nor the cargo loss. Finally, if loss of strength is an issue for a particular space, you cannot use the free-flooding option. Unless a compartment has a tankopt of D or S, any damage in that space will be ignored by the Hotspot calculations.

High Point or Low Point Sometimes it will be difficult to tell which point of damage on the tank is the low point and which is the high point, especially when heel and trim are changing. Don't worry. Mate will check your two points and figure out which one really is the high and which is the low (in earth coordinates) at equilibrium. You can put your two points in either order. Nor from a spill perspective need you be very accurate with respect the longitudinal or transverse location of the damage, an error of a few meters in these numbers is acceptable.

The transverse location of a damage point is nearly ignored by Mate from a spillage point of view. Mate will figure out the transverse location of the tank boundary . from the longitiudinal and vertical location of the damage. The spill part of Mate uses the transverse location only to figure out which side of the compartment is damaged. However, the transverse location of a damage point, especially the inboard location, is critical to damaged structural calculations. In doing these calculations, at each frame Mate eliminates all primary steel in a box bounded by the top inboard location of the damage. the top outboard, the bottom outboard, and the bottom inboard. not true 0.57.0

Normally, it is a good idea to err slightly on the bad side, that is make sure the inboardmost number is on the inboard side of the damage and the outboardmost number is on the outboard side of the damage. But try to be as accurate on the vertical ends of the damage as you can be, aiming for an accuracy of (+/-)10 cm or better.

If loss of structural strength is an issue, make sure that the longitudinal position of the high point and the low point straddle at least one frame. Otherwise the Hotspot stress anaylsis will fail to pick up the damage as it moves from frame to frame.

To Group or not to Group Two tanks are *communicating* if liquid can flow from one to the other internally either via damage or the ship's systems, e.g. sluice valves. In general, the problem of communicating damage is very complex and there is really only two cases that Mate can handle.

Inside-Out That is when the internal damage between two tanks is such that they are *fully communicating*. Two tanks are fully communicating if the internal damage or other connection between them is such that the equilibrium waterline

within each tank will be the same.[4] Effectively the same thing will happen if the internal flows are much faster than the external flows.

Outside-In The internal damage is low in the ship, and the external flows are much faster than the internal flows.

If two or more tanks are fully communicating, then the solution is simple, they should be grouped. If two or more of these tanks is also externally damaged, the question arises as to which tank should be the lead tank of the group. Here are the rules:

1. If ship survivability due to structural failure is the primary concern and more than one tank is badly damaged, don't group. Put in the damage locations of all such tanks. The spillage results will be wrong, but this will give you the best estimate of remaining structural strength.
2. If ship survivability is not an issue, and all the damage is below the waterline, the tank with the highest damage should be the lead tank of the group.
3. If ship survivability is not an issue, and all the damage is above the waterline, the tank with the lowest damage should be the lead tank of the group.
4. If ship survivability is not an issue, and the damage straddles the the waterline, any tank whose damage straddles the waterline can be the lead tank. Pick the tank with the most extensive damage near the waterline.

It is quite possible to have internal damage that is not fully communicating. An obvious case is when the damage in a wing ballast tank extends much higher than the the damage in the adjacent cargo tank. In the extreme (if very unlikely) case, where the wing ballast tank is damaged all the way up to the waterline, while the cargo tank is damaged only on the cargo tank bottom, In this case, outside-in flow will be much more accurate. Once again see CTX PTS**??** for a complete discussion.

The problem arises in intermediate cases where the damage in the wing ballast tank is more extensive vertically than that in the adjacent cargo tank, but not dramatically so. The rules here

[4] If the liquid density in the two tanks is the same, then any connection down low will be fully communicating. However, if one tank contains water and one contains oil, then two tanks will be fully communicating only if the internal damage straddles the common equilibrium internal waterline.

are:

1. If the damage in the wing ballast tank straddles the waterline but the damage in the internal tank does not, use outside-in. As far as the interior tank is concerned the wing ballast tank is simply part of the ocean. In this situation, the damage to the ballast tank is such that for all practical purposes the cargo tank is an exterior tank.
2. If the damage is all below the waterline, and you know the top of the damage is significantly below the top of the damage in the interior tank, use outside-in.
3. Otherwise group. When in doubt, group. In some damage situations, grouping will produce inaccurate spill numbers, but all the other numbers will be close, and the spillage numbers will almost always be good enough to guide your actions.

Avoid mixing grouping and outside in damage in the same tanks if at all possible. There are so many possible combinations of grouping and outside in that only a few of them have been tested. Mate is not guaranteed to correctly handle all of them. If you do mix grouping and outside in, save your loading patterns very regularly, so you can recover quickly if Mate throws a fatal error.

Be aware that internal damage can actually reduce spillage even if the tanks are also externally damaged. Consider damage low involving a wing cargo tank and the Forepeak tank in which the internal damage to the Forepeak tank is much more extensive than the external. Cargo will flow from the cargo tank into the Forepeak tank lowering the oil level in the cargo tank and drastically raising the Live Bottom. In short, transferring cargo from a damaged cargo tank to a damaged ballast tank is not necessarily a bad idea.

Un-grouping a tank is a little messy. The first step is to change the tank's GROUP back to its own tank name. Attempt to re-balance. You will get a pop-up saying tank OPT G is impossible. Click on go-ahead anyway, then change the tank OPT to P, and re-balance again. Obviously, the GUI needs improvement here.

Chapter 17

Stranding

Mate has a limited but useful grounding capability. Mate can be used in two different ways in a stranding. You may either set drafts and heel to the observed values and Mate will compute the grounding reaction, or you may use Mate normally to study different re-float alternatives.

17.1 Stranded Drafts and Heel Specified by User

If you are stranded and you know your drafts forward and aft and the heel, you may simply fix these variables and Mate will compute the grounding reaction required to generate these drafts and heel. To do this you must be in Damage mode in which case the Menubar will contain a Grounded menu. The Grounded menu has only three choices:

- Ship afloat.
- Ship stranded: drafts.
- Ship stranded: depths.

When you select `Ship stranded: drafts`, Mate will display a screen allowing you to enter the drafts at the FP and AP and the heel.

If the ship has a lot of heel, it may be better to enter water depths rather than drafts. The drafts Mate needs are the draft at the Forward Perpendicular and the draft at the Aft Perpendicular, which can be significantly different from the numbers showing on the forward and

aft draft marks especially when there is a lot of heel. As long as the bottom is reasonably flat locally, water depth measurements taken near the AP and the FP, for example, with a leadline, will probably be more accurate than averaging the draft marks. In this case, select `Ship stranded: depths`. Mate will display a form allowing you to enter the forward and aft water depth and the heel. Mate will convert the depths to drafts for you, assuming the depths that you entered are at the FP and AP.

Mate does not really handle the situation where the ship is partially aground, for example, the bow is grounded but the stern is not. However, if in this case you accurately put in the floating draft aft, Mate will figure out that it does not need any grounding force aft, and the calculations will be reasonably accurate. You cannot enter water depths in this situation.

These draft/depth numbers need not be consistent with the water depth specified on the Parcel Screen. The grounding reaction calculation is independent of the actual bottom contours. Unfortunately, this also means that Mate's stranded strength calculations can be grossly inaccurate.

Once you enter the drafts or depths, Mate will then calculate the grounding reaction and the center of this reaction. This is the force that the bottom is exerting on the ship to make up for the lost buoyancy. This force is shown as GRNDFORCE in the Summary. If this number is negative, Mate believes the ship should be afloat. If the draft/depth numbers are accurate, this is a strong sign that you have more flooding (more damage) than is in the current loading pattern. The longitudinal and transverse center of this force is shown in the Summary as GRNDxs and GRNDys.[1] The Summary also shows the longitudinal and transverse location of the lowest point on the hull as LOWxs and LOWys.

If there is a significant difference between the position of the ship's low point and the center of the grounding reaction, then something may be amiss. Possible explanations are an uneven bottom, or the low point is floating, or the low point has penetrated into the bottom, or the low point has buckled. But if the bottom really is flat, it may simply be a small error in reading the drafts or heel. If the ship

[1] If GRNDFORCE is negative, GRNDxs and GRNDys are a weak hint as to the location of the missing flooding.

is at or close to zero trim and heel on a flat level bottom, then the ship's low point doesn't have much meaning for a very slight change in trim can move the calculated low point from near the bow to near the stern. By the same token in this situation, a very sight change or error in the measured drafts and heel can move the calculated center of the grounding reaction all over the place. This is not really critical ***except in computing longitudinal strength***. For purposes of longitudinal strength, ***Mate assumes that all the grounding reaction is concentrated at the calculated center.*** This is always incorrect; the only question is how incorrect.

If the calculated center is the actual center of the grounding reaction, Mate will generally overestimate longitudinal bending moment and shear force both because the actual bottom reaction in spread out and because local deformation and structural failure will tend to spread the reaction out further. In that sense, the numbers will be conservative, possibly grossly so. However, the real problem is that, when heel and trim are close to zero, there is necessarily a great deal of uncertainty as to where the center of the reaction really is and therefore the bending moment and shear force numbers must be treated with a great deal of caution. If the center is markedly different from that calculated, the calculated bending moments and shear forces may be grossly in error and that error can go either way. If the ship's low point is grossly different from the center of the grounding reaction, then you are probably in a situation where this can happen.

Fortunately, all the other calculations including the amount spilled are insensitive to this problem and the spill numbers can be trusted in a grounding situation. This is where Mate's grounding capability can be truly valuable. However, in a casualty that combines grounding and damage, remember that Mate's numbers will be based on the equilibrium situation in the tanks after all hydrostatic and exchange flows have taken place. Until this equilibrium is reached, Mate's estimate of the grounding reaction and corresponding bending moments and shear forces will be incorrect even if the given drafts and heel are perfectly exact.

A key issue in grounding is the effect of the tide. This effect can be simulated by adding (minus if the tide is ebbing) the expected tidal change to the observed fore and aft depths. The assumption here is

that the ship's heel and trim will not change as the tide changes.[2] The effect of an ebbing tide on hydrostatic loss can be startling. Each meter the tide goes out will result in an increase in hydrostatic loss of about 1.15 meter. For a ULCC this can more than double the amount spilled as happened in the case of the Exxon Valdez. ***If you ground on an outgoing tide, you must move very quickly.*** Conversely, if the tide is rising and you are on a flat soft bottom, it may make excellent sense to ballast the ship down and let nature improve your Live Bottom height. This could give you a precious six or more hours to get oil out of the damaged tanks before the tide goes out again. It can be very educational to simply play with Mate trying out these strategies watching the impact on the amount spilled.

When you have completed, your stranded calculations you can return to standard Damage mode by selecting `Ship Afloat` from the Grounded menu.

17.2 Getting the Ship Off

The next obvious question is: how to get the ship off? What change in the loading pattern is the best way of refloating the vessel? Mate has no special facility in this regard; yet it can still be of use. The procedure is to develop possible solutions, e.g. deballasting particular tanks, cargo transfers, etc, and simply try them as if the ship were not grounded. Comparing Mate's resulting low point (LOW_PT in the Summary) with the water depth will determine whether or not the trial alternative will actually float the vessel. In this context, with draft and heel free, Mate's computation of the low point will be quite accurate. If Mate says the ship will be afloat, then as long as you have correctly specified the loading and damage pattern, the ship will be afloat. And assuming that any damaged tanks have not yet reached equilibrium, the cargo loss numbers will indicate the cost of that alternative in spilled oil.

A problem with this procedure is that the computed bending moments and shear forces are good only after the ship has refloated. It is possible to overstress the ship during refloating even though the final refloated

[2] More intelligent assumptions for a given situation are of course possible. If the ship with aft trim is grounded aft on a flat bottom and the tide is going out, a projected situation with less or no trim would be appropriate.

situation is within limits. Uncertainties in this regard can be narrowed by playing with a particular strategy until it just barely refloats the vessel. If the bending moments and shear forces at this point are acceptable, note the resulting heel and drafts (trim). Now rerun with the same loading pattern but use the stranded option (fixed drafts and heels) with this heel and reduce both drafts slightly. If the bending moment and shear force numbers are still comfortably below limits, you are probably OK.[3] If not, look for a different strategy, probably one that involves a more even distribution of the new buoyancy.

[3] But be wary in near-zero trim situations where the center of the grounding reaction may be grossly in error.

Chapter 18

Non-GUI Use of CTX_Mate

This chapter is aimed at using CTX_Mate in tanker design and evaluation. Tanker crews need not be familiar with it.

18.1 Using Mate without a graphical interface

CTX Mate is more than a tanker loading program. It is a set of programs for performing naval architectural calculations. It can be used as a tanker design tool. For example, suppose we have a set of hypothetical damage scenarios such as those used in the IMO Pollution Prevention Index calculation. But unlike IMO, we wish to calculate the spillage in each of these scenarios accurately, incorporating the change in draft and heel associated with the inflows and outflows resulting from the damage, not to mention the often critically important impact of internal flows between tanks that are inter-connected either by the damage or on purpose. This includes possible capture of oil in the top of wing ballast tanks. Typically, we might be dealing with several hundred damage scenarios which we might want to run in combination with say five or six typical cargo loading patterns.

We could of course simply run Mate for each of the 1000 or so combinations of damage and cargo loading pattern; and, for each combination, manually keep track of the hydrostatic and exchange flow spillage. But this would be a very tedious endeavor. And we'd probably want to

repeat it for a wide range of possible tanker designs. Doing all this using Mate's standard user interface would not only be inordinately time consuming; but also we could be sure that somewhere along the way we'd make important input errors.

Obviously, the proper way to do this sort of thing is to have the computer do all the work. We need to set things up so that the computer automatically runs all the combinations of tanker designs, damage scenarios, and loading patterns we are interested in without any interaction from the user.

This can be done with the help of the `ctx_mate_cmd`.[1]

18.2 The `ctx_mate_cmd`

The `ctx_mate_cmd` has a simple job. It reads in a ship's data and a loading pattern, which may include damage, balances the ship accounting for all the internal and external flows, prepares a report of the results in easily post-processable format, and exits. `ctx_mate_cmd` does what the standard `mate` command does at start-up but, after the initial ship balance, instead of displaying the Mainscreen, it immediately prepares a report, and quits.

The usage of this command is

`ctx_mate_cmd` *options loadfile*

where the available options are:

–**shipdir=*shipdir*** This option tells Mate to take the ship's data from *shipdir*. *shipdir* can be either in absolute or relative path. The shorthand is `-S`*shipdir*. You must have read permission on *shipdir*.

–**loaddir=*loaddir*** This option tells Mate to look in *loaddir* for the load file. *loaddir* can be either in absolute or relative path. The shorthand is `-L`*loaddir*. You must have read permission on *loaddir*.

–**repdir=*repdir*** This option tells Mate to put the report in *repdir*. If this option is omitted, Mate will use *loaddir* as the report folder. *repdir* can be either in absolute or relative path. The shorthand is `-R`*repdir*. You must have write permission on *loaddir*.

[1] `ctx_mate_cmd` also allows sites that do not have the libraries that Mate's GUI software needs to use CTX Mate. But that is not its real purpose.

–reports=*[S][o][P][H][T][b][B][A][F][f]* This option allows you to tell Mate which sub-reports you want included in your report. If the `--reports` option is omitted, you will get only the main results summary. Often that's all you need. Any or all of the individual letters my be specified.

- `S` will include the main results summary. See Section A.1.
- `o` will include the user options that were in effect when the report was created. See Section A.2.
- `P` will include the parcel details. See Section A.4.
- `H` will include the header stuff. See Section A.3.
- `T` will include the individual tank results. See Section A.5.
- `b` will include the longitudinal strength results, but only at the major frames (the short table). `B` will include the longitudinal strength results at every frame. `B` overrides `b`. See Section A.6.
- `A` will include the stability righting arms. See Section A.7.
- `F` will include the downflooding details. See Section A.8.
- `p` will include the point load details. See Section 5.1.
-

The letters can be in any order. And the sub-reports will be in that order.

18.3 Embedding `ctx_mate_cmd` within a bigger analysis

By itself, `ctx_mate_cmd` is hardly an improvement over the standard GUI based Mate. The real power of `ctx_mate_cmd` comes when it is included within a larger analysis. Going back to the task of running a tanker design thru a large combination of loading patterns and damage scenarios, and collecting spillage numbers, here's how we might proceed.

1. We make two lists: one of the loading patterns we want to run, and the other of the damage scenarios we want to run.
2. We write a little program, call it A, that converts a combination of loading pattern and damage in these lists into the corresponding Mate loadfile. If we have a template loading pattern which this script copies and modifies, this can usually be done in less than 30 lines of code. Need an example.

3. We write a little program that extracts the resulting hydrostatic and exchange loss from the Summary report. Thanks to Mate's use of XML, this can be done in less than 10 lines of code. For an example, see Section B.1.
4. We write a master script that loops thru our two lists, first using script A to create the corresponding loadfile, then executing `ctx_mate_cmd` on that loading and damage pattern, and then using script B to extract the hydrostatic and exchange loss, which it combines with the other outflows to collect such statistics as averages, standard deviations, and so forth.

Once we have done this for one tanker design, it is a fairly straightforward matter to put this whole process inside another loop, which ranges through a number of possible designs.

The Center for Tanker Excellence has used this approach in a number of applications. See the CTX Preliminary Tanker Design Package.**??**.

Chapter 19

Volume Correction factors

19.1 Using the `ctx_vcf` Command

The command `ctx_vcf` has been provided to allow you to obtain Table 6A, 6B, 54A and 54B Volume Correction Factors, and the Density in Air for any crude or petroleum product covered by these tables. The default is Table 6A.

`ctx_vcf` takes the following optional command line options:

–method=*m* The *method* option sets the VCF table to be used. *m* must be `C`, `F`, `c`, or `P`. `C` means use Table 6A; `F` use Table 6B; `c` use Table 54A; and `P` use Table 54B. In other words, *m* should match the parcel method code in the Parcel Screen. The default is Table 6a. If `--method` is either `C` or `F`, then the standard density should be entered in API degrees at 60F and the temperature in degrees Fahrenheit. Otherwise the standard density should be entered in specific gravity at 15C and the temperature in degrees Celsius.

–round_temp=*x* This option sets the temperature rounding policy. *x* must be `N`, `A` or `H`. `N` will round round input temperature to the nearest tenth of a degree for Fahrenheit, and nearest hundreth of a degree for Celsius. These are the CTX Mate defaults.

`A` will round round input temperature to nearest tenth of a degree for Fahrenheit and nearest twentieth of a degree for Celsius. These are the ASTM recommendations.

`H` will round round input temperature to nearest half of a degree for Fahrenheit and nearest twentieth of a degree for Celsius. Some

particularly obtuse surveyors round Fahrenheit to nearest half-degree. This is nuts and should be resisted strongly unless it works in the ship's favor.

–round_api=*y* This option sets the density rounding policy. *y* must be `N`, `A` or `H`. `N` will round API to nearest hundreth of a degree and specific gravity to nearest 0.1 kg/m3 (4 decimal places). These are the Mate defaults.

`A` will round standard density in API to nearest tenth of a degree and standard density in specific gravity to nearest 0.5 kg/m3. These are the ASTM recommendations.

`A` will round round input temperature to nearest tenth of a degree for Farenheit and nearest twentieth of a degree for Celsius.

`H` will round standard density in API to nearest half of a degree and standard density in specific gravity to nearest 0.5 kg/m3. Some particularly obtuse surveyors round API to nearest half-degree. This is nuts and should be resisted strongly unless it works in the ship's favor.

–print If `--print` is specified, ctx_vcf will prepare a hardcopy record of the ctx_vcf session and print it out at the end. This allows you to make little VCF tables. The default is no hard copy.

–help If `--help` will print out a usage message and exit. The above options are hard to remember. Starting out a ctx_vcf session with `ctx_vcf --help` is an easy way of being reminded.

Issue the command `ctx_vcf [options]`. If method is `C` or `F`, you will prompted for a crude API at standard conditions (60F and vacuum). Enter the API of the crude or product you are interested in. You will then be prompted for a temperature. Enter the temperature in degrees F. If method is `c` or `P`, you will prompted for a density in kg/m3 at standard conditions (15C and vacuum). Enter the density of the crude or product you are interested in. You will then be prompted for a temperature. Enter the temperature in degrees C.

After you respond to the density and temperature prompts, `ctx_vf` will display the the Volume Correction Factor (the ratio of the density at your ambient temperature to that at 60F/15C) to five significant figures, then the VCF rounded to four decimal places, the Table 13 WCF for this API, and the resulting densities in air using the four and five decimal places VCF's respectively.

`ctx_vcf` will then ask you if you want to enter another combination of density and temperature, and continue to do so until you answer no. If the `--print` option is set, a hardcopy of your `ctx_vcf` session will be printed out when you quit.

This command uses the same VCF computation as Mate, so it will duplicate Mate's density calculations for parcels with the same parcel type, standard density, temperature, and rounding options.

Mate's Table 6A(6B) VCF calculation is based on the algorithm outlined on pages X-100 to X-102 (X-122 to X-125) in API Standard 2540, Manual of Petroleum Measurement Standards, Chapter 11.1 – Volume Correction Factors, 1st Edition, August 1980, as corrected by the October, 1980 Editorial Amplification. The Editorial Amplification indicates that this algorithm may generate discrepancies of 1 in the fourth decimal place as compared to the printed Tables 6A and 6B at a rate of about 0.008%. You will have to be awfully unlucky to hit the three or four entries out of 87,000 for which this is the case.

However, Mate's treatment of VCF has two non-standard features you must be aware of:

- By default, Mate rounds API to the nearest hundreth of a degree, standard specific gravity to four decimal places, Farenheit to nearest tenth of a degree and Celsius to nearest hundreth of a degree, This matches the display on the Mainscreen. Industry practice with repect to rounding is all over the place. Most surveyors round API to nearest tenth of a degree and specific gravity to nearest 0.5 kg/m3. But some American surveyors round API to nearest half degree, which is totally inconsistent with attempts to be accurate to five or more significant figures elsewhere, and could easily result in a 500 barrel error on a ULCC cargo. Similarly, most surveyors round degree F to nearest tenth of a degree and degree C to nearest twentieth of a degree. But some surveyors round F to nearest half degree.
  ctx_vcf allows you to quickly study the impact of different rounding policies and issue a letter of protest when these policies work against the ship.
- ctx_vcf computes both the VCF rounded to four decimal places – called the "VCF for printing purposes" by API and the VCF rounded to five significant figures which API calls the "VCF for calculation purposes". The first number is shown as PVCF and

the second is called CVCF on the ctx_vcf output. In practice, the VCF is based on the printed tables which implies the four digit VCF. However, Surveyors who are using calculators or laptops could come up with the five digit VCF. `ctx_vcf` shows the density in air for both of these VCF's.

Chapter 20

Single Tank Analysis

20.1 The ctx_tank Command

The `ctx_tank` command is a computerized tank table. The usage is

`ctx_tank` *tankcode dipcode*

You may also specify `--fleet`, `--ship`, `--draft_fp`, `--draft_ap`, `--heel`, and `--help` on the command line. If you specify `--help`, `ctx_tank` will print a usage message including Version and Varient and exit.

tankcode is the name of the tank for which you want volumes, etc, that is, the tank code in the first column of the Mainscreen. *dipcode* is the dipping point code for the dipping point you are using. For `ctx_tank` to function completely, your ship must have a computerized tank table and trim/heel correction table which matches this combination of tank and dipping point. If these files do not exist, `ctx_tank` will still compute volumes, etc via Mate's Direct Integration method.

By default, `ctx_tank` assumes the ship you are interested in is that given by the FLEET and SHIP shell variables. If you want a different ship, then `--fleet=`*fleet* and `--ship=`*ship* on the command line (before the tankcode) will give you the ship whose fleet code is *fleet* and whose ship code is *ship*. `-f` is shorthand for `--fleet=` and `-s` is shorthand for `--ship`.

By default, `ctx_tank` assumes zero trim and heel. You can override this be setting `--draft_fp=`*xx.xxx*, `--draft_ap=`*xx.xxx*, and `--heel=`*zz.zzz*

on the command line. The drafts must be in meters and the heel must be in degrees (positive is to starboard).

`ctx_tank` will compute a tank table via direct integration, and, if a computerized tank table is available for this tank, it will compare the direct integration numbers with those of the tank table.[1] This is extremely useful during the tank tuning process. It can also be very useful to the crew on-board if there is any question about how close, Mate's tank volumes come to the tank tables.

`ctx_tank` uses the same tank offsets, and the same programming as CTX Mate. So the results for a particular tank and the same ship orientation and ullage/innage/etc will be the same. However, `ctx_tank` does not handle damaged situations.

[1] In this version, the tank table comparison is available only for zero trim and heel.

Chapter 21

Hull Hydrostatics

21.1 The `ctx_hull` Command

The CTX Mate package includes a command called `ctx_hull`. `ctx_hull` prepares a standard hydrostatics table for the subject ship. `ctx_hull` has at least two purposes:

- to compare CTX Mate offsets and the resulting hydrostatics characteristics with the yard or other sources of similar data for testing purposes,
- as a preliminary design tool in evaluating a candidate hull form, like any other hydrostatics program.

Since `ctx_hull` uses the same offsets as CTX Mate and the same programming to determine the hull displacement and centers of the displaced volume for a given hull orientation, the results are the same as those generated internally by CTX Mate.[1]

`ctx_hull` can be executed for a particular ship by issuing

`ctx_hull` *fleet ship*

where *fleet* is the ship's fleet code, and *ship* is the ship's ship code. `ctx_hull` will immediately display the hydrostatics table and put a copy of that table in `ctx_hull.txt` in the current directory, provided you have write permission on that directory. It will also put an XML version of the table in `ctx_hull.ctx`. The XML format is far better suited for post-processing.

[1] In this version, `ctx_hull` is limited to ship with a single hull consisting of a single sub-body. Unfortunately, most current tanker designs meet this criteria.

`ctx_hull` supports the following command line options:

–**ship_dir=*xxxxx*** This option allows you to specify the ship's Mate data folder directly. *xxxxx* must be the path name of that folder, either relative or absolute. If this option is specified, you don't need to include the fleet and ship code on the command line. If you do, they will be ignored.

–**min_wl=*nn.nn*** Sets the lowest waterline in the hydrostatics table to *nn.nn* meters. Default is 1.0 meters.

–**max_wl=*nn.nn*** Sets the highest waterline in the hydrostatics table to *nn.nn* meters. Default is 25.0 meters.

–**del_wl=*nn.nn*** Sets the waterline step in the hydrostatics table to *nn.nn*. If the waterline step is set to 0.5, the table will contain a waterline every half meter. Default is 1.0 meters.

When there is non-zero trim and heel, we must be careful to define "waterline" correctly. `ctx_hull`'s calculations will range from a midship depth of `min_wl` to a midship depth of `max_wl`. For non-zero trim and heel, the midship depth is not the same as the midship draft.

–**sw_sg=*n.nnn*** Sets the sea water density to *n.nnn*. Default is 1.025 tons per cubic meter.

–**trim=*n.nnn*** The hydrostatics table will assume a trim of *n.nnn* meters. Trim is the difference between the draft at the forward perpendiculat Positive is by the bow. Default is zero trim.

–**heel=*nn.nn*** The hydrostatics table will assume a heel of *nn.nn* degrees, positive is to starboard. Default is zero heel.

–**file=*filename*** Hydrostatics table will be filed in *filename*`.txt` and *filename*`.ctx`, rather than `ctx_hull.txt/.ctx` which will probably be over-written the next time `ctx_hull` is used.

-c Check frames. If this option is specified, ctx_hull will issue a warning for every frame that is not matched by a section in the hull offsets. Mate does not require that the frames match the hull sections; but mis-matches can generate artificial bumps in the shear force curve.

-q Quiet mode. Suppress all normal output to terminal. This is used when `ctx_hull` is called by another program, for example a design optimization procedure. Error messages will still go to the terminal.

–help Print out usage instructions and exit. Also shows version and varient.

Figure 21.1 shows a typical hydrostatic table produced by`ctx_hull`. The table is standard with a few exceptions. All linear numbers are in meters.

DEPTH_MID `DEPTH_MID` is the distance below the sea level of the baseline, centerline, midships point on the hull measured in earth vertical direction.

DRFT_FP Draft at forward perpendicular. The drafts are measured parallel to the aft perpendicular.

DRFT_AP Draft at aft perpendicular. Midship draft is usually taken to be the mean of `DRFT_FP` and `DRFT_AP`. This will be equal to `DEPTH_MID` only if there is no trim or heel.

HEEL Heel in degrees. Positive is to starboard.

DISPLCMENT Displacement in tons.

LCB Longitudinal center of buoyancy forward of mid-ships. LCB is in ship coordinates (measured parallel to the ship centerline); but relative to mid-ships, for comparison with standard hydrostatics tables.

TCB Tranverse center of buoyancy. Port is positive.

VCB Vertical center of buoyancy above baseline, measured parallel to aft perpendicular.

TPC Tons per centimeter immersion.

MTC Moment (ton-meters) to Trim one Centimeter. The calculation of MTC assumes BM and GM are equal. This approximation can lead to errors of up to 2% in the MTC. This error has no effect on Mate which makes no use of MTC.

KM Height of transverse metacenter.

CB Block coefficent.

WS Wetted surface in square meters.

LCF Longitudinal center of floatation, forward of midships, measured parallel to ship centerline.

The XML output, Figure 21.1, is similar, but some of the variables are a little more fundamental. Also the longitudinal numbers (except for wp_lmoi) are relative to the aft perpendicular, not mid-ships. See Appendix B for some hints on post-processing this file.

CTX MATE 0.40-BASE Hydrostatics Table. Fleet code is X. Ship code is uldh. Trim is 0.000. Heel is 0.000.
Water density is 1.025. LBP=366.000 Beam= 68.000 GMT is 2006-11-01T12-51-47.

DEPTH_MID	DRFT_FP	DRFT_AP	HEEL	DISPLCMNT	LCB	TCB	VCB	TPC	MTC	KM	CB	WS	LCF
1.000	1.000	1.000	0.000	16271.3	22.004	0.000	0.509	171.54	2957.0	304.903	0.638	16890	21.320
2.000	2.000	2.000	0.000	33960.3	21.445	0.000	1.028	181.46	3329.8	162.239	0.666	18167	20.595
3.000	3.000	3.000	0.000	52417.7	21.058	0.000	1.547	187.62	3581.4	112.182	0.685	19191	20.100
4.000	4.000	4.000	0.000	71398.9	20.753	0.000	2.067	192.01	3768.2	86.597	0.700	20111	19.718
5.000	5.000	5.000	0.000	90769.9	20.499	0.000	2.586	195.42	3914.5	71.199	0.712	20978	19.408
6.000	6.000	6.000	0.000	110450.1	20.277	0.000	3.106	198.20	4036.5	60.952	0.722	21819	19.080
7.000	7.000	7.000	0.000	130384.8	20.070	0.000	3.625	200.49	4135.4	53.687	0.730	22643	18.766
8.000	8.000	8.000	0.000	150529.0	19.874	0.000	4.144	202.41	4216.7	48.307	0.738	23458	18.429
9.000	9.000	9.000	0.000	170861.3	19.670	0.000	4.662	204.24	4301.6	44.200	0.744	24263	17.895
10.000	10.000	10.000	0.000	191371.8	19.443	0.000	5.181	205.98	4388.2	40.990	0.750	25067	17.211
11.000	11.000	11.000	0.000	212055.2	19.185	0.000	5.700	207.69	4478.2	38.446	0.756	25873	16.384
12.000	12.000	12.000	0.000	232909.9	18.891	0.000	6.219	209.40	4572.7	36.404	0.761	26684	15.422
13.000	13.000	13.000	0.000	253938.2	18.557	0.000	6.739	211.16	4674.3	34.756	0.766	27503	14.311
14.000	14.000	14.000	0.000	275146.4	18.181	-0.000	7.260	213.00	4785.2	33.420	0.770	28333	13.040
15.000	15.000	15.000	0.000	296542.5	17.759	-0.000	7.783	214.93	4906.3	32.334	0.775	29174	11.619
16.000	16.000	16.000	0.000	318136.3	17.288	-0.000	8.307	216.97	5040.6	31.448	0.779	30032	10.024
17.000	17.000	17.000	0.000	339936.1	16.768	-0.000	8.832	219.05	5181.3	30.727	0.784	30909	8.318
18.000	18.000	18.000	0.000	361933.1	16.206	-0.000	9.359	220.95	5308.9	30.139	0.788	31806	6.660
19.000	19.000	19.000	0.000	384120.3	15.603	-0.000	9.887	222.82	5439.3	29.663	0.793	32687	4.887
20.000	20.000	20.000	0.000	406490.7	14.962	-0.000	10.416	224.62	5567.9	29.281	0.797	33574	3.020
21.000	21.000	21.000	0.000	429024.4	14.290	-0.000	10.946	226.10	5670.1	28.977	0.801	34446	1.371
22.000	22.000	22.000	0.000	451701.3	13.610	-0.000	11.476	227.45	5763.5	28.742	0.805	35284	0.111
23.000	23.000	23.000	0.000	474505.3	12.938	-0.000	12.005	228.63	5844.1	28.564	0.809	36096	-0.828
24.000	24.000	24.000	0.000	497419.0	12.288	-0.000	12.535	229.64	5913.6	28.433	0.812	36892	-1.511
25.000	25.000	25.000	0.000	520427.6	11.668	-0.000	13.064	230.53	5974.7	28.344	0.816	37678	-1.982

```
<ctx_Hydrostatics time="2006-11-01T15-23-23" version="0.40" varient="BASE"
    ship_dir="/X/uldh/DATA/MATE" trim="  0.000" heel="  0.000">
    <ctx_Hull depth_mid=" 1.000" volume=" 15874.5" lcb_xs="205.004" tcb_xs=" 0.000" vcb_xs=" 0.509"
        wp_area=" 16735" wp_lmoi="105585791" wp_tmoi="4832088" ws="16890" lcf_xs="204.320"/>
    <ctx_Hull depth_mid=" 2.000" volume=" 33132.0" lcb_xs="204.445" tcb_xs=" 0.000" vcb_xs=" 1.028"
        wp_area=" 17704" wp_lmoi="118900001" wp_tmoi="5341241" ws="18167" lcf_xs="203.595"/>
    <ctx_Hull depth_mid=" 3.000" volume=" 51139.2" lcb_xs="204.058" tcb_xs=" 0.000" vcb_xs=" 1.547"
        wp_area=" 18305" wp_lmoi="127881224" wp_tmoi="5657790" ws="19191" lcf_xs="203.100"/>
    <ctx_Hull depth_mid=" 4.000" volume=" 69657.4" lcb_xs="203.753" tcb_xs=" 0.000" vcb_xs=" 2.067"
        wp_area=" 18732" wp_lmoi="134553945" wp_tmoi="5888175" ws="20111" lcf_xs="202.718"/>
    <ctx_Hull depth_mid=" 5.000" volume=" 88556.0" lcb_xs="203.499" tcb_xs=" 0.000" vcb_xs=" 2.586"
        wp_area=" 19065" wp_lmoi="139777908" wp_tmoi="6076077" ws="20978" lcf_xs="202.408"/>
    <ctx_Hull depth_mid=" 6.000" volume="107756.1" lcb_xs="203.277" tcb_xs=" 0.000" vcb_xs=" 3.106"
        wp_area=" 19337" wp_lmoi="144132216" wp_tmoi="6233235" ws="21819" lcf_xs="202.080"/>
    <ctx_Hull depth_mid=" 7.000" volume="127204.7" lcb_xs="203.070" tcb_xs=" 0.000" vcb_xs=" 3.625"
        wp_area=" 19560" wp_lmoi="147664525" wp_tmoi="6368109" ws="22643" lcf_xs="201.766"/>
    <ctx_Hull depth_mid=" 8.000" volume="146857.5" lcb_xs="202.874" tcb_xs=" 0.000" vcb_xs=" 4.144"
        wp_area=" 19748" wp_lmoi="150567375" wp_tmoi="6485727" ws="23458" lcf_xs="201.429"/>
    <ctx_Hull depth_mid=" 9.000" volume="166694.0" lcb_xs="202.670" tcb_xs=" 0.000" vcb_xs=" 4.662"
        wp_area=" 19925" wp_lmoi="153599742" wp_tmoi="6590776" ws="24263" lcf_xs="200.895"/>
    <ctx_Hull depth_mid="10.000" volume="186704.2" lcb_xs="202.443" tcb_xs=" 0.000" vcb_xs=" 5.181"
        wp_area=" 20095" wp_lmoi="156690741" wp_tmoi="6685828" ws="25067" lcf_xs="200.211"/>
    <ctx_Hull depth_mid="11.000" volume="206883.1" lcb_xs="202.185" tcb_xs=" 0.000" vcb_xs=" 5.700"
        wp_area=" 20263" wp_lmoi="159905933" wp_tmoi="6774660" ws="25873" lcf_xs="199.384"/>
    <ctx_Hull depth_mid="12.000" volume="227229.2" lcb_xs="201.891" tcb_xs=" 0.000" vcb_xs=" 6.219"
        wp_area=" 20430" wp_lmoi="163278935" wp_tmoi="6858942" ws="26684" lcf_xs="198.422"/>
    <ctx_Hull depth_mid="13.000" volume="247744.6" lcb_xs="201.557" tcb_xs=" 0.000" vcb_xs=" 6.739"
        wp_area=" 20601" wp_lmoi="166906163" wp_tmoi="6941038" ws="27503" lcf_xs="197.311"/>
    <ctx_Hull depth_mid="14.000" volume="268435.5" lcb_xs="201.181" tcb_xs="-0.000" vcb_xs=" 7.260"
        wp_area=" 20781" wp_lmoi="170866992" wp_tmoi="7022286" ws="28333" lcf_xs="196.040"/>
    <ctx_Hull depth_mid="15.000" volume="289309.8" lcb_xs="200.759" tcb_xs="-0.000" vcb_xs=" 7.783"
        wp_area=" 20969" wp_lmoi="175189799" wp_tmoi="7102991" ws="29174" lcf_xs="194.619"/>
    <ctx_Hull depth_mid="16.000" volume="310376.9" lcb_xs="200.288" tcb_xs="-0.000" vcb_xs=" 8.307"
        wp_area=" 21168" wp_lmoi="179987053" wp_tmoi="7182704" ws="30032" lcf_xs="193.024"/>
    <ctx_Hull depth_mid="17.000" volume="331644.9" lcb_xs="199.768" tcb_xs="-0.000" vcb_xs=" 8.832"
        wp_area=" 21371" wp_lmoi="185011534" wp_tmoi="7261219" ws="30909" lcf_xs="191.318"/>
    <ctx_Hull depth_mid="18.000" volume="353105.5" lcb_xs="199.206" tcb_xs="-0.000" vcb_xs=" 9.359"
        wp_area=" 21556" wp_lmoi="189564802" wp_tmoi="7337604" ws="31806" lcf_xs="189.660"/>
    <ctx_Hull depth_mid="19.000" volume="374751.5" lcb_xs="198.603" tcb_xs="-0.000" vcb_xs=" 9.887"
        wp_area=" 21739" wp_lmoi="194221864" wp_tmoi="7411256" ws="32687" lcf_xs="187.887"/>
    <ctx_Hull depth_mid="20.000" volume="396576.3" lcb_xs="197.962" tcb_xs="-0.000" vcb_xs="10.416"
        wp_area=" 21914" wp_lmoi="198815678" wp_tmoi="7481347" ws="33574" lcf_xs="186.020"/>
    <ctx_Hull depth_mid="21.000" volume="418560.4" lcb_xs="197.290" tcb_xs="-0.000" vcb_xs="10.946"
        wp_area=" 22058" wp_lmoi="202463937" wp_tmoi="7547382" ws="34446" lcf_xs="184.371"/>
    <ctx_Hull depth_mid="22.000" volume="440684.2" lcb_xs="196.610" tcb_xs="-0.000" vcb_xs="11.476"
        wp_area=" 22190" wp_lmoi="205798958" wp_tmoi="7609199" ws="35284" lcf_xs="183.111"/>
    <ctx_Hull depth_mid="23.000" volume="462932.0" lcb_xs="195.938" tcb_xs="-0.000" vcb_xs="12.005"
        wp_area=" 22305" wp_lmoi="208677227" wp_tmoi="7665378" ws="36096" lcf_xs="182.172"/>
    <ctx_Hull depth_mid="24.000" volume="485286.8" lcb_xs="195.288" tcb_xs="-0.000" vcb_xs="12.535"
        wp_area=" 22404" wp_lmoi="211157597" wp_tmoi="7715033" ws="36892" lcf_xs="181.489"/>
    <ctx_Hull depth_mid="25.000" volume="507734.3" lcb_xs="194.668" tcb_xs="-0.000" vcb_xs="13.064"
        wp_area=" 22491" wp_lmoi="213340374" wp_tmoi="7758120" ws="37678" lcf_xs="181.018"/>
</ctx_Hydrostatics>
```

Chapter 22

Errors

There are four kinds of abnormal errors with which the user may be confronted:

- User Interface Problems
- Missing or Inconsistent Input
- Convergence Failure
- Everything else

22.1 User Interface Problems

The flexibility and ease of use associated with mice and windows does have one drawback. It is possible to confuse the User Interface by issuing commands, either from the keyboard or the mouse, that the program doesn't know how to handle. Sometimes this can be done by issuing a command before the program has finished processing the last command. Usually, when this occurs the program will pop up a warning window with a cryptic message and ask you what you want to do. Almost always all you have to do is click on the OK button and you will be back in business.

Remember that some of the pop-up windows require a response from you before Mate can do anything more. Until you dismiss such a pop-up, hitting buttons outside the pop-up will do nothing. If Mate appears to be being unresponsive, make sure that there are no such windows still active. Mate attempts to keep windows that require an immediate response from being hidden, but it can happen. Moving

or removing a non-Mate window may allow you access to the hidden pop-up.

Occasionally, the program will be so confused that you will have to kill the Mate session and start again. You can do this by moving back to the launch window and issuing a Cntl-C, (hit the C key while holding the Control key down). This means you will lose the current loading pattern unless the loadfile is up to date. If this happens, always check the launch window for error messages. If this occurs when you think you have done little or nothing wrong, then please fill out a bug report. See Section 22.5 for bug report instructions.

In general, if you are having problems, check the launch window. You can do this by sliding the Mainscreen to the right. Sometimes the messages (usally the bottom message) in the launch window will tell you what causing the problem.

22.2 Missing or Inconsistent Input

Mate is unusual among loading programs in that the input (e.g. loadfiles) can be edited from outside the program by standard editors. This is a powerful tool and allowing us, among other things, to transfer input files among ships and offices. However, it also means that Mate cannot check these files for completence and consistency until the input is read into the program. At that point it does a large number of checks on the input. If it finds something wrong with the data, it will issue an error message in the launch window and abort. Usually you will be able to tell what file is at fault from the message. Go into that file with the editor and see if you can spot the problem and fix it.

If you are unable to determine what is wrong with a particular loading pattern, start from scratch by copying /*fleet*/*ship*/`DATA/MATE/MAN/lf_selftest` into the working directory.

If you believe your data is correct but Mate won't accept it, fill out a bug report (see Section 22.5.

22.3 Convergence Failure

Mate uses a trial and error process. At each step in attempting to balance the hull, it makes a guess at draft, heel and trim and, for that

draft, heel and trim, then guesses the ullage in each tank. It adjusts this guess of the ullage until the results for that tank match the volume in the tank. It does that for each tank in turn. It then checks to see if the resulting weights and positions of all the tank liquids match the hull's buoyancy and longitudinal and transverse centers. If not, Mate adjusts its guess and repeats the process until everything is in balance.

If Mate is unable to reach a balance after a large number of tries, it will give up and generate a series of error messages in the launch window. This is known as a *convergence failure*.

Almost always the problem is not the overall hull balance but rather the determination of the position of the liquid level within an individual tank. The most difficult problem Mate faces is the combination of a nearly empty tank and very large heel or trim. This combination occurs most often during the righting arm computation when doing stability analysis. In this computation Mate must assume very large angles of heel (up to 50 degrees). At such large heels, the guessing process which the program uses to zero in on where the waterline is within the tank can become confused, especially if the tank is nearly empty. If the stability calculation fails to converge, you will not only get warning messages in the launch window, but the analysis will stop at the last heel angle which did converge. This will show up in error messages on the stability plot and report. Almost always the angle of heel at convergence failure is well outside the range of interest for tankers and no harm is done. The portion of the righting arm shown will be correct. However, in such situations, some of the stability indicators such as the GZ mode and max and areas under the GZ curve may err on the low side, perhaps drastically so.

Convergence failure outside the stability analysis is extremely rare. But, if it does happen, you will be given a fairly complete error message in the launch window indicating whether the problem is balancing the hull or inability to determine the level of the waterline in the tank. If it's the latter, which it almost certainly will be, the error message will tell you which tank failed to converge, the liquid volume the program needed and the difference between that volume and the volume it reached. You will then be asked if you want to go-ahead anyway.

Answering yes (Y) to this prompt, is acceptable only if it is a tank problem. If this is going to happen, it will usually involve a tank that is nearly empty or very small (fresh water tank). Failure to converge in

a nearly empty tank or very small tank will usually have no significant impact on the overall strength or hull balance calculations, so you can answer yes. In such a situation, a better solution is to rerun setting OPT for the nearly empty tank to E. That is, assume it is actually empty. As long as the tank is very small or nearly empty, the overall results with respect to draft and trim and longitudinal strength will be usable.

If the tank is sizable and not nearly empty check the difference between the volume required and the volume reached, if this difference is small, the overall results will be usable but file a bug report. See Section 17.5.

If Mate is able to get convergence in each tank, then it has never failed to obtain convergence in hull balance. If this occurs, it is a good sign that the situation is truly unstable. This can be checked by re-running with the drafts and heel fixed. This can be done by switching to damage mode, and clicking on Grounded. When Mate prompts you for the drafts and heel, enter the approximate drafts and heel. and then run the Stability analysis.[1] If the loading pattern is unstable, change it or don't use it. If the pattern is stable, file a bug report.

22.4 Other Error

If you encounter any other type of problem, it is probably hardware or operating system related. Switch to the back-up computer. When time permits, fill out a complete bug report. If despite all the redundancy, you can't get any of the hardware working, call/email the office with the loading pattern(s) you need, and use the office's computer(s) to make the runs. Another option is to contact a sistership with the same request. ....maybe we should have a server independent backup.

22.5 Bug Reports

CTX Mate maintains a Log File of every session. The contents of this file are similar to the messages in the Launch Window but more comprehensive. The Log File contains a fairly complete history of each session and all the error messages. Each Log File is created in

[1] If the entered drafts and heel are close to correct, Mate will recognize that the ship is not really stranded, and any grounding reaction will be negligible.

the current working directory under the name `matelog.`*nnnnn* where *nnnnn* is a five digit number. Normally, this file is deleted at the end of each session. However, if Mate senses something is wrong, or the sessions ends abnormally, or the User exits MLOAD by hitting Cntl-C in the Launch Window, the session Log File is not deleted.

Try this in the V/TEST directory and then use any editor to display your Log File. If there is more than one file named `matelog.`*nnnnn* — normally there should not be — then the most recently modified log file is the one you want. Issue `ls -ltr`. The last `matelog.`*nnnnn* shown is the most recently modified. Almost always, this will be the one with the highest *nnnnn*.

If you are having a problem, exit Mate via Cntl-C, and then email the session's Log File together with your own description of what you did and what went wrong to the office. If possible include reports which show the error. If you can, include the loadfile and the F5 report based on that loading pattern. If you have already left the session normally, try to duplicate the error and, if successful, exit via Control-C to generate a Log File for emailing.

Appendix A

CTX Mate XML Reports

CTX Mate's native report format is a dialect of XML. This means the report is self-identifying, human readable, and can be easily post-processed by any site that has a standard XML parser, regardless of the operating system that that site uses. See Appendix B for more info. The report is modular, consisting of a number of sub-reports. The Mate user can select which of these sub-reports he wants included with the exception that all the reports will at a minimum include the Summary sub-report.

A.1 The Summary sub-report

Figure A.1 shows a sample Summary sub-report. This is the minimal CTX Mate report; but in many design applications it will be all you will need. The report is nearly self-explanatory. The first five lines are meta-data identifying the GMT time the report was created, Mate version and varient, the ship folder, the loading pattern and the GMT time the loading pattern file was last modified. `report_author` is the user who created this report. `load_author` is the user who last modified the load file. The time the loadfile was last modified (or created if it has not been modified since creation) can be used to check for stale reports. Only if the `mod_time` of a loading pattern file is the same as the `mod_time` showing in a report file can you be sure that the report is consistent with that loading pattern file. `host` is the hostname of the computer on which the report was generated.

The ctx_Summary element contains the main results. Each value is sandwiched in an element which shows the name of the value. All weights are in metric tons; All linear dimensions are in meters. Areas are in square meters; volumes in cubic meters; moments in ton-meters. Most of the values in the Summary are self-explanatory. However, a few need a little explanation:

displacement Buoyancy in tons. This is also the weight of the ship, fixed loads, and all liquids in tanks and compartments less any grounding reaction.

bfo_dwt Tons of liquid in the ship's main fuel tanks. Does not include MDO (marine diesel oil) unless that is the ship's main fuel.

other_dwt Does include MDO.

draft_fp Draft at the forward perpendicular, measured parallel to the aft perpendicular.

draft_ap Draft at the aft perpendicular, measured parallel to the aft perpendicular.

heel_deg Rotation about the ship's centerline in degrees. Positive is to starboard.

gm Metacentric height before free-surface correction.

gm_corr Metacentric height after free-surface correction.

lcg_xs Ship's longitudinal center of gravity forward of the Aft Perpendicular measured parallel to the ship's centerline.

lcb_xs Ship's longitudinal center of buoyancy forward of the Aft Perpendicular measured parallel to the ship's centerline. The `lcg_xs` and `lcb_xs` at equilibrium need not be the same; but they will be on the same earth vertical line.

tcg_ys Transverse center of gravity off centerline measured parallel to the flat bottom. Port is positive; starboard is negative.

tcb_ys Tranverse center of buoyancy measured like `tcg_ys`. forward of the Aft Perpendicular measured parallel to the ship's centerline. The `tcg_ys` and `tcb_ys` at equilibrium need not be the same; but they will be on the same earth vertical line.

wp_tmoi Waterplane transverse moment of inertia in m^4.

wp_lmoi Waterplane longitudinal moment of inertia in m^4.

wp_area Waterplane area in m^2.

wetted_surf Wetted surface in square meters,

blind_zone Blind zone forward of bow.

mani_stbd_ze The height of the center of the starboard manifold above sea level measured parallel to gravity.

mani_port_ze The height of the center of the port manifold above sea level measured parallel to gravity.

roll_rog Roll radius of gyration.

pitch_rog Ptich radius of gyration.

prop_imm The earth vertical distance between the tip of the propeller and sea level. Negative means the tip is above water.

low_ze The height of the lowest point on the hull relative to sea level measured parallel to gravity. Negative means below sea level.

flood_ze The height of the lowest downflooding opening above sea level. If negative, the lowest opening is immersed.

flood_name The name of the lowest downflooding opening.

shear_max The largest shear force in tons. Positive means excess buoyancy forward.

moment_max The largest bending moment in ton-meters. Positive means hog: negative means sag.

hog_max The largest hull deflection in meters. Positive means hog: negative means sag. Only in Summary if hull moment of inertia curve is available.

shear_max_pct The largest ratio of shear force to allowable as a percent. More than 100 is illegal; but beware allowable may be In-Port allowable. Need Options sub-report to be sure. Only in Summary if allowables are available.

moment_max_pct The largest ratio of bending moment to allowable as a percent. Same comments as `shear_max_pct`.

hydroloss Net hydrostatic petroleum outflow to sea in cubic meters. Only in Summary if in Damage mode.

exchgloss Net exchange flow to sea in cubic meters. Only in Summary if in Damage mode.

grndforce The grounding reaction force. Only in Summary if ship is stranded. See Chapter 17.

grnd_xs The longitudinal center of the grounding reaction force forward of the AP. Only in Summary if ship is stranded. See Chapter 17.

grnd_ys The transverse center of the grounding reaction force port of centerline. Only in Summary if ship is stranded See Chapter 17.

```
<ctx_Report opts="S" time="2006-10-24T13-39-57Z" version="0.40" varient="BASE"
    path="/X/uldh/V/DEMO/sum_al98dep_grp2.ctx"
    ship_dir="/X/uldh/DATA/MATE"
    load_file="/X/uldh/V/DEMO/lf_al98dep_grp2" mod_time="2006-07-05T14:47:15Z"
    host="pc204" report_author="root" load_author="abcd"
    <ctx_Summary>
        <displacement>     490750 </displacement>
        <deadweight>       422828 </deadweight>
        <cargo_dwt>        362747 </cargo_dwt>
        <ballast_dwt>       54863 </ballast_dwt>
        <bfo_dwt>           11409 </bfo_dwt>
        <other_dwt>             5 </other_dwt>
        <draft_fp>         21.315 </draft_fp>
        <draft_ap>         26.119 </draft_ap>
        <heel_deg>          1.351 </heel_deg>
        <sg_sw>            1.0234 </sg_sw>
        <tpc>               230.9 </tpc>
        <mtc>              6023.1 </mtc>
        <gm>                9.945 </gm>
        <gm_corr>           8.881 </gm_corr>
        <lcg_xs>          189.705 </lcg_xs>
        <tcg_ys>           -0.234 </tcg_ys>
        <vcg_zs>           18.718 </vcg_zs>
        <lcb_xs>          189.619 </lcb_xs>
        <tcb_ys>           -0.382 </tcb_ys>
        <vcb_zs>           12.442 </vcb_zs>
        <wp_tmoi>         7779676 </wp_tmoi>
        <wp_lmoi>       952060620 </wp_lmoi>
        <wp_area>         22563.8 </wp_area>
        <wetted_surf>       36718 </wetted_surf>
        <blind_zone>      285.339 </blind_zone>
        <mani_stbd_ze>     11.188 </mani_stbd_ze>
        <mani_port_ze>     11.188 </mani_port_ze>
        <roll_rog>         19.737 </roll_rog>
        <pitch_rog>        84.786 </pitch_rog>
        <prop_imm>         14.273 </prop_imm>
        <low_ze>          -25.941 </low_ze>
        <water_depth>     999.999 </water_depth>
        <freeboard>         4.256 </freeboard>
        <flood_ze>          5.739 </flood_ze>
        <flood_name>    3FOS_VENT </flood_name>
        <shear_max>         14595 </shear_max>
        <moment_max>     -1307734 </moment_max>
        <hog_max>          -0.345 </hog_max>
        <shear_max_pct>     -61.8 </shear_max_pct>
        <moment_max_pct>   -120.0 </moment_max_pct>
        <hydroloss>       22212.8 </hydroloss>
        <exchgloss>       13292.1 </exchgloss>
    </ctx_Summary>
</ctx_Report>
```

A.2 The Options sub-report

In certain design applications, the Summary sub-report is all you need. However, in most cases, it is not enough. For one thing, the Summary report is not self-standing. Among other things, it does not document the user options than were in effect at the time the report was created. To do this, include an `o` in the sub-report options. Here's a sample Options sub-report.

```
<ctx_Options
    mode="D"       use_si="N"     use_harbor="N"   zero_inn_zero_vol="N"
    loadline="S"   non_rigid="N"  show_hidden="N"  wave_opt="D"
    exact_vcf="N"  round_api="N"  round_temp="N"   bend_mom_pct="Y"
    grounded="N">
</ctx_Options>
```

This little sub-report is a bit cryptic. Here are the definitions:

mode The CTX Mate mode. N is Normal. D is Damage. A is Auto.

use_si If Y, all output is in metric units. Otherwise display temperature in fahrenheit and volume in barrels for Table 6A and 6B parcels.

use_harbor If Y, use harbor allowables; otherwise use at-sea.

zero_inn_zero_vol Y if zero innage means zero volume, otherwise compute volume normally.

loadline S is use Summer Loadline. T means use Tropic Loadine. W is Winter Loadline.

non_rigid Y feeds hull deflection back into hydrostatics. NOT IMPLEMENTED IN THIS VERSION.

show_hidden N/T/A show no hidden/all hidden tanks/all hidden tanks and compartments.

wave_opt Determines longitudinal wave bending moment used in Hotspot analysis. D is IACS design wave. S is 0.8 design wave. H is 0.5 design wave. C is zero wave bending moment.

use_exact_vcf Y means VCF computed to 5 decimal places; otherwise rounded to 4.

round_api Density rounding policy. H/A/N for API round to 0.5/0.1/0.01; for kg/m3 round to 0.5/0.5/0.1. A is ASTM recommendation.

round_temp Temperature rounding policy. H/A/N for degrees F round to 0.5/0.1/0.1; for degrees C round to 0.05/0.05/0.01. A is ASTM recommendation.

show_bend_mom_pct Y will display shear force/bend moment as percent of allowables, else absolute.

grounded N is ship afloat. Y is ship grounded, user entering drafts. V is ship grounded, user entering water depths.

A.3 The Header sub-report

In most tanker operational and regulatory situations, it is a good idea to include the Header sub-report. The Header variables are not used by CTX Mate, so this is not necessary to make the report self-standing. Nonetheless the Header variables are needed by any good Tanker Management System. To include the Header sub-report, include an `H` in the sub-report options. Here's a sample Header sub-report.

```
<ctx_Header
    fleet="U" ship="al" shipname="Hellespont Alhambra" imo_number="9224752"
    voy_num="" leg="" type="None" port="xxxx" berth=""
    title1="this is a template for loading pattern files as used by 0.20 and later."
    title2="based on /tfs/u/NLOAD/1.92/LF.al98dep.">
</ctx_Header>
```

Here are the definitions:

fleet The ship's fleet code. See Section 2.3.

ship The ship's ship code. See Section 2.3.

shipname Duh!

imo_number The seven digit number IMO assigned to the ship when it was ordered. Ship names can both change and be reused. The IMO number stays with the ship thru its life and is never re-used. For regulatory bodies, this is the key to identifying a ship.

voy_num The voyage number. See Section 6.1.

leg The leg code. In the CTX system this is *ppppn* where *pppp* is the four character code of the leg's FAOP port, and n is the leg index with the initial leg of a voyage having an index of 0. See Section 6.1.

type The load pattern type. See Section 6.1.

port Portname.

berth The berth or, if STS, lighter/mothership name.

title1 First line of a free form title.

title2 Second line of a free form title.

Any or all of these fields can be blank. Mate does not force you to enter any of these fields. But your owner might.

A.4 The Parcel sub-report

If you need the parcel details, include a `P` in the sub-report options. Here's a sample Parcel sub-report.

```
<ctx_Parcels>
    <ctx_Parcel code="sw" method="s" density="1.0234" color=""
        name="test sea water" sulfur="0.0000" ash="" water="" vp="" comment=""/>
    <ctx_Parcel code="AL" method="C" density="34.56" color=""
        name="test arab ligh" sulfur="0.0000" ash="" water="" vp="" comment=""/>
    <ctx_Parcel code="f1" method="P" density="0.9876" color=""
        name="test 54b" sulfur="" ash="" water="" vp="" comment=""/>
</ctx_Parcels>
```

Each liquid parcel is described by a `ctx_Parcel` element, everything between a <ctx_Parcel and the next />. The first "parcel" is always ambient seawater. It will always be present, even if there are no liquids on board. Here are the definitions:

code A two character parcel code. See Section 4.1

method A single character code which specifies how the parcel density varies with temperature. See Section 4.1.

density Density at standard temperature. Depending on `method`, this will either be in API degrees or specific gravity. See Section 4.1.

color Not currently used.

name A free form name for the parcel.

sulfur Sulfur content in percent mass. Mate does not require. But other programs might. For example, ctx_Rob estimates bunkers NCV from density, sulfur, ash and water.

ash Ash content in percent mass.

water Water content in percent volume. Mate does not require.

vp Vapor pressure in bar. Mate does not currently require.

comment Free form description of parcel. Some owners put Bill of Lading number here.

A.5 The Tank sub-report

If you need the individual tank results, include a `T` in the sub-report options. Figure 14.7.1 contains an excerpt from a sample Normal mode Tank sub-report. Figure A.5 shows an excerpt for a sample Damage mode Tank sub-report in which 2C is intact, 1P is damaged, and 1C is grouped with 1P. The intact tank variables are discussed in Section 14.7.1. The definitions of the additional Damage mode variables are:[1]

igs_mm The equilibrium pressure in the ullage space in millimeters water gage.

hbl The amount of hydrostatic over-balance in meters. A positive value indicates the tank is over-balanced and would have to be drawn down this amount to become hydrostatically balanced.[2] A negative value indicates the tank is under-balanced and could be filled this amount before it will become hydrostatically balanced. An under-balanced tank will not lose cargo from damage that is confined to the flat bottom.

hydroloss The net hydrostatic outflow of petroleum from the tank group in cubic meters. This variable applies only to the lead tank in a group.

exchgloss The net exchange flow loss of petroleum from the tank group in cubic meters. This variable applies only to the lead tank in a group.

oil_sw_ze The height of the oil/sea water interface above sea-level in the tank. This in measured in the direction of gravity.

crit_ze The height above sea-level of the damage location that determines the outflow. This will be the lowest point of the damage if the damage is entirely above sea-level; the highest point of the damage if the damage is entirely below sea-level; otherwise it will be the waterline (0.000).

dam_hi_xs The distance forward of the AP of the high point of the damage. measured along the ship centerline.

dam_hi_ys The transverse location of the high point of the damage. Port is positive.

[1] A number of Normal mode tank variables are not applicable in Damage mode. These are not included in the Damage mode sub-report.

[2] Not quite true since drawing down the tank will change the ship's drafts and heel slightly. Down in this case is in the direction of gravity.

dam_hi_zs The distance of the high point of the damage above the baseline measured parallel to the Aft Perpendicular.

dam_lo_xs The distance forward of the AP of the low point of the damage. measured along the ship centerline.

dam_lo_ys The transverse location of the low point of the damage. Port is positive.

dam_lo_zs The distance of the low point of the damage above the baseline measured parallel to the Aft Perpendicular.

grp The lead tank with which this tank is grouped. This variable applies only to tanks that are grouped,

Figure A.1: Excerpt from Damage Mode Tank sub-report


```
<ctx_Tanks mode="D">
    <ctx_Tank name="1C      " type="C"   par="AL" dip_pt="UL" opt="G"
          temp=      " 15.56" sg=       "0.85019" vcf=      "1.00000"
          tovintact="40316.4" grp="      1P">
    </ctx_Tank>
    <ctx_Tank name="2C      " type="C"   par="AL" dip_pt="UL" opt="P"
          temp=      " 15.56" sg=       "0.85019" vcf=      "1.00000"
          wl_ze=    " 12.022" ullage=   "  1.436" innage=   " 31.425"
          tov=      "47619.7" wt=       "40485.9" igs_mm=   "    510" hbl=      "  7.938"
          lcg_xe=  " 262.710" tcg_ye=   " -0.489" vcg_ze=   " -3.671" moi_m4=   "  79913">
    </ctx_Tank>
    <ctx_Tank name="1P      " type="C"   par="AL" dip_pt="UL" opt="D"
          temp=      " 15.56" sg=       "0.85019" vcf=      "1.00000"
          wl_ze=    "  1.736" oil_sw_ze="-11.467" ullage=   " 12.178" innage=   " 20.234"
          tov=      "39958.6" wt=       "36274.8" igs_mm=   "    510" hbl=      "  0.000"
          hydroloss="22212.8" exchgloss="13292.1" tovintact="21855.0" crit_ze=  "-11.467"
          dam_hi_xs="300.000" dam_hi_ys=" 30.100" dam_hi_zs=" 10.000"
          dam_lo_xs="300.500" dam_lo_ys=" 25.350" dam_lo_zs="  3.300"
          lcg_xe=  " 317.619" tcg_ye=   "  5.796" vcg_ze=   " -8.633" moi_m4=   "  81822">
    </ctx_Tank>

.... more tanks .......

</ctx_Tanks>
```

A.6 The Strength sub-report

If you need the longitudinal strength results, include a `b` (short form) or a `B` (long form) in the sub-report options.[3] Figure A.6 contains an excerpt from a sample Strength sub-report. The sub-report begins with a header section showing the size and location of the maximal shear force, bending moment, and deflection. All these values are self-explanatory with the exception of `shear_error` and `moment_error`. These are the shear force and bending moment imbalances at the bow (Mate works aft to forward). They should be near-zero.

There will be a ctx_Beam element for each frame in the report. If the `b` option is specified, then only the major frame and the maximal frames will be included. This includes all the frames that Class requires, so in many cases, this will be all you need. If the `B` option is specified, then every frame in the ship will be included. A large tanker may have as many as 200 frames. In many situations, this will be over-kill.

In either case, the ctx_Beam variables are:

name The frame name.

xs The longitudinal location of the frame foward of the AP in meters.

show A flag which indicates whether the frame is included in the short form report. If this field is `Y`, the frame will also be delineated on the shear force/bending moment plots.

sf The shear force at the frame in tons. Plus is excess buoyancy forward.

bm he bending moment at the frame in ton-meters. Plus is hog.

hog The vertical hull deflection at the frame relative to the baseline in meters. Plus is hog; negative is sag. If a hull Moment of Inertia curve is not available, this field will not be present.

sf_allow The relevent shear force allowable in tons. If allowables are not available, or this frame is outside the range of assigned allowables, this field will not be present.

bm_allow The relevent bending moment allowable in ton-meters. This will be the hog allowable if the frame is in hog; the sag allowable otherwise. Same comment as `sf_allow`.

[3] The maximal shear force and bending moment, both absolute and relative to the allowables, are in the Summary report. That may be all you need.

Figure A.2: Excerpt from Strength sub-report

```
<ctx_Beam_Curve allowables="AT SEA" moi_curve="Y"
    shear_max= "   19843" shear_max_frame= "FR105a  " shear_max_xs= "292.449" shear_error= "-0"
    moment_max="-1614795" moment_max_frame="FR090   " moment_max_xs="204.400" moment_error="134"
    hog_max=   "  -0.416" hog_max_frame=   "FR087   " hog_max_xs=   "186.790"
    shear_max_pct= "-70.7" shear_max_pct_frame=  "FR040   " shear_max_pct_xs= "  35.150"
    moment_max_pct="-148.1" moment_max_pct_frame="FR090   " moment_max_pct_xs=" 204.400">
  <ctx_Beam frame="TRNSM   " xs=" -6.500" show="Y" sf="     0" bm="       0" hog="-0.000"/>
  <ctx_Beam frame="AP      " xs="  0.000" show="Y" sf="  -553" bm="   -1681" hog="-0.021"/>
  <ctx_Beam frame="FR017   " xs=" 14.450" show="Y" sf=" -2831" bm="  -21751" hog="-0.067"
            sf_allow=" -7500" bm_allow="  -64600"/>
  <ctx_Beam frame="FR029   " xs=" 25.250" show="Y" sf=" -5256" bm="  -64966" hog="-0.101"
            sf_allow=" -8750" bm_allow=" -112750"/>
  <ctx_Beam frame="FR040   " xs=" 35.150" show=" " sf=" -8512" bm=" -128782" hog="-0.133"
            sf_allow="-12043" bm_allow=" -171142"/>
  <ctx_Beam frame="FR041   " xs=" 36.050" show="Y" sf=" -8490" bm=" -136294" hog="-0.135"
            sf_allow="-12342" bm_allow=" -176450"/>

  ..... more frames ......

  <ctx_Beam frame="FR115   " xs="351.150" show="Y" sf="  5299" bm="  -45576" hog="-0.072"
            sf_allow=" 15000" bm_allow=" -147400"/>
  <ctx_Beam frame="FR129   " xs="363.050" show="Y" sf="  1062" bm="   -3562" hog="-0.032"
            sf_allow="  5405" bm_allow="  -29281"/>
  <ctx_Beam frame="FP      " xs="366.000" show="Y" sf="   630" bm="   -1267" hog="-0.022"/>
</ctx_Beam_Curve>
```

A.7 The Stability sub-report

If you need the righting arm curves, include an `A` in the sub-report options. There is no difference between CTX Mate's intact and damaged stability calculations. If the ship is damaged, the righting arms will reflect not only the equilibrium flooding and petroleum outflows, but also the flooding associated with the heel imposed in order to calculate the righting arms. Figure A.7 contains an excerpt from a sample Stability sub-report. The sub-report is divided into two sub-sections: one for each righting arm. Each sub-section begins with a header showing the overall results for that righting arm. The header variables are:

area_to_30 The area under the righting arm curve to 30 degrees in the direction of heel in meter-radians. Thanks to an overly literal interpretation of IMO A.749, Class requires that this number be based on 30 degrees absolute rather than 30 degrees from equilibrium. This generates some anomolous numbers in cases of very high equilibrium heel. See Section 9.2. In such situations, ignore the `area_to` variables and concentrate on the righting arm itself.

area_to_40 The area under the righting arm curve to 40 degrees in the direction of heel in meter-radians. Same comments as above a fortiori.

gz_max The maximum righting arm in meters.

gz_mode The location of maximum righting arm in degrees.

flood_deg The heel at which an Unprotected downflooding point is immersed. For the purposes of this calculation, all Closable downflooding points are considered to be closed and watertight.

flood_name The name of the downflooding point that resulted in `flood_deg`.

Within each righting arm sub-section, there will be a ctx_Arm_point element for each angle of heel in the report. The ctx_Arm_point variables are:

heel The point's heel in degrees. Positive is heel to starboard; negative is heel to port. Heels start at equilibrium and go as far as 50

degrees off equilibrium; but, if GZ goes negative, the curve stops at this point.[4]

gz The righting arm in meters at this heel. `gz` is measured in earth coordinates, parallel to the sea level.

area The area under the curve up to this point. If the point is past the downflooding angle, then area will be constant.

margin The earth vertical distance between the lowest Unprotected downflooding point and the sea level.

[4] It is possible that Mate's calculations will fail to converge in which case the righting arm will stop at the last heel for which convergence was obtained.

Figure A.3: Excerpt from Stability sub-report

```
<ctx_Arm side="stbd" area_to_30=" 1.274" area_to_40=" 2.067"
         gz_max=" 4.614" gz_mode_=" 37.36" flood_deg=" 43.18" flood_name="LIFTDOORA">
    <ctx_Arm_point heel=" -0.14" gz=" 0.000" area=" 0.000" margin=" 12.311"/>
    <ctx_Arm_point heel="  2.36" gz=" 0.386" area=" 0.008" margin=" 11.951"/>
    <ctx_Arm_point heel="  4.86" gz=" 0.783" area=" 0.034" margin=" 11.566"/>
    <ctx_Arm_point heel="  7.36" gz=" 1.194" area=" 0.077" margin=" 11.166"/>
    <ctx_Arm_point heel="  9.86" gz=" 1.618" area=" 0.138" margin=" 10.752"/>

   .... more points .......

    <ctx_Arm_point heel=" 39.86" gz=" 4.600" area=" 2.056" margin="  1.460"/>
    <ctx_Arm_point heel=" 42.36" gz=" 4.535" area=" 2.256" margin="  0.364"/>
    <ctx_Arm_point heel=" 44.86" gz=" 4.426" area=" 2.320" margin=" -0.745"/>
    <ctx_Arm_point heel=" 47.36" gz=" 4.278" area=" 2.320" margin=" -1.863"/>
    <ctx_Arm_point heel=" 49.86" gz=" 4.096" area=" 2.320" margin=" -2.988"/>
</ctx_Arm>
<ctx_Arm side="port" area_to_30=" 1.253" area_to_40=" 2.040"
         gz_max=" 4.582" gz_mode_="-37.64" flood_deg="1000.00" flood_name="">
    <ctx_Arm_point heel=" -0.14" gz=" 0.000" area=" 0.000" margin=" 12.311"/>
    <ctx_Arm_point heel=" -2.64" gz=" 0.387" area=" 0.008" margin=" 12.403"/>
    <ctx_Arm_point heel=" -5.14" gz=" 0.785" area=" 0.034" margin=" 12.484"/>
    <ctx_Arm_point heel=" -7.64" gz=" 1.198" area=" 0.077" margin=" 12.548"/>
    <ctx_Arm_point heel="-10.14" gz=" 1.624" area=" 0.139" margin=" 12.594"/>

    ...... more points .....

    <ctx_Arm_point heel="-40.14" gz=" 4.563" area=" 2.051" margin="  8.260"/>
    <ctx_Arm_point heel="-42.64" gz=" 4.495" area=" 2.249" margin="  7.514"/>
    <ctx_Arm_point heel="-45.14" gz=" 4.382" area=" 2.443" margin="  6.741"/>
    <ctx_Arm_point heel="-47.64" gz=" 4.232" area=" 2.630" margin="  5.946"/>
    <ctx_Arm_point heel="-50.14" gz=" 4.048" area=" 2.811" margin="  5.128"/>
</ctx_Arm>
```

A.8 The Downflooding sub-report

If you need the downflooding sub-report include an `F` in the sub-report options. Figure A.8 contains an excerpt from a sample Downflooding sub-report. The downflooding report is very simple. It contains one line for each opening. The openings are sorted in order of their height above the sea level, lowest first. The variables are:

name The name of the downflooding opening.

type The type is either C (closable) or U (unprotected). The downflooding report contains all openings regardless of type. You may want to search for the lowest type U opening.

ze The earth vertical height above sea level. Negative means the opening is immersed.

xs The longitudinal location of the opening forward of the Aft Perpendicular.

ys The transverse position of the opening off the centerline, port is positive.

Figure A.4: Excerpt from Downflooding sub-report

```
<ctx_Floods>
    <ctx_Flood name="S/G_VENTP   " type="C" ze="  5.258" xs=" -1.000" ys=" 11.000"/>
    <ctx_Flood name="S/G_VENTS   " type="C" ze="  5.310" xs=" -1.000" ys="-11.000"/>
    <ctx_Flood name="3FOP_VENT   " type="C" ze="  5.404" xs=" 17.250" ys=" 15.000"/>

.... more openings .....

    <ctx_Flood name="FP_VENT_S   " type="C" ze=" 16.014" xs="354.550" ys="-14.000"/>
    <ctx_Flood name="FOCSLE_P    " type="C" ze=" 16.244" xs="363.900" ys=" 12.000"/>
    <ctx_Flood name="FOCSLE_P    " type="C" ze=" 16.244" xs="363.900" ys=" 12.000"/>
    <ctx_Flood name="FOCSLE_S    " type="C" ze=" 16.301" xs="363.900" ys="-12.000"/>
    <ctx_Flood name="STAIRS__C   " type="U" ze=" 18.110" xs=" 45.100" ys=" -2.335"/>
    <ctx_Flood name="LIFTDOORC   " type="U" ze=" 18.124" xs=" 45.100" ys=" -8.400"/>
</ctx_Floods>
```

A.9 The IMO Reg 25 sub-report

Still to be written.

Appendix B

Post Processing CTX Mate XML Reports

This Appendix is intended only for personnel who need to write scripts to post-process CTX Mate's XML reports. It assumes some knowledge of computer programming and a basic understanding of XML. It proceeds by example, using one of the most popular scipting languages: Perl. But this should be sufficient guidance for users of any language which has an XML parser and a means for converting the XML into a data structure that the language can access directly.

B.1 Post-processing with Perl

There is no mixed content in any of the CTX XML reports. And all the reports are small enough, so that the whole report can be easily handled at once. Therefore, the easiest way to post-process these reports using Perl is via the XML::Simple module. The required code can be trivial. The following four line program is all that is needed to extract and print out the hydrostatic and exchange loss from the Summary sub-report.

```
#!/usr/bin/perl
# extract_spillage.pl call with ctx report-file-name
# extracts hydroloss and exchgloss from given report file.

use XML::Simple;
$report = XMLin($ARGV[0]);
print "hydroloss = $report->{ctx_Summary}->{hydroloss}\n";
print "exchgloss = $report->{ctx_Summary}->{exchgloss}\n";
```

The following snippet of pseudo-code shows how to extract any CTX XML report variable.

```
my $report = XMLin($xml_file,
  forcearray => [ctx_Parcel, ctx_Tank, ctx_Cargo, ctx_Spike, ctx_Arm, ctx_Arm_point],
  keyattr => { ctx_Parcel => code, ctx_Arm => side, ctx_Arm_point => heel,
   ctx_Tank => name,  ctx_Beam => frame, ctx_Spike => name}
);
$var_i_want = $report->{xxxxx}->{yyyyy}->{zzzzz}->{var_i_want};
```

where *xxxxx*, *yyyyy* (if necessary), and *zzzzz* (if necessary) are the names of the enclosing XML elements. For example, to extract a variable from the Header sub-report, all you need is

```
$report = XMLIN($xml_file);
$var_i_want = $report->{ctx_Header}->{var_i_want};
```

where $xml_file is the name of the report file.[1]

The parcel stuff is two more levels down and the individual parcel key is the two character parcel code. For example, to extract the sulfur content of a parcel whose code is `AL` use

```
$report = XMLIN($xml_file, forcearray => [ctx_Parcel], keyattr => {ctx_Parcel => code});
$sulfur = $report->{ctx_Parcels}->{ctx_Parcel}->{AL}->{sulfur};
```

The `forcearray` option instructs XML::Simple to treat every `ctx_Parcel` element as an array, even if it only contains one parcel. The `keyattr` option tells XML::Simple that the key to the Parcel table is the two character parcel code.

The individual tank results follow exactly the same pattern. The enclosing elements are ctx_Tanks and ctx_Tank and the key to the individual tank is the tank name. For example, to extract the ullage of tank `1C` use

```
$report = XMLIN($xml_file, forcearray => [ctx_Tank], keyattr => {ctx_Tank => name});
$ullage = $report->{ctx_Tanks}->{ctx_Tank}->{1C}->{ullage};
```

In most cases, you will be looping over every tank (or every parcel or every whatever) in the sub-report. It is not necessary to know the keys (eg the tank names) to do this. The following code will compute the total observed volume in all cargo tanks.

[1] Meta-data is a slight exception. There are no enclosing sub-sections so use $metadata_i_want = $report->metadata_i_want;

```
$total_tov = 0;
for $tank_name (keys(%{$report->{ctx_Tanks}->{ctx_Tank}})) {
    $tank = $report->{ctx_Tanks}->{ctx_Tank}->{$tank_name};
    if ($tank->{type} =~ /[CGS]/) {
        $total_tov += $tank->{tov};
    }
}
```

The Strength sub-report has both header variables (e.g, `max_moment` and a table containing the results for each frame in the report. The latter is keyed by the attribute `frame` (the frame name). Therefore for the header variables use:

```
$report = XMLIN($xml_file, keyattr => {ctx_Beam => frame});
$var_i_want = $report->{ctx_Beam_Curve}->{var_i_want};
```

And for the individual frame stuff

```
$var_i_want = $report->{ctx_Beam_Curve}->{ctx_Beam}->{frame}->{var_i_want};
```

where *frame* is the frame name.

The Stability sub-report is really two sub-reports: one for each righting arm. The individual righting arm points are keyed by the heel. Therefore, you need either

```
$report = XMLin(reportfile);
$report = XMLIN($xml_file, keyattr => {ctx_Arm => side},
                           keyattr => {ctx_Arm_point => heel});
$var_i_want = $report->{ctx_Arm}->{stbd|port}->{var_i_want};
```

or

```
$var_i_want = $report->{ctx_Arm}->{stbd|port}->{ctx_Arm_point}->{heel}->{var_i_want};
```

where *stbd*|*port* is either `stbd` or `port`. Use the first form for the header variables, and the second for the individual points on the righting arm curve.

The CTX Mate distribution includes a Perl script, `mate2perl.pl`, which shows how to extract any value in the Mate XML reports using Perl. It also includes a sample post-processor, `underkeel.pl`. This little program prepares a USCG Under-Keel clearance report for a given loading pattern, water depth, and ship speed. The heart of the program is three lines of code. See the CTX Mate Programmer's Manual.

CTX Mate starts every XML element on a new line, and the nesting is indicated by the indentation. This is done primarily to make the reports easier for humans to read. However, in a pinch, it also allows the data to be extracted without an XML parser. One way to do this is with regular expressions. For example, the information on each line in the Summary sub-report could be extracted via

```
($varname, $value) = ($_ =~ /^\s*<([^>]+)>([^<]+)/);
```

This approach should be used only if no XML parser is available. It is hard to write regular expressions that can't be fooled, and it is certainly a lot more work.