



設計處專題報導—4IntShip 計畫 之裝載電腦軟體 LoadingExpert

前言：

裝載電腦是船舶一項必要的裝備，他是用於透過油水艙存量及載貨量計算預估船舶姿態的軟體工具，對於透過壓載水調整船舶平衡以及評估船舶現況之安全起到重要的作用。2019 年配合政府政策，本公司自行投資建造大型離岸風電用駁船(台船 15 號，HNO. 1110)，有鑑於其營運狀態特殊，專用於運送離岸風電大型海洋工程結構物，因貨物體積大且重，需同時考量甲板與碼頭齊平，否則無法運用軌道或滾裝方式，將貨物運送上船，考量裝載計算之過程繁瑣，若非有經驗的工程師，通常耗時甚久，為增進人員操作效率，並且計算裝載船況為本公司船型設計核心能力之一，故起動自行發裝載計算軟體(LoadingExpert)地的開端以配合自動調水系統之裝載船況規劃，並於近期獲得船籍協會的裝載電腦型式認證。

參照法規：

裝載電腦在國際上參照 IACS UR L5 為準則，下方法規對裝載電腦定義的節錄以及所計算出來的結果之誤差範圍，明確規範了裝載電腦須符合的功能以及評估結果的準確性。

1. General

- The scope of a stability calculation software shall be in accordance with the stability information as approved by the administration and shall at least include all information and perform all calculations or checks as necessary to ensure compliance with the applicable stability requirements.
- Approved stability software is not a substitute for the approved stability information, and is used as a supplement to the approved stability information to facilitate stability calculations.
- The input/output information shall be easily comparable with approved stability information so as to avoid confusion and possible misinterpretation by the operator relative to the approved stability information.

Hull Form Dependent	
Displacement	+/- 2%
Longitudinal center of buoyancy, from AP	+/- 1% / 50 cm
Vertical center of buoyancy	+/- 1% / 5 cm
Transverse center of buoyancy	+/- 0.5% of B / 5 cm
Longitudinal center of flotation, from AP	+/- 1% / 50 cm
Moment to trim 1 cm	+/- 2%
Transverse metacentric height	+/- 1% / 5 cm
Longitudinal metacentric height	+/- 1% / 50 cm
Cross curves of stability	+/- 5 cm

Compartment dependent	
Volume or deadweight	+/- 2%
Longitudinal center of gravity, from AP	+/- 1% / 50 cm
Vertical centre of gravity	+/- 1% / 5 cm
Transverse center of gravity	+/- 0.5% of B / 5 cm
Free surface moment	+/- 2%
Shifting moment	+/- 5%
Level of contents	+/- 2%

Trim and stability	
Draughts (forward, aft, mean)	+/- 1% / 5 cm
GMt (both solid and corrected for free surfaces)	+/- 1% / 5 cm
GZ values	+/- 5% / 5 cm
Downflooding angle	+/- 2°
Equilibrium angles	+/- 1°
Distance from WL to unprotected and weathertight openings, or other relevant point, if applicable	+/- 5% / 5 cm
Areas under righting arm curve	+/- 5% / 0.0012mrad

裝載電腦依照對於破損穩度計算的要求分為四個等級，如下條文所示，目前公司自行研發的軟體 LoadingExpert 是拿到了 TYPE2 第二等級的認證，除了一些對破損航行比較嚴格的像是油輪化學品輪或大型客輪以外，對於大部分的一般商船及水面艦艇應用上是綽綽有餘。

Type 1

Software calculating intact stability only (for vessels not required to meet a damage stability criterion).

Type 2

Software calculating intact stability and checking damage stability on basis of a limit curve (e.g. for vessels applicable to SOLAS Part B-1 damage stability calculations, etc.) or checking

all the stability requirements (intact and damage stability) on the basis of a limit curve.

Type 3

Software calculating intact stability and damage stability by direct application of preprogrammed damage cases based on the relevant Conventions or Codes for each loading condition (for some tankers etc.).

Type 4

Software calculating damage stability associated with an actual loading condition and actual flooding case, using direct application of user defined damage, for the purpose of providing operational information for safe return to port (SRtP).

船籍協會型式認證證書：

	中國驗船中心 CR Classification Society	Certificate No. 898-21-055 Date December 20, 2021
型式認可證書 TYPE APPROVAL CERTIFICATE		
<i>This is to certify that the undernoted product(s) has/have been approved by CR Classification Society in accordance with the requirements given in CR Rules for the Construction and Classification of Steel Ships as an approved type for use in ships classed or intended to be classed with the Society.</i>		
Manufacturer	: CSBC CORPORATION, TAIWAN	
Approved Product(s)	: Loading Computer Systems	
Types of stability software & Application	: Type 2 ; Type approved for calculation and control of loading conditions with the following functions: 1. Check of shear force and bending moments against limit curves 2. Check of intact and damage stability against limit curve	
Program name	: LoadingExpert	
Version	: 1.2.0	
This certificate is valid until December 19, 2026		
 CHIH-HUA HUANG 中國驗船中心 總驗船師 Chief Surveyor CR Classification Society (See next page for further details regarding the approval.)		
This certificate evidences that the type of the products of the Manufacturer has been assessed to be in compliance with the specified CR Rules or Guidelines and to be capable of providing the listed products. This Certificate may be cancelled by CR Classification Society if the applicant makes any changes or modifications relevant to the approval, which have not been notified to, and agreed in writing with the Society. Any person not a party to the contract pursuant to which this document is delivered may not assert a claim against CR Classification Society for any liability arising out of errors or omissions which may be contained in said documents, or for errors of judgment, fault or negligence committed by personnel of the Society. Please refer to the CR website for the latest status of this approval: www.crclass.org/au/rao.htm		
FORM NO. KC15 / 05.2021 TYPE APPROVAL - 1/3 -		

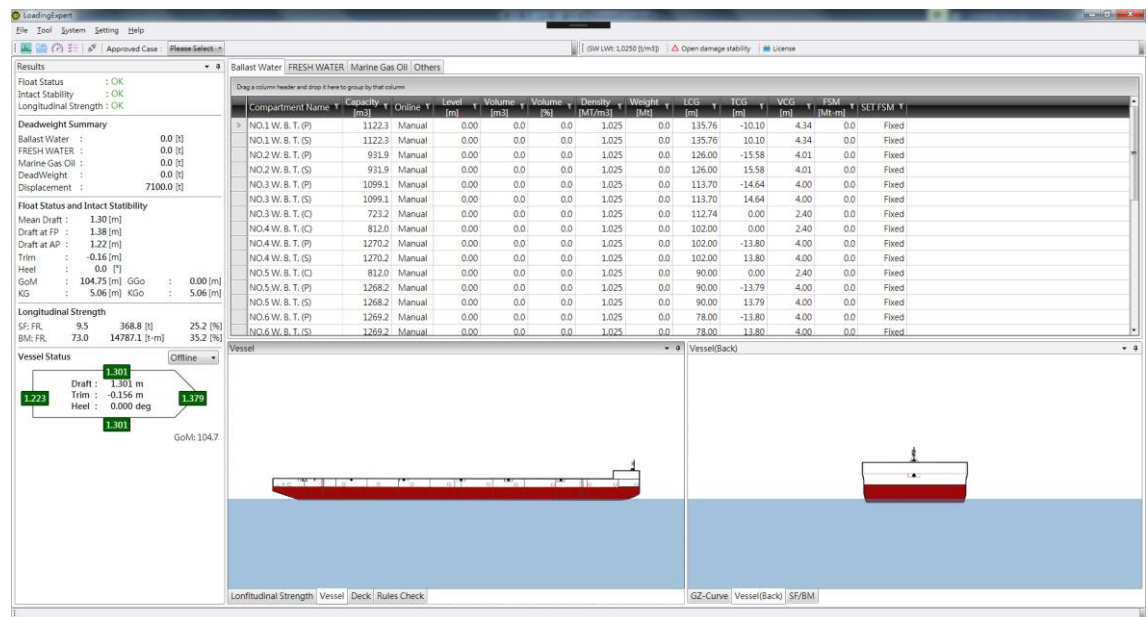
功能概述：

本次裝載電腦開發採用商用軟體 Aveva Marine 之匯出資料作為計算參照，裝載電腦中主要功能如下所示：

- A. 排水量與載重噸計算
- B. 俯仰、橫搖及吃水計算
- C. 螺槳沒水率計算
- D. 可視距離計算
- E. 自由液面效應計算
- F. 縱強度計算
- G. 完整穩度計算

- H. 提供即時警告
- I. ICMS 連接介面
- J. 使用者權限管理
- K. 調水建議排程計算

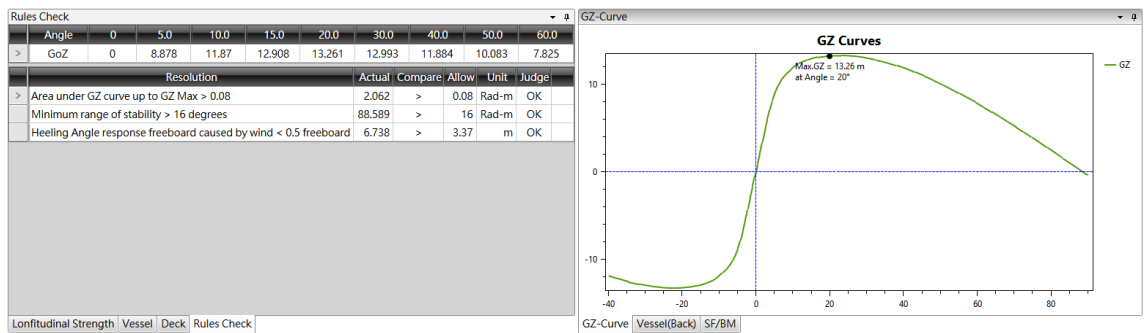
使用者介面：



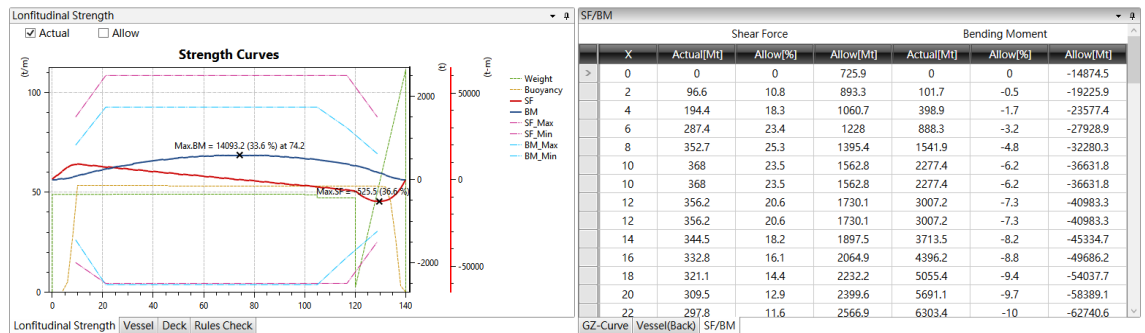
LoadingExpert 主畫面

Ballast Water Fresh Water Fuel Oil Marine gas oil Others													
Drag a column header and drop it here to group by that column													
	Compartment Name	Capacity [m3]	Online	Level [m]	Volume [m3]	Volume [%]	Density [MT/m3]	Weight [Mt]	LCG [m]	TCG [m]	VCG [m]	FSM [Mt-m]	SET FSM
>	F.P.T. (C)	482.1	Manual	0.00	0.0	0.0	1.025	0.0	195.95	0.00	6.69	0.0	Fixed
	NO.1 D.B.W.B.T. (C)	497.8	Manual	0.00	0.0	0.0	1.025	0.0	167.43	0.00	2.47	0.0	Fixed
	NO.1 W.B.T. (P)	541.8	Manual	0.00	0.0	0.0	1.025	0.0	166.87	-7.55	8.64	0.0	Fixed
	NO.1 W.B.T. (S)	541.8	Manual	0.00	0.0	0.0	1.025	0.0	166.87	7.55	8.64	0.0	Fixed
	NO.2 F.W.B.T. (P)	302.0	Manual	5.39	178.9	59.3	1.025	183.4	152.57	-11.49	8.43	210.7	MaxFSM
	NO.2 F.W.B.T. (S)	302.0	Manual	7.18	267.2	88.5	1.025	273.9	152.59	12.09	9.18	79.0	Fixed
	NO.2 D.B.W.B.T. (P)	276.3	Manual	1.89	276.3	100.0	1.025	283.2	143.86	-5.50	1.02	0.0	Fixed
	NO.2 D.B.W.B.T. (S)	276.3	Manual	1.89	276.3	100.0	1.025	283.2	143.86	5.50	1.02	0.0	Fixed
	NO.2 A.W.B.T. (P)	359.3	Manual	7.78	359.3	100.0	1.025	368.3	138.49	-13.87	8.04	0.0	Fixed
	NO.2 A.W.B.T. (S)	359.3	Manual	7.78	359.3	100.0	1.025	368.3	138.49	13.87	8.04	0.0	Fixed
	NO.3 D.B.W.B.T. (P)	560.2	Manual	1.80	560.2	100.0	1.025	574.2	116.51	-7.89	0.94	0.0	Fixed
	NO.3 D.B.W.B.T. (S)	560.2	Manual	1.80	560.2	100.0	1.025	574.2	116.51	7.89	0.94	0.0	Fixed
	NO.3 W.B.T. (P)	661.2	Manual	10.38	661.2	100.0	1.025	677.8	115.12	-14.88	7.02	0.0	Fixed
	NO.3 W.B.T. (S)	661.2	Manual	10.38	661.2	100.0	1.025	677.8	115.12	14.88	7.02	0.0	Fixed
	NO.4 F.W.B.T. (P)	168.4	Manual	12.18	168.4	100.0	1.025	172.6	95.45	-15.27	9.59	0.0	Fixed

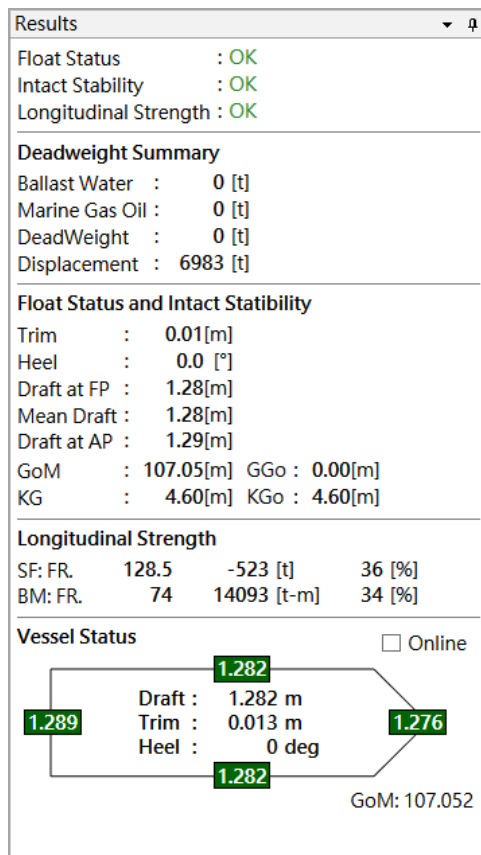
LoadingExpert 艙區輸入及顯示介面



LoadingExpert 法規計算介面



LoadingExpert 結構計算介面

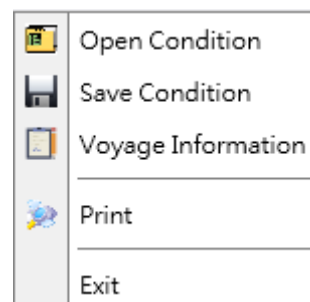


LoadingExpert 計算結果彙整介面

功能操作說明：

1 檔案功能表 (File)

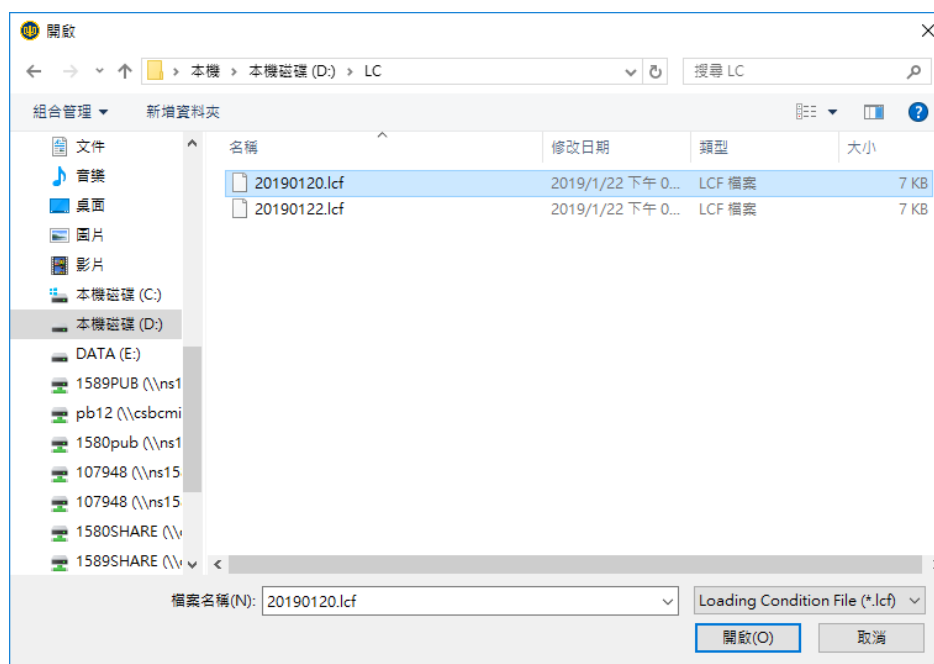
FILE 功能表包含基本的開啟及保存裝載條件的功能。此外亦包含更改當前資料夾、修改航程資訊、列印報告及離開裝載專家之功能。



1.1 開啟裝載條件(Open Condition)

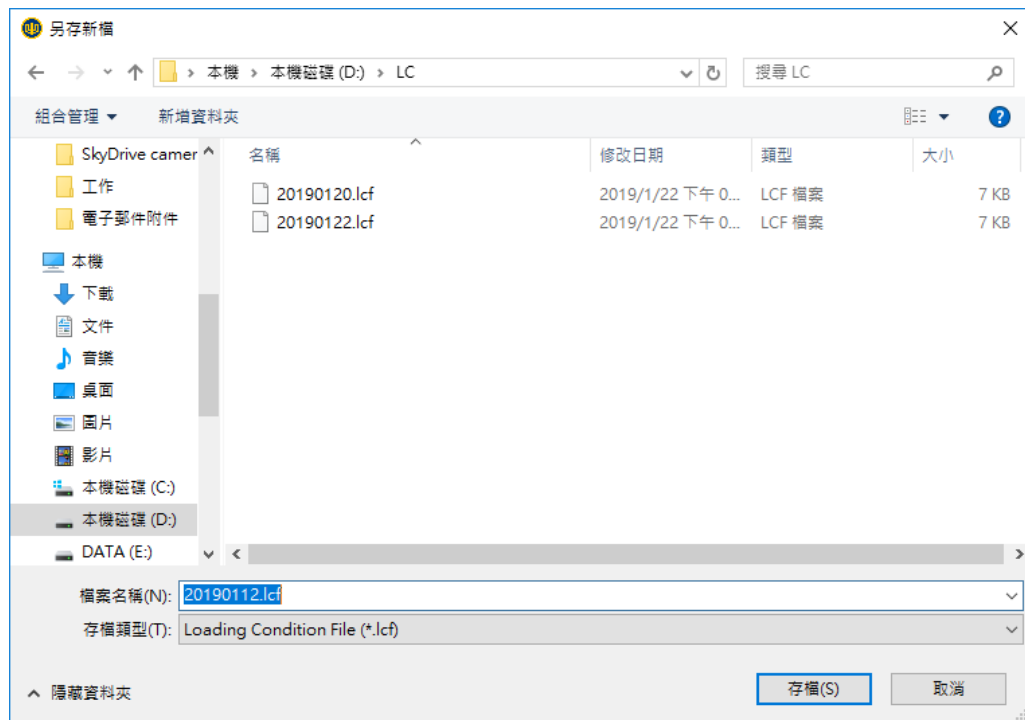
- A. 選擇「File」功能表
- B. 選擇「Open Condition」項目，將會出現名為「開啟」之視窗，如下圖所示

- C. 您可以在此處選擇目標之磁碟、目錄及檔案
- D. 按下「開啟」按鈕，您指定的檔案將會被讀入裝載專家



1.2 儲存裝載條件(Save Condition)

- A. 選擇「File」功能表
- B. 選擇「Save Condition」項目將會出現名為「另存新檔」之視窗，如下圖所示
- C. 您可以在此處選擇要儲存之磁碟、目錄及檔案名稱
- D. 按下「存檔」按鈕以儲存目前裝載條件，或按下「取消」離開



1.3 航程資訊 (Voyage Information)

- A. 選擇「File」功能表
- B. 選擇「Voyage Information」項目，將會出現「VoyageInfoWin」視窗，如下圖所示
- C. 可在此輸入當前裝載條件之日期、編號、描述、起點、終點、填寫人及註解。

Voyage Information

Date : 2019-02-13 12:00:57

Voyage No :

Voyage Desc :

From :

To :

By :

Remark :

OK Cancel

1.4 列印 (Print)

- A. 選擇「File」功能表
- B. 選擇「Voyage Information」項目，將會出現名為「PDFPrintCe」之視窗，如下圖所示

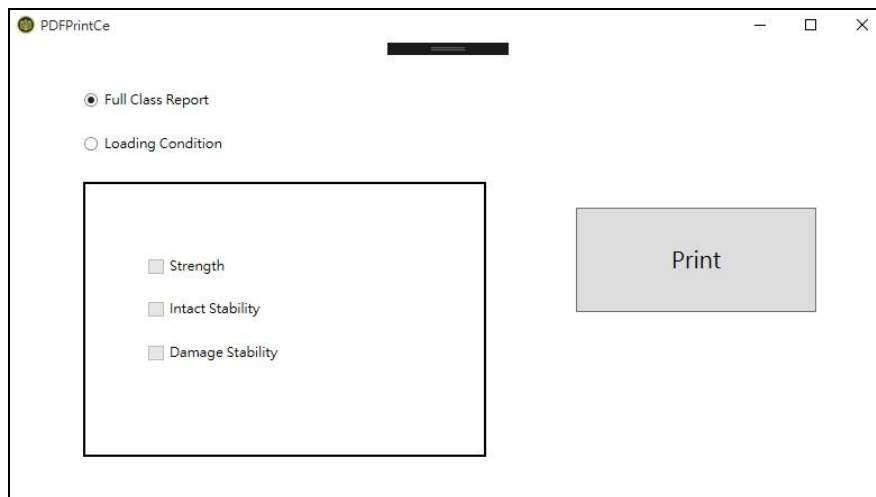
C. 選擇要輸出之項目

Full Class Report : 輸出經船級協會審核過的測試計算報告

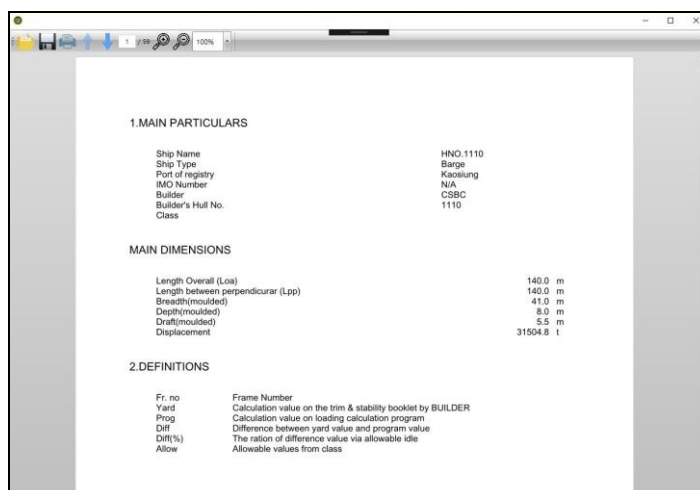
Loading Condition :

- 未選取：輸出目前裝載船況之裝載及浮態
- Strength：勾選後會加上縱向強度的計算報告
- Intact Stability：勾選後會加上完整穩度的計算報告
- Damage Stability：勾選後加上破損穩度的計算報告

D. 按下「Print」以預覽 PDF 檔案。



<Full Class Report>



<Loading Condition>

Compartment	FillRatio (%)	S.G. (t/m3)	Weight (t)	LCG (m)	VCG (m)	TCG (m)	FSM (t-m)
NO.1 W. B. T. (P)	56.9%	1.025	654.0	135.575	-10.099	2.756	5529.8
NO.1 W. B. T. (S)	58.4%	1.025	672.0	135.587	-10.101	2.813	5529.8
NO.2 W. B. T. (P)	100.0%	1.025	955.2	126.000	-15.583	4.006	0.0
NO.2 W. B. T. (S)	100.0%	1.025	955.1	126.000	-15.580	4.010	0.0
NO.3 W. B. T. (C)	100.0%	1.025	741.3	112.737	0.000	2.400	0.0
NO.3 W. B. T. (P)	100.0%	1.025	1126.5	113.700	-14.640	4.000	0.0
NO.3 W. B. T. (S)	100.0%	1.025	1126.5	113.700	-14.640	4.000	0.0
NO.4 W. B. T. (C)	100.0%	1.025	832.3	102.000	0.000	2.400	0.0
NO.4 W. B. T. (P)	100.0%	1.025	1302.0	102.000	-13.803	4.004	0.0
NO.4 W. B. T. (S)	100.0%	1.025	1302.0	102.000	-13.803	4.004	0.0
NO.5 W. B. T. (C)	100.0%	1.025	832.3	90.000	0.000	2.400	0.0
NO.5 W. B. T. (P)	100.0%	1.025	1299.9	90.000	-13.790	4.000	0.0
NO.5 W. B. T. (S)	100.0%	1.025	1299.9	90.000	-13.790	4.000	0.0
NO.6 W. B. T. (C)	100.0%	1.025	832.3	78.000	0.000	2.400	0.0
NO.6 W. B. T. (P)	100.0%	1.025	1300.9	78.000	-13.800	4.000	0.0
NO.6 W. B. T. (S)	100.0%	1.025	1300.9	78.000	-13.800	4.000	0.0
NO.7 W. B. T. (C)	36.0%	1.025	300.0	66.000	0.001	0.868	2950.2
NO.7 W. B. T. (P)	100.0%	1.025	1300.9	66.000	-13.800	4.000	0.0
NO.7 W. B. T. (S)	100.0%	1.025	1300.9	66.000	-13.800	4.000	0.0
NO.8 W. B. T. (C)	100.0%	1.025	832.3	54.000	0.000	2.400	0.0
NO.8 W. B. T. (P)	100.0%	1.025	1299.9	54.010	-13.790	4.000	0.0
NO.8 W. B. T. (S)	100.0%	1.025	1299.9	54.010	-13.790	4.000	0.0
NO.9 W. B. T. (C)	100.0%	1.025	832.3	42.000	0.000	2.400	0.0
NO.9 W. B. T. (P)	100.0%	1.025	1302.0	42.000	-13.803	4.004	0.0
NO.9 W. B. T. (S)	100.0%	1.025	1302.0	42.000	-13.803	4.004	0.0
NO.10 W. B. T. (C)	100.0%	1.025	832.3	30.000	0.000	2.400	0.0
NO.10 W. B. T. (P)	100.0%	1.025	1299.9	30.000	-13.790	4.000	0.0
NO.10 W. B. T. (S)	100.0%	1.025	1299.9	30.000	-13.790	4.000	0.0
NO.11 W. B. T. (C)	100.0%	1.025	832.3	18.000	0.000	2.400	0.0
NO.11 W. B. T. (P)	100.0%	1.025	1286.6	18.040	-13.740	3.970	0.0
NO.11 W. B. T. (S)	65.1%	1.025	298.0	6.343	0.001	2.437	2441.8
NO.12 W. B. T. (C)	35.8%	1.025	200.0	8.662	-13.769	1.532	1939.6
NO.12 W. B. T. (P)	35.8%	1.025	200.0	8.662	-13.771	1.532	1939.6
Ballast Water Total			33836.7	70.286	0.005	3.570	20310.7
M. G. O. STOR. TK (P)	98.0%	0.900	43.1	137.300	-5.540	9.884	37.7
Marine Gas Oil Total			43.1	137.300	-5.540	9.884	37.7

2.2 打水建議(Ballast Adviser)

- 選擇功能表「Tool」
- 選擇「Ballast Adviser」項目，並依提示輸入具有權限之使用者帳密，若正確無誤，將會顯示 Ballast Adviser 視窗，如下圖所示。
- Calc:Draft 與 Trim 欄位預設帶出目前的 Draft 與 Trim 值，按下按鈕後進行打水目標計算。
- Step Preview：預覽各步驟預計打入的水量。
- Auto：計算出各步驟預計打入的水量，並開始打水。綠底為正在打水的步驟，灰底為完成打水的步驟。注意：打水過程中不能使用預覽步驟 Step Preview、關閉視窗 Close、重新計算 Calc 或 Assign to MainWindow 等功能按鈕。
- < >：切換上下頁。
- Assign to MainWindow：將 Target 按鈕左方下拉式選單所選取的欄位寫回主畫面之 INPUT AREA。
- Close：關閉 Ballast Adviser 視窗。

Ballast Adviser

Draft : m
Trim : m

Status Prediction
 Draft at FP 2.000
 Draft at AP 2.000
 Displ. 11015.890
 KM 73.180
 GM 68.930
 Draft 2.000
 Trim 0.000

Processing time : 2 sec

Step Preview Auto ■ Processing ■ Completed

TankName	Now[t]	Step1[t]	Step2[t]	Target[t]
NO.1 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.1 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.2 W. B. T. (P)	0.0	534.1	718.0	718.0
NO.2 W. B. T. (S)	0.0	534.1	718.0	718.0
NO.3 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.3 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.3 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.4 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.4 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.4 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.5 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.5 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.5 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.6 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.6 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.6 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.7 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.7 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.7 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.8 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.8 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.8 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.9 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.9 W. B. T. (P)	0.0	965.9	1298.6	1298.6
NO.9 W. B. T. (S)	0.0	965.9	1298.6	1298.6
NO.10 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.10 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.10 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.11 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.11 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.11 W. B. T. (C)	0.0	0.0	0.0	0.0
NO.12 W. B. T. (P)	0.0	0.0	0.0	0.0
NO.12 W. B. T. (S)	0.0	0.0	0.0	0.0
NO.12 W. B. T. (C)	0.0	0.0	0.0	0.0

< > Time Consumption : 1 sec Target Assign to MainWindow

3 系統功能表(System)

「System」功能表供開發者調整系統參數，須具備開發者權限才能夠使用。



4 設定功能表(Setting)

「Setting」功能表，提供系統的相關設定及權限管理，可以管理角色、功能權限、使用者之間的對應關係。

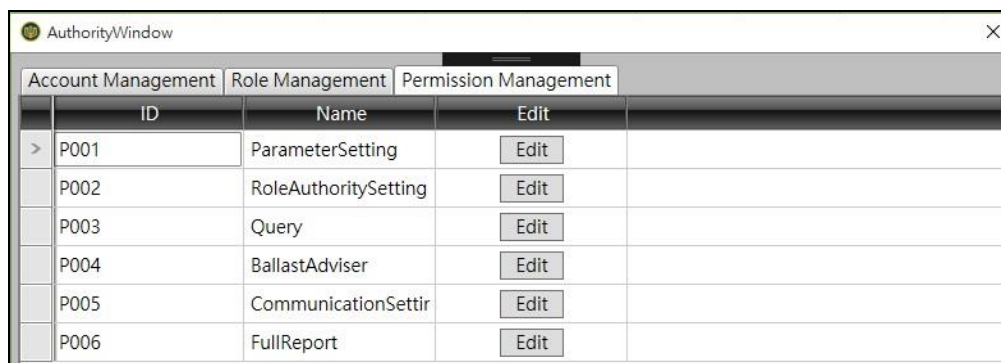
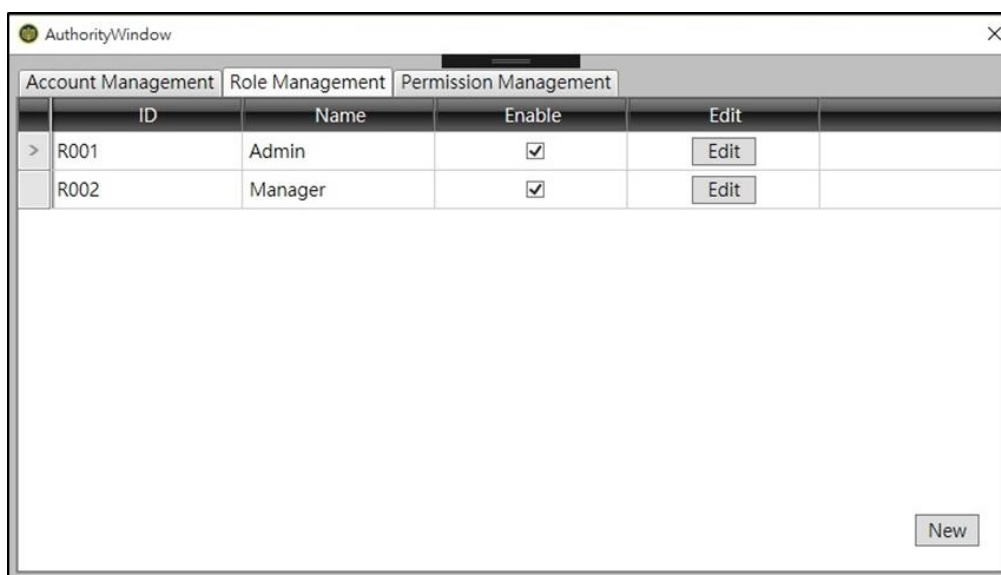
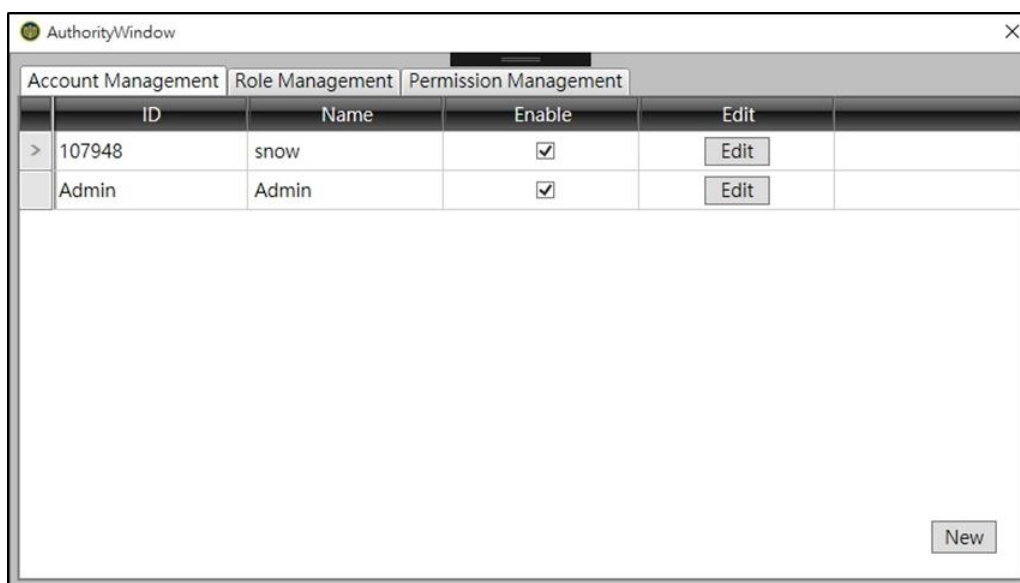


4.1 權限管理(Authority)

4.1 Authority

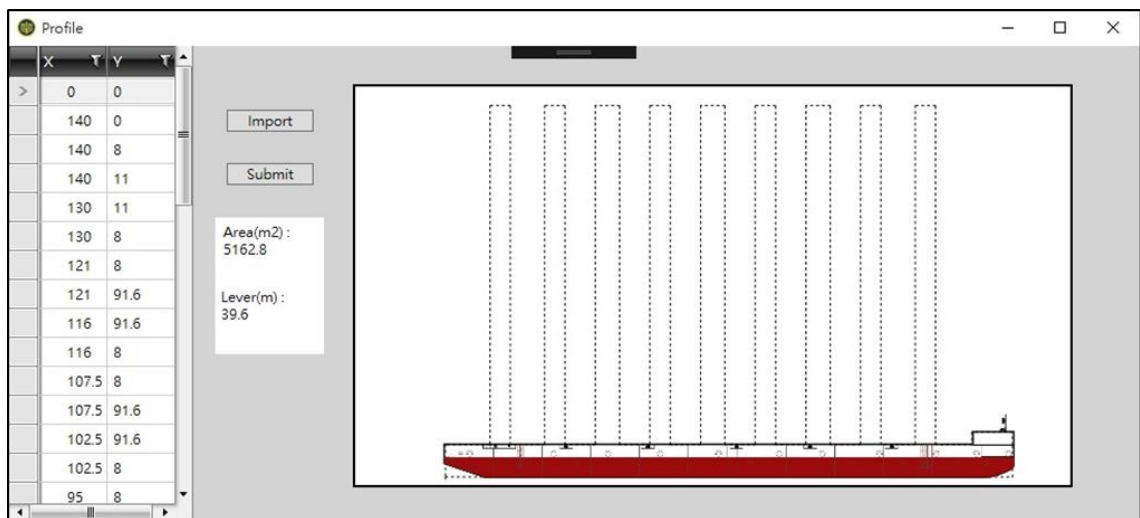
A. 選擇「Setting」功能表

- B. 選擇「Authority」項目，將會跳出「AuthorityWindow」視窗
- C. 輸入帳號密碼，驗證通過會出現管理介面
- D. 可管理三個部分：



4.2 受風面積(Windage Area Profile)

- A. 選擇「System」功能表
- B. 選擇「Profile」，將會跳出「Profile」視窗
- C. 點選 Import 匯入側視圖 X, Y 的資料(.csv)後，可於右方視窗中確認其形狀(虛線)、面積及垂向重心，若確認無誤後點下 Submit 可將匯入的資料儲存，儲存後進行船舶穩度計算時即會將其納入計算。



研發成果及未來發展：

1. 以往裝載電腦需仰賴國外廠商供應，定價高昂且品質不穩定，服務工程師到場安裝、維護或是需求調整上的間接費用更是不小的成本，取得認證的裝載電腦，可實現自供，解決以上問題，極度降低人事及額外衍生的

成本。

2. 除了實現自供外，亦可以供應國內其他船廠，有鑑於以往仰賴國外供應得以上缺點，不只是本公司的遭遇，若提供比起相對於國外更划算的價格與服務，相信會更傾向與本公司購買，實為雙贏。

3. LoadingExpert 是目前市面上幾乎僅有支持對於自動調水演算功能以及控制介接的裝載電腦，是國際市場上極具競爭優勢的產品，未來發展不言而喻。