Αρ. Πιστοποιητικού: 2323.6-5/01/19
Certificate No.: 2323.6-5/01/19

ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΥΠΟΥΡΓΕΙΟ ΝΑΥΤΙΛΙΑΣ ΚΑΙ ΝΗΣΙΩΤΙΚΗΣ ΠΟΛΙΤΙΚΗΣ
ΑΡΧΗΓΕΙΟ ΛΙΜΕΝΙΚΟΥ ΣΩΜΑΤΟΣ – ΕΛΛΗΝΙΚΗΣ ΑΚΤΟΦΥΛΑΚΗΣ
ΚΛΑΔΟΣ ΕΛΕΓΧΟΥ ΠΛΟΙΩΝ
ΔΙΕΥΘΥΝΣΗ ΜΕΛΕΤΩΝ ΚΑΙ ΚΑΤΑΣΚΕΥΩΝ ΠΛΟΙΩΝ

HELLENIC REPUBLIC
MINISTRY OF MARITIME AFFAIRS AND INSULAR POLICY
HELLENIC COAST GUARD HEADQUARTERS
SHIPS' INSPECTION GENERAL DIRECTORATE
SHIPS' DESIGN AND CONSTRUCTION DIRECTORATE

ΠΙΣΤΟΠΟΙΗΤΙΚΟ ΕΓΚΡΙΣΗΣ ΤΥΠΟΥ
ΓΙΑ ΤΟ ΣΥΣΤΗΜΑ ΔΙΑΧΕΙΡΙΣΗΣ ΘΑΛΑΣΣΙΟΥ ΕΡΜΑΤΟΣ ERMA FIRST

TYPE APPROVAL CERTIFICATE
OF THE ERMA FIRST BALLAST WATER MANAGEMENT SYSTEM

Το παρόν πιστοποιεί ότι το παρακάτω σύστημα διαχείρισης θαλασσίου έρματος έχει εξεταστεί και δοκιμαστεί σύμφωνα με τις απαιτήσεις των προδιαγραφών που περιέχονται στις Οδηγίες που περιέχονται στα ψηφίσματα του IMO MEPC 279 (70) και MEPC 169 (57). Το παρόν πιστοποιητικό ισχύει μόνο για το σύστημα διαχείρισης θαλασσίου έρματος που αναφέρεται παρακάτω.

This is to certify that the ballast water management system listed below has been examined and tested in accordance with the requirements of the specifications contained in the Guidelines contained in IMO resolutions MEPC 279 (70) and MEPC 169 (57). This certificate is valid only for the ballast water management system referred to below.

Όνομα του Συστήματος Διαχείρισης Θαλασσίου Έρματος: ***ERMA FIRST BWTS***
Name of Ballast Water Management System: **ERMA FIRST BWTS**

Το Σύστημα διαχείρισης θαλασσίου έρματος είναι κατασκευασμένο από: ***ERMA FIRST ESK ENGINEERING SOLUTIONS A.E,***
Ballast water management System manufactured by: **ERMA FIRST ESK ENGINEERING SOLUTIONS S.A.,**

Υπό τον προσδιορισμό και τύπου και μοντέλου: ***ERMA FIRST BWTS,*** *μοντέλο* ***FIT 75-3000*** *(ως Πίνακας 2)*
Under type and model designation (s): **ERMA FIRST BWTS,** model **FIT 75-3000** (as Table 2)
και συμπεριλαμβάνονται:
and incorporating:

Σχέδιο εξοπλισμού / συναρμολόγησης No:
To equipment / assembly drawing No.:
ERMA FIRST BWTS FIT 75-3000 / 2-801-G-01, date /ημερομηνία 02-04-2019.

Λοιπό εξοπλισμό κατασκευασμένο από: τις Filtrex (Italy), Filtersafe (Israel) και Hydac (Germany)
Other equipment manufactured by: Filtrex (Italy), Filtersafe (Israel) and Hydac (Germany)

με εξοπλισμό /αριθμό σχεδίου συναρμολόγησης:
to equipment/assembly drawing No.:
ERMA FIRST BWTS FIT 75-3000 / 2-801-G-01, date / ημερομηνία 02-04-2019.

Ονομαστική Χωρητικότητα επεξεργασίας (m^3/h) *90-3740 για ERMA FIRST BWTS FIT 75-3000.*
Treatment rated capacity (m^3/h) 90-3740 for ERMA FIRST BWTS FIT 75-3000.

Ένα αντίγραφο αυτού του Πιστοποιητικού Έγκρισης Τύπου πρέπει να φέρεται σε κάθε πλοίο που έχει εγκατεστημένο αυτό το σύστημα επεξεργασίας θαλασσίου έρματος. Μία αναφορά στο πρωτόκολλο δοκιμής και ένα αντίγραφο των αποτελεσμάτων δοκιμών πρέπει να είναι διαθέσιμα για έλεγχο επί του πλοίου.
A copy of this Type Approval Certificate should be carried on board a ship fitted with this Ballast Water Management System. A reference to the test protocol and a copy of the test results should be available for inspection on board the ship.

Οι Περιορισμοί Συνθηκών Λειτουργίας περιγράφονται στο παρόν έγγραφο στον Πίνακα 1.
(Θερμοκρασία / Πυκνότητα άλατος): Δεν υπάρχει περιορισμός /Δεν υπάρχει περιορισμός
Limiting Operating Conditions imposed are described in this document in Table 1.
(Temperature / Salinity): Not Applicable / Not Applicable

Άλλοι περιορισμοί που επιβάλλονται περιλαμβάνουν τα ακόλουθα, όπως περιγράφονται στον Πίνακα 4 του παρόντος εγγράφου.
Other restrictions imposed include the following as described in Table 4 of this document.

Αυτός ο εξοπλισμός έχει σχεδιαστεί για λειτουργία στις ακόλουθες συνθήκες όπως περιγράφεται στον Πίνακα 3 του παρόντος εγγράφου.
This equipment has been designed for operation in the following conditions as described in Table 3 of this document (System Design Limitations).

Ο Διευθυντής
The Director

Σπυρίδων Σκαβάρας
Spyridon Skavaras

Έκδοση στις 27 Ιουνίου 2019 / Issued this 27th day of June 2019

Ημερομηνία λήξης στις 26 Ιουνίου 2024 / Valid until the 26th day of June 2024

Περιέχεται αντίγραφο των πρωτότυπων αποτελεσμάτων των δοκιμών.
Enc. copy of the original test results.

Προσάρτημα
Appendix

1 Περιορισμοί Λειτουργικών Συνθηκών : Αναφορά στον Πίνακα 1

1 Limiting Operating Conditions: Refer to Table 1

Πίνακας 1. Περιορισμοί Λειτουργικών Συνθηκών

Table 1. Limiting Operating Conditions

ERMA FIRST BWTS περιορισμοί ERMA FIRST BWTS limitations	Model FIT 75-FIT 3000
Περιορισμοί εφαρμογής Application limitations	*Δυνατότητα ονομαστικής παροχής ηλεκτρολυτικών κελιών:* Treated rated capacity of electrolyzers: ECF100, ECF100Ex: μέχρι 100 m^3/h ECF250, ECF250Ex: μέχρι 300 m^3/h ECF500, ECF500Ex: up to 600 m^3/h ECF750, ECF750Ex: up to 800 m^3/h ECF1000, ECF1000Ex: up to 1250 m^3/h *Βαθμός Φίλτρανσης: 40 microns* Filtration grade: 40 microns *Δυνατότητα ονομαστικής παροχής φιλτρων: 20-3740m^3/h* Nominal rated capacity of filters: 20-3740m^3/h
Ελάχιστη αλατότητα συστήματος Minimum Salinity Condition	Δεν υπάρχει/Not applicable
Ελάχιστη θερμοκρασία νερού ηλεκτρολυτικού κελιού Minimum water temperature in reactor	-2 degC – 55deg C
Ελάχιστη αγωγιμότητα/αλατότητα ηλεκτρολυτικού κελιού Minimum conductivity / Salinity in reactor	>1050 μS/cm (0.9 psu at 3degC or 1.07 psu at -2 degC)
Ελάχιστος Χρόνος Παραμονής/ Holding Time	Δεν υπάρχει/Not applicable
Πίεση Λειτουργίας Συστήματος Pressure System	<6 bar
Δόση Χλωρίου ως TRO Total Residual Oxidant (TRO)	6 mg/l
Μέγιστη Επιτρεπτή Δόση Χλωρίου Maximum Allowable Dosages of Active Substances	10 mg/l
Πίεση εισόδου στο φίλτρο κατά τον καθαρισμό (FILTERSAFE) Filter inlet pressure during flushing (FILTERSAFE)	1.6 Bar
Πίεση εισόδου στο φίλτρο κατά τον καθαρισμό (FILTREX Filter inlet pressure during flushing (FILTREX)	1.5 Bar
Πίεση εισόδου στο φίλτρο κατά τον καθαρισμό (HYDAC) Filter Inlet pressure during flushing (HYDAC)	1.5 Bar

2 Λίστα πιστοποιημένων τύπων ERMA FIRST BWTS: Αναφορά στον Πίνακα 2
2 List of certified ERMA FIRST BWTS: Refer to Table 2

Πίνακας 2. Λίστα πιστοποιημένων επιπλέον τύπων ERMA FIRST BWTS FIT 75-3000
Table 2. List of certified additional ERMA FIRST BWTS FIT 75-3000

Μοντέλο Model[2,3]	**Ονομαστική Παροχή Capacity (m^3/h)**	**FILTER SAFE model [4]**	**FILTREX model**	**HYDAC model**	**EC Reactor**	**Recommended Neutralizing Medium (L)[1]**
FIT75	20-90	BS-031 H/V	ACB-906-100	RF14-10	ECF100/1	25
		BS-050H/V				
FIT100	20-140	BS-050H/V	ACB-910-150	RF14-10	ECF100/1	25
		BS-031H/V				
FIT200	40-200	BS-061H/V-T	ACB-935-200	RF14-15	ECF250/1	200
		BS-070H/V				
FIT300	60-300	BS-101H/V	ACB-945-200	RF14-20	ECF250/1	200
		BS-101H/V-T	ACB-935-200			
		BS-100H/V				
		BS-100H/V-T				
FIT400	80-515	BS-151H/V	ACB-955-250	RF14-25	ECF500/1	200
		BS-151H/V-T		RF14-20 Δ-Mesh		
		BS-150H/V				
		BS-150H/V-T				
FIT600	120-600	BS-201H/V	ACB-985-300	RF14-25	ECF500/1	200
		BS-201H/V-T				
		BS-200H/V				
		BS-200H/V-T				
FIT800	160-800	BS-300H/V	ACB-999-350	RF14-30	ECF750/1	200
		BS-300H/V-T		RF14-30 Δ-Mesh		
FIT1000	200-1200	BS-300H/V-T	ACB-999-350	RF14-35	ECF1000/1	200
		BS-400H/V		RF14-30 Δ-Mesh		
				RF14-35 Δ-Mesh		
FIT1200	200-1250	BS-400H/V	ACB-9100-400	RF14-40	ECF1000/1	200
		BS-400H/V-T	2xACB-985-300	RF14-35 Δ-Mesh		
FIT1500	160-1600	BS-603H/V	ACB-9100-400	RF14-45	ECF750/2	200
		BS-400H/V-T	2xACB-985-300	RF14-40 Δ-Mesh		
FIT2000	200-2300	BS-603H/V-T	ACB-9120-500	RF14-50	ECF1000/2	200
		BS-804H/V	2xACB-999-350	RF14-45 Δ-Mesh		
		BS-804H/V-T		RF14-50Δ-Mesh		
FIT2500	200-2500	BS-804H/V-T	ACB-9200-600	RF14-60	ECF1000/2	200
		BS-1004H/V	3xACB-999-350	RF14-50 Δ-Mesh		
		BS-1004H/V-T				
FIT3000	200-3740	BS-1004H/V-T	ACB-9200-600	RF14-60 Δ-Mesh	ECF1000/3	200
		BS-1204H/V-T	3xACB-999-350	RF14-60		
		BS-1204H/V				

Σημειώσεις / Notes

1. *Η ποσότητα του μέσου είναι ανάλογη με τις απαιτήσεις του εκάστοτε πλοίου και μπορεί να αυξηθεί ή να μειωθεί. Ο ελάχιστος όγκος είναι 25 L.* / Volume is subject to the capacity pattern of vessel's route and maybe increased or decreased. In any case it could not be less than 25 L.

2. *Όλα τα μοντέλα παρέχονται και για εγκατάσταση σε επικίνδυνη ζώνη.* / Ex models are applicable as above.

3. *Πολλαπλά μοντέλα μπορούν να χρησιμοποιηθούν για μεγαλύτερες παροχές, πχ 2 x ERMA FIRST BWTS FIT 3000.* / Multiple Models can be used to provide higher flow rates. For example 2 x ERMA FIRST BWTS FIT 3000.

4. *Ο τύπος των Φίλτρων της FILTERSAFE μπορεί να ακολουθηθεί και από ένα επιπλέον γράμμα, πχ Ε που σχετίζεται με τον προσανατολισμό των σημείων εισόδου, εξόδου και καθαρισμού και κάθε μοντέλο μπορεί να αναγράφεται ως BS-#### Ε αντί για BS-#### H/V.* / FILTERSAFE Models type name may be followed by additional letter eg E that indicates orientation and each model can be BS-#### E instead of BS-#### H/V.

Περιορισμοί Σχεδιασμού Συστήματος ERMA FIRST BWTS FIT όπως ορίζεται στο 7.1.6 του Annex 5 MEPC. 279 (70)

System Design Limitations of ERMA FIRST BWTS FIT as per 7.1.6 of Annex 5 MEPC. 279 (70)

Η αξιολόγηση περιορισμού σχεδιασμού συστήματος ήταν ήδη μέρος των προϋποθέσεων για την έκδοση του προηγούμενου Πιστοποιητικού Έγκρισης Τύπου 2323.6-5-01-18 με τις παραμέτρους της θερμοκρασίας και της αλατότητας. Πρόσθετα στοιχεία σύμφωνα με τα τελευταία έγγραφα του IMO παραδόθηκαν. Οι πληροφορίες σχετικά με τους περιορισμούς σχεδιασμού συστήματος πρώτης εγκατάστασης ERMA, συμπεριλαμβάνουν τα εξής:
1 αναγνώριση όλων των γνωστών παραμέτρων στις οποίες είναι ευαίσθητη η σχεδίαση του BWMS,
2. για κάθε παράμετρο, ο κατασκευαστής απαιτεί χαμηλή ή / και υψηλή τιμή για την οποία το BWMS μπορεί να επιτύχει πρότυπα απόδοσης του κανονισμού D-2, και
3 η προτεινόμενη μέθοδος για την επικύρωση κάθε απαιτούμενου περιορισμού του σχεδιασμού του συστήματος θα πρέπει να καθορίζεται, περιλαμβάνοντας πληροφορίες σχετικά με την πηγή, την καταλληλόλητα και την αξιοπιστία της μεθόδου.

The system design limitation evaluation was already part of conditions for the issuance of the previous Type Approval Certificate 2323.6-5-01-18 with the parameters of temperature and salinity. Additional data as per latest IMO documents were delivered.
The information regarding ERMA FIRST System Design Limitations include:
.1 the identification of all known parameters to which the design of the BWMS is sensitive;
.2 for each parameter the manufacturer should claim a low and/or a high value for which the BWMS can achieve performance standard of regulation D-2; and
.3 the proposed method for validating each claimed system design limitation should be set out, together with information on the source, suitability and reliability of the method;

Πίνακας 3. Περιορισμοί Σχεδιασμού Συστήματος
Table 3. ERMA FIRST System Design Limitations

System Design Limitation	Claim	Potential control and monitoring parameters associated with SDL	ERMA FIRST Reference
Salinity	Nil	Online Marine Sensor in the ERMA FIRST system	SMD sensor
Salinity	3psu	Online Marine Sensor in the ERMA FIRST system In case of a shipowner request that operates exclusively in areas above 3PSU	SMD sensor ERMA FIRST Scope of Supply can be amended accordingly to accommodate the Reduced installed power, Fresh water plug -in omission
Temperature	Nil	Online Marine Sensor in the ERMA FIRST system	T sensor
Hold Time	Nil	Integrated sample at least 1m3 was taken from the treated water immediately after treatment Tt0, but prior to storage in the tanks Fulfills 2.45 of the Annex and provides compliance with the D2 Standard	1606 v2.0 TQAP_LB ERMA FIRST P0021 1714 v1.2 TQAP ERMA Alternate filter 1818 v1.0 TQAP EF filter IMO-ETV As per MEA Test Protocol, Samples were taken from the treated water immediately after treatment (Tt0)
Electrolyte feed temperature	>-2 degC	Online Marine Sensor in the ERMA FIRST system	EFTF-LOWSAL-COND-00
Electrolyte feed salinity (minimum)	> 0.9 psu	Online Marine Sensor in the ERMA FIRST system In 2015, ERMA FIRST conducted tests in MEA , Netherlands. Freshwater was 0.9 psu and was	Report 141110 MEA 2014, ERMA FIRST Final Land Based Testing Recommendation to have a more frequent SOP Rector Deposit Removal

		proved that D2 standard was achieved.	as per 1980-G-03 when vessel is operating continuously under Fresh water conditions as listed in the OMSM
Filter Operating Pressure (with/without sunction pump)	Filtersafe: 1.6-6 Bar Filtrex : 1.5-6 Bar Hydac: 1.5-6 Bar	ERMA FIRST did a thorough Design Study that was part of the IMO/USCG submitted Documentation.	00065C.17.05 Design Study of ERMA FIRST BWTS FIT Filters (03 April 2019)
TRO	6-10 mg/l	Online Marine Sensor in the ERMA FIRST system As per ERMA FIRST Final Approval, Maximum Allowable Dose Concentration is 10 mg/l. In the USCG and IMO type approval, the Dose for effective D2 compliance was achieved with 6 mg/l	Online Marine Sensor in the ERMA FIRST system
Total Residual Oxidant	2 mg/l	As per ERMA FIRST Operation with Hydac Configuration, it was demonstrated that this limit was sufficient to the D-2 Standard	Report MEA 2019, Land based BE Verification IMO/USCG land based type approval FIT 300 (Hydac)

Άλλοι Περιορισμοί που επιβάλλονται από την Αρχή όπως ορίζεται στο 7.1.7 του Annex 5 MEPC.279 (70)
Other Restrictions Imposed by the Administration as per 7.1.7 of Annex 5 MEPC. 279 (70)

Πίνακας 4. Άλλοι Περιορισμοί που επιβάλλονται από την Αρχή
Table 4. Other restrictions imposed by Administration

Hydrogen By-product Assessment	Hydrogen is a by-product of the ERMA FIRST FIT treatment process. The risk of Hydrogen accumulation and formation of potential explosive atmosphere is addressed in every ship specific installation with the ERMA FIRST theoretical hydrogen calculation model as per *975.Project No.* ERMA FIRST Documentation. These theoretical Hydrogen Model Calculations are part of the Appendix in every OMSM.

Αναφορά στα πρωτόκολλα δοκιμών που ακολουθήθηκαν όπως ορίζεται στο 7.1.3 του Annex 5 MEPC. 279 (70)
Reference to the full performance test protocol on which it is based as per 7.1.3 of Annex 5 MEPC. 279 (70)

❑ 1606 v2.0_Test protocol (TQAP) for BE Verification testing ERMA FIRST, MEA Jun 2016; Project:P0021 (This TQAP is assessed in combination with MEA 1911 v1.0 Report)
❑ 1714 v1.2_Test protocol (TQAP) for BE Verification testing ERMA FIRST Alternate filter, May 2017; Project: P0048 (This TQAP is assessed in combination with MEA 1911 v1.0 Report)
❑ 1818 v1.0_Test protocol (TQAP) for BE Verification testing ERMA FIRST Alternate filter, May 2017; Project: P0048
❑ NSF IL Shipboard Test Plan_ERMA FIRST FIT 1000 BWMS_v2_FINAL_SIGNED

3 Αποτελέσματα δοκιμών
3. Test results

3.1 Δοκιμές στη ξηρά
3.1 Land based testing

The ERMA FIRST BWTS FIT 300 of ERMA FIRST ESK Engineering Solutions SA was tested at the test facility of MEA-nl BV from 2016-2019 for IMO and/USCG Regime.

In the period from June 7th 2016 to September 22nd 2017, one commissioning and 20 verification test runs were performed with the first Filter, FILTERSAFE BS.
Test results of the BWTS with primary filter FILTERSAFE BS are included in MEA Test Report 1703.
The project comprised all three salinity regimes as defined in MEPC. 279 (70) /USCG 46 CFR. Eventually seven marine, seven brackish and six freshwater test runs were performed. There were no technical failures of the BWTS during the project.

Table 5. Validation Matrix of ERMA FIRST BWTS FIT with FILTERSAFE for Marine (M), Brackish (B) and Freshwater

Criterion	PI	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX
Challenge water	M	M	M	M	M	M	M	M	B	B	B	B	B	F	F	F	F	F	B	B	F
Ballasting flowrate	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Holding time	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Processed volume	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Stored volume	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Organisms > 50 abundance	√	√	√	√	E	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Organisms > 50 diversity	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Organisms 10 – 50 abundance	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Organisms 10 – 50 diversity	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Organisms < 10 abundance	√	E	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
BWDS	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Salinity	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
DOM (as DOC)	√	√	√	√	√	√	√	√	√	√	E	E	√	√	√	√	√	√	√	√	√
POM	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
POC	√	√	E	E	E	E	√	√	√	√	E	E	√	√	√	√	√	√	√	√	√
MM	√	√	√	√	√	√	√	√	√	√	E	E	√	√	√	√	√	√	√	√	√
TSS	√	√	E	E	E	E	√	√	√	√	E	E	√	E	E	E	E	E	√	√	√
Temperature	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

Notes

Symbol (√) refers to successful treatement test cycle as per Section 4.7

Symbol (E) refers to Tests that are rendering successful treatement test cycle as per Section 4.7 with equivalent and appropriate proof as per MEA Report 1911

1. In Test Run III, Stored ballast water volume was below 200 m3 due to operational issues of the barge during the test

The ERMA FIRST BWTS FIT 300 was additionally tested with an alternate filter FILTREX ACB in the period from 29.05.2017 to 27.05.2018 also at MEA-nl BV.
The system remained installed and no changes were made except change over from FILTERSAFE BS to FILTREX ACB filter. The project comprised three tests at three different salinities as per Equivalent Test Protocol for the Second Option of Filter Device.
Test runs were carried out as defined in the MEA Test Report 1721

Table 6: Validation Matrix of ERMA FIRST BWTS FIT with Filtrex for Marine (M), Brackish (B) and Freshwater

Criterion	PI	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Challenge water	B	M	M	M	B	B	B	F	F	F	F	F	M
Ballasting flowrate	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Holding time	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Processed volume	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Stored volume	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Organisms > 50 abundance	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Organisms > 50 diversity	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Organisms 10 – 50 abundance	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Organisms 10 – 50 diversity	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Organisms < 10 abundance	√	√	√	√	√	√	√	1)	1)	√	√	√	√
BWDS	√	√	√	√	√	√	√	1)	1)	√	√	√	√
Salinity	√	√	√	√	√	√	√	1)	1)	√	√	√	√
DOM (as DOC)	√	E	√	√	√	√	√	1)	1)	√	√	√	√
POM	√	√	√	√	√	√	√	1)	1)	√	√	√	√
POC	√	E	√	√	√	√	√	1)	1)	√	√	√	√
MM	√	√	√	√	√	√	√	1)	1)	√	√	√	√
TSS	E	√	√	√	√	√	√	1)	1)	E	E	E	E
Temperature	√	√	√	√	√	√	√	1)	1)	√	√	√	√

Notes

Symbol (√) refer to successful treatement test cycle as per Section 4.7

Symbol (E) refers to Tests that are rendering successful treatement test cycle as per Section 4.7 with equivalent and appropriate proof as per MEA Report 1911

1) Test runs VII and VIII were invalid due to open by-pass valve (NCR2017-16)

The ERMA FIRST BWTS FIT 300 was additionally tested with a second alternate filter HYDAC RF14 in the period from 25.07.2018 to 30.05.2019 also at MEA-nl BV.

The system remained installed and no changes were made except change over from FILTERSAFE BS to HYDAC RF14 filter. The project comprised three tests at three different salinities as per Equivalent Test Protocol for the third Option of Filter Device.

Test runs were carried out as defined in the MEA Test Report 1818

Table 7. Validation Matrix of ERMA FIRST BWTS FIT with Hydac Validation Matrix for Marine (M), Brackish (B) and Freshwater

Criterion	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**
Challenge water	M	M	M	F	F	F	F	F	F	F	B	B	B	B	B
Ballasting flowrate	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Holding time	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Processed volume	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Stored volume	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Organisms > 50 abundance	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Organisms > 50 diversity	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Organisms 10 – 50 abundance	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Organisms 10 – 50 diversity	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Organisms < 10 abundance	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
BWDS	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Salinity	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
DOM (as DOC)	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
POM	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
POC	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
MM	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
TSS	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√
Temperature	√	√	√	1)	1)	1)	√	2)	√	√	3)	√	√	3)	√

Notes

Symbol (√) refer to successful treatement test cycle as per Section 4.7

Symbol (E) refers to Tests that are rendering successful treatement test cycle as per Section 4.7 with equivalent and appropriate proof as per MEA Report 1911

1) Test runs IV, V and VI were invalid due to malfunctioning of the BWTS. In that respect, one servicing event occurred on 04.09.2018 at the presence of representatives from BWTS and Filter manufacturers and Lloyd's Register surveyor

2) Test run VIII was invalid due to insufficient salt water supply caused by testing facility logistics

3) Salinity was not within the Brackish water regime

4) Test runs XI and XIV were invalid as test conditions could not met. The salinity of the challenge water was not as required for the brackish water regime

The BE tests do not show any significant difference of operational parameters between the ERMA FIRST BWTS with primary filter, FILTERSAFE BS, and with alternate filter, HYDAC RF14

3.1.1 Results of Biological data

3.1.1.1 Land based testing biological Efficacy

Sampling times, volumes and flow rates for both filters were in accordance with MEPC.279. (70). For both test rows the same sampling procedures and data analysis have been applied as described in Land Based Tests Reports.

This section includes the biological efficacy results of Biological data.

Table 8. Number of organisms larger than 50 micron per cubic meter counted during marine water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	187,000	84,333	n.a.	0.0	1.33	n.a.
II	147,611	80,667	n.a.	0.0	0.0	n.a.
III			n.a.	0.0	0.0	n.a.
IV	190,667	142,167	n.a.	0.0	2.1	n.a.
V			n.a.	0.0	1.3	n.a.
VI	150,111	80,667	n.a.	0.0	1.1	n.a.
VII			n.a.	0.0	0.0	n.a.
XX	136,000	97,667	n.a.	0.0	0.0	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	108,167	25,167	n.a.	0	0.3	n.a.
II	111,167	20,333	n.a.	0	1.9	n.a.
III			n.a.	0	1.6	n.a.
XI	106,000	102,833	n.a.	0	0.8	n.a.
ERMA FIRST FIT with HYDAC						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	176,667	175,667	146,333	0.0	0.0	0.0
II	151,333	63,500	73,667	0.3	0.0	0.0
III				0.0	1.9	n.a.

Table 9. Number of organisms larger than 50 micron per cubic meter counted during brackish water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VIII	502,611	502,611	n.a.	0.0	2.4	n.a.
IX			n.a.	0.0	2.7	n.a.
X	138,667	35,000	n.a.	0.0	0.0	n.a.
XI			n.a.	0.0	1.1	n.a.
XII	225,944	149,333	n.a.	0.8	1.1	n.a.
XVIII	97,667	46,500	n.a.	0.0	0.3	n.a.
XIX			n.a.	0.0	0.3	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	99,333	121,500	n.a.	0	0	n.a.
V	174,833	91,500	n.a.	0	0.3	n.a.
VI			n.a.	0	0.8	n.a.
ERMA FIRST FIT with HYDAC						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XII	208,389	133,333	n.a.	n.a.	0.0	n.a.
XIII	99,667	67,333	150,333	0.0	0.0	0.0
XIV	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XV	136,500	33,278	168,000	0.0	0.3	2.7

Table 10. Number of organisms larger than 50 micron per cubic meter counted during fresh water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XIII	291,167	304,667	n.a.	0.0	0.0	n.a.
XIV			n.a.	0.0	0.5	n.a.
XV	355,167	342,667	n.a.	0.0	0.3	n.a.
XVI			n.a.	0.0	1.1	n.a.
XVII	204,333	215,333	n.a.	0.0	0.3	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VIII			n.a.	n.a.	n.a.	n.a.
IX	127,167	132,667	n.a.	0	1.33	n.a.
X			n.a.	0	1.07	n.a.
XI	135,500	150,667	n.a.	0	0	n.a.
ERMA FIRST FIT with HYDAC						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	506,111	179,000	n.a.	84	>10	n.a.
V	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VII	213,111	175,222	83,111	0	0	0
VIII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IX	129,500	81,167	36,667	0	1	0
X			n.a.	0	4	n.a.

Table 11. Number of organisms in the size-class 10 - 50 micron per mL counted during marine water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	3,317	3,812	n.a.	0.0	0.0	n.a.
II	6,447	6,845	n.a.	0.0	0.0	n.a.
III		7,050	n.a.	0.0	0.4	n.a.
IV	4,033	6,203	n.a.	0.0	0.0	n.a.
V			n.a.	0.0	0.0	n.a.
VI	3,850	4,113	n.a.	0.0	0.0	n.a.
VII			n.a.	0.0	0.4	n.a.
XX	3,050	2,980	n.a.	0.0	0.0	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	4,503	3,313	n.a.	0.0	0.0	n.a.
II	6,080	3,527	n.a.	0.0	0.0	n.a.
III			n.a.	0.0	0.0	n.a.
XI	2,720	4,840	n.a.	0	0	n.a.
ERMA FIRST FIT with HYDAC						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	2,140	2,067	1,607	0.0	0.0	2.5
II	1,363	4,350	1,037	0.0	0.0	0.0
III				0.0	0.0	n.a.

Table 12. Number of organisms in the size-class 10 - 50 micron per mL counted during brackish water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VIII	4,017	3,690	n.a.	0.0	0.0	n.a.
IX			n.a.	0.0	0.0	n.a.
X	2,480	4,810	n.a.	0.0	0.0	n.a.
XI			n.a.	0.0	0.0	n.a.
XII	4,263	3,917	n.a.	0.0	0.0	n.a.
XVIII	4,693	6,453	n.a.	0.0	0.4	n.a.
XIX			n.a.	0.0	0.0	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	9,810	5,157	n.a.	0.0	0.0	n.a.
V	10,050	4,007	n.a.	0.0	0.0	n.a.
VI			n.a.	0.0	0.0	n.a.
ERMA FIRST FIT with HYDAC						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XII	4,500	3,950	n.a.	0.0	0.0	n.a.
XIII	3,683	4,323	2,960	2,5	0.4	0.0
XIV	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XV	3,243	2,177	1,210	0.0	0.0	0.0

Table 13. Number of organisms in the size-class 10 - 50 micron per mL counted during fresh water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XIII	3,333	2,077	n.a.	0.0	0.0	n.a.
XIV			n.a.	0.0	0.0	n.a.
XV	4,520	3,223	n.a.	3.8	0.0	n.a.
XVI			n.a.	3.8	0.0	n.a.
XVII	7,750	6,127	n.a.	0.0	0.0	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VIII			n.a.	n.a.	n.a.	n.a.
IX	1,090	1,147	n.a.	0.0	0.0	n.a.
X			n.a.	0.0	0.0	n.a.
XI	1,227	990	n.a.	0.0	0.0	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	1,953	2,730	n.a.	0.8	2.1	n.a.
V	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VII	4,017	2,163	2,880	2.1	0.0	0.0
VIII	n.a.	n.a.	n.a	n.a.	n.a.	n.a.
IX	2,680	2,560	2,120	0.4	3.3	1.7
X	2,680	2,560	n.a.	5.0	2.9	n.a

Table 14. Number of colony forming units (CFU) of heterotrophic bacteria per mL for marine water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	3,193	13,667	n.a.	< 7	843	n.a.
II	2,300	12,900	n.a.	< 7	500	n.a.
III			n.a.	< 7	550	n.a.
IV	< 7 - 1,000	63,000	n.a.	10	577	n.a.
V			n.a.	1,900	1,673	n.a.
VI	5,567	67,667	n.a.	<7	787	n.a.
VII			n.a.	<7	560	n.a.
XX	3,733	14,667	n.a.	27	1,537	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	643	>1,000	n.a.	<1	308	n.a.
II	3,600	95,000	n.a.	<7	1,123	n.a.
III			n.a.	280	557	n.a.
XI	1,076	1,733	n.a.	11,000	4,400	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	6,033	19,000	26,000	<7	129,667	466,667
II	9,900	18,500	26,000	296	681,667	763,333
III				652	501,667	n.a.

Table 15. Number of colony forming units (CFU) of heterotrophic bacteria per mL for brackish water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VIII	18,800	71,000	n.a.	130	1833	n.a.
IX			n.a.	20	583	n.a.
X	2,900	246,667	n.a.	< 7	957	n.a.
XI			n.a.	< 7	367	n.a.
XII	22,467	933,333	n.a.	20	2,290	n.a.
XVIII	42,000	22,333	n.a.	13	1,800	n.a.
XIX			n.a.	20	1,770	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	9,500	360,000	n.a.	300	121,667	n.a.
V	11,267	153,333	n.a.	150	82,667	n.a.
VI			n.a.	190	3,400	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XII	7,840	13,000	n.a.	322	1.755	n.a.
XIII	14,817	95,833	17,67	45	14,833	>200000
XIV	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XV	11,333	45,500	Ntb	420	6,250	ntb

Table 16. Number of colony forming units (CFU) of heterotrophic bacteria per mL for fresh water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XIII	142,333	170,000	n.a.	< 7	156,667	n.a.
XIV			n.a.	< 7	16,300	n.a.
XV	70,333	420,000	n.a.	10	1,900,000	n.a.
XVI			n.a.	30	543,333	n.a.
XVII	890 - > 1,000	89,667	n.a.	3.0	191,333	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VII			n.a.			n.a.
VIII			n.a.			n.a.
IX	20,333	27,667	n.a.	100	6,100	n.a.
X			n.a.	20	2,167	n.a.
XI	28,000	283,333	n.a.	60	11,167	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	64,000	384,333	n.a.	29	1,150,000	n.a.
V	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VII	18,517	76,333	171,667	41	335,000	710,000
VIII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IX	105,167	88,000	51,833	20	>200,000	500,000
X				<7	68,667	n.a.

Table 17. Number of colony forming units (CFU) of E. coli per 100 mL for marine water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	< 1	< 1	n.a.	< 1	< 1	n.a.
II	< 1 - 2	< 1	n.a.	< 1	< 1	n.a.
III			n.a.	< 1	< 1	n.a.
IV	< 1	< 1 - 2	n.a.	< 1	< 1	n.a.
V			n.a.	< 1	< 1	n.a.
VI	< 1 - 1	< 1	n.a.	< 1	< 1	n.a.
VII			n.a.	< 1	< 1	n.a.
XX	8	2	n.a.	< 1	< 1	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	<1-2	<1	n.a.	<1	<1	n.a.
II	<1	<1	n.a.	<1	<1	n.a.
III			n.a.	<1	<1	n.a.
XI	<1	<1	n.a.	<1	<1	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	21	2	<1	<1	<1	3
II	62	2	6	<1	<1	1
III	62	2	n.a.	<1	<1	n.a.

Table 18. Number of colony forming units (CFU) of E. coli per 100 mL for brackish water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VIII	46	< 1 - 4	n.a.	< 1	< 1	n.a.
IX			n.a.	< 1	< 1	n.a.
X	< 1 - 20	< 1	n.a.	< 1	< 1	n.a.
XI			n.a.	< 1	< 1	n.a.
XII	43	68	n.a.	< 1	< 1	n.a.
XVIII	78	3	n.a.	< 1	< 1	n.a.
XIX			n.a.	< 1	< 1	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	7	<1-2	n.a.	<1	<1	n.a.
V	10	1	n.a.	<1	<1	n.a.
VI			n.a.	<1	<1	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XII	<1	<1	n.a.	<1	<1	n.a.
XIII	13	6	<1	<1	<1	<1
XIV	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XV			<1	<1	<1	<1

Table 19. Number of colony forming units (CFU) of E. coli per 100 mL for fresh water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XIII	383	133	n.a.	< 1	< 1 - 5	n.a.
XIV			n.a.	< 1	< 1 - 40	n.a.
XV	817	110	n.a.	< 1	< 1 - 3	n.a.
XVI			n.a.	< 1	41	n.a.
XVII	333	270	n.a.	< 1	< 1	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VII			n.a.			n.a.
VIII			n.a.			n.a.
IX	2.0	<1	n.a.	<1	<1	n.a.
X			n.a.	<1	<1	n.a.
XI	3.3	2.3	n.a.	<1	<1	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	817	200	n.a.	<1	Out of range	n.a.
V	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VII	63	10	<1	<1	<1	<1
VIII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IX	33	50	168	<1	<1	<1
X	33	50	n.a.	<1	<1	n.a.

Table 20. Number of colony forming units (CFU) of enterococci per 100 mL for marine water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	< 1 - 1	< 1 - 1	n.a.	< 1	4.3	n.a.
II	2.3	< 1 - 1	n.a.	< 1	< 1 - 70	n.a.
III			n.a.	< 1	7.7	n.a.
IV	< 1 - 2	1	n.a.	< 1	< 1	n.a.
V			n.a.	20	< 1 - 10	n.a.
VI	< 1 - 7	< 1 - 8	n.a.	< 1	< 1 - 40	n.a.
VII			n.a.	< 1	< 1 – 2	n.a.
XX	< 1 -26	6	n.a.	< 1	< 1	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	<1	1	n.a.	<1	<1-12	n.a.
II	1	<1	n.a.	<1	<1-1	n.a.
III			n.a.	<1	<1-2	n.a.
XI	<1	<1	n.a.	<1	1	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	4	7		<1	1	11.
II	4	<1	<1	<1	6	13.
III				<1	3	n.a.

Table 21. Number of colony forming units (CFU) of enterococci per 100 mL for brackish water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VIII	5.0	< 1 - 1	n.a.	< 1	< 1	n.a.
IX			n.a.	< 1	< 1	n.a.
X	< 1	< 1 - 1,500	n.a.	< 1	< 1 - 10	n.a.
XI			n.a.	< 1	< 1	n.a.
XII	< 1 - 2	43	n.a.	< 1	< 1 - 6	n.a.
XVIII	134	2	n.a.	< 1	< 1	n.a.
XIX			n.a.	< 1	< 1	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	1	<1-17	n.a.	<1	1	n.a.
V	2	5	n.a.	<1	<1-2	n.a.
VI			n.a.	<1	<1	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XII	0	0	n.a.	0	0	n.a.
XIII	14	1	0	0	0	0
XIV	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XV	1	1	0	0	0	0

Table 22. Number of colony forming units (CFU) of enterococci per 100 mL for fresh water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XIII	< 1 - 210	2.3	n.a.	< 1	< 1 - 2	n.a.
XIV			n.a.	< 1	7.3	n.a.
XV	8.7	11.7	n.a.	< 1	< 1 - 10	n.a.
XVI			n.a.	< 1	3.7	n.a.
XVII	7.3	171.3	n.a.	< 1	< 1 - 10	E
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VIII			n.a.	n.a.	n.a.	n.a.
IX	<1	<1-2	n.a.	<1	<1	n.a.
X			n.a.	<1	<1	n.a.
XI	3.0	2.5	n.a.	<1	6.0	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	142	13	n.a.	<1	1	n.a.
V	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VII	10	5	1	<1	<1	<1
VIII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IX	302	133	3	<1	1	<1
X			n.a.	<1	4	n.a.

Table 23. Number of colony forming units (CFU) of V. cholerae per 100 mL for marine water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	< 1	< 1	n.a.	< 1	< 1	n.a.
II	< 1	< 1	n.a.	< 1	< 1	n.a.
III			n.a.	< 1	< 1	n.a.
IV	< 1	< 1	n.a.	< 1	< 1	n.a.
V			n.a.	< 1	< 1	n.a.
VI	< 1	< 1	n.a.	< 1	< 1	n.a.
VII			n.a.	< 1	< 1	n.a.
XX	< 1	< 1	n.a.	< 1	< 1	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	<1	1	n.a.	<1	<1-12	n.a.
II	1	<1	n.a.	<1	<1-1	n.a.
III			n.a.	<1	<1-2	n.a.
XI	<1	<1*	n.a	<1	<1	n.a
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
I	<1	<1	<1	<1	<1	<1
II	<1	<1	<1	<1	<1	<1
III	<1	<1	<1	<1	<1	n.a.

Table 24. Number of colony forming units (CFU) of V. cholerae per 100 mL for brackish water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VIII	< 1	< 1	n.a	< 1	< 1	n.a
IX			n.a	< 1	< 1	n.a
X	< 1	< 1	n.a	< 1	< 1	n.a
XI			n.a	< 1	< 1	n.a
XII	< 1	< 1	n.a	< 1	< 1	n.a
XVIII	< 1	< 1	n.a	< 1	< 1	n.a
XIX			n.a	< 1	< 1	n.a
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	<1	<1	n.a	<1	<1	n.a
V	<1	<1	n.a	<1	<1	n.a
VI			n.a	<1	<1	n.a
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XI	n.a	n.a	n.a	n.a	n.a	n.a
XII	<1	<1	n.a.	<1	<1	n.a.
XIII	<1	<1	<1	<1	<1	<1
XIV	n.a	n.a	n.a	n.a	n.a	n.a
XV	<1	<1	<1<1		<1	<1

Table 25. Number of colony forming units (CFU) of V. cholerae per 100 mL for fresh water testing

ERMA FIRST FIT with FILTERSAFE BS						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
XIII	< 1	< 1	n.a.	< 1	< 1	n.a.
XIV			n.a.	< 1	< 1	n.a.
XV	< 1	< 1	n.a.	< 1	< 1	n.a.
XVI			n.a.	< 1	< 1	n.a.
XVII	< 1	< 1	n.a.	< 1	< 1	n.a.
ERMA FIRST FIT with FILTREX ACB						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
VII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VIII			n.a.	n.a.	n.a.	n.a.
IX	< 1	< 1	n.a.	< 1	< 1	n.a.
X			n.a.	< 1	< 1	n.a.
XI	< 1	< 1	n.a.	< 1	< 1	n.a.
ERMA FIRST FIT with HYDAC RF14						
Test run	Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
IV	<1	n.a.	n.a.	<1	n.a.	n.a.
V	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
VII	<1	<1	<1	<1	<1	<1
VIII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IX	<1	<1	**	<1	<1	**
X				<1	<1	n.a.

3.1.2 Abiotic Parameters

3.1.2.1 Temperature challenge criteria

Challenge criteria – Temperature [°C]			
ETV 2010	Par. 5.2.1	Intake	4 – 35 °C
BWMS Code	Par. 2.46	Intake	0°C to 40°C

3.1.2.1.1 Temperature – ERMA FIRST BWTS FIT with FILTERSAFE

Table 26. Water temperature [°C] - ERMA FIRST BWTS FIT with FILTERSAFE

Test run		Control-t0	Control-t2	Treated-t0	Treated-t2
Marine	I	17.0	17.3	16.8	17.2
	II	18.3	20.2	18.5	19.8
	III			19.5	20.5
	IV	19.0	18.9	19.0	18.8
	V			19.3	19.0
	VI	18.4	18.3	18.1	18.3
	VII			17.9	19.0
	XX	16.2	15.8	16.6	15.6
Brackish	VIII	19.6	18.6	19.2	18.4
	IX			19.5	18.6
	X	20.8	22.6	21.3	22.2
	XI			22.3	23.1
	XII	21.6	21.0	21.8	21.2
	XVIII	15.8	16.0	16.5	15.4
	XIX			17.0	16.4
Fre	XIII	18.8	18.8	18.5	18.0

	XIV			19.5	19.1
	XV	19.1	20.0	19.5	19.4
	XVI			19.6	20.4
	XVII	20.4	21.4	21.0	20.7

3.1.2.1.2 Temperature - ERMA FIRST BWTS FIT with FILTREX

Table 27. Water temperature [°C] - ERMA FIRST BWTS FIT with FILTREX

Test run		Control-t0	Control-t2	Treated-t0	Treated-t2
Marine	I	18.3	19.1	18.1	18.6
	II	17.3	19.9	17.7	19.3
	III			18.4	20.1
	XI	19.2	22.2	18.6	20.0
Brackish	IV	23.0	22.1	22.9	21.1
	V	22.4	23.8	22.5	22.5
	VI			22.7	23.0
Fresh	VII	8.4	n.a.	8.6	n.a.
	VIII			8.6	n.a.
	IX	9.1	9.1	9.7	8.8
	X			9.1	9.9
	XI	8.2	8.9	8.4	9.3

3.1.2.1.3 Temperature - ERMA FIRST BWTS FIT with HYDAC

Table 28 . Water temperature [°C] - ERMA FIRST BWTS FIT with HYDAC

Test run		Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
Marine	I	25.0	25.8	23.8	24.2	25.0	23.7
	II	22.8	24.2	24.6	22.8	24.4	23.8
	III				24.2	24.7	n.a.
Fresh	IV	23.7	21.7	n.a.	23.6	22.5	n.a.
	V	21.7	n.a.	n.a.	21.5	n.a.	n.a.
	VI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	VII	19.2	18.9	17.8	18.4	18.4	17.6
	VIII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	IX	17.9	17.4	14.6	18.0	16.2	14.2
	X			n.a.	18.2	15.9	n.a.
Brackish	XI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	XII	12.6	12.6	n.a.	12.7	12.9	n.a.
	XIII	14.3	14.1	14.5	14.2	14	14.5
	XIV	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	XV	14.2	15	15.7	14.1	14.7	16

3.1.3 Salinity challenge criteria

Challenge criteria – Salinity [PSU]			
ETV 2010	Par. 5.2.1	Intake	Fresh water: < 1 PSU Brackish water: 10-20 PSU Marine water: 28-36 PSU
BWMS Code	Par. 2.29	Intake	Fresh water: < 1 PSU Brackish water: 10-20 PSU Marine water: 28-36 PSU Tests under adjacent salinity ranges in the above table shall be separated by at least 10 PSU

3.1.3.1 Salinity - ERMA FIRST BWTS FIT with FILTERSAFE

Table 29. Salinity [PSU] measured during testing – Filtersafe filter

Test run		Control-t0	Control-t2	Treated-t0	Treated-t2
Marine	I	28.1	28.1	28.1	28.2
	II	28.1	28.0	28.1	27.7
	III			28.3	27.9
	IV	26.8	26.7	26.6	26.8
	V			27.1	26.8
	VI	27.3	27.7	27.2	27.6
	VII			27.2	27.1
	XX	27.9	28.0	29.9	29.7
Brackish	VIII	20.4	18.2	18.4	17.4
	IX			20.7	20.5
	X	23.1	23.0	23.4	23.1
	XI			15.5	15.2
	XII	14.9	15.0	14.9	15.0
	XVIII	14.4	14.1	14.8	14.6
	XIX			11.6	11.5
Fresh	XIII	0.3	0.3	1.1	1.1
	XIV			1.2	1.2
	XV	0.3	0.3	1.3	1.3
	XVI			1.2	1.2
	XVII	0.3	0.3	1.3	1.4

3.1.3.2 Salinity - ERMA FIRST BWTS FIT with FILTREX

Table 30. Salinity [PSU] measured during testing – Filtrex filter

Test run		Control-t0	Control-t2	Treated-t0	Treated-t2
Marine	I	30.5	30.5	30.8	30.7
	II	30.8	30.4	30.8	30.7
	III			30.8	30.5
	XII	29.7	29.6	29.7	29.8
Brackish	IV	18.8	19.2	11.8	11.9
	V	20.6	20.6	20.3	20.5
	VI			21.2	21.7
Fresh	VII	0.6	n.a.	2.5	n.a.
	VIII			2.0	n.a.
	IX	0.5	0.5	2.0	2.0
	X			1.5	1.5
	XI	0.5	0.5	1.4	1.4

3.1.3.3 Salinity - ERMA FIRST BWTS FIT with Hydac

Table 31. Salinity measured during marine water testing

Test run		Control-t0	Control-t2	Control-t5	Treated-t0	Treated-t2	Treated-t5
Marine	I	31.0	30.8	30.3	30.8	30.6	30.9
	II	31.5	31.5	31.4	31.2	31.0	31.4
	III				31.8	31.5	n.a.
Fresh	IV	0.4	0.5	n.a.	2.0	2.0	n.a.
	V	0.5	n.a.	n.a.	2.5	n.a.	n.a.
	VI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	VII	0.6	0.6	0.6	2.2	2.2	2.2
	VIII	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	IX	0.6	0.6	0.6	2.1	2.2	2.2
	X			n.a.	2.2	2.3	n.a.
Brackish	XI	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	XII	18.5	18.4	n.a.	12.0	12.0	n.a.
	XIII	21.1	18.8	18.9	21.1	18.5	18.6
	XIV	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	XV	18.2	18.6	18.6	17.2	17.6	17.6

3.2 Δοκιμές στη θάλασσα
3.2 Shipboard testing

This Section provides a summary of the GSI Test Report that is under the GSI 2017, Shipboard testing FIT1000 USCG Type Approval; GSI-SB-NSF-IL-TR-ERMA_07APR2017_GSI Signed.
Testing Facility was Great Ships Initiative (GSI) acting under NSF International a USCG-accepted Independent Laboratory (IL) of which the GSI is a sub-laboratory (SL). Performance testing was conducted consistent with USCG regulations for BWMS type approval (46 CFR Chapter I, Part 162, Subpart 162.060, Section 162.060-28), as guaranteed by NSF International, Testing comprised eight BWMS biological efficacy (BE) test cycles (of which five were valid), and 11 months of continuous operational performance monitoring. The testing period was November 2015 through October 2016. The host ship was the *CV IRENES REMEDY* (IMO 9315850), a commercial container vessel operated by Tsakos Columbia of Palaio Faliro-Athens, Greece, in which the BWMS had been installed and was operated in a location and configuration consistent with its final intended use. The *CV IRENES REMEDY*'s master and Tsakos Columbia representatives participated in the GSI shipboard evaluation of the ERMA FIRST FIT 1000 BWMS. GSI implemented all aspects of the empirical performance evaluation tests, and independently reported the test process and findings. The NSF IL provided active oversight of the testing process. Technicians representing the BWMS vendor, ERMA FIRST ESK Engineering Solutions SA of Perama, Greece, were often present for the tests, but did not participate in or interfere with testing activities or decisions. Source water was drawn from diverse ecosystems, i.e., Morocco, Spain, England, France and the USA, per USCG requirements.
In summary, the outcomes of this shipboard evaluation of the ERMA FIRST FIT 1000 BWMS were that:

1) Only the *CV IRENES REMEDY* crew operated the ERMA FIRST BWMS, unless otherwise authorized and documented in advance by the NSF IL.
2) The ship's crew monitored and recorded details, summarized in Section 4 of Ship-Board test report, of the BWMS operational performance, including usage of consumables, any operational discrepancies from the BWMS's Operation, Maintenance and Safety Manual, any scheduled and unscheduled maintenance, and any other relevant information.
3) Source water locations for the valid test cycles represented several distinct marine ecosystems, salinities and seasons;
4) The NSF IL testing team alone took measurements and samples using methods consistent with NSF IL and USCG (2012) requirements to assess BWMS biological efficacy consistent with requirements.
5) In every valid test cycle, biological efficacy met USCG requirements

The *NSF IL ERMA FIRST FIT 1000 BWMS Shipboard Test Plan,* which details testing entities, experimental design, and analytical methods; and the *GSI Quality Management Plan* (QMP; GSI, 2016) and *GSI Shipboard Quality Assurance Project Plan* (QAPP; GSI 2016b).

Table 32. Biological Efficacy, Environmental Soundness, and Operational Performance Outcomes Across Consecutive Valid Test Cycles of the ERMA FIRST BWMS Onboard the *CV IRENES REMEDY*.

Parameter	US Coast Guard Requirement	Test Cycle				
		3	4	5	6	8
Were Intake Challenge Conditions Met?		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Organisms ≥ 50 μm	≥ 100(live organisms/m^3)	15,100	5,200	8,200	125,300	8,600
Organisms ≥10 μm and < 50 μm	≥ 100 (live organisms/mL)	132	162	295	161	105
Was the Ballast Discharge Standard Met?		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Organisms ≥ 50 μm	< 10(live organisms/m^3)	< 1	1	0	< 1	0
Organisms ≥10 μm and <50 μm	< 10 (live organisms/mL)	2	1	< 1	< 1	< 1
Escherichia coli	< 250 (CFU per 100 mL)	< 10 MPN/100 mL	< 10 MPN/100 mL	< 10 MPN/100 mL	< 10 MPN/100 mL	< 10 MPN/100 mL
Enterococcus spp.	< 100 (CFU per 100 mL)	< 10 MPN/100 mL	< 10 MPN/100 mL	< 10 MPN/100 mL	< 10 MPN/100 mL	< 10 MPN/100 mL
***Culturable Vibrio cholerae* (serogroup O1)**	<1(CFU per 100 mL)	Negative [A]	Negative [A]	Negative [A]	Negative [A]	< 1 [C]
***Culturable Vibrio cholerae*(serogroup O139)**	<1(CFU per 100 mL)	Negative [B]	Negative [B]	Negative [B]	Negative [B]	< 1 [C]
Was Operational Performance Consistent with BWMS OMSM During Test Cycles?		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

[A] Analyzed using the Cholera Sensitive Membrane Antigen Rapid Test II (New Horizons Diagnostics Corporation; Columbia, Maryland, USA)
[B] Analyzed using the Cholera O139 Sensitive Membrane Antigen Rapid Test II (New Horizons Diagnostics Corporation; Columbia, Maryland, USA)
[C] *Vibrio cholerae* samples collected and shipped to Maryland Pathogen Research Institute for analysis were not received within the 24 hour hold time, violating hold time requirements of the protocol.

3.2.1 Test cycles validity outcomes

Of the eight test cycles undertaken, five consecutive test cycles met all BWMS operational and source water requirements. Specifically, ballast flow rates were consistently within the operating range of the ERMA FIRST BWMS, as defined by the BWMS's OMSM. Uptake flow rate to the ERMA FIRST BWMS ranged from 542 – 830 m^3/hr, while discharge flow rate in the ballast main ranged from 263 – 904 m^3/hr. Uptake water temperature and salinity across the eight test cycles also met the BWMS's operational requirements.

The five valid test cycles took place in Morocco, Spain, England, France and the US across fall, spring and summer seasons, thus exceeding USCG and NSF IL Test Plan requirements for diverse large marine ecosystems and climate variability. Total densities of organisms ≥ 50 μm in preserved uptake samples ranged from 5,200 to more than 125,300/m^3, also well in excess of the USCG and NSF IL Test Plan challenge condition requirement. In the ≥ 10 and < 50 μm size class, total cell densities in preserved uptake samples ranged from 105 to 295 cells/mL, also meeting USCG and NSF IL Test Plan requirement of at least 100 organisms/mL.

Three of the eight test cycles were deemed invalid by the NSF IL. Test Cycles 1 and 7 were deemed invalid solely due to inadequate numbers of organisms in the ≥ 10 and < 50 μm size class in uptake source water (i.e., 29 cells/mL and 33 cells/mL, respectively). Test Cycle 2 was invalidated due to ship operational events which conflicted with the NSF IL Test Plan. On 20 March 2016, during Test Cycle 2 discharge operations, untreated water was inadvertently drawn into the treated discharge stream from the low sea chest via BE17V and SA3V due to an incorrect valve position. The corrective action for this event was to assure that the valve (BE17V) was completely closed (the correct position) prior to the next deballasting operation. The corrective action could not restore Test Cycle 2 validity, however, so Test Cycle 2 was deemed invalid.

Table 33. Data (Average ± Standard Deviation) used to Determine Test Cycle Validity for NSF Independent Laboratory (IL) Shipboard Type Approval Tests of the ERMA FIRST BWMS on Board the *CV IRENES REMEDY;* (Parameter leading to invalidity in bold font).

Category	Parameter	Requirement	Test Cycle							
			1INVALID	2INVALID	3	4	5	6	7INVALID	8
BWMS Operational Conditions	Uptake Flow Rate (m^3/hr)	200 to 1,000	No.2F(S): 542 No.2F(P): 551	799	738	756	659	825	830	691
	Discharge Flow Rate (m^3/hr)	200 to 1,000	804	Unknown	695	820	865	904	678	770
	Uptake Water Temp. (°C)	≥ 3	20.5 ± 0.1	17.06 ± 0.13	16.10 ± 0.32	10.44 ± 0.14	19.94 ± 0.18	19.26 ± 0.15	24.88 ± 0.09	16.29 ± 0.25
	Discharge Water Temp. (°C)	≥ 3	20.3 ± 0.1	16.31 ± 0.15	16.11 ± 0.33	19.96 ± 0.11	20.17 ± 0.33	18.94 ± 0.21	29.61 ± 0.10	17.26 ± 0.21
	Uptake Water Salinity(PSU)	≥ 0.9	36.5 ± 0.7	35.64 ± 0.10	36.62 ± 0.12	20.21 ± 0.96	10.04 ± 0.47	33.92 ± 0.20	25.78 ± 0.30	4.89 ± 0.17
Source Water Conditions	Climate and Season	≥ Two large marine ecosystems (LME) over two seasons	LME 27/Fall	LME 27/Spring	LME 26/ Spring	LME 7/ Spring	LME 22/Summer	LME 22/ Summer	LME 7/ Summer	LME 22/ Fall
	Total Organisms ≥ 50 μm	≥ 100 organisms/m^3	20,300	7,400	15,100 Copepod Nauplii,	5,200 (Copepod Nauplii,	8,200 (Calanoid Copepods,	125,300 (Copepod Nauplii,	89,300	8,600 (Copepod Nauplii,

Category	Parameter	Requirement	Test Cycle							
			1INVALID	2INVALID	3	4	5	6	7INVALID	8
					Calanoid Copepods, Protista - Dinoflagellate, Harpacticoid Copepods, Eggs	Calanoid Copepods, Cyclopoid Copepods, Hapacticoid Copepods, Protista - Dinoflagellate)	Copepod Nauplii, Polychaet worm, Cirripedia Nauplii, Mysid)	Harpacticoid Copepod, Calanoid Copepod, Bivalve Veliger, Barnacle Nauplii)		Protista - Tintinnid, Calanoid Copepod, Synchaeta, Cirripedia Nauplii)
	Total Organisms ≥10 μm&< 50 μm	≥ 100 organisms/mL	**29**	222	132 Centric, Spherical, Irregular, Dinoflagete, Flagellate)	162 (Centric, Round/Oval (unknown), Ciliates, Cryptophytes, Dinoflagellate)	295 (Diversity data not available)	161 (Diversity data not available)	**33**	105 (Flagellate, Round, Ciliate, Centric, Dinoflagellate)

Table 34. The Type, Number and Volume of Operational, Water Chemistry, Water Quality and Biological Data and Samples Collected During Test Cycles 1 - 8 of the ERMA FIRST BWMS on Board the *CV IRENES REMEDY*.

*Samples collected during Test Cycle 8 only.

Operation	Parameter	Sample Location	Sample Type	Number of Samples per Location	Sample Volume
Uptake	Ballast System Flow Rate	Vessel Ballast System	Calculation from Tank Soundings	Every 10 to 15 minutes	N/A
	Ballast Tank Volume	Vessel Ballast System	Calculation	Every 10 to 15 minutes	N/A
	GSI Shipboard Sampling System (SSS) Flow Rate	GSI Shipboard Sampling System (SSS)	In-Line	Continuous Measurement	N/A
	GSI SSS Volume: Sample Collection Tub	GSI SSS	In-Line	Continuous Measurement	N/A
	BWMS: Amount of Consumables Used, Discrepancies from the Operation, Maintenance and Safety Manual (OMSM), Shipboard Non-Conformities, Maintenance and Other Events	Vessel	Various	Various (Recorded by the Crew throughout the entire testing period)	N/A

Operation	Parameter	Sample Location	Sample Type	Number of Samples per Location	Sample Volume
	Temperature, Specific Conductivity, Salinity, Dissolved Oxygen, pH, Turbidity, Chlorophyll *a* (green algae), and Phycocyanin Accessory Pigment (Blue-Green Algae)	GSI SSS – Whole Water Sample	Discrete Grab	3 samples (Beginning, Middle, End)	N/A
	Total Suspended Solids (TSS), Percent Transmittance (%T, Filtered and Unfiltered), and Particulate Organic Matter (POM)	GSI SSS – Whole Water Sample	Discrete Grab	3 samples (Beginning, Middle, End)	0.9 L - 1 L
	Non-Purgeable Organic Carbon (NPOC), and Dissolved Organic Matter (DOM) as Dissolved Organic Carbon (DOC)	GSI SSS – Whole Water Sample	Discrete Grab	3 samples (Beginning, Middle, End)	100 mL – 125 mL
	Total Residual Oxidants (TRO)	GSI SSS – Whole Water Sample	Discrete Grab	3 samples (Beginning, Middle, End)	450 mL - 475 mL
	Organisms ≥ 50 μm	GSI SSS - Sample Collection Tub	Time-Integrated	1	≥ 2 m^3
	Organisms ≥ 10 μm to < 50 μm	GSI SSS – Seep Sampler	Time-Integrated	2	450 mL - 475 mL
Discharge	Ballast System Flow Rate	Vessel Ballast System	Calculation from Tank Soundings	Every 10 to 15 minutes	N/A
	Ballast Tank Volume	Vessel Ballast System	Calculation	Every 10 to 15 minutes	N/A
	GSI Shipboard Sampling System (SSS) Flow Rate	GSI Shipboard Sampling System (SSS)	In-Line	Continuous Measurement	N/A
	GSI SSS Volume: Sample Collection Tub	GSI SSS	In-Line	Continuous Measurement	N/A
	BWMS: Amount of Consumables Used, Discrepancies from the Operation, Maintenance and Safety Manual (OMSM), Shipboard Non-Conformities, Maintenance and Other Events	Vessel	Various	Various (Recorded by the Crew throughout the entire testing period)	N/A
	Temperature, Specific Conductivity, Salinity, Dissolved Oxygen, pH, Turbidity, Chlorophyll *a* (green algae), and Phycocyanin Accessory Pigment (Blue-Green Algae)	GSI SSS – Whole Water Sample	Discrete Grab	3 samples (Beginning, Middle, End)	N/A
	Total Residual Oxidants (TRO)	GSI SSS – Whole Water Sample	Discrete Grab	3 samples (Beginning, Middle, End)	450 mL - 475 mL
	Organisms ≥ 50 μm	GSI SSS - Sample Collection Tub	Time-Integrated	1	≥ 2 m^3
	Organisms ≥ 10 μm to < 50 μm	GSI SSS – Seep Sampler	Time-Integrated	2	450 mL - 475 mL

Operation	Parameter	Sample Location	Sample Type	Number of Samples per Location	Sample Volume
	Organisms < 10 μm: *E. coli*, Intestinal *Enterococci, and Vibrio cholerae* (O1 and O139 antigen rapid tests)	GSI SSS – Seep Sampler	Time Integrated	3	1.9 – 2 L
	Organisms < 10μm: *Vibrio cholerae* (O1 and O139 colony blot and detection of ctxa gene)*	GSI SSS – Seep Sampler	Time Integrated	3	0.9 – 1 L

Additional Information were provided from the manufacturer to demonstrate that the system was able to perform as per Part 2.3 and 2.3.12. All the information's are included in the Ship-board test report Annexes.

Shipboard testing of the FIT 1000 BWTS showed uptake flow-rates to the BWTS ranging from 659 to 825 m3/hr, below the FIT 1000 rated capacity of 1,000 m3/hr. The following explanation was shared by the manufacturer and deemed equivalent. IRENES REMEDY, as any other container vessel is low ballast depended vessel. As such the routine ballasting/ de- ballasting events is not frequent and never lengthy. The ballasting/ de- ballasting rates during the sampling collection at ship-board trials were based on the loading/ uploading conditions of the vessel at this particular moment and of course sampling teams restrictions (sampling time, sampling volume etc). As a result, the ballasting/ de- ballasting flow rate during the ship-board trials ranged between 65.9%- 82.5% of ERMA FIRST FIT 1000 maximum rated capacity. However, this remained at the upper end of its range since the specific model has a rated capacity ranged between 200-990 (BS300T Filter). ERMA FIRST FIT 1000 data log proved that the system operated at its maximum treated rated capacity in some cases during the 10 months of the shipboard trials. Those did not coincide with a sampling event but were provided in detail in document 00079C.17 Shipboard Test Report.

3.3 Πρόσθετες δοκιμές στην ξηρά για επιπρόσθετα μοντέλα

3.3. Additional land based testing for additional Models

From the 15th of May until the 8th of July 2014, the ERMA FIRST BWM System, based on a primary filter and electro-chlorination, has conducted the required land-based testing at a specialised test barge (MEA-nl, the Netherlands) designed for such testing. During this period a total of five full scale land-based test runs were conducted of which five were successful in terms of meeting the discharge standard as indicated in the IMO Regulation-D2.
The full-scale land-based tests were based on modifications of the original BWM system of ERMA FIRST and an amendment in water types tested (fresh water with salinity of < 1 PSU).
Summary table of collected data covering the major groups of viable organisms of the five valid test-runs for the saline, brackish, and fresh water salinity range.

Table 35. Additional Test results (MEA 2014)

Fresh-brackish-saline water	Control			Treated		
salinity 0.6 - 34.3 PSU	Intake			Discharge		
natural plankton	Average	min.	max.	Average	min.	max.
total bacteria [counts/ml]	3.0+E6	1.8+E6	4.0+E6	1.1+E6	9.4+E4	2.7+E6
E. coli [cfu/ml]	< 1	< 1	15	< 1	< 1	< 1
Enterococci [cfu/100 ml]	< 1	< 1	8	< 1	< 1	3
microplankton 10-50 µm [counts/ml]	6.7	0.28	29.66	0.08	0	0.20
phytoplankton 10-50 µm [counts/ml]	1,711	1,000	2,121	5.7	0	< 10
plankton >50 µm [counts/m^3]	146,510	74,850	282,000	1.7	0	4.0

3.4 Υπάρχοντα αποτελέσματα δοκιμών ξηράς

3.4 Existing land based test results

The land based tests were conducted on the ERMA FIRST BWTS in accordance with IMO Resolution MEPC.174(58), adopted on 10 October, 2008 (G8).
The land based trials were conducted by the Royal Netherlands Institute for Sea Research (NIOZ), the Netherlands from April to July 2010.
In total 10 test runs were successful and the ERMA FIRST BWT system performed on average much better than stated in Regulation-D2 by achieving values of organisms well below the requirements of the D2 Standard.
From the results of land based testing can be concluded that ERMA FIRST offers an effective, reliable and environmental safe cleaning of ballast water resulting in organism numbers well below the Standard of the IMO Regulation-D2.

Table 36. Land based results (NIOZ 2010)

2 Summary table with results for the Type Approval Certificate of the ERMA First BWT System

Summary table of collected data covering the major groups of organisms at two series of test-runs for low and high salinity range, respectively.

n.d.: non detectable in sample. -: no data; * numbers as determined in bottle incubations of neutralized discharge water

Land-based tests NIOZ	**Reference & Treated**			**Reference**			**Treated**			
Average salinity 24.6 PSU	**Intake**			**Discharge**			**Discharge**			**Discharge***
natural plankton	Average	min.	max.	Average	min.	max.	Average	min.	max.	Average
total bacteria [counts/mL]	8.25+E6	4.49+E6	12.3+E6	3.64+E6	2.14+E6	4.62+E6	1.45+E5	0.82+E5	2.02+E5	2.89+E6
E. coli [cfu/mL]	-	<0.1	0.43	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	<0.1
Enterococci [cfu/100 mL]	-	< 1	71	< 1	< 1	<1	< 1	<1	<1	<1
plankton <10 µm [counts/mL]	3668	792	9379	605	263	1219	27.0	3.2	62.7	28.7
plankton 10-50 µm [counts/mL]	1193	1017	1564	112	101	125	0.3	0	0.8	0.1
plankton >50 µm [counts/m^3]	5.45+E5	1.08+E5	14.8+E5	3.32+E4	1.11+E4	8.64+E4	2.3	1.7	2.73	-

Land-based tests NIOZ	**Reference & Treated**			**Reference**			**Treated**			
Average salinity 34.7 PSU	**Intake**			**Discharge**			**Discharge**			**Discharge***
natural plankton	Average	min.	max.	Average	min.	max.	Average	min.	max.	Average
total bacteria [counts/mL]	5.36+E6	2.42+E6	7.28+E6	3.70+E6	3.63+E6	3.79+E6	2.14+E5	1.88+E5	2.37+E5	1.47+E6
E. coli [cfu/mL]	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Enterococci [cfu/100 mL]	-	< 1	6	< 1	< 1	<1	< 1	<1	<1	< 1
plankton <10 µm [counts/mL]	794	654	1233	512	241	974	2.4	0	6.3	1.8
plankton 10-50 µm [counts/mL]	1094	960	1258	101	87	112	0.2	0	0.8	0.1
plankton >50 µm [counts/m^3]	1.75+E5	0.84+E5	3.41+E5	5.93+E4	3.20+E4	7.67+E4	0.13	n.d.	0.3	-

3.5 Υπάρχοντα αποτελέσματα δοκιμών θαλάσσης

3.5 Existing shipboard test results

The shipboard tests were conducted on the ERMA FIRST BWTS in accordance with IMO Resolution MEPC.174(58), adopted on 10 October, 2008 (G8).

Three shipboard test cycles were conducted to test the performance of the ballast water treatment system developed by ERMA FIRST ESK Engineering Solutions S.A. The tests were undertaken on three voyages of the test vessel, i.e. the container vessel Cosco Guangzhou. The voyages stretched from January to August 2011.

The ballast water treatment system

- has a capacity to match the vessel's ballast water pumps capacity,
- was installed in the engine room,
- was fully implemented and integrated into the ballast system of the vessel, and
- was only operated during the tests performed.

The ballast water was taken up in the following ports

- Test cycle 1 – Rotterdam, The Netherlands
- Test cycle 2 – off Vlieland, The Netherlands, and
- Test cycle 3 – Felixstowe, United Kingdom.

During the test runs all samples were taken by sampling team members of GoConsult, Hamburg, Germany. Please refer to Table 4,5,6 for Results from shipboard testing.

Table 37. Shipboard test cycle 1

Final report, shipboard tests of the ERMA First ESK Engineering Solutions S.A. ballast water treatment system

Test Cycle Report, Test 1

Date and time for **ballast water uptake**: 28.01.2011, 10.45 to 12.41.

- Position of ship during start of ballast water uptake: Port of Rotterdam, EUROMAX Terminal.
- Water depth ca. 8 to 12 m.
- Distance to nearest main land ca. 0 nm.

Date and time for **ballast water discharge**: 29.01.2011, 11.15 to 12.55.

Holding time of ballast water between uptake and discharge: approximately 24 hrs.

Table 3. Results of test 1.
(nd = not detectable).

Parameter	Unit	Uptake water			Discharge water						
		control	IMO	before treatment	Control	IMO	Treated # 1	Treated # 2	Treated # 3	aver. #1-#3	IMO
Temperature	°C	5.2	-	5.1	6.0	-	5.0	5.0	5.0	-	-
Salinity	psu	28.2	-	27.5	28.1	-	28.0	28.0	28.0	-	-
POC *	mg/l	4.8	-	5.1	4.8	-	4.5	4.5	4.4	-	-
TSS *	mg/l	10.5	-	10.8	9.9	-	9.4	9.5	9.5	-	-
Sample vol. ≥50 µm	Litres	1374	≥1000	1876	1678	≥1000	1287	1271	1280	-	≥1000
Sample vol. 50-10 µm	Litres	7	≥1	7	7	≥1	7	7	7	-	≥1
Sample vol. bacteria	Litres	1	≥0,5	1	1	-	1	1	1	-	≥0,5
Organisms ≥50µm	org./1m³	3246	≥90	3726	3218	≥10	nd	5.6	nd	1.9	≤10
Organisms 10-50µm*	org./1ml	1647	≥90	2323	4409	≥10	nd	nd	nd	nd	≤10
Organisms 6-7µm*	org./1ml	2725	-	3680	3690	-	nd	nd	nd	nd	-
Organisms ca. 4 µm*	org./1ml	1148	-	1468	1490	-	nd	nd	nd	nd	-
Escherichia coli	cfu/100ml	22	-	42	16	-	nd	nd	nd	nd	≤250
Intestinal *Enterococci*	cfu/100ml	29	-	nd	74	-	nd	4	2	2	≤100
*Vibrio cholerae***	cfu/100ml	nd	-	nd	nd	-	nd	nd	nd	nd	≤1

* Analyzed at NIOZ, Texel, The Netherlands. ** Analysed at IBEN, Bremerhaven, Germany.

Table 38. Shipboard test cycle 2

Final report, shipboard tests of the ERMA First ESK Engineering Solutions S.A. ballast water treatment system

Test Cycle Report, Test 2

Date and time for **ballast water uptake**: 05.04.2011, 18.49 to 21.06.

- Position of ship during start of ballast water uptake: off Vlieland, The Netherlands
- Distance travelled during uptake was ca. 35 nm.
- Water depth ca. 24 m.
- Distance to nearest main land ca. 16 nm.

Date and time for **ballast water discharge**: 06.04.2011, 18.18 to 20.03.

Holding time of ballast water between uptake and discharge: approximately 24 hrs.

Table 4. Results of test 2.
(nd = not detectable).

Parameter	Unit	Uptake water			Discharge water						
		control	IMO	before treatment	Control	IMO	Treated # 1	Treated # 2	Treated # 3	aver. #1-#3	IMO
Temperature	°C	7.1	-	7.2	10.1	-	9.0	9.0	9.0	-	-
Salinity	psu	34.0	-	32.4	33.7	-	32.9	32.9	32.9	-	-
POC *	mg/l	4.7	-	4.7	4.1	-	4.1	5.2	5.6	-	-
TSS *	mg/l	11.1	-	9.2	10.6	-	10.3	12.1	14.1	-	-
Sample vol. ≥50 µm	Litres	1386	≥1000	1969	1563	≥1000	1279	1242	1276	-	≥1000
Sample vol. 50-10 µm	Litres	7	≥1	7	7	≥1	7	7	7	-	≥1
Sample vol. bacteria	Litres	1	≥0,5	1	1	-	1	1	1	-	≥0,5
Organisms ≥50µm	org./1m³	3487	≥90	4275	2777	≥10	nd	nd	3.6	1.2	≤10
Organisms 10-50µm*	org./1ml	374	≥90	162	120	≥10	nd	nd	nd	nd	≤10
Organisms 6-7µm*	org./1ml	965	-	1014	696	-	nd	nd	nd	nd	-
Organisms ca. 4 µm*	org./1ml	310	-	527	381	-	nd	nd	nd	nd	-
Escherichia coli	cfu/100ml	nd	-	nd	nd	-	nd	nd	nd	nd	≤250
Intestinal *Enterococci*	cfu/100ml	14	-	22	15	-	6	nd	10	5.3	≤100
*Vibrio cholerae***	cfu/100ml	nd	-	nd	nd	-	nd	nd	nd	nd	≤1

* Analyzed at NIOZ, Texel, The Netherlands. ** Analysed at IBEN, Bremerhaven, Germany.

Table 39. Shipboard test cycle 3

Final report, shipboard tests of the ERMA First ESK Engineering Solutions S.A. ballast water treatment system

Test Cycle Report, Test 3

Date and time for **ballast water uptake**: 29.08.2011, 15.57 to 18.32

- Position of ship during start of ballast water uptake: in Port of Felixstowe, United Kingdom
- Distance travelled during uptake was ca. 0 nm.
- Water depth ca. 10 m.
- Distance to nearest main land ca. 0 nm.

Date and time for **ballast water discharge**: 31.08.2011, 10.05 to 11.42

Holding time of ballast water between uptake and discharge: approximately 40 hrs.

Table 5. Results of test 3.
(nd = not detectable).

Parameter	Unit	Uptake water			Discharge water						
		control	IMO	before treatment	Control	IMO	Treated # 1	Treated # 2	Treated # 3	aver. #1-#3	IMO
Temperature	°C	17.6	-	17.6	17.8	-	18.0	18.0	18.0	-	-
Salinity	psu	33.8	-	33.5	33.8	-	33.5	33.5	33.5	-	-
POC *	mg/l	18.0	-	14.9	13.4	-	10.0	10.6	11.0	-	-
TSS *	mg/l	61.0	-	34.0	38.0	-	19.6	21.2	21.4	-	-
Sample vol. ≥50 µm	Litres	1378	≥1000	1559	1227	≥1000	1266	1274	1273	-	≥1000
Sample vol. 50-10 µm	Litres	7	≥1	7	7	≥1	7	7	7	-	≥1
Sample vol. bacteria	Litres	1	≥0,5	1	1	-	1	1	1	-	≥0,5
Organisms ≥50µm	org./1m³	12494	≥90	9771	10052	≥10	6.6	nd	6.5	4.4	≤10
Organisms 10-50µm*	org./1ml	1398	≥90	775	473	≥10	nd	nd	nd	nd	≤10
Organisms 6-7µm*	org./1ml	5495	-	3664	2249	-	nd	nd	nd	nd	-
Organisms ca. 4 µm*	org./1ml	12379	-	13484	3846	-	nd	nd	nd	nd	-
Escherichia coli	cfu/100ml	37	-	29	9	-	nd	nd	nd	nd	≤250
Intestinal *Enterococci*	cfu/100ml	14	-	20	6	-	nd	1	10	3.7	≤100
*Vibrio cholerae***	cfu/100ml	nd	-	nd	nd	-	nd	nd	nd	nd	≤1

* Analyzed at NIOZ, Texel, The Netherlands. ** Analysed at IBEN, Bremerhaven, Germany.

4 *Σχετικά Έγγραφα Έγκρισης*
4 Approval Documentation

Table 40. Existing Data under ERMA FIRST BWTS Certification

Application for Type Approval of ERMA FIRST Ballast water treatment system Revision 0.0	01/2012
E-DRAWINGS ERMA FIRST BWTS 100	06/02/2012
E-DRAWINGS ERMA FIRST BWTS 500	06/02/2012
C018.12 bw12 ERMAFIRST report-Additional algae test	09/02/2012
ERMA FIRST BWTS _ Additional data to Type App. ERMA FIRST BWTS50	09/02/2012
ERMA FIRST response to comments for mechanical appraisal of ERMA FIRST_Final	09/02/2012
ERMA FIRST SCOPE OF SUPPLY_summarizedrev.1	09/02/2012
Theoretical vs measured hydrogen_ERMA FIRST LR 02 04 2012	02/04/2012
Experimental set-up: Hydrogen production of ERMA FIRST BWTS – Simulation of ballasting	30/04/2012
Annex3_M_H2	30/04/2012
Annex6_ERMA FIRST BWTS List of Alarms_rev 3	30/04/2012
Annex8_Ship Specific Hydrogen Calculations	30/04/2012
Gas separator	30/04/2012
Lloyd's Register statement "ERMA FIRST BALLAST WATER MANAGEMENT SYSTEM v.1"	03/05/2012
ERMA FIRST BWTS 200_Assemply	03/05/2012
ERMA FIRST BWTS 700_Assemply	03/05/2012
2-800-G-08Operation, Maintenance and Safety Manual (OSMS), ERMA FIRST BWTS FIT 75-3000,Rev08, Feb2018	02/2018
1-1920 Equipment Operation and Technical Manual Vol.I,II,III	18/04/2017
2-1920 Equipment Operation and Technical Manual Vol I,II,III	24/10/2017
2-1920 Equipment Operation and Technical Manual Vol I,II,III Ex	18/04/2017
1-801-G-00/1-110-CERT-50-3000-PFD-01	26/08/2014
1-801-G-00/1-120-CERT-50-3000-PID-01	26/08/2014
1-801-G-00/1-130-CERT-50-3000-CON-01	05/09/2014
1-801-G-00/1-140-CERT-50-3000-ELE-WIR-00	05/09/2014
2-801-G-00/2-110-CERT-75-3000-PFD-03	13/10/2015
2-801-G-00/2-120-CERT-75-3000-PID-03	13/10/2015
2-801-G-00/2-130-CERT-75-3000-CON-02	05/06/2015

2-801-G-00/2-140-CERT-75-3000-ELE-WIR-02	05/06/2015
2-801-G-00/2-150-CERT-75-3000-ELE-INT-02	04/06/2015
1-801-G-00-Drawings: Data of complete list of ERMA FIRST BWTS and Equipment Drawings	04/12/2014
1-802-G-00-Equipment Manual: Data of complete list of Components Equipment manuals for ERMA FIRST BWTS	04/12/2014
2-801-G-00-Drawings: Data of complete list of ERMA FIRST BWTS FIT and Equipment Drawings	24/10/2017
2-802-G-00-Equipment Manual: Data of complete list of Components Equipment manuals for ERMA FIRST BWTS FIT	26/01/2017
12-802-G-00 Equipment Manual: Data of complete list of Components Equipment manuals for ERMA FIRST BWTS FIT and ERMA FIRST BWTS	04/12/2014
12-840-G Environmental data as per IACS UR E10 et al.	29/11/2017
2-823-G Installation in Hazardous Areas	29/11/2017
Letter FILTERSAFE Type approval Filters	26/11/2014
6391_1 Filtrex - Letter of compliance ACB filters_Erma First	28/08/2014
Letter ECOTOX, Toxicity tests	14/09/2014
Lloyd's Register statement "ERMA FIRST FIT BALLAST WATER MANAGEMENT SYSTEM"(Letter to FSA final 2)	18/12/2014
00059C.16 Scaling Document of ERMA FIRST system	12/09/2017
2-805-G-00 Standard operation procedure (SOP) in Freshwater	April 2015
EFTF-LOWSAL-COND ERMA FIRST Operation in -2 degC	22/5/2017
Installation Specifications 2012-G	28/06/2017
Equipment list 2-1921-G	30/05/2017
Scope of supply 2-822-G	06/03/2018
Spare Parts 2-1902-G	30/05/2017
Scope of supply 1-822-G	19/10/2015
Model's Schedule 2-824-G	31/01/2018
12-833-G-00 Risk assessment Responsibilities and Ship Safety	10/05/2017
ERMA FIRST Risk Assessment APT Management 2-831-APT	24/11/2017
DNV-18ESY7N-1.2013-1357 HAZOP ERMA FIRST BWTS	03/12/2013
DNVGL-2621-015717-J-26,REV.1-SAFETY ASSESSMENT	10/07/2014
LR 2015 ERMA FIRST BWTS Risk Study (TID8064)	15/05/2015
1-910-Shop test report with FAT	18/04/2017

1-950-StartUp checklist	18/04/2017
2-910-Shop test report with FAT	18/04/2017
2-950-StartUp checklist	18/04/2017
1830-G-00-Software Assurance Plan	23/05/2017
1831-ProjectNo-00_Software Quality Report	23/05/2017
1832-ProjectNo-00_Record of History Changes	23/05/2017
12-820-G-00: List of Active, Relevant and Other Chemicals	11/2014
ERMA FIRST Application for Type Approval Amendment (00076C.17 GR TA)	25/10/2017
ERMA FIRST BWTS 75-3000 BV Type Approval 51808_A0 BV	04/05/2018
ERMA FIRST BWTS 75-3000 ABS Design Assessment ERMAFIRSTHS1713862PDA_107785521	02/07/2018
BV Type Approval Certificate 39354 A3 BV FILTERSAFE BS series	26/02/2018
LR Design Appraisal Document UKITSO/19807859/ENG Issue 4 BS031, 061, 101/101E, 151/151E AND 201/201E	09/2018
LR Design Appraisal DocumentUKITSO/11127144/ENG Issue 5BS025, 050, 070, 100, 150, 200, 300/300E, 400/400E & 500E	09/2018
LR Design Appraisal Document UKITSO/18940362/ENG Issue 7 BS603/603E, 804/804E, 1004/1004E, 1204/1204E, 1206E & 1406E	09/2018
Type Approval PDA Details ACB-999-350, ACB-985-300, ACB-955-300, ACB-955-250, ACB-945-200, ACB-935-200, ACB-915-150, ACB-910-150, ACB-906-100, ACB-904-80, ACB-903-65	11/02/2016
Type Approval PDA Details ACB-9100-400, ACB-9120-500 and ACB-9200-600	20/07/2017

Table 41. New/updated Data under ERMA FIRST BWTS Certification

Description	Document ID	Date
ERMA FIRST Submission for Type Approval	00151C.18 ERMA FIRST Application for Type Approval MEPC.279(70)	31/01/2019
ERMA FIRST Additional Data for Type Approval	00151C.18.01 ERMA FIRST Application for Type Approval MEPC.279(70)	20/06/2019
ERMA FIRST Additional Data for Type Approval	00151C.18S.01 ERMA FIRST Application for Type Approval MEPC.279(70)	20/06/2019
Data/Folder of complete list of ERMA FIRST BWTS FIT and Equipment Drawings	2-801-G-01-Drawings Data/Folder of complete list of ERMA FIRST BWTS FIT and Equipment Drawings	20/06/2019

Description	Document ID	Date
Schedule of Data/Folder of complete list of ERMA FIRST BWTS FIT and Equipment Drawings	2-801-G-01.S-Drawings Schedule of Data/Folder of complete list of ERMA FIRST BWTS FIT and Equipment Drawings	20/06/2019
Procedure Commissioning Onboard for ERMA FIRST BWTS Model FIT 75-3000	2-950-01	06/06/2018
Procedure Shop test for ERMA FIRST BWTS Model FIT 75-3000	2-910-01	06/06/2018
Bill of Materials ERMA FIRST BWTS Model FIT 75-3000	2-822-G-09	12/04/2019
Environmental data as per IACS URE10 Rev. 6 et al.	12-840-G	08/04/2019
Installation Specifications	2012-G	10/04/2019
ERMA FIRST control Panels	00111C.18.Panels-00	13/12/2018
ERMA FIRST Model's Schedule	2-824-G	10/06/2019
Piping and Instrumentation Diagram	0000-10001-01	22/03/2019
Cooling Diagram	0000-10001-02	20/03/2019
Connections Diagram	0000-10001-03	22/03/2019
Detailed Wiring	0000-10001-04	22/03/2019
Internal Wiring FS	0000-10001-05-FS	22/03/2019
Internal Wiring FX_HY	0000-10001-05-FX_HY	22/03/2019
Piping and Instrumentation Diagram	0000-30001-01	22/03/2019
Cooling Diagram	0000-30001-02	20/03/2019
Connections Diagram	0000-30001-03	22/03/2019
Detailed Wiring	0000-30001-04	22/03/2019
Internal Wiring FS	0000-30001-05-FS	22/03/2019
Internal Wiring FX_HY	0000-30001-05-FX_HY	22/03/2019
Process Flow Diagram ERMA FIRST BWTS FIT Ex with 1 EC	2-1110-G-1X-1xCELL Ex-PFD-01	08/01/2018
Process Flow Diagram ERMA FIRST BWTS FIT Ex with 2 EC	2-1110-G-1X-2xCELL Ex-PFD-01	08/01/2018
Process Flow Diagram ERMA FIRST BWTS FIT Ex with 3 EC	2-1110-G-1X-3xCELL Ex-PFD-01	08/01/2018
Equipment Operation and Technical Manual for ERMA FIRST FIT OMSM	2-1920-G-06 ERMA FIRST FIT OMSM	06/2019
Software Quality Assurance Plan	1830-G-01	10/06/2018

Description	Document ID	Date
Software Quality Report	1831-G-01	10/06/2018
Record of History Changes	1832-G-01	10/06/2018
Technical Data sheet of Filter-Hydac	RF14 technical Data Rev 05	02/04/2019
Overview Drawing RF14-10-60	4265038 000 H	12/11/2018
Filter Hydac Operating Manual	4225695 EN	25/06/2018
Hydrogen Calculations	975.ProjectNo.00	06/2019
DNVGL Type Approval Hydac	000001U2	06/2019
Administration Vising Report in MEA Facility	MEA2019_Visiting report	05/2019

5 Εκθέσεις αποτελεσμάτων δοκιμών

5 Test reports

Table 42. ERMA FIRST Existing Test Reports

Final report of the land based testing of ERMA FIRST Ballast water treatment system, for Type Approval according to Regulation-D2 and the relevant IMO Guidelines (April-July 2010)	05/2011
Final report of the shipboard tests of the ERMA First ESK Engineering Solutions S.A. Ballast Water Treatment System for Type Approval according to Regulation D-2 and the relevant IMO Guideline (G8) (January 2011 – August 2011) Shipboard tests onboard MV Cosco Guangzhou	01/10/2011
Land based verification report of the ballast water management system of ERMAFIRST, (MEA 2014, ERMA FIRST Final LB-test report 141110 pdf version)	11/2014
Report on Ecotoxicity testing-land based testing	22/08/2014
Great Waters Research Collaborative, 2017.LSRI/GWRC/TR/BENCH/1: Tests of the ERMA FIRST FIT Bench Scale Pilot Ballast Water Management System on Fresh water	08/08/2017

Table 43. ERMA FIRST New Test Reports

Description	Document ID	Date
ERMA FIRST System Performance	00080C.17 ERMA FIRST System Performance	07/2017
ERMA FIRST Chlorine (TRO)	00083C.17.01 ERMA FIRST Chlorine (TRO)	12/2017
ERMA FIRST Shipboard test report	00079C.17ERMA FIRST Shipboard test report	07/2017
ERMA FIRST Data for Initial Evaluation	00107C.18.01 ERMA FIRST Data for Initial Evaluation	07/2018
ERMA FIRST System Environmental Testing Report	00111C.18.02 ERMA FIRST Environmental Test Report	13/12/2018
Scaling Document of ERMA FIRST system	00059C.16.11 ERMA FIRST Scaling Report	10/06/2019
ERMA FIRST Filter Design Study	00065C.17.05 Design Study	03/04/2019
Gap Analysis of ETV and IMO TA	IMTCI 2018 Gap Analysis for ERMA FIRST FIT BWMS	17/05/2018
GSI 2017, Shipboard testing FIT1000 USCG Type Approval	GSI-SB-NSF-IL-TR-ERMA_07APR2017_GSI Signed	04/2017

Description	Document ID	Date
NSF IL ERMA FIRST FIT 1000 BWMS Shipboard test plan	NSF IL Shipboard Test Plan_ERMA FIRST FIT 1000 BWMS_FINAL_29OCT15-signed(2)	10/2015
GSI Quality Management Plan (QMP; GSI, 2016)	GSI-QAQC-QMP-1-Rev5_15JUL16_Signed	07/2016
GSI Shipboard Quality Assurance Project Plan (QAPP; GSI 2016b)	GSI-QAQC-QAPP-SB-1 - Revision2_15JUL16_SIGNED	07/2016
MEA 2015, DOC Deviations under Ambient conditions	1507 v1.0 Potential Deviations	09/2015
MEA 2016, TQAP for USCG land based type approval FIT 300 (Filtersafe)	1606 TQAP v2.0 Primary filter (Filtersafe), Jun 2016	06/2016
MEA 2016, QAPP for USCG land-based type approval FIT 300 (Filtersafe)	1608 QAPP v2.0 Primary Filter (Filtersafe), Jun 2016	06/2016
MEA 2016 Water quality augmentation	1615 v1.0 Water quality Augmentations; Abiotic parameters	11/2016
MEA 2017, Land based BE Verification USCG land based type approval FIT 300 (Filtersafe)	1703 BE TR v2.0 Primary filter (Filtersafe)	10/2017
MEA 2017, Toxicity testing report with Primary filter (Filtersafe)	1706 v1.0 Toxicity test and chemical analysis Primary filter (Filtersafe)	04/2017
MEA 2017, DOC and Biological efficacy of a BWTS	1711 v1.0 Additional Information on the correlation between organic carbon (DOC) and biological efficacy of a BWTS	05/2017
MEA 2017, QAPP for USCG land-based type approval FIT 300 (Filtrex)	1713 QAPP v0.1 Alternate (Filtrex)	05/2017
MEA 2017, TQAP for USCG land based type approval FIT 300 (Filtrex)	1714 TQAP v1.2 Alternate filter (Filtrex)	05/2017
MEA 2017, Land based BE Verification USCG land based type approval FIT 300 (Filtrex)	1721BE TR v1.0 Alternate filter (Filtrex)	03/2018
MEA 2018, Toxicity testing report with Secondary filter (Filtrex)	1722 v1.0 Toxicity test and chemical analysis Alternate filter (Filtrex)	05/2018
MEA 2018 Biological Requirements	1808 v1.0 P0048 Biological requirements	04/2018
MEA 2018, Land based BE Verification USCG land based type approval FIT 300 (Filtrex)	1814 v1.0 P0048 Test run XII	06/2018
MEA 2018, TQAP for IMO/USCG land based type approval FIT 300 (Hydac)	1818 v1.0 TQAP EF filter IMO-ETV	07/2018
MEA 2018, Heterotrophic culturable bacteria	1822 v1.0 P0072 Bacteria	08/2018
MEA 2019, Land based BE Verification IMO/USCG land based type approval FIT 300 (Hydac)	1829 v1.0 P0070 Alternate filter (Hydac)	06/2019
MEA 2019, Toxicity testing report with Alternate filter (Filtrex)	1832 v1.0 P0070 Toxicity test and chemical analysis Alternate filter (Hydac)	06/2019
MEA 2019 Equivalent report to cover Gap analysis of ETV and MEPC.300 (72) for all tests	1911 v1.0 ERMA FIRST BWTS FIT 300 Summary report for the 2 alternate filters	06/2019
ERMA FIRST 2019 Type Approval Test Report	00155C.18TR.00 Type Approval Report as per MEPC 279 (70)	06/2019
Lloyd's Register statement "ERMA FIRST BWTS water Management System"	LR2019_Letter of ERMA FIRST Compliance	06/2019