

Information on land based test and onboard test results of JFE BallastAce

(1) Land based Test

Testing Organization

BallastTech NIVAAS (Norway) (<http://www.ballasttech-niva.no/index.html>)

Tested Ballast Water Management System

JFE BallastAce® Capacity : 350 m³/h

Outline of the testing procedure

- (1) Test treated ballast water which is firstly treated by TG Ballastcleaner® (NaClO) was stored in the simulated ballast water tank (in dark condition)
- (2) Total residual oxidants (TRO) contained in above treated water was neutralized by sodium sulfite.
- (3) This neutralized ballast water, which corresponds to discharged ballast water, was inspected and analyzed.

Test Results

1) Water quality of test water

Chemical and biological water quality of the test water was adjusted in accordance with IMO G8 guideline adding artificial matters and cultivated organisms.

Measured test water quality data for all test cycles fulfilled the G8 guideline.

Table 1 Table of test water quality

Test Water	Brackish Water		Seawater	
	2, 3, 4, 5, 6	G8 def.	1, 7, 8, 9, 10	G8 def.
Salinity (PSU)	20.6–21.5	3–32	32.1–33.6	>32
Dissolved Organic Carbon (DOC)	5.4–7.1	>5	1.5–1.8	>1
Particulate Organic Carbon (POC)	5.6–7.2	>5	1.5–2.0	>1
Total Suspended Solid (TSS)	75.7–81.5	>50	12.5–14.4	>1

2) Test methods

- ① Large Size Organisms (>50 μm)
Counted using optical microscope
- ② Small Size Organisms (10~50 μm)
Counted using optical microscope
- ③ Bacteria
Spread plate method and Membrane filter method
Marine heterotropic bacteria
Escherichia. Coli
Intestinal *Enterococci*
Toxinogenic *Vibrio cholerae* (serotypes O-1, O-139)

3) Efficacy data of the treated ballast water

All data of each test cycle fulfilled the test water quality and treated ballast water defined in G8 Guideline as shown in Table 1 and 2.

Table 2 Biological Treatment Test Results in Land Based Tests

Test Cycle	Organisms	Test water (Day 0)			5 days after treatment		
		G8	Min	Max	G8	Min	Max
2, 3, 4, 5, 6 Brackish Water	≥50μm (ind./m3)	>1x10 ⁵	124, 500	208, 950	<10	0	1.3
	10-50μm (ind./ml)	>1x10 ³	1, 392	2, 014	<10	0	0
	Heterotropic bacteria (cfu/ml)	>10 ⁴	1.3E4	6.6E4	N. D.	3.0	90
	<i>Escherichia coli</i> (cfu/100ml)	N. D.	0	1	<250	0	2
	Intestinal <i>Enterococci</i> (cfu/100ml)	N. D.	5*	77*	<100	<1	<1
	Toxinogenic <i>Vibrio cholerae</i> (cfu/100ml) (serotypes O1 and O139)	N. D.	<1	<1	<1	<1	<1
1, 7, 8, 9, 10 Seawater	≥50μm (ind./m3)	>1x10 ⁵	124, 338	159, 321	<10	0.26	1
	10-50μm (ind./ml)	>1x10 ³	1, 219	3, 578	<10	0	0
	Heterotropic bacteria (cfu/ml)	>10 ⁴	1.0E4	2.8E4	N. D.	0.3	0.6
	<i>Escherichia coli</i> (cfu/100ml)	N. D.	0	0	<250	0	0
	Intestinal <i>Enterococci</i> (cfu/100ml)	N. D.	1E0*	1.5E2*	<100	0	0
	Toxinogenic <i>Vibrio cholerae</i> (cfu/100ml) (serotypes O1 and O139)	N. D.	<1	<1	<1	<1	<1

*Number of Enterococcus group N.D.: Not Defined

(2) Eco-toxicological Test

Test Organization : BallastTech NIVAAS (Norway)

Dosage concentration

TG Ballastcleaner® : 20 mg/l (as Cl₂)

Sodium sulfite : 1.6 times relative to the theoretical amount of neutralize TRO (as Cl₂)

Outline of the Test Method

Treated ballast water using TG Ballastcleaner® was neutralized by sodium sulfite after 5 days storage under dark condition in the simulated ballast water tank. This neutralized water was used for eco-toxicity tests.

Test Results : Test results are listed below.

1) Acute toxicity tests results

- | | | |
|----------------|---|-----------|
| ① Marine algae | Growth inhibition test | |
| | Marine diatoms (<i>Skeletonema costatum</i>) | no effect |
| ② Invertebrate | | |
| | 48h Marine crustacean (<i>Acartia tonsa</i>) | no effect |
| ③ Fish | | |
| | Larvae of juvenile Turbot (<i>Scophthalmus maximas</i>) | no effect |

2) Chronic toxicity tests results

- | | | |
|----------------|--|-----------|
| ① Marine algae | | |
| | Growth Inhibition tests | |
| | Marine diatoms (<i>Skeletonema costatum</i>) | no effect |
| ② Invertebrate | | |
| | 13 days Marine crustacean <i>Nitocra spinipes</i> reproduction test | no effect |
| | 72 hours Marine rotifer (<i>Brachionus plicatilis</i>) reproduction test | no effect |
| ③ Fish | | |
| | 28 days Juvenile Turbot (<i>Scophthalmus maximas</i>) | no effect |
| ④ Invertebrate | | |
| | 48 hours chronic toxicity test, Oyster embryo (invertebrate) | no effect |

From all of the above test results, neutralized ballast water has no acute or chronic toxicity effects on algae, invertebrates, or fish.

(For more information, please refer to the document MEPC 60/2/12 ANNEX 5, p. 37-p. 39)

(3) Onboard Test

Test Organization : Fuyo Ocean Development & Engineering Co. Ltd.

Test Method : Treated water using TG ballastcleaner® was neutralized after 2days.
This neutralized ballast water was inspected and analyzed.

Dosage control concentration : 10 mg/L

- ① Large Size Organisms (minimum dimension : $\geq 50\mu\text{m}$)
- ② Small Size Organisms (minimum dimension : $10\sim 50\mu\text{m}$)
- ③ Bacteria
 - 1) *Escherichia coli*
 - 2) Intestinal *Enterococci*
 - 3) Toxinogenic *Vibrio cholerae* (serotype O-1 and O-139)

Table 3 Efficacy of JFE BallastAce® on the organisms specified by G8 in onboard tests

Size of Organisms	Kind of Water	G8 Guide line	Test cycle		
			1	2	3
$\geq 50\mu\text{m}$ (ind./m ³)	Test water	≥ 100	19,741	64,814	27,285
	Treated water	< 10	0	0	0
	Control water	≥ 10	177,304	65,712	52,038
10–50 μm (ind./ml)	Test water	≥ 100	753	1,140	780
	Treated water	< 10	0	0	0
	Control water	≥ 10	627	743	117
<i>Escherichia coli</i>	Test water	Not defined	5.3	19.7	29.7
	Treated water	< 250	0	0	0
	Control water	Not defined	3	3.7	12.3
Intestinal <i>Enterococci</i>	Test water	Not defined	46.7	61.7	8.7
	Treated water	< 100	0	0	0
	Control water	Not defined	0.7	0.7	1.7
<i>Vibrio cholerae</i> (serotype O1 and O139)	Test water	Not defined	0	0	0
	Treated water	< 1	0	0	0
	Control water	Not defined	0	0	0

unit for bacteria : cfu/100ml (cfu : colony forming unit)