BIBLOGRAPHY

DATE	REV.	DESCRIPTION	CHECK	APP.	APP.	REMARK
2021.06.03	A	Submitted to Buyer for Approval	K.Y.LEE	C.E.CHOI	S.K.LEE	

OWNER

SHIP BUILDING & ENG. CO.,LTD.

FOR APPROVAL

DATE : 2021.06.03

DESIGN DEPT.

TOTAL (9) SHEETS WITH COVER

APPROVED BY	S.K.LEE	DWT 6,800 CLASS	HULL NOS. SB646 / SB647	
APPROVED BY	C.E.CHOI	PRODUCT & CHEMILCAL TANKER	Hull Design Team (Painting Design)	
APPROVED BY	K.Y.LEE	**ARR'T OF CATHODIC PROTECTION**	SCALE NONE	OWNER 성호해운
CHECKED BY			DATE 2021.06.03	REV. NO. A
DRAWN BY	JooYoung Oh(오주영) (+82-51-419-5457)		CLASS KR	DWG' NO. 3P104001PB

DETAIL DRAWING HISTORY

PAGE	1
HULL NOS.	SB646 / SB647
DWG. NO.	3P104001PB

REV.NO.	REVISED BY	REV.NO.	REVISED BY
O	OWNER'S COMMENT	DI	DESIGN IMPROVEMENT
C	CLASS COMMENT	DM	DESIGN MISTAKE
A	AUTHORITY COMMENT	DA	DETAIL ARRANGEMENT
MO	MAKER'S MISTAKE	DO	OTHER DESIGN PART

DATE	REV. NO.	REV. SYMBOL	DESCRIPTION	PAGE	REMARK
2021.06.03	A		Submitted to Buyer for Approval		

CONTENTS

1. SCOPE

The purpose of this document is to describe the requirements for design, fabrication and installation of sacrificial anodes used for the cathodic protection of sea chests

2. DESIGN BASE

2.1. Assumed electrolyte resistivity of seawater is 25 ohm - cm.

2.2. Anode utilization factor : **0.85** (for Sea Chests Anodes-Flush mounted type)

2.3. Protected potential : - 0.80 Volt or more negative with Ag/AgCl reference electrode.

2.4. Electrochemical characteristics

Alloy	Electrochemical Capacity(Ah/kg)	Closed Circuit Potential
Al-base	2,600	-1.11

2.5. Mean Current density (mA/m^2) : 25 mA/m^2 **for External hull**

2.6. Design life (years) : 5 (years) **for External hull**

2.7. Ballast ratio (%) : 100 % **for External hull**

3. DETAIL OF ANODE

Anode Type	Approx. Dimension(mm)	Net Weight(Kg)	Gross Weight(Kg)
A-135N(Al-Anode) (Flush-mounted type)	90 x 200 x 300	13.2	13.7

4. ANODE OUTPUT CURRENT

The anode current output is calculated from Ohm's law ;

$$I = \frac{\triangle V}{R}$$

where; I = Anode output current(Amp.)
R = Anode resistance(ohm)
$\triangle V$ = Driving voltage between protected steel potential and anode closed circuit
(Al) = | (-1.11 V) - (-0.80 V) | = 0.31 V

4.1 Flush-mounted Type (for Sea Chests. anode : A - 135N)

Anode resistance 'R' is given by following formular;

$$R = \frac{\rho}{2S}, \quad S = \frac{a+b}{2}$$

* A-135N : 90 x 200 x 300
ρ = 25 ohm-cm , a = 20 cm , b = 30 cm

where, ρ = Assumed electrolyte resistivity of sea water (ohm-cm)
a = anode width (cm)
b = anode length (cm)

$$R = \frac{25 \text{ ohm-cm}}{2 \times \frac{(20 + 30)}{2} \text{ cm}}$$

= 0.5 ohm

$$\text{Therefore, } I = \frac{0.31 \text{ volts}}{0.5 \text{ ohm}} = \underline{\textbf{0.620 A}}$$

5. ANODE MASS CALCULATION

① **Required Weight (kg)** $= \dfrac{\text{Lifetime of Anode(Yr)} \times 8760\text{(Hr/Yr)} \times \text{Required Current(A)} \times \text{Ballast Ratio(\%)}}{\text{Anode Material Current Capacity (A.Hr/Kg)} \times \text{Utilization Factor}}$

② **Required Anode Quantity (pcs)** $= \dfrac{\text{Required Weight (Kg)}}{\text{Individual Anode Net Weight (Kg/Pc)}}$: based on net weight

$= \dfrac{\text{Required Current (A)}}{\text{Individual Anode Output Current (A/Pc)}}$: based on output current

* Required Current(A) = Estimated Protective Area(m^2) x Current Density(A/m^2)

* Actual Total Weight (kg) = Individual Anode Net Weight (kg/Pc) x Applied Anode Quantity (pcs)

* Actual Total Current (A) = Individual Anode Output Current (A/pc) x Applied Anode Quantity (cs)

* Quantity Check : Required Weight (kg) ≤ Actual Total weight (kg) ----- O.K
Required Current (A) ≤ Actual Total Current (A) ----- O.K

6. ANODE QUANTITY CHECK PROCEDURE

6.1. ANODE TYPE A-135N

Compartments	Estimated Protective Area (m^2)	Required Weight (Kg)	Actual Total Weight (Kg)	Required Current (A)	Actual Total Current (A)	Applied Anode Q'ty (pcs)
HIGH SEA CHEST(P) (FR.27~FR.29)	17	7.9	13.2	0.4	0.6	1
LOW SEA CHEST(S) (FR.27~FR.29)	13	5.9	13.2	0.3	0.6	1
BALLAST PUMP ROOM SEA CHEST(P)(FR.32~FR.33)	10	5.9	13.2	0.3	0.6	1
Total net weight 39.6 kg		**Total gross weight 41.1 kg**		**Total quantity 3 pcs**		

7. ANODE INSTALLATION

The arrangement of the anodes shall be shown on this drawing in details. However, the actual location of the anodes may be adjusted during installation work considering its workability.

The drawings are symmetrical unless otherwise noted. Plan, section and elevation on drawings are expressed as "Looking down", "Looking forward" and "Looking port" respectively

※ Note : : Visible side anodes

: Invisible side anodes

8. ANODE MANUFACTURE

The anodes shall be manufactured in accordance with following chemical composition and manufacturer's standard.

Aluminum alloy anodes	
Zn	2.5~5.75
Al	Remainder
In	0.015~0.040
Cd	Max.0.002
Si	Max.0.12
Fe	Max.0.09
Cu	Max.0.003

9. GUARANTEE

HDM will guarantee all defects arising from design and material for a period of one(1) year after ship's delivery to the Owner.

10. ANODES QUANTITY FOR BLOCK

10.1. ANODE TYPE A-135N

BLOCK NO.	Q'TY(PCS)			PAGE NO.	BLOCK NO.	Q'TY(PCS)			PAGE NO.
	P	C	S			P	C	S	
E11		3		8					
TOTAL Q'TY OF A-135N TYPE : 3 PCS									

11. CERTIFICATE OF Al-ANODE

DNV·GL

Certificate No:
TAS00000AX
Revision No:
2

TYPE APPROVAL CERTIFICATE

This is to certify:
That the Sacrificial Anode Material for Corrosion Protection

with type designation(s)
Al-Anode (HDM)

Issued to
Haedong Metal Co., Ltd.
Busan, Republic of Korea

is found to comply with
DNV GL class programme DNVGL-CP-0107 – Type approval – Sacrificial anode materials
DNV GL recommended practice DNVGL-RP-B401 – Cathodic protection design, June 2017

Application :
The mean current capacity of the sacrificial anode material after 12 months free running testing is 2661 Ah/kg. The mean closed circuit potential is -1113 mV vs. Ag/AgCl seawater. The approval is given for use in sea water at temperatures below 30°C.

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV GL.

Issued at Høvik on 2020-10-29

This Certificate is valid until 2025-10-28.
DNV GL local station: Gimhae Station

Approval Engineer: Gisle Hersvik

for DNV GL

Gustav Heiberg
Head of Section

a. Certificate No. : TAS00000AX

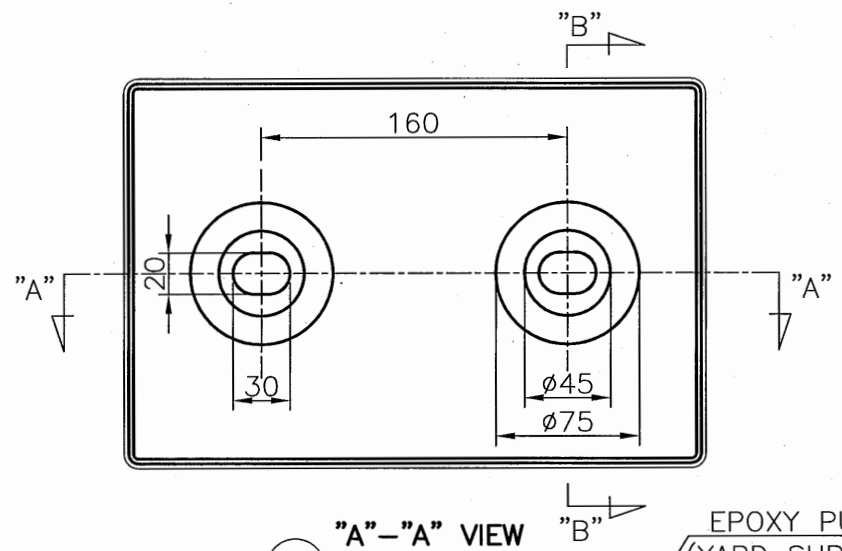
b. Type Designation : Al-Anode(HDM)

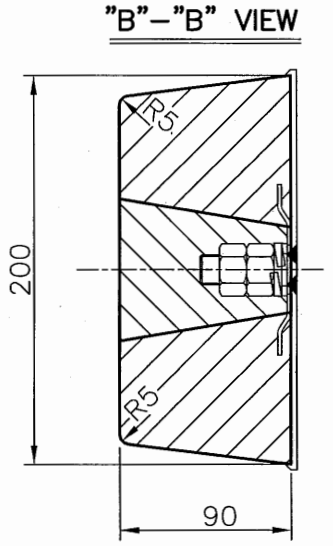
c. Manufactured : Haedong Metal Co., Ltd.

d. Application : The mean current capacity of the sacrificial anode material after 12 months free running testing is 2661 Ah/kg. The mean closed circuit potential is -1113 mV vs. Ag/AgCl seawater. The approval is given for use in seawater at temperatures below 30℃

e. Web Site
https://approvalfinder.dnvgl.com/
-> TAS00000AX

12. DETAIL OF Al-ANODE FOR SEA CHESTS & ETC.





PHYSICAL REQUIREMENTS	
SACRIFICIAL ANODE	REQUIREMENTS
TOLERANCE OF LENGTH	±3% OR ±25mm, WHICHEVER IS SMALLER
TOLERANCE OF WIDTH	±5%
TOLERANCE OF DEPTH	±10%
TOLERANCE OF WEIGHT	±3%
NET WEIGHT	13.2 Kg(90x200x300)
GROSS WEIGHT	13.7 Kg(INCLUDE RUBBER)

COMPOSITION OF Al-ANODE		
ELEMENT	MINIMUM (Wt %)	MAXIMUM (Wt %)
ZINC	2.5	5.75
ALUMINIUM	REMAINDER	REMAINDER
INDIUM	0.015	0.040
CADMIUM		0.002
SILICON		0.12
IRON		0.09
COPPER		0.003
*ANODE MATERIAL CURRENT CAPACITY : Min. 2,600 A.Hr/Kg		

NO.	DESCRIPTION	MAT'L	Q'TY	REMARK
7	RUBBER SHEET	RUBBER	1	2tx206x306(±5%)
6	SPRING WASHER	SUS304	2	M16
5	PLAIN WASHER	SUS304	2	M16
4	HEX NUT	SUS304	4	M16
3	STUD BOLT	SUS304	2	M16x50L
2	ANODE CORE	SS400	1	3tx160P(GALV'D)
1	Al - ANODE	Al-ALLOY	1	90tx200x300

TITLE

A-135N TYPE Al-ANODE(BOLTING TYPE)

PROJECT NAME	HULL NO. SB646/7			DATE	MAY 17,2021
SCALE	N/S	REV. NO.	△	DWG. NO.	3P104001PB
DESIGNED	J. H. KIM	CHECKED	H.Y. JUNG	APPROVED	Y. I. SHIN

HDM HAEDONG METAL CO., LTD.

PAGE NO. HDANODE - 7/8

※ Please contact us whenever you need an installment of new anodes or a replacement. We will provide you the design, inspection, supply services with the world best quality products.
(Tel. No.82-51-974-1051, Fax. No.82-51-831-3755, E-Mail : hdm@hdanode.com)

ARR'T OF ANODE FOR TYP. SECTION

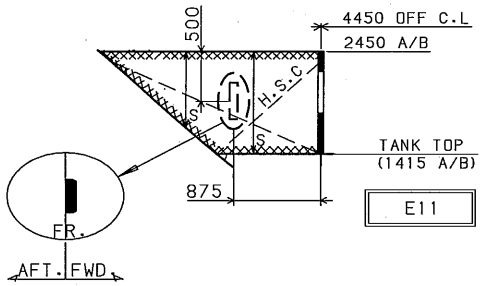
PAGE	8 / 8
HULL NO	SB646/7
DWG. NO	3P104001PB

HIGH SEA CHEST(P) (FR.27~FR.29)

TOTAL Q'TY : 1 PC

FR. 27 SEC.

Q'TY : 1 PC

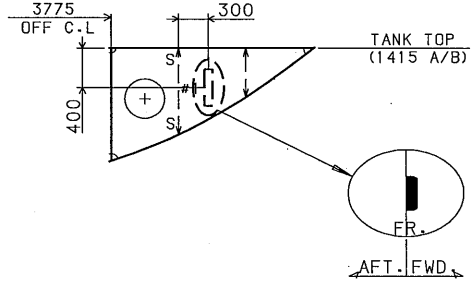


LOW SEA CHEST(S) (FR.27~FR.29)

TOTAL Q'TY : 1 PC

FR. 28 SEC.

Q'TY : 1 PC

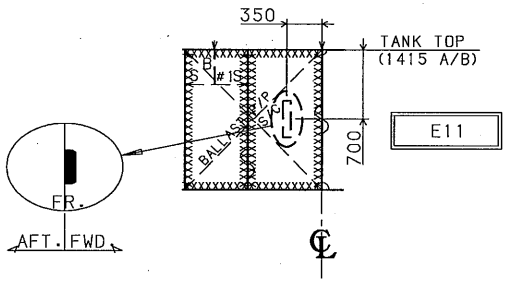


BALLAST SEA CHEST(P) (FR.32~FR.33)

TOTAL Q'TY : 1 PC

FR. 32 SEC.

Q'TY : 1 PC



⊖⊖ : A - 135N TYPE Al-ANODES

TOTAL Q'TY : 3 PCS

TITLE ARRANGEMENT OF ANODES FOR SEA CHESTS

HDM HAEDONG METAL CO., LTD.

DAE SUN SHIPBUILDING & ENGINEERING CO., LTD.