

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Printed Circuit Heat Exchanger (PCHE)

with type designation(s)
High-pressure vaporizer SS-9000WT-B-P

Issued to

Hangzhou Shenshi Energy Conservation Technology Co., Ltd.
Hangzhou, Zhejiang, China

is found to comply with

DNV rules for classification – Ships Pt.4 Ch.7 Pressure equipment
DNV rules for classification – Ships Pt.5 Ch.7 Liquefied gas tankers

Application :

Products approved by this certificate are accepted for installation on all vessels classed by DNV.

Temperature range: Both sides: -196°C to +85°C
Design pressure: Cold side: 380 bar / Hot side: 10 bar
Operating media: Cold side: LNG / Hot side: Glycol water

Issued at **Hamburg** on **2022-07-04**

This Certificate is valid until **2027-07-03**.

DNV local station: **Jiangyin NB & CMC**

for **DNV**

Approval Engineer: **Malta Frederik Niederstadt**

Jonathan Struwe
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

LEGAL DISCLAIMER: Unless otherwise stated in the applicable contract with the holder of this document, or following from mandatory law, the liability of DNV AS, its parent companies and their subsidiaries as well as their officers, directors and employees ("DNV") arising from or in connection with the services rendered for the purpose of the issuance of this document or reliance thereon, whether in contract or in tort (including negligence), shall be limited to direct losses and under any circumstance be limited to 300,000 USD.



Product description

Several types of diffusion bonded printed circuit heat exchangers to be installed in fuel gas supply system for vaporization of liquified natural gas (LNG). Cold side of heat exchanger is to heat LNG into fuel gas to be used onboard, by use of hot water on the hot side of exchanger.

DNV pressure equipment class following DNV-RU-SHIP Pt.4 Ch.7 Sec.1 [2.5.1]:

- LNG side: Class I
- Water side: Class III

Application/Limitation

Applied Rules and Design Codes:

- DNV SHIP Pt.4 Ch.7 'Pressure Equipment' (Edition July 2021)
- DNV SHIP Pt.5 Ch.7 'Liquefied gas tankers' (Edition July 2021)
- ASME Sec.IX Part QW & ASME Sec.VIII Div.1 Appendix 42

Materials

- The materials used shall have certificates acc. to DNV-RU-SHIP Pt.4 Ch.7 Sec.1 [3].
- Materials used for LNG side shall comply with DNV Pt.2 Ch.2 Sec.3 [3] 'Steel for low temperature service'.
- The supply piping of each gas consumer unit shall be provided with gas fuel isolation and vented to a safe location, under both normal and emergency operation acc. DNV-RU-SHIP Pt.5 Ch.7 Sec.16 [4.5.1].

Welding

The welding work for pressure equipment graded as PEC I shall be carried out by a welding workshop holding a valid certificate acc. to following DNV class programmes:

- DNV-CP-0261 'Approval of manufacturers – Pressure equipment' and
- DNV-CP-0352 'Approval of manufacturers – Manufacture of welded products – Welding workshop'.

NDT of inlet and outlet including attachment welds to diffusion bonded main body is to be non-destructive tested according to DNV-RU-SHIP Pt.4 Ch.7 Sec.7 [4.1.1], the welding joint efficiency is $v = 1$.

Diffusion Bonding

The diffusion bonded main body of the heat exchanger is approved according to DNV-RU-SHIP Pt.4 Ch.7 based on the requirements of ASME VIII Div.1 Appendix 42 Diffusion Bonding, in accordance with Pt.4 Ch.7 Sec.4 [1.1.4]. The design of the diffusion bonded main body is documented; acc. to ASME VIII Div.1 Appendix 42-8 first paragraph by calculations acc. to Appendix 13-9 (c), and acc. to second paragraph by **proof testing of test piece to 4 times design pressure** acc. to ASME VIII Div.1 UG-101 (m).

- Main body of heat exchanger is to be manufactured acc. to diffusion bonding procedure; diffusion bonding is to be performed by operator holding a Diffusion Bonding Performance Qualification, as described in ASME BPVC. VIII.1-2019, Div.1 Appendix 42-4.
- Diffusion bonded main body incl. attachment welds shall be examined acc. to ASME VIII Div.1 Appendix 42-7:
 - Ultrasonic examination of attachment welds
 - Liquid penetrant examination of diffusion bonded main body
 - Visual examination

Remarks

The approval is limited to the main heat exchanger body size range stated in drawing No. SS-9000WT-B-P:

Asm. Dwg. No.	CWT900000001	CWT900000002	CWT900000003	CWT900000004	CWT900000005
Length (L)	674	674	674	674	674
Width (W)	330	330	330	330	330
Height (H)	504	423	374	324	275

This type approval covers the design of the filter assembly only. Manufacturing, workmanship, and testing shall be done acc. to DNV-RU-SHIP Pt.4 Ch.7 Sec.7. Each heat exchanger assembly is to be:

- Constructional tested and hydraulic pressure tested with 1.5 times the design pressure,
- Certified by a DNV surveyor and delivered with a product certificate.

Type Approval documentation

Tests carried out

Pressure test and burst pressure test.

Marking of product

For identification to this Type Approval the products are to be marked with:

- a) the name and domicile of the manufacturer,
- b) the manufacturer's type designation and serial number,
- c) the year of manufacture,
- d) the design pressure,
- e) the design temperature (s) in °C,
- f) the hydraulic test pressure,
- g) DNV's identifying mark.

Periodical assessment

The objective of periodical assessments is to verify that the conditions for the type approval (TA) have not been altered. The main scope of the periodical assessment will normally include:

- Verification of the TA applicant's production and quality system with relation to ensuring continue consistent production of the type approved products at the TA applicant's own premises and at other companies that are given the responsibility for manufacturing of the products,
- Review of the TA documentation and that this is still used as basis for the production,
- Review of possible changes to the design, the material and the performance of the product,
- Verification of the product marking.

Periodical assessments for type approvals with a validity period of five years will be required after two years (+/- 90 days) and after 3.5 years (+/- 90 days).

Unscheduled assessments for retention of the type approval may be carried out when there is reason to believe that the TA applicant has not adhered to the obligations stipulated in the TA certificate or in the applicable requirements.

END OF CERTIFICATE