



APPROVAL OF MANUFACTURER CERTIFICATE

Certificate No:
AMMM000015R
Revision No:
4

This is to certify:

That

Doosan Enerbility Co., Ltd.
22, Doosan Volvo-ro, Seongsan-gu, Changwon-si, Gyeongsangnam-do,
Republic of Korea

is an approved manufacturer of
Steel Forgings

in accordance with

DNV rules for classification – Ships
DNV-OS-B101 – Metallic materials
DNV class programme – DNV-CP-0247 Steel forgings

and the following particulars:

| | |
|---------------------------------------|--|
| Application area | Forgings for hull structures and equipment Forgings for shafting and machinery Forgings for crankshafts |
| Steel type | Carbon and carbon-manganese, Alloy, See page 2 |
| Forging method | Open die forging |
| Max. weight | 230 000 kg |
| Heat treatment condition | See page 2 |
| Additional approval conditions | Including steelmaking |

Manufacturer(s) approved by this certificate is/are accepted to deliver according to DNV GL, DNV and GL rules.
Materials to be applied to DNV classed object shall fulfill the material requirements in the applicable DNV class rules.

Issued at **Hamburg** on **2023-02-23**

for **DNV**

This Certificate is valid until **2025-12-31**.

DNV local unit: **Gimhae Station**

Approval Engineer: **Andreas Koch**

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Thorsten Lohmann
Head of Section

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.



Particulars of the approval

Forgings for hull structures and equipment

| Steel type | Grade ³⁾ | Forging method ¹⁾ | Max. weight [kg] | Heat treatment condition ²⁾ |
|------------|--|------------------------------|------------------|--|
| C and C-Mn | NV F400UW, NV F440UW, NV F480UW, NV F520UW, NV F560UW, NV F600UW | OD | 230 000 | N, NT, QT |
| Alloy | NV F550AW, NV F600AW, NV F650AW | OD | 230 000 | QT |

Forgings for shafting and machinery Forgings for crankshafts

| Steel type | Grade ³⁾ | Forging method ¹⁾ | Max. weight [kg] | Heat treatment condition ²⁾ |
|------------|--|------------------------------|------------------|--|
| C and C-Mn | NV F400U, NV F440U, NV F480U, NV F520U, NV F560U, NV F600U, NV F640U, NV F680U, NV F720U, NV F760U | OD | 230 000 | N, NT, QT |
| Alloy | NV F600A, NV F700A, NV F800A, NV F900A, NV F1000A, NV F1100A | OD | 230 000 | QT |

Extra high strength steels for structural application

| Steel type | Grade | Forging method ¹⁾ | Max. weight [kg] | Max. thickness [mm] | Heat treatment condition ²⁾ |
|------------|---------------------------------|------------------------------|------------------|---------------------|--|
| Alloy | NV EO690 QT S ⁴⁾⁵⁾⁶⁾ | OD | 30 000 | 254 | QT+SR |

Remarks:

- 1) OD: Open die forging
- 2) QT: Quenched and tempered
 QT + SR: Quenched and tempered together with stress relieved
 N: Normalized
 NT: Normalized and tempered
- 3) Incl. equivalent grades in acc. to other standards
- 4) Qualified with CTOD test at CGHAZ after welding with a minimum value and average value of 0.12 and 0.16 respectively.
- 5) Acceptance testing shall be performed on each piece as per DNVGL-RU-SHIP Pt.2 Ch.2 Sec.2 / DNVGL-OS-B101 and to comply with the requirements given therein. Furthermore, the test results (mechanical properties as well as chemical analysis) shall comply with the manufacturer specification **MIP-CF-OSPQ-210705 Rev.0** dated 2021-07-05.
 Definitions given in DNVGL approval letter No. A1027943 / 263.11-011368-1 dated 2021-07-05 to be observed.
- 6) Qualified max. heat input. 2.8 kJ/mm. $C_{eq} = 0.82$ during weldability testing