



# APPROVAL OF MANUFACTURER CERTIFICATE

Certificate No:  
**AMMM000015R**  
Revision No:  
**2**

This is to certify:

That

**Doosan Heavy Ind. & Construction Co., Ltd.**  
**Changwon-si, Gyeongsangnam-do,**  
**Republic of Korea**

is an approved manufacturer of  
**Steel Forgings**

in accordance with  
**DNV GL rules for classification – Ships**  
**DNVGL-OS-B101 – Metallic materials**

and the following particulars:

<b>Application area</b>	<b>Forgings for hull structures and equipment Forgings for shafting and machinery Forgings for crankshafts</b>
<b>Steel type</b>	<b>Carbon and carbon-manganese, Alloy, See page 2</b>
<b>Forging method</b>	<b>Open die forging</b>
<b>Max. weight</b>	<b>230 000 kg</b>
<b>Heat treatment condition</b>	<b>See page 2</b>
<b>Additional approval conditions</b>	<b>Including steelmaking, Approved as Independent Heat Treatment Company, See page 3</b>

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 **2021-07-05**

for **DNV**

This Certificate is valid until **2022-12-31**.

DNV local station: **Gimhae Station**

Approval Engineer: **Eva Junghans**

**Thorsten Lohmann**  
**Head of Section**

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Form code: AM 311

Revision: 2021-03

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## Particulars of the approval

### Forgings for hull structures and equipment

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

### Forgings for shafting and machinery

#### Forgings for crankshafts

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

#### Remarks:

- 1) OD: Open die forging
- 2) QT: Quenched and tempered  
 N: Normalized  
 NT: Normalized and tempered
- 3) Incl. equivalent grades in acc. to other standards

**Extra high strength steels for structural application**

Steel type	Grade	Forging method <sup>1)</sup>	Max. weight [kg]	Max. thickness [mm]	Heat treatment condition <sup>2)</sup>
Alloy	VL EO690 QT S <sup>3)4)5)</sup>	OD	30 000	254	QT

Remarks:

- 1) OD: Open die forging
- 2) QT: Quenched and tempered
- 3) Qualified with CTOD test at CGHAZ after welding with a minimum value and average value of 0.12 and 0.16 respectively.
- 4) 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.
- 5) Qualified max. heat input. 2.8 kJ/mm.  $C_{eq} = 0.82$  during weldability testing

**Approval scope for Independent Heat Treatment Company**

Item	Description
Product type	Steel Forgings
Steel Type	Carbon and carbon-manganese, Alloy
Maximum Loading Weight	2-2-1B: 160 ton 2-2-4G: 200 ton 2-2-4B: 250 ton 2-2-1A: 160 ton 2-2-17: 250 ton 2-2-1D: 150 ton
Max. Thickness	Carbon and carbon-manganese: 1 400 mm Alloy: 1 000 mm
Heat Treatment Type	2-2-1B: Normalizing, Tempering, Stress Reliving 2-2-4G: Quenching, Normalizing, Tempering, Stress Reliving 2-2-4B: Quenching, Normalizing, Tempering, Stress Reliving 2-2-1A: Quenching, Normalizing, Tempering, Stress Reliving 2-2-17: Normalizing, Tempering, Stress Reliving 2-2-1D: Tempering, Stress Reliving
Furnace Details	Car bottom type, Working zone (mm): 2-2-1B: Length 10 500, Width 6 000, Height 3 000 2-2-4G: Length 15 600, Width 4 000, Height 3 000 2-2-4B: Length 17 500, Width 5 000, Height 3 000 2-2-1A: Length 9 500, Width 6 500, Height 3 000 2-2-17: Length 12 000, Width 6 000, Height 3 000 2-2-1D: Length 9 800, Width 4 900, Height 3 000
Heat Treatment Procedure	Doc. No. HTF-CF1403 Rev.9 dated 2019-07-10
Temperature Uniformity Survey Procedure	Doc. No. HTF-CF1402 Rev.7 dated 2018-07-10