

## Industeel®S355NLO

### Industeel®S355NLO : A weldable normalized structural steel for large offshore structures with excellent toughness and weldability

**Industeel®S355NLO** is a normalized structural steel plate grade with a nominal minimum yield strength of 300MPa\* ( for thickness range >150mm) dedicated to large offshore structures in the North Sea and similar environments. Thanks to the application of Option 17 of EN10225, the weldability of the steel is prequalified with a documentary file that has been reviewed by DNV-GL and Lloyd's Register, making its implementation easier.

Its extreme purity with very low sulphur and phosphorus contents, as well as its adapted chemical analysis, makes **Industeel®S355NLO** easy to cut, shape and weld, and provides excellent impact toughness and CTOD properties in the very large sizes available.

**Industeel®S355NLO** is elaborated through Electric Arc Furnace (EAF) melting of selected scraps with fine grain practice, vacuum treatment and ingot casting to provide the necessary characteristics of the material. The steel is rolled in plates with a quarto mill and finished using a separate normalizing heat treatment.

\* 1MPa = 1N/mm<sup>2</sup> , for thickness above 150 mm.

#### PROPERTIES

#### STANDARD

##### CLASSIFICATION SOCIETY AND STANDARD (MAX. THICKNESS TESTED)

EN 10225:2009 S355G10+N (250 mm)

EN 10225-1:2019 S355NLO or 1.8808 (250 mm)

DNV-GL VL E36 (250 mm), VL F36 (200 mm on demand)

ABS AB EH36 Z35 (250 mm), AB FH36 Z35 (200 mm on demand)

LR LR EH36 (400 mm), LR FH36 (200 mm on demand)

**Industeel®S355NLO** has been qualified to the following requirements of EN10225-1.2019

Option 11 (strain-ageing testing)

Option 12 (through-thickness testing)

Option 17 (weldability testing)

This prequalification has been reviewed and approved by DNV-GL and Lloyd's Register.

The grade can be delivered according to **NORSOK M-120 Ed. 5 datasheet MDS-Y20 Rev.5** and at thicknesses above the maximum defined in the standard.

#### CHEMICAL ANALYSIS - WEIGHT %, MAXIMUM UNLESS A RANGE IS INDICATED

C	Si	Mn	P	S	Cr	Mo	Ni	Al	Cu
0,14	0,15 0,55	1,00 to 1,65	0,020	0,010	0,25	0,08	0,70	0,015 0,055	0,30
N	Nb	Ti	V	B	Nb+V	Nb+V+Ti	CEV	Pcm	
0,010	0,050	0,025	0,060	0,0008	0,06	0,08	<b>0,43</b>	0,22	

$$CEV = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15$$

$$Pcm = C + Si/30 + (Mn+Cu+Cr)/20 + Ni/60 + Mo/15 + V/10 + 5 B$$

## PROPERTIES

### MECHANICAL PROPERTIES

#### Tensile

Thickness range (mm)	Yield Strength $R_{eH}$ (MPa)	Tensile Strength $R_m$ (MPa)	Yield to tensile strengths ratio	Elongation on base 5,65 $\sqrt{S_0}$ A (%)	Through thickness reduction of area Z (%)
80-150	325	460-620	Maximum 0,87	Minimum 22	Minimum 35
150-250	Minimum 300	450-600	Maximum 0,87	Minimum 22	Minimum 35

1MPa = 1N/mm<sup>2</sup>

#### Charpy Impact tests

Minimum values according to EN10225-1:2019 Table 5

Test temperature	Transverse direction impact test sub-surface	Transverse direction impact test mid-thickness
-40°C	Minimum 50 J	Minimum 50 J

#### CTOD

EN 10225-1:2019 Option 17 has been prequalified for

**Industeel®S355NLO** according to Norsok MDS-Y20

Temperature	As welded condition	580°C nominal PWHT condition
-10°C	Minimum 0,25 mm	Minimum 0,20 mm

CTOD test specimen of weldment

## DELIVERY CONDITIONS

The steel is manufactured through Electric Arc Furnace (EAF) melting of selected scraps with fine grain practice, vacuum treatment and ingot casting to provide the necessary characteristics of the material.

#### Sizes

Thickness range.....80mm to 255mm

Maximum unit weight.....60 tonnes

Maximum width.....4350mm

Maximum length.....19000mm

#### Heat treatment conditions

Heat treatment.....normalizing of plates at 900°C

Simulated PWHT.....on request on test coupon; nominal 580°C

#### Material condition

Edges.....oxycut

Surface condition.....EN10163-2 Class B Sub-class 3, ground

Internal soundness.....ultrasonic testing according to EN10160 S1/E2

Other delivery conditions can be agreed on request



Very large plate sizes are available

## PLATE PROCESSING

### FORMING, CUTTING & MACHINING

Industeel®S355NLO can be processed with the parameters generally applied for mild steels. Please enquire for advice if requested.

### WELDING

The weldability of Industeel®S355NLO is excellent thanks to its balanced chemical composition. The weldability has been prequalified according to EN 10225-1:2019 annexes B, C, D according to Option 17:

#### Weldability testing according to annex B

Cross weld tensile tests and Charpy V notch impact tests at -40°C fulfill the requirements of the standard. Eighteen 250mm thick CTOD tests have also been performed to check NORSOK MDS-Y20 requirements at -10°C.

#### Bead on plate tests (BOP) according to annex C

Maximum hardness is below the required 325HV<sub>10</sub>

#### Controlled Thermal Severity test (CTS) according to annex D

No cracking has been observed after preheating at 50°C.

### Welding processes

Conventional fusion welding methods can be used, such as submerged arc welding (SAW), flux cored wire arc welding (FCAW), metal cored arc welding (MCAW), shielded metal arc welding (SMAW), GMAW and GTAW. Preheating at 125°C is recommended and interpass temperature should be limited to a maximum of 250°C. A maximum heat input of 3,5kJ/mm should be observed to achieve good properties in the weld metal. A Post Weld Heat Treatment (PWHT) at 580°C +/- 10°C for 1hour per 25mm thickness is appropriate.

### Welding consumables

Fluxes should be re-dried at 300-350°C for minimum 2 hours and stored at 150°C until used.

Standard	SMAW	GMAW	FCAW MCAW	SAW
AWS	AWS A5.1 E7018-G H4R AWS A5.5 E8018-C3 H4R	AWS 5.28 ER80S-Ni1	AWS A5.36 E71T5-M21P8-G-H4 E8xT1x-M21P8-Ni1-H4	AWS A5.17 F7A8-EH12K F7P8-EH12K
EN	EN ISO 2560-A E 42 4 B 3 2 H5 E46 6 1Ni B 4 2 H5	EN ISO 14341-A G 46 6 M21 3Ni1	EN ISO 17632-A T 42 6 Z B M 1 H5 T46 6 1Ni x M 1 H5	EN ISO 14171-A S46 6 FB S3Si

## APPLICATIONS

Industeel®S355NLO is designed for use in thick and very thick parts of large offshore structures.

## YOUR CONTACTS

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