



GROTNES STEEL

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| Specification: NS-EN 10025        | Revision:    | 06                 |
| Material: HEAVY STEEL PLATE/SHAFT | Designation: | GROTNES TTSTE355Z3 |
| Approved: Knut Hatlen             | Date:        | 28.04.2015         |

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## 2.0 INTRODUCTION

This document is an attachment to Grotnes Steel AS purchase orders for slabs and blooms of steel used for flame cut products.

## 3.0 SCOPE

This document is referring to the standards NS-EN 10025 and \*NORSOK M-120, MDS Y-20 rev.5 2007.

The document specifies the selected options in the referred standards and modified requirements which shall supersede the corresponding requirements in the same standards.

*Exception:*

*\* When NORSOK MDS Y-20 requires CTOD (CTOD only on customers demand)*

## 4.0 MATERIAL

### 4.1 Material designation

The material is designated TTSTE355Z3.

### 4.2 Steel making process and refining

Liquid pig iron shall be produced from iron ore in a blast furnace and the steel making shall be executed in a converter.

Steel refining shall be executed in a ladle furnace adding elements as Mn, Nb, Ca, Si and reducing C. The steel finally has to be vacuum degassed to achieve acceptable levels of N and H.

### 4.3 Casting

The steel is to be cast with temperature control and shrouded pouring into big end up, bottom poured steel ingot moulds.

After stripping of the ingots, the surface shall be inspected and harmful defects removed by scarfing before soaking.



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#### 4.4. Rolling/Forging

The ingots are to be rolled / forged applying sufficient water pressure to remove possible surface- scaling. After rolling / forging the surface of the plates or shaft shall be inspected, ultrasonic tested and tolerances checked. If necessary, mechanical flattening shall be executed.

Ends shall be trimmed back to clean steel.

#### 4.5. Chemical composition

The chemical composition shall be within the limits as follows:

|                    |   |                 |
|--------------------|---|-----------------|
| %C                 | : | 0.11 - 0.14     |
| %Si                | : | 0.30 - 0.40     |
| %Mn                | : | 1.30 - 1.45     |
| %P <sub>max</sub>  | : | 0.030           |
| %S <sub>max</sub>  | : | 0.008           |
| %N <sub>max</sub>  | : | 0.012           |
| %Al                | : | 0.030 - 0.050   |
| %Cr                | : | 0,10 - 0.20     |
| %Mo <sub>max</sub> | : | 0.05            |
| %Ni                | : | 0,10 - 0.30     |
| %Cu <sub>max</sub> | : | 0.20            |
| %Nb                | : | 0.020 - 0.035   |
| %V <sub>max</sub>  | : | 0.02            |
| %Ti <sub>max</sub> | : | 0.01            |
| %Sn <sub>max</sub> | : | 0.020           |
| %Ca                | : | 0.0020 - 0.0040 |
| %Cr+%Cu+%Mo        | : | max 0.45        |
| CE <sub>max</sub>  | : | 0.41            |
| H                  | : | max 2 ppm       |

#### 4.6 Destructive testing (DT)

The material shall be tensile- and impact- tested longitudinal and / or transverse\* to the rolling direction (X/Y) and with documented through thickness properties (Z). Samples shall be located as described in the standard NS-EN-ISO 377.

\* Depending on referring standard



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#### 4.7 Mechanical properties in longitudinal- / transverse- to rolling direction

| Material       | Thickness (mm) | Tensile strength, $R_m$ (N/mm <sup>2</sup> ) | Min. yield strength, $R_{eH}$ (N/mm <sup>2</sup> ) | Min. elong. (mm) | Min. Charpy-V, Average (°C/J) |
|----------------|----------------|--|--|------------------|-------------------------------|
| TTSTE355Z3-MOD | 63 < t ≤ 150   | 470-630                                      | 340  | 22               | -46*/50                       |
| TTSTE355Z3-MOD | 150 < t < 720  | 460-620                                      | 320  | 22               | -46*/50                       |

\* Unless other agreed with the customer

#### 4.8 Heat treatment

##### Normalizing:

The heating rate shall be 50<sup>0</sup>C per hour. The material is held at normalizing temperature 915<sup>0</sup>C for 2,4 minutes per mm thickness and cooled in shallow air.

All flame cut parts shall be normalized according to this procedure, unless otherwise is agreed.

##### Stress relieving

If stress relieving after welding are necessary, the material shall be stress relieved at temperature 580<sup>0</sup>C for 2,4 minutes per mm thickness. Heating rate is 50<sup>0</sup>C. Cooling rate is 50<sup>0</sup>C down to 300<sup>0</sup>C, then shallow air.

All welds shall be stress relieved according to this procedure, unless otherwise is agreed. For flame cut products stress relieving must be agreed separately.

Graphs for normalizing and stress relieving procedures are shown in Appendix 2.

#### 4.9 Non destructive testing (NDT)

The material shall be Ultrasonic Tested (UT) fulfilling the acceptance criteria given in EN 10160 S1/E2. MPI is to be performed according to ASME V and fulfilling the acceptance criteria given in ASME VIII, appendix 6.

#### 4.10 Marking

All material shall be traceable.

#### 4.11 Certification

All materials shall be certified according to EN 10 204 Type 3.1.



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## 5.0 APPENDIX 1 – TYPICAL TEST CERTIFICATE



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**Test Certificate of Materials**

|                  |  |                                |                  |  |               |
|------------------|--|--------------------------------|------------------|--|---------------|
| Date             |  | 15.04.2015                     | Certificate no.  |  | 11988,0       |
| Our order        |  | 22295                          | Invoice no.      |  |               |
| Your order       |  | P28462                         | Material quality |  | TTSTE 355 Z3. |
| Purchaser/client |  | SERVICYLINDERSERVICE AS        |                  |  |               |
| PB 3269 Sluppen  |  | 7439 Trondheim                 |                  |  |               |
| Destination      |  | Rissa                          |                  |  |               |
| Certification    |  | 3.1 EN 10204                   |                  |  |               |
| Stamping         |  | C01732                         |                  |  |               |
| Delivery cond.   |  | N                              |                  |  |               |
| Object           |  | Emne skåret tegn. 05254 Rev. A |                  |  |               |

**CERTIFIED MATERIAL**

|      |                                |            |                  |         |        |          |   |          |
|------|--------------------------------|------------|------------------|---------|--------|----------|---|----------|
| Item | Emne skåret tegn. 05254 Rev. A | Dimensjons | 175x328x371/ø100 | Cast no | C01732 | Quantity | 1 | Surveyor |
|------|--------------------------------|------------|------------------|---------|--------|----------|---|----------|

**CHEMICAL COMPOSITION %**

| Item | Cast no. | C     | Si%  | Mn%  | P%    | S%    | N%    | Cr%   | Ni%   | Al%   | Cu%   | Mo%   | Nb%   | V%    | Sn%   | Ti%   | H <sub>2</sub> ppm | CE   |
|------|----------|-------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------------------|------|
|      | C01732   | 0,121 | 0,33 | 1,37 | 0,012 | 0,001 | 0,003 | 0,111 | 0,135 | 0,033 | 0,011 | 0,003 | 0,024 | 0,003 | 0,002 | 0,003 | 1,4                | 0,38 |

**TEST RESULTS**

| Cast no. | Test no. | Yield Point.<br>N/mm <sup>2</sup><br>R <sub>e</sub> 2 | Tensile<br>strength | Elongation<br>A 5 % | Contraction<br>% | Impact test (J) | °C  |        |
|----------|----------|---|---------------------|---------------------|------------------|-----------------|-----|--------|
| C01732   | 8 X2     | 342   | 482                 | 40,7                | 80               | 209-182-212     | -46 | 175 mm |
| C01732   | 8 Z1     | 321   | 492                 |                     | 78               | 150-176-154     | -46 | 175 mm |
| C01732   | 8 Z2     | 321   | 491                 |                     | 78               |                 |     | 175 mm |
| C01732   | 8 Z3     | 323   | 495                 |                     | 77               |                 |     | 175 mm |

Non-destructive testing. Remarks

Report.no:

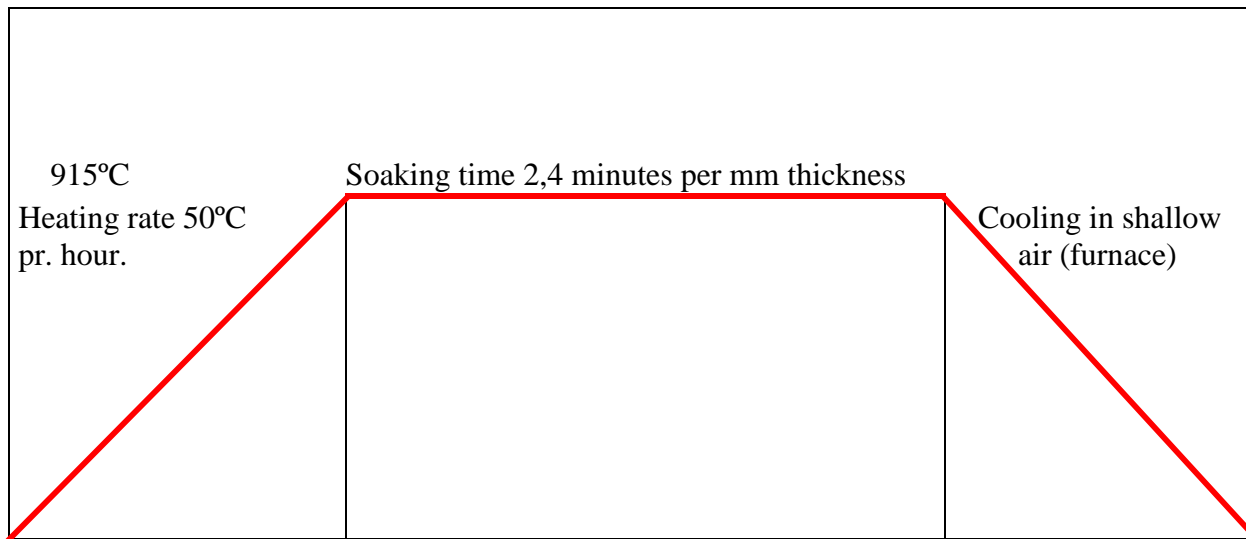


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## 6.0 APPENDIX 2 – TYPICAL HEAT TREATMENT

### Standard Normalizing at 915°C



### Standard Post Weld Heat Treatment at 580°C

