R1 78 40 01 Technical Directive

Inspection specifications for steel castings and steel forgings.

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Intended for the Location IJmuiden

Information and alterations:

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1. GENERAL

1.1. Scope

The inspection specifications have been set up for the purpose of establishing general requirements and methods of inspections for all grades of steel castings and forgings, ordered either directly through Corus IJmuiden or through third parties.
This Technical Directive is a partial elaboration of, and a continuation of instructions pertaining to article 6 of the Conditions of Delivery of Corus IJmuiden

Castings such as bells and hoppers, for which separate inspection specifications exist, do not fall within the scope of this Technical Directive.

1.2. Definitions

The following definitions are applicable in this Technical Directive:

- Supplier/manufacturer: The foundry or forge that produces the castings or forgings.

- Customer: Corus IJmuiden

Furthermore, in the event that a third party places an order at a supplier for castings or forgings destined to be used by Corus, within the framework of this Technical Directive, Corus is, and will always continue to be, considered as the customer.

- The customer's inspection service: The inspection body of the quality control department of Corus IJmuiden, or a similar inspection body appointed by Corus IJmuiden to carry out such inspection activities.

- Ordered unit: A shipment, comprising one or more items of the same steel grade that is ordered at the same time, or practically at the same time.

- Inspection unit: A shipment, comprising one or more items of the same steel grade, for which the results of a prescribed inspection – with respect to its/their acceptance or rejection – is applicable.

2. DEFINITIONS OF STEEL CASTINGS AND FORGINGS

Orders for steel castings and forgings must, in principle, be in accordance with that for a product standard, whereby the conditions mentioned later on in this Technical Directive and pertaining to the inspection must be taken into account. With respect to the mechanical and chemical requirements that the steel castings must comply with, unless it is otherwise prescribed in the order, reference is similarly made to the applicable product standard.

The quality grades of steel castings and forgings are given below.

2.1. Unalloyed steel castings for general purposes

In accordance with DIN 1681: unalloyed steel castings for which, at room temperature, specific mechanical requirements are applicable.
In accordance with DIN 17182: unalloyed steel castings with better weldability and superior mechanical properties than unalloyed steel castings in accordance with DIN 1681.

2.2. Quenched and tempered steel castings

In accordance with SEW 510 or SEW 515: steel castings that in a quenched and tempered condition are usable up to temperatures of approximately 300 C°. The required quench and temper condition must be given on the order. The method of quenching and tempering will be left to the discretion of the supplier.

2.3. Steel castings for service at elevated temperatures

In accordance with DIN 17245: steel castings whose mechanical properties can be guaranteed in applications up to 600 C°.

2.4. Steel castings for service at low temperatures

In accordance with SEW 685: steel castings that retain sufficient ductility at temperatures lower than -10 C°.

2.5. Stainless steel castings

In accordance with DIN 17445 and SEW 410: steel castings containing at least 12% Cr. and which are particularly resistant to chemical attack.

2.6. Highly heat resisting steel castings

In accordance with DIN 17465: steel castings that are particularly resistant to the oxidisation effects of gases above a temperature of 600 C°.

2.7. Wear resistant steel castings

This denomination is given to austenitic steel castings that offer good resistance to wear in conditions of use in which hardening takes place as a result of shock loads or pressure, in accordance with SEW 395.

2.8. Steel castings for surface hardening

This category comprises alloyed and unalloyed steel castings that are particularly suitable for flame hardening, induction hardening, and other methods of surface hardening, in accordance with SEW 835.

The heat treatment condition and the location of the area(s) to be surface-hardened on the steel castings must be indicated on the order. If the surface hardening treatment is to be carried out by or on behalf of the steel casting supplier, the applicable party is responsible for determining the surface hardness and, if specified, the depth of case. The results of the appropriate test must be given on an accompanying document (refer to section 4.1).

2.9. Unalloyed steel forgings

In accordance with EN 10083, part 2, in which the mechanical properties are laid down.

2.10. Quenched and tempered steel forgings

In accordance with EN 10083, part 1, in which the mechanical properties are laid down and with particular emphasis being placed on the thickness of the material.

3. GENERAL REQUIREMENTS

3.1. Preparation and manufacture

Unless it is otherwise specified by the customer or in the applicable product standard or manufacturing instruction, the method of manufacture used to make the steel castings or forgings will be left to the discretion of the supplier.

3.2. Delivery conditions

Before being submitted for inspection, the castings or forgings must undergo heat treatment. However, the highly heat resisting grades of steel castings form an exception to this rule, because a number of these grades do not undergo any form of heat treatment. Generally speaking, this also applies to forgings.

Unless it is otherwise stated, the heat treatment with respect to the dimensions, shape, and chemical composition, must comply with the relevant specifications for the applicable material grade.

If more quenching and tempering requirements are given in the product standard, it is the customer's responsibility to indicate the minimum required tensile strength.

When submitted for inspection, materials must be free of feeders, risers, fins, moulding and core sand, and loose scale.

In the customer's estimation, the castings or forgings must not have any shrinkages, blisters, porous areas, sand or slag inclusions, or any other such defects that might have a detrimental effect on the use they are intended for. Cracks and unfused chaplets are not acceptable.

3.3. Rectification of defects

3.3.1. Repairs by means of cutting, gouging, or grinding

Providing the wall thickness is not reduced to the extent it falls below the minimum as defined by the dimensional tolerances, minor superficial casting defects may be removed by cutting, gouging, or grinding until a smoothly blended transition is achieved.

3.3.2. Repairs by means of welding

Inhomogenities such as inclusions, blowholes, blisters, cracks, and the like, may, if necessary, be repaired by welding.

Unalloyed steel castings and forgings

Providing this does not have any detrimental influence on the use of the casting or forging, the supplier is authorised to repair 'minor casting defects' on unalloyed castings and forgings by welding.
In such a case, the defect – after the casting or forging has undergone the applicable heat treatment – must first be removed all the way down to sound material. This must be done in compliance with the appropriate checking methods.

This repair, if necessary with the aid of preheating, must be carried out in a responsible manner and using the latest technology. Obvious differences in hardness are not acceptable.

The following cannot be regarded as "minor casting and forging defects":

- craters with a depth greater than 20% of the local thickness
- craters with a depth greater than 25 mm
- craters with an area greater than 100 cm^2
- craters which mean the casting is no longer pressure proof

In such cases, welding may only be used with the express permission of the customer's inspection service.

After being welded, the castings or forgings must undergo a heat treatment.

Alloyed steel castings and forgings

Alloyed steel may only be welded after permission is received from the customer's inspection service. After being welded, the castings or forgings must undergo a heat treatment.

General

If permission to weld is given, this can be made subject to the compliance with one or more requirements to be specified later, or the making of supplemental guarantees, such as the provision of a situation diagram giving details of the location and description of the repair, or the results of a crack-detection inspection and determination of the hardness.

Welded repairs are subject to the same requirements that are originally placed on the castings or forgings.

Special requirements pertaining to such welding repairs can be incorporated in the drawing or the order, and if incorporated, these requirements will overrule the directions given in this Technical Directive.

3.4. Shape and dimensions

The shape and dimensions of a casting or forging must correspond with the model or drawing on the basis of which it was originally ordered.
Deviations from the model or drawing, that may be necessary or desirable for moulding or casting purposes, may be carried out by the supplier after consultation with, and approval from, the customer.
It is the responsibility of the supplier to check the patterns and drawings provided by the customer; in accordance with article 4 of the Terms and Conditions of Delivery of Corus IJmuiden, the supplier is expected to carry out such verification.

In the event of dimensional deviations of unmachined casting surfaces for which no tolerances are stipulated, the provisions in DIN 1683 will be applicable.

If the drawing does not specify which tolerance groups the casting is to be manufactured in accordance with, tolerance group 19/5 will be applicable for length dimensions (in accordance with DIN 1683 – page 1, table 2), and tolerance group 18 will be applicable for thickness dimensions (in accordance with DIN 1683 – page 1, table 3).

3.5. Machining allowance

It is the responsibility of the supplier to ensure that sufficient machining allowance is present on the areas of the casting that are to be machined. These areas will be indicated on the drawing. If a pattern has been supplied by the customer, the supplier must verify that sufficient machining allowance is present.

3.6. Machining

If the supplier is also responsible for machining the material, such machining must be in complete accordance with the drawings provided by the customer, and must also take into account the indicated machining symbols, tolerances, roughness values, and any other specifications indicated on the drawing or provided separately by the customer.
For machined dimensions for which no tolerances are given, that which is indicated in DIN 7168 will be applicable. If no other required degree of accuracy has been specified in the order, generally speaking, the “mittel” class will be applicable.

3.7. Manufacturers’ trademarks

Every casting must be provided with the supplier’s trademark. For all other markings refer to section 4.2.5 of this directive.

3.8. Visual and dimensional inspection

The customer's inspection service is authorised to inspect the appearance and dimensions of the castings or forgings on the supplier's premises. To this end, the castings or forgings must be such that this inspection will be made possible without hindrance. They may not be painted or coated in oil or similar substances.

The supplier is obliged to have at its disposal suitably trained personnel and sufficiently accurate measuring instruments so that the customer's inspector can be suitably convinced of the products' dimensional integrity. If required, it must be possible to carry out ultrasonic wall thickness measurements.

3.9. Weight

Possible weight requirements must be agreed between the customer and supplier in a timely manner.

3.10. Rejection

The non-compliance with mechanical and/or chemical requirements, internal or external defects, dimensional deviations or weight deviations, which, in the opinion of the customer, can have a detrimental effect on the usability of the product, can lead to rejection. Unless, that is, the acceptability of one or more such deviations has been agreed to, in writing, by the customer, including the definition of specifically agreed guarantee arrangements.

Any process carried out on the products that is clearly meant to distract attention from any defects, can also lead to rejection.

In the event of complaints after delivery, the supplier will be expected to investigate the foundations of such complaints.

3.11. General

If it is not otherwise stated in this Technical Directive, the conditions according to European standard EN 10204 will be applicable.

4. MATERIALS TESTING

4.1. Documents

Group A: Unalloyed steel, **without** guaranteed impact value (energy absorbed)

Guaranteed tensile strength	Documents
< 570 N/ mm²	Test report in accordance with European standard EN 10204.2.2 of the chemical analysis
≥ 570 N/ mm²	Inspection certificate in accordance with European standard EN 10204.3.1.B, including the chemical analysis and the Brinell hardness.

Group B: Unalloyed steel, **with** guaranteed impact value (energy absorbed)

Guaranteed tensile strength	Documents
< 570 N/ mm²	Inspection certificate in accordance with European standard EN 10204.3.1.B, including the chemical analysis and the results of tensile and impact tests.
≥ 570 N/ mm²	Inspection certificate in accordance with European standard EN 10204.3.1.C, including the chemical analysis and the results of tensile and impact tests.

Group C: Quenched and tempered steel castings and other grades of special steel castings

Inspection certificate in accordance with European standard EN 10204.3.1.C, including the chemical analysis and the results of tensile and impact tests, and, if applicable, supplementary tests specified on the drawing or on the order.

In special cases, such as castings or forgings deemed by the customer to be of exceptional importance, or those with extremely light or heavy weights or dimensional proportions, the above may be deviated from. These exceptions will be indicated in the order or on the drawing. If considered necessary, the customer's inspection service can, after placement of the order, yet prior to manufacture, make further arrangements with respect to the testing procedure.

4.2. Mechanical tests

If the inspection certificate is in accordance with European standard EN 10204.3.1.C, the inspection will be carried out by the customer's inspection service. In such a case the following conditions will be applicable:

- batch weight of ≤ 2500 kg: at least one test piece

- batch weight of > 2500 kg: at least one test piece per 2500 kg, plus one test piece for the remaining part above 1250 kg
- batch weight of ≥ 5000 kg: at least two test pieces

4.2.1. Number of test pieces

Unless it is stated in the order that the material tests must be carried out piece by piece, the number of cast test pieces per cast and/or per annealing furnace batch will be of the same material quality.

4.2.2. Characteristics of the test pieces

Cast-on test pieces must, over their complete length, correspond closely with the casting or forging and must therefore have been subjected to the same conditions – with respect to heating and cooling – as the immediately adjacent material of the product.

4.2.3. Amount of test material

The amount of cast-on or forged-on test material must be such that in addition to being able to provide the required number for the inspection, or the otherwise agreed number of test pieces, it will also be sufficient to fabricate a number of extra test pieces for possible repeat tests.

4.2.4. Location and direction of the test pieces

The test pieces must, insofar as possible, be cast-on at approximately half the height of the product and in such a way that the structure of the test piece will correspond as much as possible with the structure of the product itself.

If more than one test piece is to be made per product, these must – in principle – be diametrically opposite each other alongside the longest axis of the product. If the supplier is of the opinion that it is not possible to cast-on the test pieces, consultation between the supplier and the customer's inspection service must take place.

4.2.5. Stamping and removing test pieces

The test pieces are stamped after the products have undergone a heat treatment.
Every test piece will be marked on its head with the appropriate number of inspection stamps of the customer or the customer's authorised inspection service and with the test-piece number. Moreover, this is to be carried out in such a way that the markings will remain easily visible after the test pieces have been machined.
When submitted for inspection, the products must be provided with the cast or forge number. Above all, after the test pieces have been stamped, the products must be marked with the test-piece number and the inspection stamp of the customer or the customer's authorised inspection service.

A test piece that has not been stamped may not be removed from the product without receiving prior permission from the customer's inspection service. If it is necessary to remove test pieces from the product, for example in conjunction with the preparatory machining of the product, the test pieces must first be marked (authenticated) by the customer or the customer's inspection service.

4.2.6. Types of test pieces

As a rule, unless it is otherwise stated, test pieces will be in accordance with the specifications laid down in the applicable product standard the various steel grades must comply with.
The following supplementary conditions should preferably also be taken into account:

Tensile test:	Use a short or proportional test piece in accordance with European standard EN 10002-1, $Lo = 5\,d_o$, $d \geq 10$mm
Impact test	Use test pieces in accordance with European standard EN 10045 (type KV)

4.2.7. Prescribed tests

Unless it is otherwise stated or agreed with the customer's inspection service, the number of tests that are to be carried out for the various material grades must be in compliance with the prescribed tests laid down in the applicable product standards. Here again, it'll need to be taken into account that the test pieces are to be cast-on in accordance with section 4.2.1.

For the determination of the impact value (energy absorbed) an average of three tests is applicable, whereby no separate value is permitted to be under ⅔ of the minimum guaranteed impact value.

4.2.8. Repeat tests

If the results of the tests are unsatisfactory, it is possible to resort to repeat tests according to a ratio of two tests for every test with unsatisfactory results. The inspection unit will be accepted on condition that all repeat tests prove satisfactory. Even if just one of the repeat tests fails to meet all the requirements, the inspection unit will be rejected. However, the supplier has the right to subject the inspection unit to an appropriate heat treatment again, either before or after carrying out the repeat tests, and then to re-submit the product for inspection.

4.3. Chemical examination

If the product standard also contains specifications pertaining to the chemical composition, the actual composition of the inspection unit must be given on the inspection documents. Generally speaking, the results of the ladle analysis can be copied, unless it is otherwise stated. In the latter case, the specifications in the applicable product standard should preferably be followed.

4.4. Non-destructive testing

This type of test is only carried out if it is specified on the order or indicated on the drawing. However, following a repair, or if after carrying out a visual inspection there is reason enough to suspect the presence of defects, the customer will also be entitled to expect that a supplementary non-destructive test as detailed below be carried out. The customer will indicate the areas to be tested.
A basic assumption is that the presence of cracks is never acceptable.

4.4.1. Testing for surface cracks

If this inspection is required, the indicated areas will, for example, be inspected by means of:

- the *magnetic* method
- the *liquid penetrant inspection* method

The choice of the method is subject to the approval of the customer, as is the method chosen to carry it out.

4.4.2. Testing for internal defects

If this inspection is required, the indicated areas will be inspected by means of:

- *Ultrasonic testing:* The method to be used by the supplier must be submitted to the customer for approval beforehand.
  If nothing else is specified on the drawing or order, the customer and supplier must agree on the basis for approval in a timely manner beforehand.

- *Radiographic testing:* in principle this should be carried out in accordance with ASTM E 94.
  The assessment of imperfections must be in accordance with ASTM E 446, E 186 or E 280. The customer must indicate the approval class(es) on the drawing or on the order.
  If the supplier has a preference for a different method, the method in question – together with possible different approval criteria – must be submitted to the customer for the customer's approval.

4.4.3. Testing for pressure tightness

If nothing is specified in the applicable product standard, the specifications given in DIN 50104 must be followed, and, if applicable, supplemented with specific requirements that may be specified in the order.

4.4.4. Reporting

The results of the inspections/tests, which must be carried out by persons qualified to do so, must be documented in a certificate by the supplier. This certificate must be presented to the customer's inspection service immediately after the inspection/test. This certificate must contain at least the following details:

- the inspection/testing method
- the place(s) and magnitude of the inspection/test and, if necessary, indicated on a sketch
- the method of determining the extent of the defects and of the execution of the inspection/test, including the specification of the equipment used, type and strength of (electrical) current, frequency, probes, dye liquids, pressures, etc.
- the rejection criteria (if necessary, including the specification of the place on the casting) with respect to the nature, number and extent of the defects
- the results of the inspection/test
- the specification, if applicable, of any repair methods used to rectify unacceptable defects
- the results of any repeat inspections/tests
- all other relevant details that could be of importance to the applicable non-destructive test. It can also be determined beforehand that the customer's inspection service will be present during the execution of the inspection/test.

5. THE DELIVERY OF STEEL CASTINGS AND FORGINGS BY THIRD PARTIES

In the event that third parties place orders for steel castings or forgings that are destined to be used by Corus, these suppliers must indicate on their orders that the castings and forgings must be supplied in accordance with these specifications. Immediately after placing this type of order, a copy must be sent to the department of Corus IJmuiden that placed the order and a copy must also be submitted to the inspecting department.

6. REFERENCES

In this Technical Directive reference is made to:

DIN
- 1681
- 1683
- 7168
- 17182
- 17245
- 17445
- 17465
- 50104

European standard
- 10002
- 10045
- 10083, part 1
- 10083, part 2
- 10204
- 10213

ASTM E
- 94
- 186
- 280
- 446

SEW
- 395
- 410
- 510
- 515
- 685
- 835

7. STATEMENT

Version 1.0:
This Technical Directive replaces Corus standaard 78.00.40.001

Version 2.0:
Name of Hoogovens changed into Corus

Minor changes on numbering.

Par. 4.2.6 European Standard changed into EN 10002-1 and $Lo = 5\,d_o$, $d \geq 1$mm
changed into $Lo = 5\,d_o$, $d \geq 10$mm

Version 2.1:
Par 4.2 and 4.2.1 changed.
Par 4.4.2 "*Ultrasonic testing*" first sentence changed.