

Quality Requirement

Forgings & Castings General Requirements

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1 CASTINGS AND FORGINGS MATERIALS SCOPE

This quality clause provides guidance in requirements that shall be met and documented during the manufacturing process of casting and forging materials also called “the part”.

Requirements are captured in the manufacturing documents e.g. material specifications, casting and forging drawings, or any other part defining document that comes with the purchase order. Material specifications shall be the leading document for all manufacturing steps.

Any deviation from the requirements shall be reported to NOV prior to delivery. A written and signed approval from the NOV representative is required to release shipment from the supplier to NOV unless otherwise agreed upon.

2 PROCESS REQUIREMENTS

2.1 Process conditions

For castings: After the first article is approved the manufacturing process shall not be changed without written approval from the NOV technical authority. Any deviation shall be permitted only upon written approval from NOV.

Acceptable casting process may include but not limited to: sand casting, investment casting and centrifugal casting.

Parts shall be manufactured and delivered per applicable casting material specification requirements.

For Forgings: All forgings shall be furnished in compliance with the referenced material specification and 3rd party applicable document.

Forgings shall be made by open die, closed die, or ring rolling, as well as any combination of these processes.

For casting and forging materials: Shall be produced by electric arc furnace, or by induction melting, vacuum degassed or AOD, and fully killed with fine grain practice. If another process is selected for production, a written deviation request shall be provided to NOV technical authority.

In case material specification dictates differently these are to be considered leading.

2.2 Heat treatment

Heat treating furnaces and equipment shall meet the requirements of applicable codes e.g. API 6A Annex M. or API 16A Annex B.

The heat treatment shall be performed using a Programmable Logic Controller (PLC) automated furnace.

Actual temperatures against a time scale during heat treatment shall be recorded on a chart and the records shall be traceable to the castings and forgings it represents.

No direct flame on the castings and forgings is allowed.

The above and additional requirements may also be covered in the material specification.

2.3 Qualification Test Coupon (QTC)

Mechanical test specimen shall be extracted from QTC's that are representative for the actual parts. The QTC shall be an integral part of the part it represents, a separate test coupon in the same heat marked with heat number or a sacrificial part taken from the heat it represents. Separately cast or forged QTC's, or sacrificial production parts shall be heat treated at the same time and in the same furnace as the parts they represent. Any deviation shall be permitted only upon written approval from NOV or when dictated in the NOV manufacturing documents.

Example of deviation:

When the QTC is not heat-treated as part of the same heat treatment load as the parts it qualifies, the austenitizing (or solution heat-treat) temperatures for the QTC shall be within 14 °C (25 °F) of those for the parts. The tempering temperature for the part shall be no lower than 14 °C (25 °F) below that of the QTC. The upper limit shall be no higher than permitted by the heat-treatment procedure for that material. The cycle time of the QTC at each temperature shall not exceed that for the parts

2.4 Inspection

Personnel performing NDE examination shall be qualified and certified as a minimum level II in accordance with EN ISO 9712 unless otherwise noted in the material specification. Inspections must be performed according to the relevant International standards or equivalent.

Inspection method	Symbol	General principles	Inspection conditions
Visual examination	VT	EN 13018	EN 1370
Liquid penetrant	PT	ISO 3452-1	EN 1371-1
Magnetic particle	MT	ISO 9934-1	EN 1369
Ultrasonic examination	UT	ISO 16810	EN 12680-1
Radiographic examination	RT	ISO 5579, ISO 19232-1	EN 12681

Table 1: International standards for inspection methods.

3 REPAIR

3.1 Repair by grinding

The rejectable surface indications that are repairable by excavating may be repaired with proper equipment to a depth of 10% off the section thickness or .138inch, (3.5mm), whichever is smaller. Care shall be taken to prevent flaw propagation.

Grinding shall result in a smooth transition through the flow area to the original shape and contour.

A suitable NDE method shall be used by qualified inspectors to examine the entire excavation area to insure removal of unacceptable indications.

3.2 Repair by welding (see material specification)

Note: No weld repair shall be allowed on forgings.

All defects present in a cast surface when exceeding the excavation depth as dictated in section 4.1 shall be weld repaired using an approved welding specification, by a qualified and certified welder only.

All defects grinded in a machined surface shall be weld repaired. After weld repair the machined surface dimensional and visual shall be in the as untouched condition. The exception is a pre-machined surface having machining allowance left resulting in a clean surface after final machining.

3.3 Weld repair map record (see material specification)

A welding map is required when castings are being subject to major weld repairs.

Unless otherwise specified, if the excavation after removal of an indication meets any of the following criteria, the repair is classified as major repair:

- Depth D is more than 25% of the original wall thickness T.
- Depth D is more than 1inch, (25.4mm).
- Width W is more than 1inch, (25.4mm).
- Length L is more than 2inch, (50.8mm) and the total area is more than 1.5 inch², (968mm²)

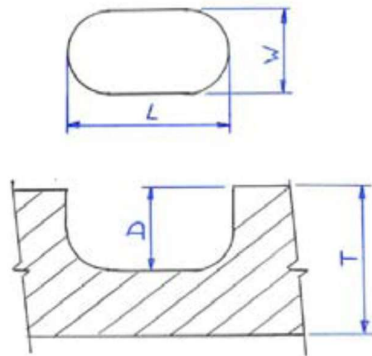


Figure 1: Major weld repair.

The full record (weld map) detailing the extent (dimensions & orientation) and location of all major weld repairs made to each casting, and details of weld procedures and heat treatment applied shall be maintained and provided to NOV.

All major weld repairs must be approved by NOV prior to welding.

Weld repairs shall be inspected using the same quality requirements as are used to inspect the casting.

If the repair is classified as major it shall also be examined by either radiography or ultrasonic methods.

4 PROTOTYPE CASTING OR FORGING

When specified “Prototype” on the purchase order the following additional requirements are applicable:

For first article, minimum two contact thermocouples must be attached to the part to demonstrate that the part reaches the same temperature as the furnace thermocouples. The size and the nature of the design may require more thermocouples. These thermocouples shall be positioned in opposed direction 180 degree of each other.

All NDE (MT, PT, UT, RT) as described in this document and the accompanying with purchase order must be followed prior to any repair or welding on the part. Inspection report must be sent to NOV prior to any excavating.

For castings each first article shall be subjected to 100% radiographic examination. Radiographic films shall be submitted to NOV for approval. If the thickness exceeds 12 inches, (305mm) or RT is cannot be performed, then Ultrasonic NDE (UT) shall be utilized for volumetric examination.

A complete dimensional report must be submitted to NOV for approval.

Production castings or forgings will not be accepted by NOV without NOV's approval of the prototype part.

Final NDE as MT, PT and UT must be witnessed by NOV, manufacturer is responsible for notifying NOV unless agreed differently.

Final dimensional control must be witnessed by NOV, supplier is responsible for notifying NOV. Mechanical properties testing shall be carried out by an independent laboratory and be delivered with a 3.2 certificate.

5 MARKING

All castings and forgings including QTC's supplied to this specification shall be legibly marked with a heat number to allow traceability through inspection documents, and any other specific information related to a heat.

Each casting and forging shall be marked with:

- The supplier logo.
- The heat number. In case the drawing does not indicate a position for marking, the position will be mutually agreed by supplier and NOV.
- All other marking as required by the applicable manufacturing drawing.

The use of the letters "I", "O" and "Q" should be avoided in the heat Code to avoid miss readings.