

## Understanding end user valve approvals

# Part 11i – Castings- heat treatment



The end user visit continues at the foundry and is faced with heat treatment. This is a very critical aspect of foundry practice which, if executed correctly, will result in a good casting reflecting good mechanical and chemical properties. So what should the end user be aware of?

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It is suggested that the end user auditor prepares for the visit by gathering heat treatment details for various materials to compare temperatures, hold times etc.

### Heat treatment specification

A good place to start the audit would be to request and review the foundry's heat treatment specification. This should cover the full range on cast materials available at the foundry detailing:

- An understanding of the type and size of the furnace being used, electric, oil fired, gas fired?
- The aspect of temperature control and number of and location of thermocouples.
- At what stage of the casting production should heat treatment be done?
- Details of the size of furnace charge.
- Control of stacking castings to ensure uniform heating throughout the charge.

- Details of the furnace maintenance cycle and review of the check lists.
- Heat treatment thermal cycle including heating rates, hold temperatures, cooling/quenching practices.
- Increase in heat treatment time with increase material thicknesses.
- Adequate control for controlling the time between opening the furnace and quenching.
- Quenching coolants temperature controls.
- Heat treatment test coupon size.
- Number of test coupons required.
- Location of test coupons within the furnace charge.

The above points seem simple on paper but in reality are far from it.

Having discussed the specification the auditor should ask for examples of pilot and production heat treatment charts to confirm the above thermal cycles and material variations. Always request at least those pilots' results relevant to your order. It's advised that you do spend time on this aspect ensuring hold times, heating rates are correct. Also check the actual heat treatment time to understand whether the operation was over night or not. You will be amazed how the hours of treatment are cut short or even the hold temperatures are not reached. Sometimes the foundry goes into "auto pilot" and does not operate an effective QA checking system and the heat charts are stamped by QC as acceptable but they have not been reviewed.

I recently had to reject 29 charts for WCB showing the hold temperature to be below the heat treatment specification, 890°C instead of 920°C +- 10°C. Hundreds of casting components were affected.

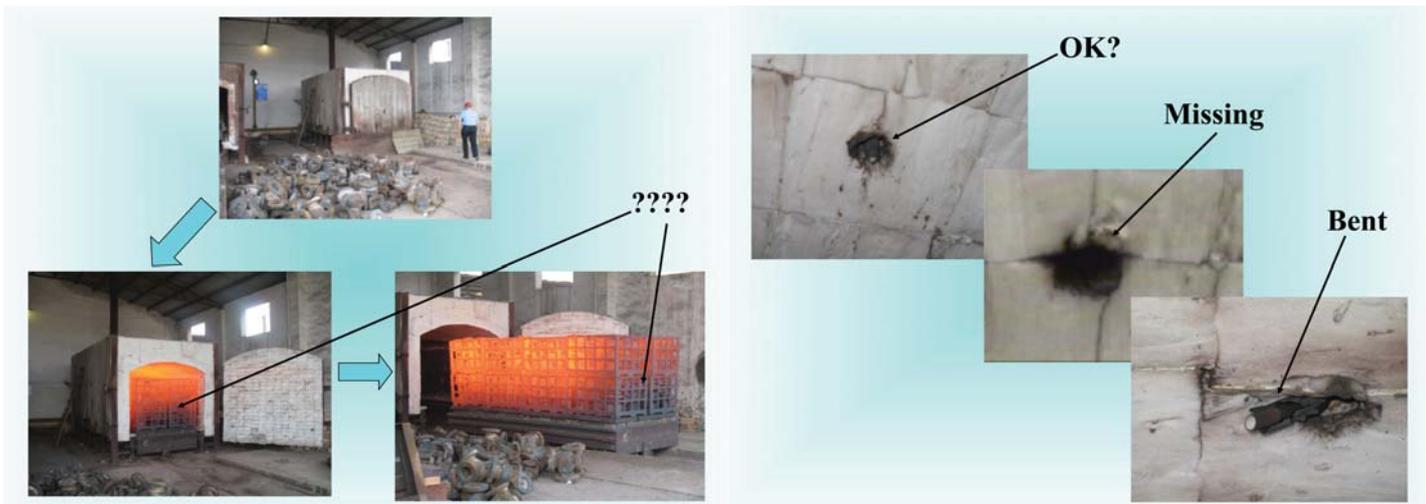
**Important: Ensure the latest revision of the heat treatment specification is available and controlled on the shop floor. Normal practice is to transfer the heat treatment requirements onto shop heat treatment cards for production. Too often inconsistencies are found between the specification... the cards... and shop floor practice.**

### Visit the foundry furnaces

You will find variations of all sorts such as:

- Make sure you actually visit all the furnaces and not just those pre-selected by the foundry.
- Upon arriving at the furnace assess the process flow of the castings to make the charge. Are they just a mixed mound of castings or are they in some way segregated into components and size?
- Does the charge consist of all weld repaired castings? If not, why not? Minor weld repairs are often not included. Is this correct? Opinions vary.
  - Some foundries state they have a local very small furnace for major weld repairs for single castings. Double check that it's used.
- Do undertake a visual examination of the furnaces condition and challenge to see check lists.
  - Is rubbish found around the furnace, especially hidden round the back? If there is this indicates poor housekeeping.
  - Are there test bars lying around uncontrolled?
  - Look closely at the closing door mechanism and see if there are any "burnt" or "flame deposits" around the door seal which indicates it's not sealing.





- Look inside the furnace and check the location of thermocouples. The most common is typically 3 off in the top roof on the furnace. This obviously records the hottest part of the furnace and may not be truly representative. The more informed foundry also locates thermocouples at the sides of the furnace. I remember hours of discussions on this aspect as the foundry wrestles against such a practice.
- Check the thermocouples' condition. Are there any bent from an overloading? Are any burnt out? Is there any heavy soot deposit?
- For electric furnaces are the heating elements in good condition?
- For oil / gas fired check the heating area for even heat distribution within the furnace.
- Check the control panel and certification of the thermocouples and instrument charts. Is the control panel well maintained?
- Look at the charge stacking of castings to ensure adequate spacing for flow of heat to all areas. Some are just laid on the floor of the moveable trolley whilst others are stacked on each other or via baskets. All are acceptable.
- Check that the correct numbers of test bars are in the charge and are positioned to represent the furnace temperature. *Yes, when challenged the furnace was heating up and the test bars were still laying on the shop floor! Whoops!*
- Try and be present when the furnace door is opened and the charge pulled out. This will visually indicate an even heat temperature has been achieved. Any dark red areas indicate temperatures are suspect.
- Also inspect a charge when it's totally cooled down. A good heat treatment leaves a consistent, even colour. For carbon steel this is light grey. Beware of colour variations as sometimes these are a result of incorrect heating.

**End User experience:**

Poor or incorrect treatment has resulted in several issues that have put HSE and operations at risk. Checking of mechanical / impact properties / chemical and NDT have identified major inconsistencies with the foundry data. Investigations identified:

- Heat treatment within the furnaces were not correct... temperatures, hold times in error.
- Weld repairs were not heat treated.
- Thermocouples were not calibrated or were broken.
- Charge stacking was very poor with poor heating.
- Furnaces had major heat leakage via the door seal.
- Inconsistent gas / oil flame burn.

Following the above will enable the auditor to establish an informed position. By no means is it a complete check list.

**Once again I appear to have let my "pen" run away with me. It's amazing how much there is to share on castings which, by the way, is really just an introduction.**

**A quick thank you to the various readers who have taken the time to comment on previous issues!**

Please contact me if you have any questions or different views. They are most welcome.

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