



1. SCOPE: This process standard applies to austempering of medium and high carbon steels to the hardness specified on the Engineering print.
2. APPLICATION: Austempering is usually employed in place of conventional quench and tempering on parts of relatively thin cross-section (e.g. 5mm (0.2 in.) max. for SAE 1080 steel; depending upon the alloy content, the maximum cross-section that can be austempered will vary accordingly).
 - (a) to achieve improved mechanical properties (higher ductility or notch toughness for a specified high hardness), and/or
 - (b) to reduce the risk of cracking or distortion.
3. REQUIREMENTS:

Note: A control plan as referenced in this standard is defined in Quality System Standard Q-101, Appendix A.

3.1 PROCESS: Austenitizing of the part prior to quenching in a :

- continuous muffle or radiant tube furnace or
- molten salt bath or
- fluidized bed (if approved by the affected Ford SQA or Quality activity and documented in the control plan).

(The continuous muffle or radiant tube furnace is the preferred method of heat treatment).

The heating facilities must be able to heat the parts uniformly in the range of 815-950 °C (1500-1750 °F). There shall also be facilities for quenching (Para. 3.6).

3.2 LOADING: The loading practice shall be as follows:

- Components must be thoroughly cleaned of oils, die lubricants, and related materials prior to introduction to the austenitizing furnace.
- The parts shall be suitably loaded to assure that every part is adequately heated during austenitizing and is properly exposed to the quenchant.
- With any continuous process there shall be adequate spacing between lots which require different austenitizing, quenching, or tempering times or temperatures to ensure that lot is processed as necessary to attain the specified metallurgical properties.

3.3 FURNACE ENVIRONMENT: Furnace atmospheres suitable for austempering normally consist of a carrier gas (endothermic or nitrogen-base or a nitrogen-methanol blend*) with additions of a hydrocarbon gas (such as methane (CH₄) or propane (C₃H₈)). The gas atmosphere must be circulated in the furnace chamber and be of sufficient volume to ensure a positive pressure in the furnace. A neutral furnace atmosphere



carbon potential shall be utilized for the grade of steel involved. No ammonia shall be added to austempering furnace atmospheres nor shall there be an ammonia line connected to the unit.

* It is essential that nitrogen-methanol furnace atmospheres be blended so that the mole ratio of the nitrogen to methanol is two to one in order that CO₂, dew point, or oxygen potential control is feasible. Consequently, such atmospheres are permitted only when specifically authorized by the affected Ford SQA or Quality activity and are documented in the control plan.

3.4 AUSTENITIZING TEMPERATURE: The temperature shall be controlled within +/- 5°C (+/- 10°F) of the set point, as evidenced by continuous recording pyrometers.

3.5 AUSTENITIZING TIME: The parts shall be held for such time to assure that the parts have been completely austenitized.

Note: Certain alloy steels may require extra holding time to assure adequate carbon dissolution in the austenite.

3.6 QUENCHING: The parts shall be at a temperature at least 25°C (45°F) above the upper critical temperature (Ac₃) for hypoeutectoid steels and at least 25°C (45°F) above the Ac_m for hypereutectoid steels at the time of the quench.

3.6.1 Quench systems must have provisions for maintaining both maximum and minimum temperatures of the quenchant. Forced agitation must be provided in the quench system to assure uniformity of temperature and efficiency of quench. The temperature of the quenchant shall be controlled within +/- 5°F (+/- 10°C) of set point, as evidenced by continuous monitoring pyrometers.

3.6.2 Molten salt is an acceptable quenching media for austempered parts. Moisture additions to the salt bath to achieve faster quench rates are not permissible unless prior approval is granted by the affected Ford SQA or Quality Control activity and documented in the control plan.

3.6.3 To assure proper quenching, parts shall not be stacked together when entering the quenching media.

3.6.4 Direct quenching is preferred. Delayed quenching that forms austenitic decomposition products which degrade the parts is specifically prohibited. (Refer to Par. 3.8)

3.6.5 Parts shall be held in the quenching medium for sufficient time to assure complete transformation to bainite. The minimum times for specific grades and quench temperatures are listed in Chart no. 1.



- 3.6.6 Use of quenchant temperatures below the "martensite start" temperature of the steel may be used only with prior approval of the affected Ford SQA or Quality activity and are documented in the control plan. Quench immersion times must be adequate to assure complete transformation to bainite.
- 3.7 REMOVAL OF QUENCH SALT: Adequate washing and/or rinsing capability must be available to remove salt residue from the parts after salt quenching. The parts shall be subsequently treated to assure freedom from rusting.
- 3.8 MICROSTRUCTURE: The microstructure shall consist of bainite. On hypereutectoid steels, fine, uniformly-dispersed carbides within a bainite matrix are acceptable.
- NOTE: The presence of an intermediate transformation structure (such as fine pearlite mixed with bainite) (because of the specified steel chemistry or part cross-section) is acceptable only upon concurrence of the affected Ford SQA or Quality activity (and documented in the control plan) as well as verification that the part meets the requirements of the Engineering print.
- 3.9 PROCESS CONTROL: Suppliers utilizing this process standard must be able, by means of their existing process practices and records, to show evidence of control of the process as per Ford Quality System Standard Q-101. Users of this process are referred to Ford Manufacturing Standard W-HTX-1 (for parts with heat treat characteristics denoted as Control Item (V) characteristics or for part with Engineering prints denoted as "Must conform to Q-101, Appendix E" or "Must conform to Q-101, Appendix F") or to W-HTX-12 (for heat treated parts not covered by W-HTX-1) in which control practices are outlined.
- 3.9.1 The suppliers utilizing this process must have a defined process for Ford parts which shall include furnace loading rates, austenitizing times and temperatures, quench salt immersion times and temperatures, and related pertinent parameters.
- 3.9.2 The salt immersion time actually employed shall be traceable for each batch of parts processed for Ford Motor Company.
- 3.9.3 On austemper units which utilize a "standard" time for parts in the quench salt (i.e. the salt bath belt speed remains constant for all parts regardless of steel grade or salt temperature), the following must be in effect:

A permanent sign stating the minimum allowable temperature for the specific grades of steel processed must be located adjacent to the salt bath temperature indicator.

Example: (Assuming that 1700 seconds had been selected as the "standard" time.)