



Crankshaft Hardening and Tempering Measurement Analysis Strategy

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard describes the methodology to

- Interpret in-process measurements that fall out of tolerance.
- Calculate compliance to the: **Tempered is documented by a minimum two (2) Hardness Rockwell C Scale (HRC) reduction between fully quenched without temper and production temper process requirement.** This drop in surface hardness is used to confirm the tempering process meets the intent of **tempered** as noted on crankshaft prints. Reference Figure 1.
- Confirm the heat treat inspection parameters used to verify consistent hardening of the crankshaft.

1.2 Applicability. This standard applies to hardened crankshafts.

1.3 Remarks. This specification is in support of the sample print note shown in Figure 2.

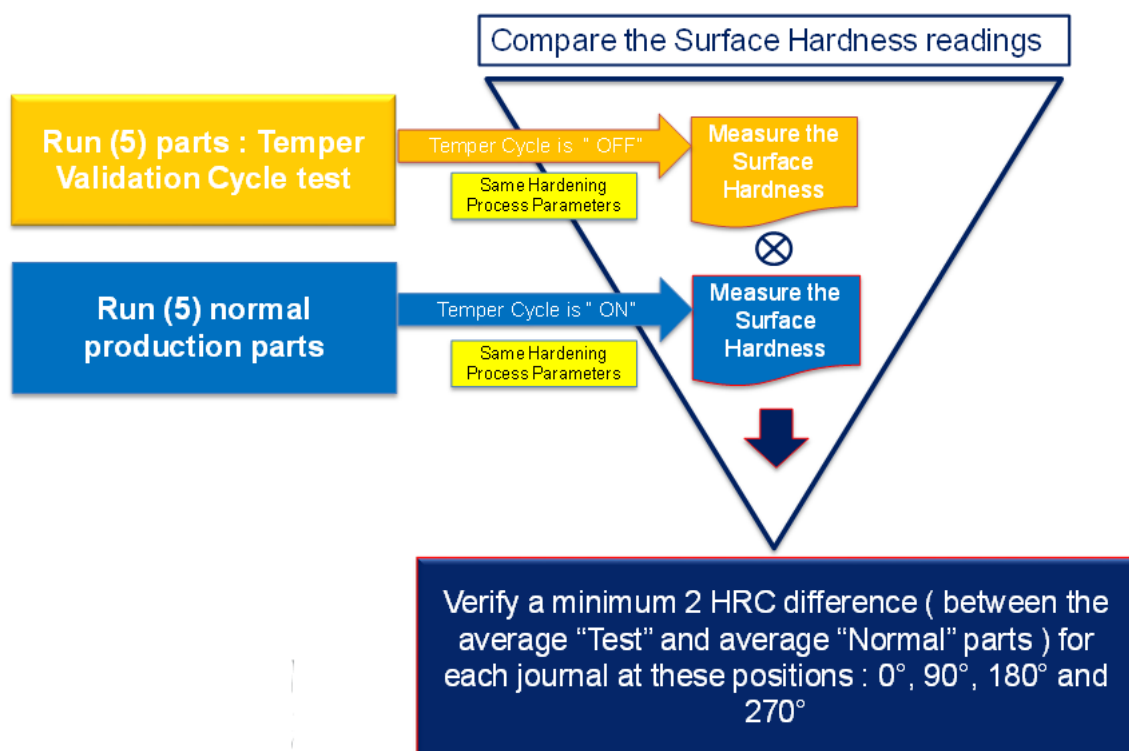


Figure 1: Scope of the Temper Validation Test

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MICROSTRUCTURE TO BE 100% TEMPERED MARTENSITE TO 0.25 MIN DEPTH (EXCLUDING INCLUSIONS) WITH NETWORKING ALLOWED. TEMPERED IS DOCUMENTED BY A MINIMUM 2 HRC REDUCTION BETWEEN FULLY QUENCHED WITHOUT TEMPER AND PRODUCTION TEMPERING PROCESS.

Note: MIN = Minimum

Figure 2: Typical Part Print Note

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

AIAG CQI-9

2.2 GM Standards/Specifications.

None

2.3 Additional References.

Q-DAS, Incorporated, Rochester Hills, Michigan (www.q-das.com)

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment. Standard laboratory Rockwell Hardness tester (C Scale).

3.3 Test Vehicle/Test Piece. Crankshaft main and pin journals: Five (5) samples of fully quenched without temper and five (5) production process samples. The five (5) production process samples may be produced consecutively or drawn from the last five (5) control plan samples.

3.4 Test Time. After producing the test parts, preparation through evaluation will take approximately 2.5 h.

3.5 Test Required Information. Part Unique Number (PUN) and surface hardness data for each sample.

3.6 Personnel/Skills. Reference documentation AIAG CQI-9, Special Process: Heat Treat System Assessment, section titled: Management Responsibility and Quality Planning.

3.7 Automatic/Countdown Temper Validation Test (TVT) Software. The Automatic/Countdown TVT Software is a machine program that is selectable by the operator. The operator selects the program and inputs the number of TVT parts requested; a standard test produces five (5) non-tempered/fully quenched parts. The machine will then automatically process these test parts. If induction tempering is the current process, the machine will not perform the temper cycle in addition to fully quenching the part, upon completion of the hardening cycle. If auto tempering is the current process, the machine will fully quench the part upon completion of the hardening cycle. As each part is processed, the machine will countdown and display the number of TVT parts remaining to be processed. Upon completion of the requested test parts, the machine will stop and automatically turn the tempering cycle back to ON and switch out of automatic cycle. The TVT test parts are not stamped as OK and the machine identifies these test parts to the gantry as Not OK (NOK) parts. The machine can only be placed back into automatic normal production mode by the operator. Reference Figure 3.

3.7.1 Typical Operator Sequence for the Automatic/Countdown TVT Cycle.

- Operator automatically empties out the machine; the machine provides acknowledgment that it is emptied and ready to perform the TVT.
- Operator selects **Temper Validation Test**.
- Operator inputs the number of test parts desired.
- Operator selects **Automatic Start** for the TVT.

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Documents

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- e. The machine automatically processes the selected number of parts. Once this number is reached the machine will acknowledge all requested parts have been processed.
- f. The machine will then automatically empty out the machine and provide acknowledgment to the operator the test has been completed.

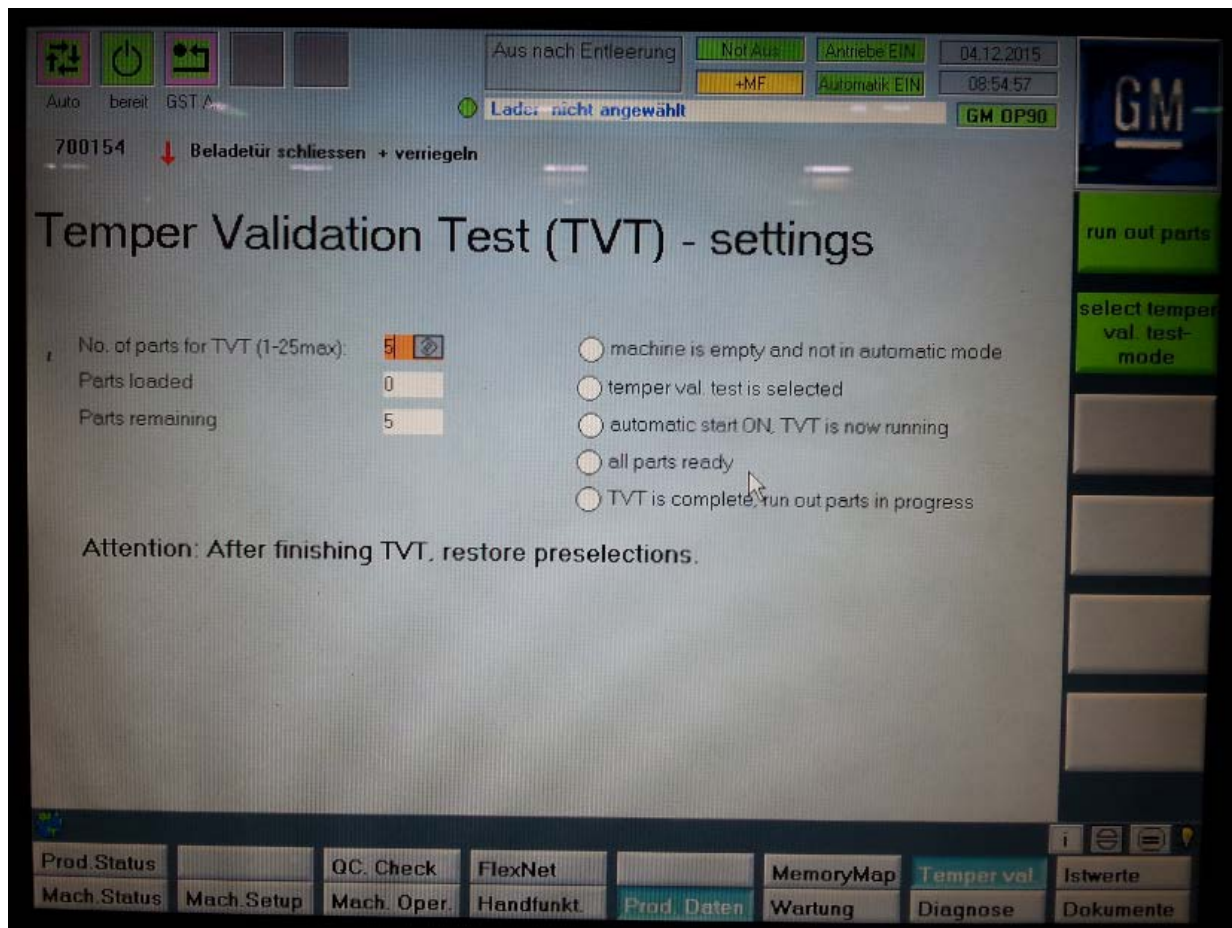


Figure 3: Reference Human Machine Interface (HMI) Screen of Typical Automatic/Countdown TVT Software

4 Procedure

4.1 Preparation.

4.1.1 Surface hardness gauge connected to a statistical data analysis program and data collection system similar to the Q-DAS (available from Q-DAS, Incorporated) or similar software.

4.1.2 Automatic/Countdown TVT software is installed and functioning in the induction hardening equipment or these procedures are manually performed, utilizing the analysis methodology outlined in this specification.

4.2 Conditions. Surface hardness readings have exceeded the established in-process upper limit. Base crankshaft Process Failure Mode and Effects Analysis (PFMEA) is maintained within stature by Central Manufacturing Engineering (CME). A sample is provided in Figure 4 for reference. The control plan has identified the tempering cycle as a possible cause.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

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