

Technical Justification for Lower Weld & HAZ Hardness values for P1 material without PWHT

As per clause no. 11.7 of CA specification (GENERAL SPECIFICATION FOR WELDING PIPING & COMPONENT) --

Limiting value of Hardness for weld and HAZ of P1 material is 200 BHN.

(Condition of weld is not specified i.e. as welded condition or welds with PWHT)

Justification:

Hardness measurement and its control in P1 base material, weld & HAZ is important only when main stream (process feed) contains sufficient level of H₂S.

After detailed evaluation and based on exhaustive practical data NACE committee has developed and issued NACE MR 0175 which gives comprehensive data for material control for H₂S containing environment.

As per NACE MR 0175 maximum acceptable hardness value of weld & HAZ of P1 material is 250 Hv even if H₂S is present in main stream.

In addition to that NACE MR 0175 ask for PWHT of P1 welds only if weld and HAZ hardness values exceeds 250 HV (equals to 237 BHN).

According to NACE MR 0175 philosophy carbon steel welds, HAZ and base metals may be encountered with sulfide stress cracking (SSC) or hydrogen induced cracking (HIC) if partial pressure of H₂S is more than 0.3 kPa (0.05 psi). Thus in cases where partial pressure of H₂S is more than 0.3 kPa (0.05 psi) weld, HAZ and Base metal of P1 material shall be hardness tested and proven to be resistant of SSC and HIC.

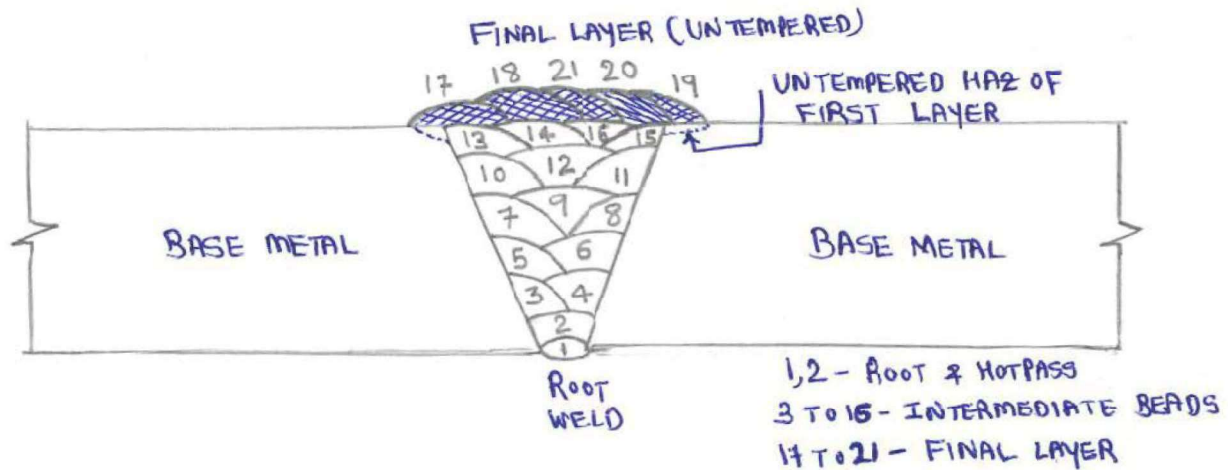
In SWGFD project, in HTJ field H₂S content is **1.3 PPM**, in TNK field H₂S content is **1.0 PPM** and in HBH field **H₂S is not present** in raw gas composition. This H₂S values in PPM are too small that it can be disregard.

It is always technically meaningful to measure hardness of P1 material weld and HAZ if there is PWHT.

Also in case of welds without PWHT top layer final weld beads are always remain untempered as shown in the below sketch which will have higher cooling rate so these top layer weld beads will have inherent high hardness values (i.e. between 200 BHN to 240 BHN).

In production, hardness measurement can only be performed on top surface layers of welds as shown in the below sketch which are always untempered and possess high hardness as stated above.

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TYPICAL SKETCH - SINGLE SIDE FULL PENETRATION WELD

For the assistance of above made justification [] has attached here two nos. of PQRs for [] process (PQR []) and [] process (PQR []) respectively which are in as welded condition (without PWHT) where hardness values are more than 200 BHN at top surface layers.

Also as per international standard API 582 (welding guidelines for chemical, oil and gas industries) hardness testing should be performed after PWHT and hardness values to comply with NACE MR 0175 or NACE SP 0472.

As per project PMS document [] which is given by CA as feed document, [] ask for hardness if PWHT is performed.

Conclusion:

With the above made justification [] request CA to again relook hardness criteria for P1 material welds and HAZ in as welded condition.

[] Proposition:

For P1 material weld and HAZ **with PWHT** hardness values shall be **200 BHN max.**

For P1 material weld and HAZ **without PWHT** hardness values shall be **237 BHN max.**

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11.5 NDE Locations

Locations of NDE's shall be in accordance with the applicable documents or as selected by CA's representative. Methods and extent of NDE shall be indicated on the fabrication drawing. All welds shall be subject to 100% NDE examination. At CA sole discretion, based upon demonstration of sound production welding, this may be reduced to an agreed random percentage inspection for non-hydrocarbon piping systems.

11.6 Visual Testing VT

VT shall be performed after the welding. Weld spatter and slag shall be removed from the surface of finished welds. Fillet size, weld reinforcement, misalignment, overlap, undercut and pits shall be examined in accordance with applicable code and standard.

11.7 Hardness Test

When required, hardness tests shall be performed on production welds using a portable Telebrineller hardness tester or Purchaser approved equal. A minimum of 10 percent of all welds, and 100 percent of those welds which are locally heat treated, shall be hardness tested.

Hardness limits shall be as follows:

Material Group	Maximum Brinell Hardness
P-1	200
P-3, P-4, P-5	225
P6	241

Report all hardness readings in excess of values shown above to Purchaser. Review any corrective action with Purchaser before proceeding. Nonferrous materials and austenitic stainless steel welds will not require hardness testing. If PWHT is applied, perform the hardness test after PWHT.

11.8 Ferrite Measurement

When ferrite measurement is required, check the ferrite content of each austenitic stainless steel weld, including overlay welds, in the as-welded condition using a Severn gauge or a Feritscope. Ferrite content shall be between 3 and 10 percent. Type 310 welds are exempt from this requirement.

11.9 Alloy Control

When positive material identification (PMI) is specified, all low alloy piping (P-3, P-4, P-5, P-9A, P-9B, P-9C, P-11A) shall be tested for alloy content in accordance with Contractor's specification for alloy material control.

