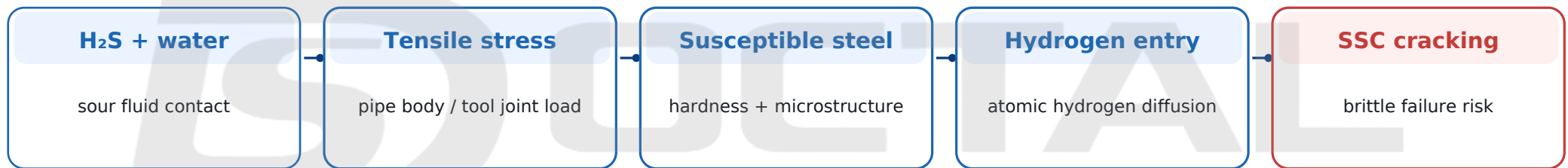


Sour Service Drill Pipe Hardness and SSC Control Guide

H₂S sour drilling condition · SSC mechanism · hardness limits · NACE TM0177 Method A · heat / lot traceability

Why this guide matters

Sour service drill pipe is used where H₂S-bearing fluids, water phase and drilling load can create sulfide stress cracking (SSC) risk. In this condition, high strength alone is not a safe selection logic. The material must show controlled hardness, suitable microstructure, sour-service test basis and traceable records for the pipe body, tool joint and friction weld zone.



Control Area	Technical Focus	Meaning for Sour Service
H ₂ S sour drilling condition	H ₂ S + water + tensile / torsional stress	Creates the environment for SSC and hydrogen-assisted cracking risk
Hardness control	Pipe body, tool joint and weld zone controlled separately	Limits excessive hardness that can increase SSC sensitivity
SSC test basis	NACE TM0177 Method A, Test Solution A, 720 h exposure when specified	Provides a documented basis for sour-service resistance validation
Traceability chain	Pipe marking -> heat number -> MTC -> hardness / NDT / test record	Keeps material identity and test evidence connected to the actual drill pipe

Technical basis used in this guide: API 5DP Addendum 1 (2025) for SS grade hardness, microstructure, test frequency and tool-joint H₂S resistance requirements; NACE TM0177 Method A public technical descriptions for uniaxial tensile SSC exposure in H₂S test solution.

H₂S Sour Drilling Condition and SSC Risk Mechanism

SSC is not a normal wear problem. It is a cracking risk driven by the combined presence of H₂S, water, tensile stress and susceptible steel condition. Drill pipe in sour wells may also see torsion, bending and cyclic load, so the risk is not limited to one single pipe area.

Risk Factor	How It Acts in the Drill String	Control Logic
H ₂ S + water phase	Creates a sour environment where hydrogen can enter susceptible steel	Define sour-service severity and test basis
Tensile stress	Pipe body and tool joint are loaded during drilling, tripping and overpull events	Control material strength window and avoid excessive hardness
Torsion and make-up load	Tool joint shoulder and threads carry torque and repeated connection loading	Separate tool joint hardness and connection-area control
Weld-zone transition	Friction weld area has different thermal history from pipe body and tool joint	Evaluate weld zone hardness, toughness and NDT separately
Heat / lot variation	Different heats or heat-treatment lots may not behave the same in sour exposure	Keep heat number, hardness data and test records traceable

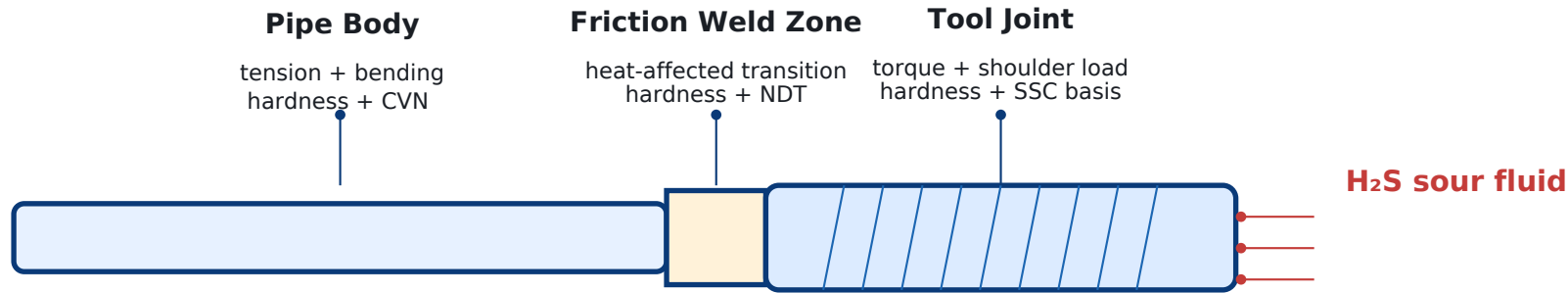
Why high strength alone is not enough

High-strength grade name	Sour-service concern	More reliable control point
Higher yield strength	May increase SSC sensitivity if hardness and microstructure are not controlled	Defined yield / hardness window
Stronger tool joint	May still fail sour-service logic if the H ₂ S resistance basis is missing	Tool joint H ₂ S resistance test basis and hardness range
General API grade compliance	May not address sour-service cracking behavior by itself	SS grade control, NACE TM0177 basis and traceable material identity

Field interpretation: for sour service, material behavior must be stable under load and sour exposure. The most useful technical evidence is not a single high strength value, but a connected record of chemistry, heat treatment, hardness, SSC test basis and product-element traceability.

Pipe Body / Tool Joint / Weld Zone: Separate Control Areas

Sour service drill pipe should be reviewed as an assembly. The pipe body, tool joint and friction weld zone have different heat-treatment histories, stress states and cracking sensitivities, so one general hardness value cannot represent the whole product.



Product Element	Primary Load / Exposure	Hardness and SSC Control Focus
Pipe body	Tension, bending, rotation, sour fluid exposure	SS grade hardness range, through-wall survey, grain size and martensitic transformation control
Tool joint	Torque, shoulder contact, make-up / break-out cycles	Surface and through-wall hardness range; H ₂ S resistance threshold for SS tool joints when required
Friction weld zone	Transition between pipe body and tool joint; affected by welding heat	Mean hardness limit, NDT, toughness / impact review where specified

Hardness Limits for API 5DP SS Grade Drill Pipe

Product Element	Minimum HRC (HBW)	Maximum Average HRC (HBW)	Maximum Single Reading HRC (HBW)
SS75 pipe body	None	22.0 (237)	24.0 (247)
SS95 pipe body	18.0 (216)	25.0 (253)	27.0 (264)
SS105 pipe body	21.0 (231)	28.0 (271)	29.0 (279)
SS tool joint	24.0 (247)*	30.0 (286)	32.0 (301)
SS weld zone	None	30.0 (286)	32.0 (301)

NACE TM0177 Method A and 720 h SSC Exposure Test Basis

NACE TM0177 Method A is a smooth uniaxial tensile test used to evaluate SSC resistance in H₂S-containing environments. The specimen is loaded in tension and exposed to the specified sour test solution for an extended period. For API 5DP SS tool joints, Addendum 1 states an H₂S resistance threshold of 493 MPa (72 ksi), equal to 65% SMYS, for 720 hours using NACE TM0177 Method A, Test Solution A.

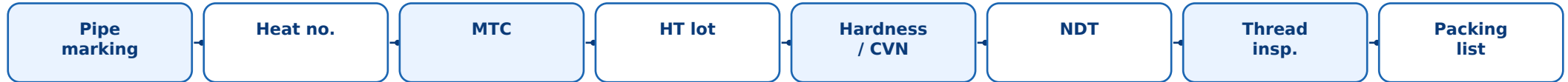
Item	Technical Value / Basis	Control Meaning
Test method	NACE TM0177 Method A	Uniaxial tensile SSC evaluation under sour exposure
Loading condition	Sustained / constant tensile loading	Simulates cracking risk under applied stress
Exposure duration	Up to 720 h; API SS tool-joint threshold uses 720 h	Long-duration no-failure basis for SSC resistance
API SS tool joint threshold	493 MPa (72 ksi), 65% SMYS	Specific H ₂ S resistance benchmark in API 5DP Addendum 1
Test Solution A description	Acidified buffered brine: 5 wt% NaCl + 0.5 wt% acetic acid, saturated with H ₂ S; pH about 2.6-2.8 in common Method A lab description	Aggressive sour test environment for SSC susceptibility
Temperature basis	About 24°C (75°F) ±3°C in common Method A lab description	Room-temperature SSC evaluation condition

API 5DP Addendum 1 Control Point	Frequency / Requirement
SS pipe body outside surface hardness	Each drill pipe body on outside surface of the upset
SS pipe body through-wall hardness	Radial cross-section; all four quadrants tested; frequency per Table C.10 / D.10
SS tool joint H ₂ S resistance	One specimen per heat, per heat-treat lot, or every 200 tool joint box / pin set, whichever is more frequent
Failed SS tool-joint H ₂ S specimen	Two additional specimens with no failures required; rejected lots may be reheat-treated and retested as new lots

Reading note: Method A confirms SSC resistance under a defined laboratory basis; it does not replace full service-condition review. Downhole pH, H₂S partial pressure, chloride, temperature, load history and drilling fluid chemistry can make actual service more complex than a single test result.

Heat / Lot Traceability and Technical File Control

For sour service drill pipe, hardness and SSC-related records are meaningful only when they can be matched to the actual pipe identity. A traceability gap between pipe marking, heat number, heat-treatment lot and inspection report can make the material difficult to evaluate for H₂S exposure.



Record / Evidence	What It Should Identify	Why It Matters for Sour Service
Pipe marking	Pipe identity, size, grade, connection, heat / lot reference	Links the physical pipe to its technical records
MTC	Chemical composition, mechanical properties, heat number	Confirms base material identity
Heat treatment lot	Furnace / lot route and final condition	Connects hardness, toughness and microstructure to production route
Hardness report	Pipe body, tool joint and weld zone values when required	Verifies each element stays within the control window
SSC / H ₂ S test record	Method, solution, stress level, duration and result	Documents the sour-service resistance basis
NDT / thread inspection	Inspection method, scope, connection result	Supports weld integrity and connection reliability

Practical Control Summary

Control Rule	Technical Meaning
Do not treat S135 or another high-strength grade as sour-service proof by itself.	Sour service requires hardness, microstructure, SSC test basis and traceability control.
Separate pipe body, tool joint and weld zone.	They experience different heat histories and stress states, especially near the connection and friction weld.
Connect all test records to heat / lot identity.	A hardness or SSC result without traceability is weak evidence for sour exposure.