Drill Pipe Manufacturing Route: Pipe Body, Tool Joint and Final Assembly

Technical Reference Sheet

PIPE BODY ROUTE

1 Seamless Tube Verification

- API 5DP / ISO 11961
- Dimensional Check
- Visual & Surface Check
- UT / ECT
- PMI & Chemical Check

2 Upsetting

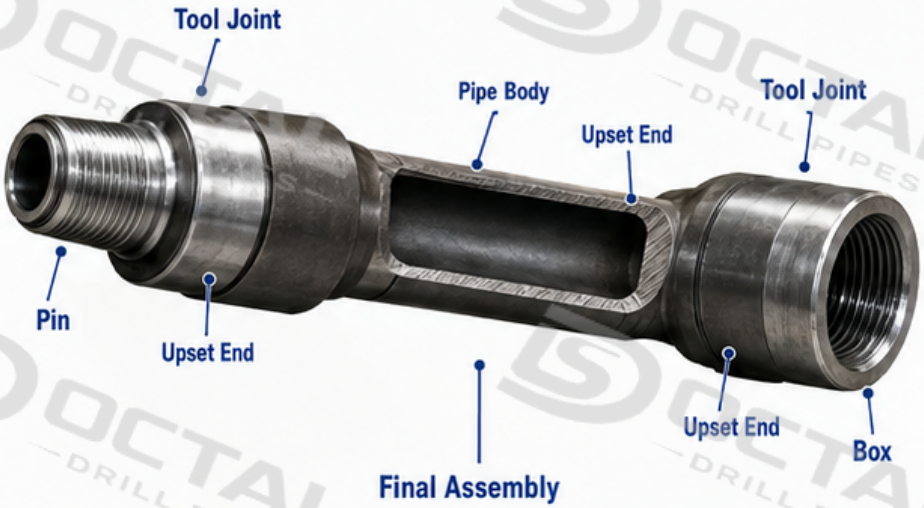
- Hot Upsetting
- Forms Thickened Weld Ends
- Controlled Diameter & Length

3 Pipe-Body Heat Treatment

- Normalizing / Quenching & Tempering
- Through-Hardening
- Mechanical Properties Per Spec.

4 Straightening

- Cold Straightening
- OD & Straightness Control
- Final Visual Check



TOOL JOINT ROUTE

1 Tool-Joint Material

- API 5DP / ISO 11961
- Approved Steel Grade
- Chemical & Mechanical Verification
- Traceability

2 Tool-Joint Heat Treatment

- Quenching & Tempering
- Microstructure Control
- Mechanical Properties Per Spec.

3 Machining

- CNC Turning
- Threading (API Reg.)
- Shoulders & Gauges
- Surface Finish Control

4 Pin/Box Connection

- Pin (Male) / Box (Female)
- API Thread Gauging
- Fit-Up Verification
- Visual Inspection

FINAL ASSEMBLY

1 Friction Welding

- Solid-State Joining (No Filler, No Arc)
- Controlled Upset Pressure
- Flash Removal
- Aligned & Coaxial Weld

2 PWHT

- Post Weld Heat Treatment
- Stress Relief
- Tempering to Meet Properties
- Controlled Cycle

3 NDT

- 100% UT of Weld & HAZ
- UT of Pin/Box Threads
- Visual Inspection
- Acceptance per Spec.

4 Marking

- Specification & Grade
- Size, Weight, & Connection
- Heat / Lot Number
- Traceability & Country of Origin

Typical manufacturing route. Acceptance and verification per API 5DP / ISO 11961 / project specification.

Drill Pipe Manufacturing Route: Pipe Body, Tool Joint and Final Assembly

Technical Reference Sheet

PIPE BODY ROUTE

1 Seamless Tube Verification

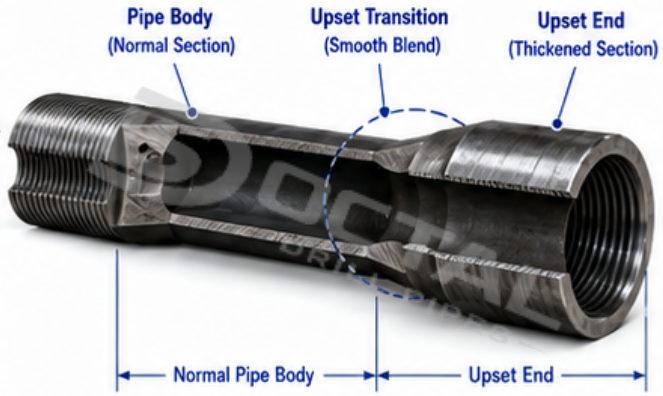
- Material Identity (Grade & Heat No.)
- OD / Wall Verification
- Surface Condition
- Visual & Dimensional Check
- Traceability

Per API 5DP / ISO 11961 / Project Specification

2 Upsetting – Heated Pipe End (Not Welding)

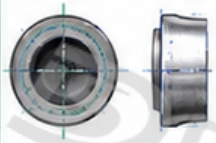
- Localized heating for plastic forming
- Upsetting increases end wall thickness to form drill pipe body
- Do not confuse with welding
- Controlled temperature & time

3 Upset Pipe Body – Geometry Overview (Cutaway)



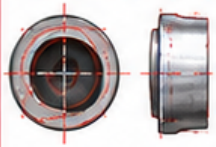
4 Concentricity & Upset Transition Control

ACCEPTABLE – CONCENTRIC



- Centered bore
- Concentric OD/ID
- Smooth transition
- Aligned load path
- Optimized stress distribution

UNACCEPTABLE – ECCENTRIC



- Eccentric bore
- Wall thickness variation
- Misaligned load path
- Elevated stress / fatigue risk

5 Pipe-Body Heat Treatment

- Through-Hardening to specified temperature profile
- Quenching & Tempering as required
- Heat treatment establishes the specified mechanical condition of the main tubular
- Hardness & Mechanical property verification

Per API 5DP / ISO 11961 / Project Specification

6 Straightening

- Cold Straightening on multi-roll equipment
- Remove curvatures to achieve straightness
- Straightness & run-out verification
- OD / Wall / Length control maintained

Per API / ISO / Project Specification

7 Body Inspection – Controlled Areas

A. Normal Pipe Body

- UT / EMI
- Visual
- Dimensional

B. Upset Transition

- UT (Focused)
- EMI (Optional)
- Visual / Dimensional

C. End Preparation Area

- UT / Visual
- Dimensional
- Thread / OD / Length

Typical pipe-body manufacturing route. Acceptance and verification per API 5DP / ISO 11961 / project specification.

Drill Pipe Manufacturing Route: Pipe Body, Tool Joint and Final Assembly

(Page 3 / 5) – Tool Joint Route

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Reliable Steel Solutions for Energy

The tool joint is produced separately from the pipe body using high-strength alloy steel. It is heat treated, machined and gauged to ensure the connection strength and dimensional accuracy required for **API/ISO oilfield drill pipe.**

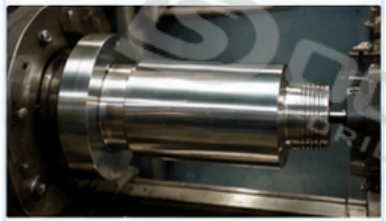
1. Tool Joint Material Preparation

- Select alloy steel per API 5DP / ISO 11961 / project specification
- Verify chemical composition and material certification

2. Heat Treatment

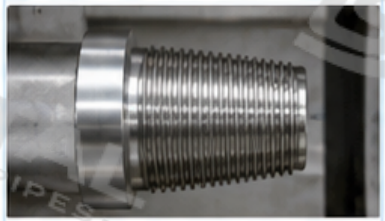
- Normalize / quench & temper per grade requirement
- Ensure mechanical properties meet specification

3. OD / ID Machining



- Machine outer diameter, inner diameter and length
- Achieve required surface finish and dimensional tolerance

4. Thread Machining

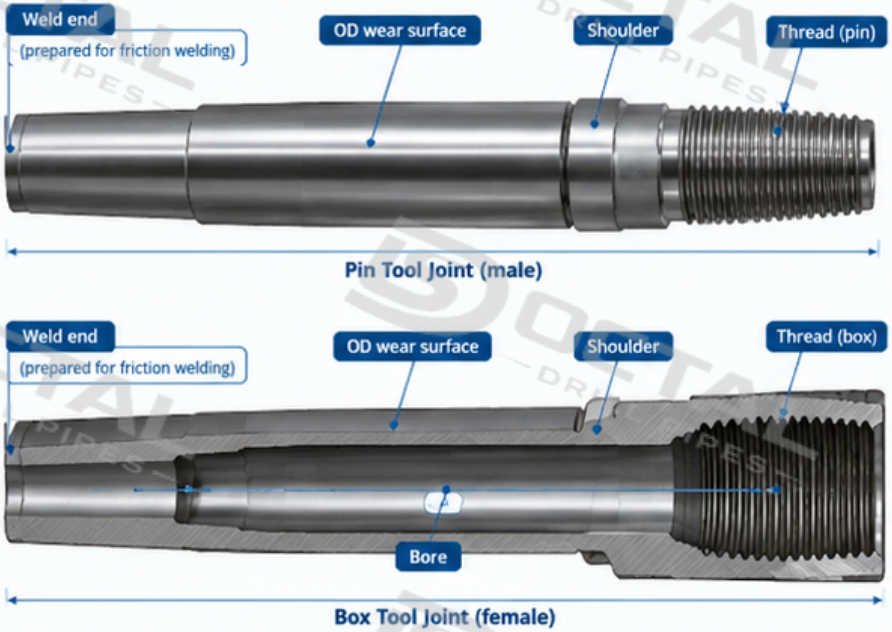


- Machine pin and box threads per API 7-2 / ISO 10424-2
- Control thread profile, pitch and surface finish

5. Gauging

- Verify connection dimensions and thread profile
- Ensure interchangeability and fit-up performance

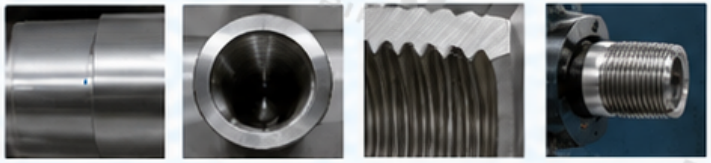
Tool Joint Anatomy



Material Identity and Heat Treatment

- ✓ Separate material identity from pipe body
- ✓ Heat treatment per grade requirement
- ✓ Controlled machining and surface finish

Key Machining and Inspection Features



OD machining (surface finish) | ID machining (bore size) | Thread machining (API 7-2 / ISO 10424-2) | Gauging (connection fit)

Tool Joint Route – Key Control Points

Material
Alloy steel per API 5DP / ISO 11961 / project specification

Heat Treatment
Meet mechanical property requirements for the grade

Machining
OD, ID, shoulder and thread per drawing and standard

Gauging
Thread profile and connection dimensions per API 7-2 / ISO 10424-2

Traceability
Heat/lot ID, MTC and inspection records

Drill Pipe Manufacturing Route:
Pipe Body, Tool Joint and Final Assembly

4/5

Final Assembly Route
Friction Welding → Flash Removal → PWHT → NDT

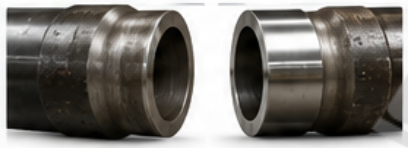
Oilfield Steel Drill Pipe
API 5DP / ISO 11961

OVERVIEW

The prepared pipe body end and tool joint are joined by rotary friction welding to form a solid-state bond. After welding, the external and internal flash is removed, the weld zone is heat treated, and the joint is inspected to verify integrity and alignment before final release.

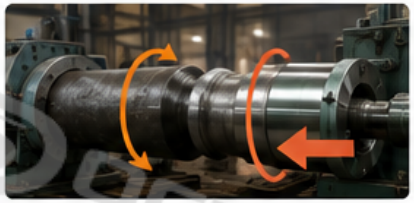
FINISHED DRILL PIPE ASSEMBLY – LOAD PATH

1 PREPARED COMPONENTS



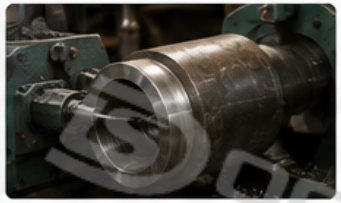
- Ends faced square and clean
- OD and bore concentricity verified
- Clean, dry contact surfaces
- Alignment per API 5DP / ISO 11961 / project specification

2 ROTARY FRICTION WELDING



- Relative rotation + axial force
- Frictional heating at the interface
- Material plasticized (no melting)
- Axial forging forms solid-state joint
- Weld flash expelled radially

3 WELD FLASH REMOVAL



- External flash removed by facing or grinding
- Internal flash removed by mandrel or boring
- Bore continuity and dimensions verified

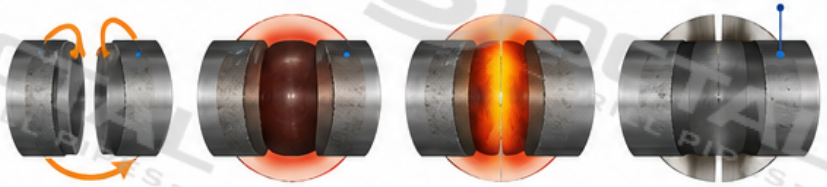
4 WELD-ZONE HEAT TREATMENT

- Localized post-weld heat treatment (PWHT)
- Restores and refines mechanical properties in the weld zone
- Process per API 5DP / ISO 11961 / project specification

5 NDT AND VERIFICATION

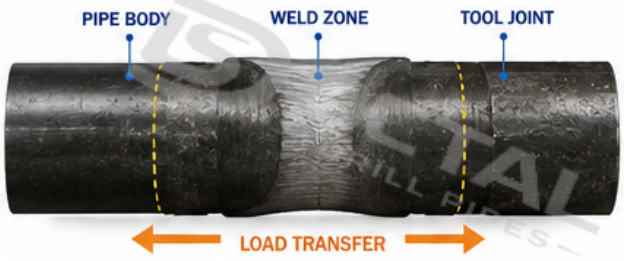
- 100% visual examination
- NDT per ITP: UT / MT as required
- Alignment, straightness, OD and bore dimensions verified
- Ready for final marking and release

FRICTION WELDING MECHANISM (SOLID-STATE JOINING)



1. The pipe body and tool joint rotate relative to each other under axial force.
2. Friction at the interface generates heat. The material softens without reaching melting point.
3. The interface becomes plasticized. Oxides are broken up and expelled with the flash.
4. Rotation stops and axial forging pressure consolidates the joint into a continuous, solid-state bond.

WELD-ZONE STRUCTURE AND LOAD TRANSFER



The friction welding process creates a homogeneous, forged joint. Loads are transferred smoothly from pipe body through the upset transition, across the weld zone, into the tool joint.

KEY CONTROL OBJECTIVES

Solid-State Integrity
No melting or filler metal. Joint formed by frictional heating and axial forging.

Alignment and Concentricity
Concentricity of OD and bore is critical for fatigue life and smooth load path.

Weld-Zone Strength Restoration
PWHT controls hardness and toughness in the weld zone per API 5DP / ISO 11961 / project specification.

Complete Inspection
NDT, dimensional checks, and connection verification ensure reliability in service.

Full Traceability
All records from welding through final release are linked to heat/lot identification.

Friction welding is a controlled solid-state joining process. Do not confuse with arc welding or fusion welding.

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Reliable Pipes, Reliable Solutions

Standards: API 5DP • ISO 11961 • API 7-2 • ISO 10424-2

Note: All manufacturing and inspection activities shall comply with the ordered grade, PSL level, and project specification.

Drill Pipe Manufacturing Route:
Pipe Body, Tool Joint and Final Assembly

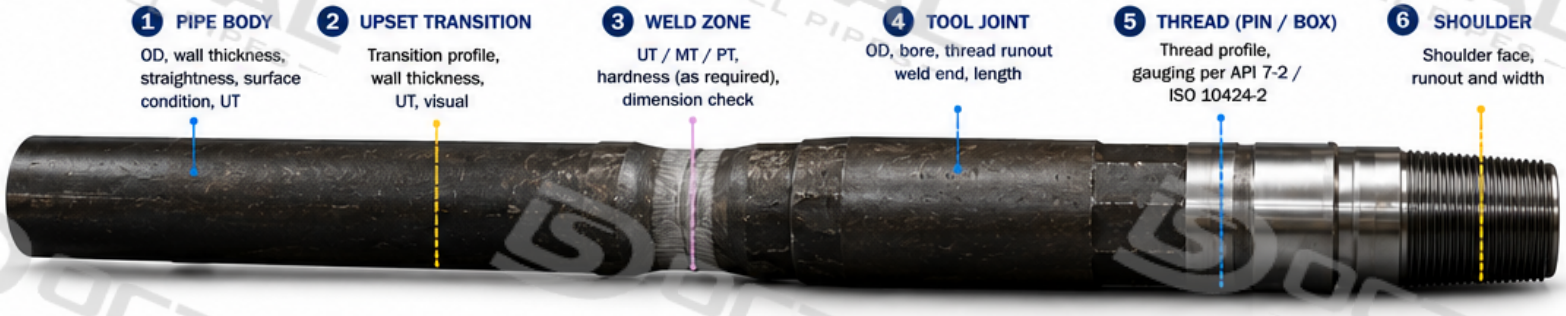
5/5 | **Final Inspection and Release**

Oilfield Steel Drill Pipe
API 5DP / ISO 11961

OVERVIEW

Every drill pipe is inspected at critical locations to verify dimensional accuracy, material integrity, connection quality, and complete traceability. Only when all inspection and documentation requirements per **API 5DP / ISO 11961 / project specification** are met is the product released for shipment.

CRITICAL INSPECTION ZONES



INSPECTION METHODS (PER ITP)

VISUAL & DIMENSIONAL

OD, WT, length, straightness, bevel, runout

ULTRASONIC TEST (UT)

Pipe body, upset transition and weld zone

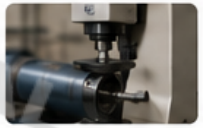
MAGNETIC PARTICLE (MT)

Surface and near-surface discontinuities

LIQUID PENETRANT (PT)

Surface-breaking defects on weld end and threads

HARDNESS TESTING



HBW / HRC at base metal and weld zone (as required)

HYDROSTATIC TEST

When required by project, typically 1.5 × design pressure with hold time per specification

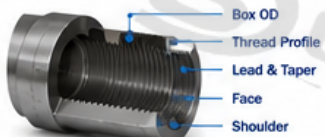
Note: Inspection scope and acceptance criteria shall be in accordance with API 5DP / ISO 11961 and the project ITP.

CONNECTION INSPECTION ZONES

PIN CONNECTION

Gauged per API 7-2 / ISO 10424-2

BOX CONNECTION



Gauged per API 7-2 / ISO 10424-2

TRACEABILITY CHAIN – FROM RAW MATERIAL TO RELEASE

1 HEAT / LOT IDENTIFICATION

Steel heat / lot ID captured and linked to production order

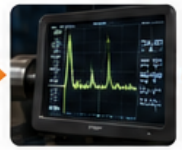
2 HEAT TREATMENT RECORD

Pipe body and tool joint heat treatment with furnace records

3 WELDING RECORD

Friction welding parameters and operator record

4 NDT & TEST RECORDS



NDT results and mechanical tests per ITP

5 CONNECTION INSPECTION

Thread gauging and dimensional verification

6 MARKING & IDENTIFICATION

Permanent marking with heat / lot, grade, size, PSL

7 PACKING LIST & DOCUMENTS

MTC, inspection reports, packing list and certificates

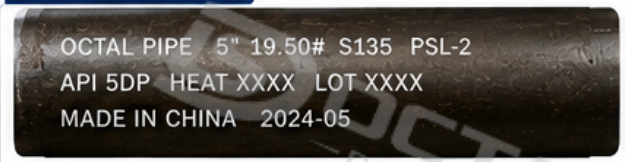
All records are linked to the heat / lot identification and maintained for full traceability.

RELEASE ACCEPTANCE CHECKLIST (EXAMPLES)

- ☑ Material and dimensions conform to API 5DP / ISO 11961 / project specification
- ☑ Heat treatment completed per procedure and records available
- ☑ NDT performed per ITP with acceptable results
- ☑ Connections gauged and within tolerance
- ☑ Weld zone heat treatment completed (when required)
- ☑ Hydrostatic test performed (when required)
- ☑ Marking is complete and legible
- ☑ All documents compiled and traceable

Only drill pipe with complete inspection and documentation shall be released.

MARKING EXAMPLE



- Manufacturer / Brand
- Size, Wall, Grade, PSL
- Standard
- Heat / Lot
- Country of Origin
- Date

Inspection scope, acceptance criteria and documentation shall comply with API 5DP / ISO 11961 and the project ITP.

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Standards: API 5DP • ISO 11961 • API 7-2 • ISO 10424-2
Note: All manufacturing and inspection activities shall comply with the ordered grade, PSL level, and project specification.