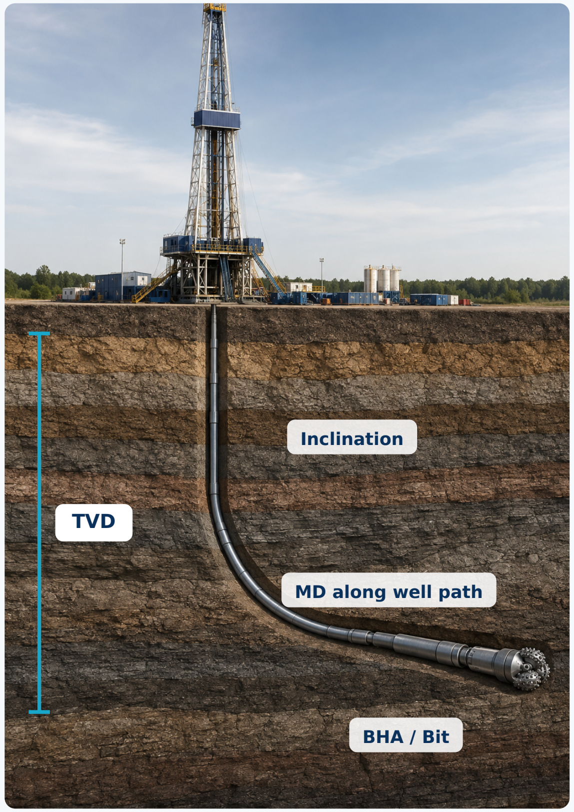
Calculation Scope and Required Inputs

Why drill string capacity requires configuration, condition and well-specific data

Capacity is a system limit

A drill string cannot be rated from pipe-body yield alone. The controlling limit may occur in the pipe body, upset, friction weld, tool joint, connection, crossover, jar or another BHA tool - and it may change between drilling, rotating, tripping and overpull operations.

Input group	Required data
Well profile	MD, TVD, inclination, azimuth and dogleg severity
Wellbore geometry	Open-hole diameter, casing ID and radial clearance
Fluid data	Mud density and internal / annular fluid conditions
Drill pipe	OD, wall thickness, grade, adjusted weight and length
Tool joint	OD, ID, connection, make-up torque and torsional rating
BHA	HWDP, drill collars, subs, jars, motors and tool weights
Operating loads	WOB, surface torque, drag, overpull and internal pressure
Condition	New, Premium Class, actual remaining wall and inspection status



Photorealistic cutaway - not to scale

OUTPUT PRINCIPLE

Report a location-specific governing limit and its assumptions - not a single universal drill string capacity.

Pipe-Body and Connection Capacity

5 in x 19.50 lb/ft S135 nominal pipe-body example

Core equations

METAL AREA

$A = (\pi / 4) \times (OD^2 - ID^2)$

TENSILE YIELD LOAD

$P_y = A \times \text{minimum yield strength}$

REMAINING-WALL EFFECT

Recalculate ID and metal area from measured wall; do not scale load from grade marking alone.

Parameter	Value
Pipe OD	5.000 in
Wall thickness	0.362 in
Calculated ID	4.276 in
Metal area	Approximately 5.28 in^2
Minimum yield strength	135,000 psi
Nominal pipe-body yield load	Approximately 713,000 lbf
Equivalent load	Approximately 3,170 kN

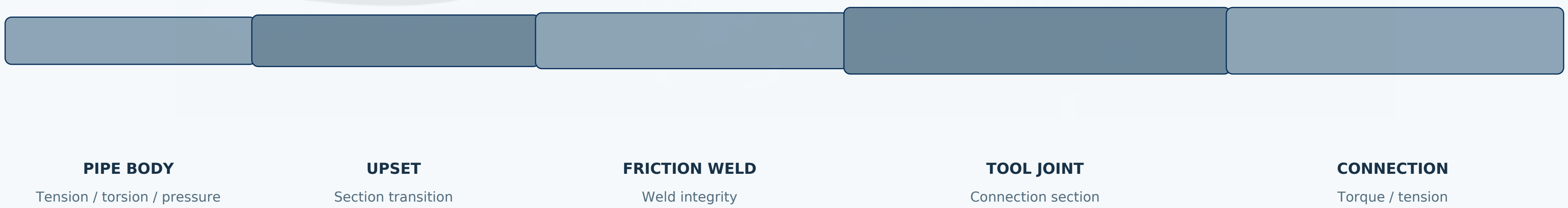
CONNECTION CHECK

Pipe OD, nominal weight and grade do not define connection capacity. Use the exact tool-joint OD / ID, thread form, shoulder geometry, material condition and connection data for the supplied configuration.

DO NOT INTERCHANGE TORQUE TERMS

Make-up torque assembles the connection. Operating torque is the permitted service value. Torsional yield is the onset of permanent deformation. Each must be listed separately.

Potential governing locations along a drill pipe joint



Tension, Buoyancy and Overpull

Illustrative calculation - uniform 10.0 ppg fluid and project-assumed design factor

Calculation sequence

BF = 1 - 10.0 / 65.5 = 0.847

Buoyed weight = 300,000 x 0.847 = 254,100 lbf

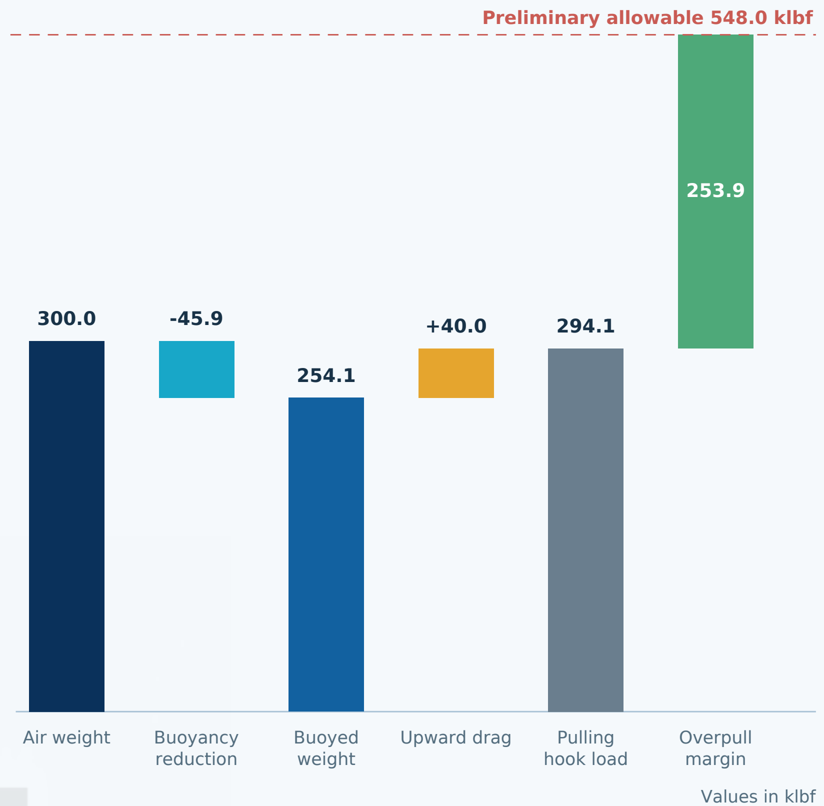
Pulling hook load = 254,100 + 40,000 = 294,100 lbf

Preliminary allowable = 713,000 / 1.30 = 548,000 lbf

Overpull margin = 548,000 - 294,100 = 253,900 lbf

Calculation item	Illustrative value
Air weight	300,000 lbf
Mud density	10.0 ppg
Buoyancy factor	0.847
Buoyed weight	254,100 lbf
Upward drag	40,000 lbf
Pulling hook load	294,100 lbf
Nominal pipe-body yield	713,000 lbf
Illustrative design factor	1.30
Preliminary allowable load	548,000 lbf
Overpull margin	253,900 lbf

Tension and Overpull Waterfall

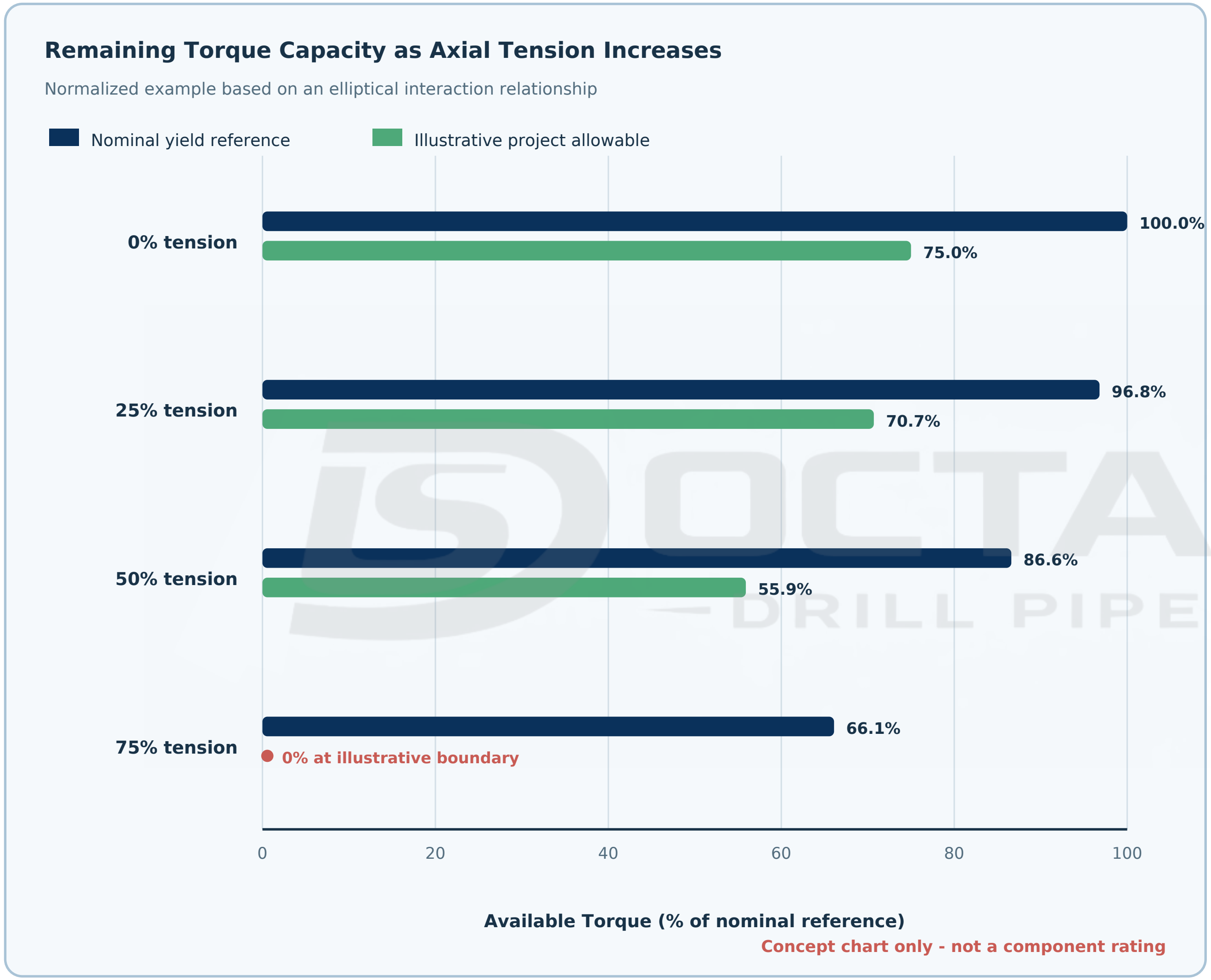


BOUNDARIES OF THE EXAMPLE

The 1.30 design factor is an assumption, not a universal API requirement. Long-string hook load should use adjusted weight that includes tool-joint effects. Final allowable load must also be checked against connection, weld, crossover, jar and BHA capacities, plus combined torque and bending.

Combined Tension and Torque

Why independent 100% tensile and 100% torsional ratings cannot be used together



LOAD INTERACTION

Axial tension consumes part of the material's available yield capacity. As tension rises, the remaining torque capacity falls; the reverse is also true.

CONNECTION MAY GOVERN

The pipe body may remain below its interaction boundary while a thinner, worn or lower-capacity tool joint or connection reaches its limit first.

WEAR CHANGES THE ENVELOPE

Reduced tool-joint OD, increased bore, shoulder damage and thread-root loss reduce available section and can move the governing boundary inward.

HOW TO USE THIS CHART

The curves are normalized concept illustrations, not ratings. Plot project tension and torque only against an approved configuration-specific interaction model.

Compression and Buckling

Simplified horizontal-well example for 5 in x 19.50 lb/ft S135 drill pipe

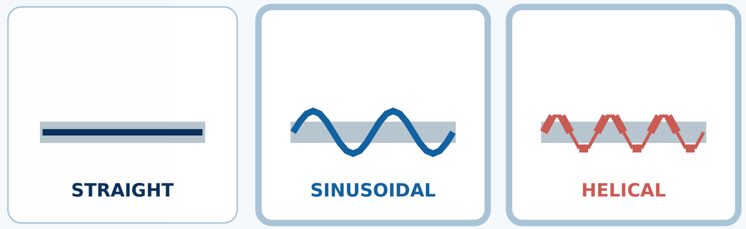
Input	Value
Drill pipe	5 in x 19.50 lb/ft S135
Wall thickness	0.362 in
Pipe-body moment of inertia	Approximately 14.27 in^4
Young's modulus	30 x 10^6 psi
Mud density	10.0 ppg
Buoyed unit weight	16.52 lb/ft
Wellbore diameter	8.500 in
Radial clearance	1.750 in
Inclination	90 degrees
Estimated sinusoidal onset	Approximately 36.7 klbf
Nominal pipe-body yield load	Approximately 713 klbf

SIMPLIFIED SINUSOIDAL-BUCKLING MODEL

F_s = 2 sqrt(E I w sin(theta) / r) Horizontal condition: sin(theta) = 1. The result applies only to the listed assumptions and a simplified straight wellbore model.

Buckling onset versus nominal pipe-body yield

Compression State Progression



INTERPRETATION

Buckling can begin far below material yield. The critical compression changes with pipe stiffness, unit weight, inclination, curvature, wellbore clearance, tool joints, torque and friction. Do not transfer the 36.7 klbf result to another pipe or well geometry.

Engineering Limits and References

Governing checks, calculation boundaries and technical basis

Check	Governing basis
Tensile load	Actual wall and weakest load-carrying component
Overpull	Allowable load minus predicted maximum hook load
Torque	Exact connection and tool-joint configuration
Combined load	Approved tension-torque interaction model
Compression	Location-specific buckling calculation
Fatigue	Stress cycles, curvature, condition and service history

Minimum record content

- Well profile and hole / casing geometry used in each interval
- Fluid densities, pressure conditions and buoyancy treatment
- Actual or specified tubular dimensions, grade, adjusted weight and condition
- Connection ratings, make-up torque and dimensional basis
- Predicted load profiles for drilling, rotating, tripping and overpull cases
- Design factors, exclusions, sensitivity cases and governing location
- Inspection status and remaining dimensions for used components

Technical basis

- API Spec 5DP - finished steel drill pipe
- API Spec 7-1 - rotary drill stem elements including HWDP
- API Spec 7-2 - rotary-shouldered connection threading and gauging
- API RP 7G-2 - inspection and classification of used drill stem elements
- Manufacturer data for the exact connection and tool-joint configuration
- Named buckling / interaction model, software version and calculation assumptions

FATIGUE IS HISTORY-DEPENDENT

Grade and remaining wall do not establish fatigue life. Track curvature, rotating cycles, stress concentration, corrosion, inspection sensitivity and prior service exposure.

ENGINEERING USE NOTICE

Values are illustrative and configuration-specific.

This document is a calculation reference, not a safe-load certificate or operating authorization. Final operating limits require verification by the responsible project engineering team using the actual well plan, supplied component data, measured condition and approved analysis methods.