

# API 5DP Drill Pipe Grade Selection Matrix by Drilling Condition

Technical matrix for reviewing E75, X95, G105 and S135 by actual drilling condition, load path, torque demand, dogleg severity, fatigue exposure, service environment, connection review and inspection records.

<b>Purpose</b> Turn grade comparison into an engineering selection matrix, not only a strength table.	<b>Grades covered</b> E75, X95, G105, S135	<b>Selection route</b> Drilling condition → load path → grade range → connection review → inspection records
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## 1. How to Read This Matrix

API 5DP drill pipe grade selection should begin with the strength ladder, but the grade should be filtered by the drilling condition. The same S135 grade can behave differently in a deep vertical well, a long horizontal section or a high-torque ERD program because the controlling factor changes from tensile load to torque-drag, fatigue, connection stress or service qualification.

Grade	Minimum Yield Strength	Common Review Position	Main Selection Boundary
<b>E75</b>	75,000 psi / 517 MPa	Baseline API grade	Moderate tensile load, normal rotary torque and controlled well profile.
<b>X95</b>	95,000 psi / 655 MPa	Intermediate grade	E75 margin becomes limited, but G105 strength window is not yet required.
<b>G105</b>	105,000 psi / 724 MPa	Higher-strength grade	Deeper or directional drilling with higher combined tension, torque and bending.
<b>S135</b>	135,000 psi / 931 MPa	Common high-strength API grade	High hook load, long horizontal rotation, ERD or high-torque drilling.

Matrix principle: a higher grade increases pipe-body tensile margin, but it does not automatically solve connection torque, dogleg-related fatigue, upset-transition stress, sour-service cracking risk or missing inspection evidence.

## 2. Drilling Condition Matrix - Conventional, Directional and Deep Wells

The first review layer separates normal grade selection from high-load or fatigue-sensitive grade selection. These are typical review ranges, not fixed grade rules.

Drilling Condition	Typical Operating Detail	Common Grade Review	Key Control Point	Next Review Trigger
<b>Conventional vertical well</b>	Short to medium measured depth, low dogleg, normal rotary torque, limited cyclic bending at tool joints.	E75 / X95	Hook load, OD / wall thickness, connection match, pipe marking and MTC.	Move toward X95 / G105 when tensile margin decreases or drilling depth increases.
<b>Moderately directional well</b>	Build and hold sections with controlled dogleg, higher torque than vertical wells, limited long-lateral rotation.	X95 / G105	Bending load, torque demand, connection compatibility and tool joint condition.	Move toward G105 when X95 load margin becomes insufficient or torque-drag increases.
<b>Medium-depth directional well</b>	Longer directional interval, repeated rotation in curved sections, combined tension and torque.	X95 / G105	Torque-drag, dogleg severity, cyclic bending and shoulder contact.	Review G105 when directional load and fatigue exposure become part of the load case.
<b>Deep vertical or deviated well</b>	Higher string weight, larger hook load, greater overpull margin, deeper measured depth.	G105 / S135	Tensile margin, tool joint strength, connection review and traceability records.	Review S135 when hook load approaches the G105 margin or torque rises with depth.
<b>High-pressure / high-load drilling</b>	Higher working load, stronger BHA influence, larger overpull expectation or more demanding string design.	G105 / S135	Pipe body strength, connection capacity, shoulder contact and fatigue margin.	Review S135 or special route when high load combines with severe fatigue or service limits.

### 3. Drilling Condition Matrix - Horizontal, ERD and Severe Dogleg Wells

Long horizontal and ERD wells are not controlled only by vertical depth. Torque-drag, rotation time, dogleg severity and fatigue-sensitive transition areas can become more important than the grade name.

Drilling Condition	Typical Operating Detail	Common Grade Review	Key Control Point	Next Review Trigger
<b>Long horizontal section</b>	Long lateral rotation, accumulated torque-drag, repeated bending near tool joints and upset transition.	G105 / S135	Torque-drag, fatigue exposure, dogleg severity and connection shoulder condition.	Review S135 when long rotation or bending fatigue approaches G105 margin.
<b>ERD well</b>	Extended measured depth with combined axial load, rotary torque, drag and lateral contact.	S135 or special route review	Combined tension, torque, drag, connection torque capacity and fatigue life.	Move beyond normal API grade review when torque / drag and fatigue become the controlling design limits.
<b>High-torque drilling</b>	Higher make-up torque requirement, stronger rotary torque transfer, higher connection-side loading.	G105 / S135	Connection rating, shoulder contact, thread condition, tool joint matching.	Review S135 when connection-side load must match a higher-strength pipe body.
<b>Severe dogleg or high build-rate section</b>	High curvature zone, repeated bending cycle, local stress concentration near upset and tool joint.	G105 / S135 plus fatigue review	Dogleg severity, bend cycle exposure, transition-zone inspection and fatigue margin.	Move to special route when fatigue-sensitive geometry controls the design more than strength number.
<b>Small OD / limited clearance drilling</b>	Restricted bore, upset transition clearance, tool passage or hydraulic limitations.	Grade plus clearance review	OD / wall thickness, tool joint ID, drift path, upset type and internal clearance.	Grade is not enough when clearance or hydraulic restriction becomes the limiting factor.

## 4. Risk Notes - When Normal API Grade Selection Is Not Enough

Some conditions should not be handled by moving upward through E75, X95, G105 and S135 alone. If the controlling factor is sour-service cracking, low-temperature toughness, severe fatigue or special connection demand, the review must include service-specific evidence.

Risk Condition	Why Normal Grade Selection Is Limited	Required Review Logic	Records / Evidence to Check
<b>Sour service / H2S exposure</b>	Higher strength can increase cracking sensitivity if hardness and microstructure are not controlled.	Use sour-service or special material route review instead of grade name alone.	Hardness record, heat treatment record, MTC, NACE / ISO 15156 basis where applicable.
<b>Low-temperature drilling</b>	Yield strength does not prove impact resistance at lower service temperature.	Add Charpy impact review at required test temperature.	Charpy impact test, test temperature, absorbed energy requirement, heat number link.
<b>Severe fatigue exposure</b>	Repeated bending can control service life even when tensile strength is adequate.	Review fatigue-sensitive zones, upset transition, thread shoulder and rotation exposure.	NDT, dimensional inspection, tool joint inspection, dogleg severity and operating history where available.
<b>High-torque connection demand</b>	Connection, shoulder and tool joint can limit performance before pipe body strength is reached.	Check connection torque capacity and shoulder contact, not only pipe body grade.	Thread inspection, shoulder condition, make-up torque record, tool joint dimensions.
<b>Controlled yield-strength window</b>	Some designs need tighter strength consistency instead of only a higher nominal grade.	Review actual test values and heat-to-heat consistency.	MTC, tensile test, heat number map, release records.

Risk reading: sour service and low-temperature drilling are not simple grade upgrades. They require hardness, toughness, heat-treatment and traceability evidence that supports the intended service environment.

## 5. Key Control Point Table

This table turns drilling condition into engineering review items. The goal is to connect the grade range with the actual load path and with the evidence needed for release.

Control Point	What to Review	Why It Matters	Typical Grade Effect
<b>Hook load</b>	String weight, overpull, safety margin, planned depth.	The first filter for moving from E75 / X95 toward G105 / S135.	Higher hook load usually moves review toward G105 or S135.
<b>Torque</b>	Rotary torque, make-up torque, tool joint torque capacity.	High torque can make the connection area more critical than the pipe body.	High-torque drilling usually pushes review toward G105 / S135 with connection verification.
<b>Dogleg severity</b>	Build rate, curvature, rotation through dogleg, bending cycle.	Controls fatigue near upset transition, thread shoulder and tool joint area.	Severe dogleg needs fatigue review even if grade strength is enough.
<b>Fatigue</b>	Lateral length, rotation time, bending stress, transition-area inspection.	Fatigue damage accumulates under repeated rotation and bending.	Long horizontal / ERD wells often require G105 / S135 or special fatigue review.
<b>Connection</b>	NC / FH connection, shoulder contact, thread condition, torque transfer.	Connection mismatch can reduce the value of a higher pipe body grade.	High grades need matching tool joint and thread inspection.
<b>Documentation</b>	Pipe marking, heat number, MTC, tensile / impact / hardness records, NDT, thread inspection.	Records prove that the grade and performance route are tied to the delivered pipe.	Higher or special service grades need deeper record chain verification.

## 6. Selection Flow - From Drilling Condition to Release Records

The grade matrix should be used as a workflow. It starts with the well condition, then moves to load path, grade range, connection review and final record verification.

Step	Review Question	Output
1. Drilling condition	Is the well vertical, directional, deep, long horizontal, ERD, high-torque, sour-service or low-temperature?	Defines the initial grade review range.
2. Load path	Which load controls the pipe: hook load, torque, drag, dogleg bending, fatigue or service environment?	Identifies the real limiting factor.
3. Grade range	Does the condition fit E75 / X95, X95 / G105, G105 / S135, or S135 / special route review?	Builds the grade selection boundary.
4. Size and connection review	Do OD, wall thickness, upset type, tool joint OD / ID, connection and shoulder contact support the load?	Confirms the drill pipe assembly, not only pipe body strength.
5. Service review	Does H2S, low temperature, severe fatigue or high torque require extra hardness, impact or connection evidence?	Confirms whether normal API grade review is enough.
6. Inspection records	Are pipe marking, heat number, MTC, test results, NDT, dimensional inspection and thread inspection connected?	Confirms traceable release basis.

**Final note:** the grade should match the actual load path, not only the strength number. A grade range is useful only when the selected size, connection, fatigue margin, service requirement and record chain support the same drilling condition.

*Reference basis: publicly available API 5DP grade values and common technical discussions of API 5DP drill pipe selection. Final engineering use should be checked against the applicable standard edition, project specification, well design and certified release records.*