Stick-Slip Mitigation
Stick-slip Mitigation Option Tree

High/Severe Stick-slip

1 - PDC Bit
   - More blades/smaller cutters
   - Increase cutter back-rake angle
   - Depth of cut limiters/Hybrids
   - Tapered gauge
   - Use Insert bit

2 - BHA
   - Undergauge stabilizers 1/8” to 1/16”
   - Integral Blade or Melon-profile stabilizers
   - Drop Flex Collar
   - Drop stabilizer above MWD Or reduce # stabilizers
   - Add a Roller Reamer

3 - Drilling parameters
   - Increase RPM, as per chart
   - Decrease WOB, as per chart
   - Pick up off bottom, stop rotary, as per chart
   - Change On/Off bottom procedures

4 - Increase Mud Lubricity
   - Better hole cleaning

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Cutters & Blades

- More blades and smaller cutters
  - More blades mean load better distributed over more cutters
  - With larger cutters, depth of cut is deeper, giving a higher Torque response
  - With smaller and more cutters, depth of penetration is smaller, which gives a lower Torque response
Back-rake Angle

- Increase cutter back-rake angle
  - Back rake angle typically varies between 15 to 45 degrees (angle from vertical)

- Lower back rake angle, larger depth of cut, more aggressive = higher Torque and potential for Stick-slip

- Higher back rake angle, less aggressive = lower Torque

- Higher angle gives smaller vertical and higher horizontal component of force, so less potential for stick-slip
Depth of cut limiters

- Depth of cut limiters / Hybrids

  ✓ Depth of cut limiters “limit” the cutter penetration into the formation, thereby decreasing Torque

  ✓ When mitigating stick-slip with depth of cut limiters, DO NOT reduce WOB as per usual guidelines – actually, increase WOB to bury the cutters and allow the limiters to do their job

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Tapered Gauge

- Tapered gauge

✓ Tapered gauge will help decrease the Torque generated at the upper gauge pad area, allowing the cutters only to generate Torque
Insert Bit

- Change to Insert bit

  - Roller cone insert bits have a different cutting action than PDC bits, which cut by shearing and can generate high Torque

  - Insert bits cut by rolling and crushing actions and do not generate as much Torque
Undergauge Stabilizers

- Use undergauge stabilization – 1/16” to 1/8”

  ✓ As well as helping with directional control, using undergauge stabilizers help reduce borehole wall contact and resultant friction forces
  ✓ Gauge stabilizers increase friction factors and will help increase stick-slip levels due to interactions with the wellbore
Stabilizer Types

- Use spiral Integral blade stabilizers instead of welded, straight blade stabilizers

- Use melon-profile stabilizers instead of stabilizers with 90-degree or high angle leading edges
  - Smoother angle and profile helps reduce chance of generating shocks and stick-slip when interacting with formations, formations changes, ledges, etc
Flex Collar

- Flex collars have been known to generate stick-slip due to their flexibility
  - Only use Flex collars when directional responses in an area/well are unknown, or you need DLS > 3 degrees/100 ft
Reduce Stabilization

- Keep the number of stabilizers to a minimum, just enough to accomplish your directional goals
  - Dropping the stabilizer above the MWD collar has been observed to reduce stick-slip – in most cases, high MWD shocks do not decrease because of this, but MWD shocks have increased in some other cases – use a rigid-mount collar to offset MWD shock generation if you drop the stabilizer
  - Less stabilization means less borehole wall contact, less friction forces, less torque and thus the less chance to generate stick-slip
Roller Reamers

- Add a roller reamer
  - Adding a roller reamer will reduce BHA to borehole friction and torque and thus reduce the chance for stick-slip generation
  - Note that some operators do not like to use roller reamers due to their sometimes short bearing life and propensity to come apart downhole
Increase RPM

- Increasing RPM will help increase the drillstring inertia and help overcome the formation friction factor

- Remember that changing RPM and WOB to reduce stick-slip can initiate other even more destructive vibration types, such as BHA whirl

- Try to optimize RPM/WOB to maximize ROP
Reduce WOB

- Reducing Weight On Bit pulls the cutters out of the formation a little, thereby reducing torque and side forces on the BHA.

- Reducing WOB will often result in a decrease in ROP?

- Remember that changing RPM and WOB to reduce stick-slip can initiate other even more destructive vibration types, such as BHA whirl.

- Try to optimize RPM/WOB to maximize ROP.
Pick up off bottom

- Picking up off bottom and stopping the drillstring is often the cure when stick-slip levels are severe.

- Reducing WOB will often result in a decrease in ROP, which will not make the client happy?

- Try to optimize RPM/WOB to maximize ROP
### On/Off bottom Procedure

#### Actions to Address Drill String Vibrations

<table>
<thead>
<tr>
<th>Condition</th>
<th>RPM</th>
<th>WOB</th>
<th>Flowrate</th>
<th>Complete Action and Comments</th>
</tr>
</thead>
</table>
| **Shutting Down for a Connection** | Reduce RPM  | Drill off to 50% of drilling WOB | Shut Down Pumps. | 1. Reduce RPM to between 60 to 80.  
2. Drill off to 50% of Drilling WOB, and  
4. Make the Connection. |
| **Starting Up after a Connection** | Start the rotary between 60 and 80 RPM. | Slowly Increase WOB to target drilling value | Bring Pumps up gradually to drilling value | 1. Start the rotary between 60 & 80 rpm.  
2. Place the bit on bottom.  
3. Slowly increase WOB to target drilling value.  
**CAUTION:** Take Care not to initiate Stick / Slip.  
4. Increase RPM to the target drilling value. |
| **Reaming Guidelines**            | Use low RPM | Use minimal WOB | No Change         | 1. Use minimal WOB while reaming.  
2. Control reaming penetration rate to below 50% of the normal drilling penetration rate.  
3. Ensure the bit torque does not exceed 50% of the normal drilling torque for that bit and formation.  
4. Keep reaming speed below 35 fpm. and  
5. Use low rpm to minimize vibration levels while monitoring RT shock measurements. |
| **Bit Break-in Procedure**        | Start the RPM at half the target drilling rate | Begin drilling with low WOB <6K for 2 to 3 feet. | Target Drilling Flowrate | 1. Start the RPM at half the target drilling rate.  
2. Tag Bottom.  
3. PU 1 foot off bottom & circulate for 5 minutes.  
4. Begin Drilling with low WOB & drill 2 - 3 feet. (no more than 500 psi of bit diameter -- 6K WOB)  
5. Increase the WOB to target drilling value, then  
6. Increase the RPM.  
**CAUTION:** Take Care not to induce Stick Slip or Axial & Lateral Vibrations |
Hole Cleaning

- Poor hole cleaning, especially in wells with angles of 35-65 degrees, can help induce stick-slip.

- Cuttings can build up around the BHA, especially the stabilizer blades, binding the drillstring and causing stick-slip.
Mud Lubricity

- Increasing the lubricity of the mud will help “slick up” the hole and reduce stick-slip tendencies
  - Try to use liquid lubricants where possible, in water-based muds – avoid solids such as beads to avoid any downhole tool jamming issues
  - Increasing oil percentage can help
  - In some cases with oil-based muds, stick-slip can be accelerated by the extreme “slickness” of the mud system