XPS Consulting & Testwork Services

Recurring Failures of Rod Mill Liner Bolts

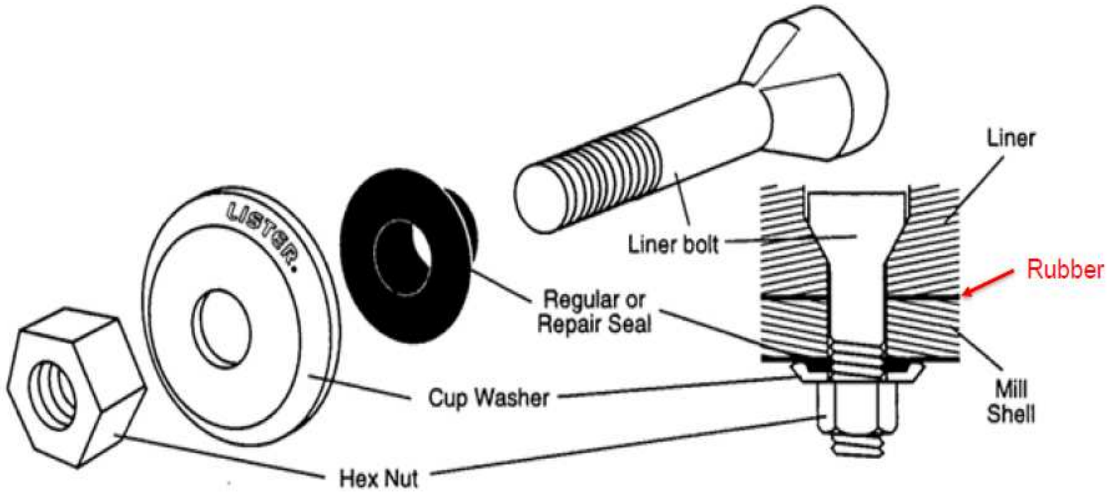
Materials Technology

Presented by Wilson Pascheto
Wilson.Pascheto@xps.ca

IMPC, Quebec City, QC September 2016

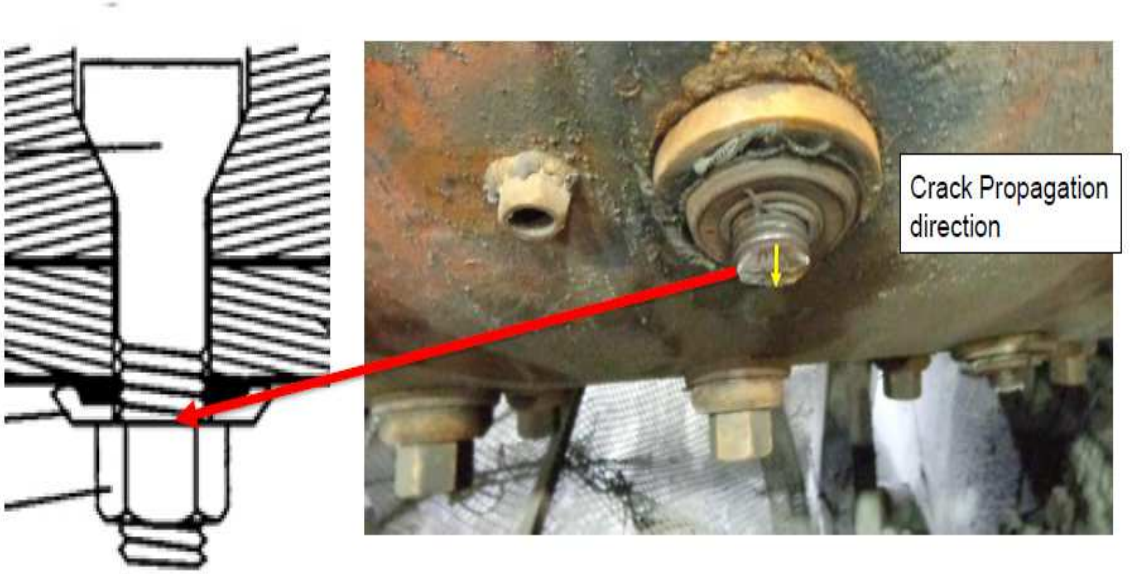
A GLENCORE COMPANY

Schematic Representation of Joint Assembly



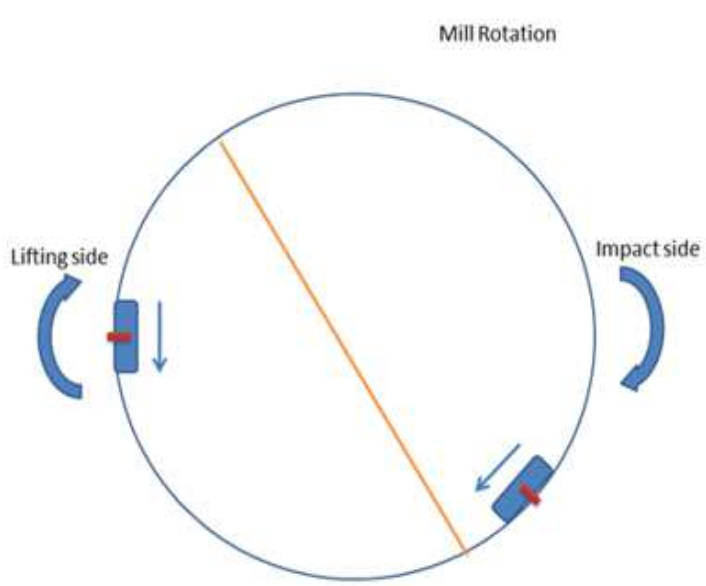
[1] Lister liner bolts brochure, Columbus McKinnon Corporation, 2012

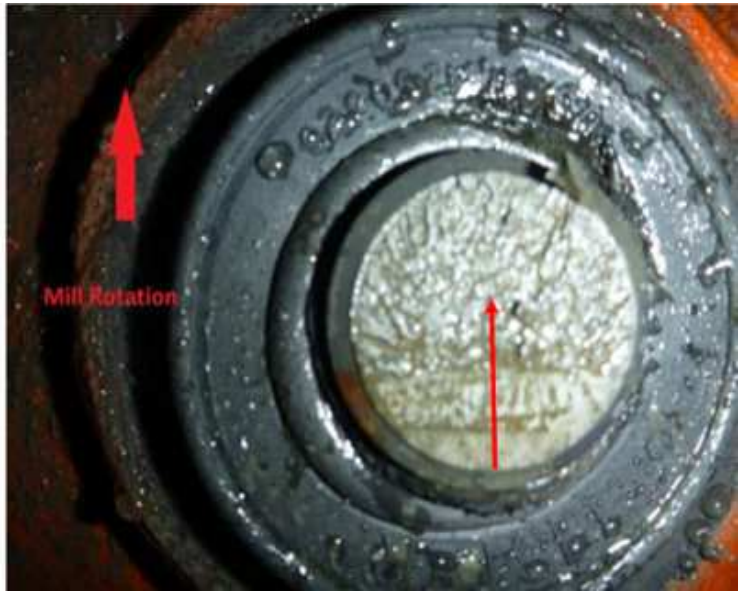
Failure Location: 1st thread from the nut bearing face



XPS Consulting & Testwork Services

Direction of Crack Propagation and Mill Rotation



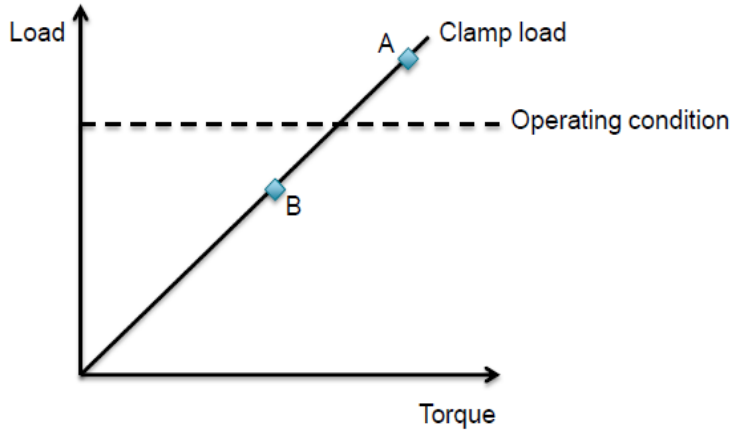


XPS Consulting & Testwork Services

Plastic deformation of bolt threads and mill shell

Schematic Representation of Bolt Loads

Bolted Assembly



A: Torque applied creates a clamp load higher than operating condition. Bolt is unaffected by load cycle.

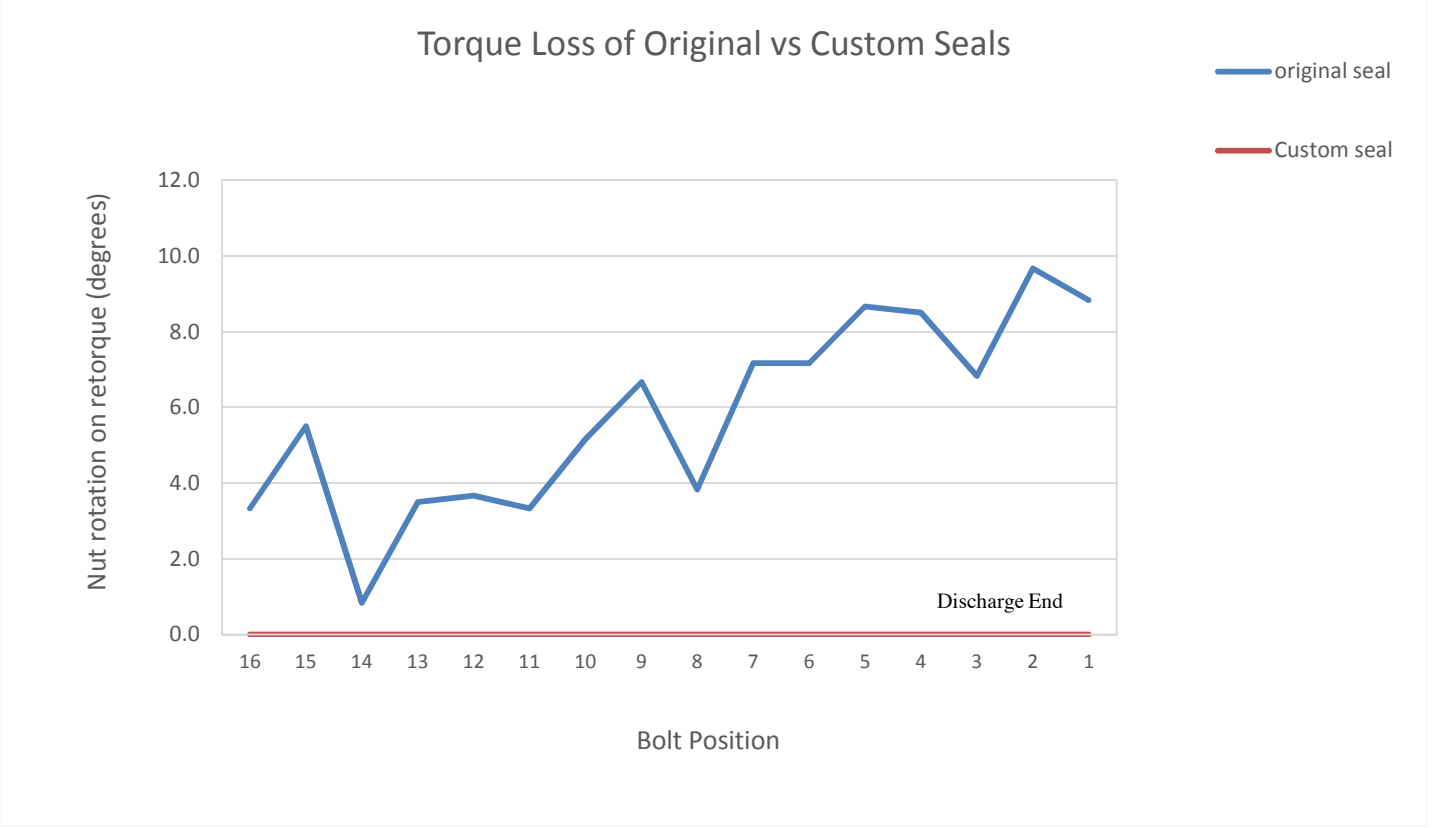
B: Torque applied creates a clamp load lower than operating condition. Bolt assembly will be exposed to load cycle.

XPS Consulting & Testwork Services

Damaged Rubber Seal

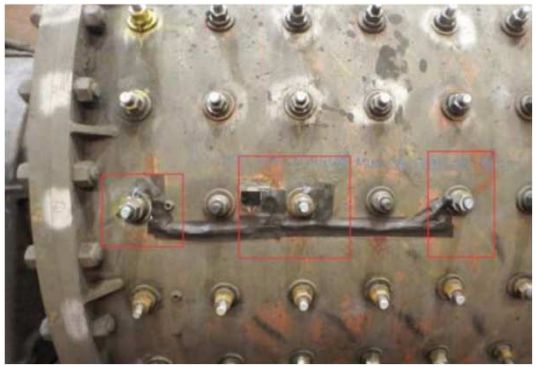
XPS Consulting & Testwork Services

Rubber Seal Test



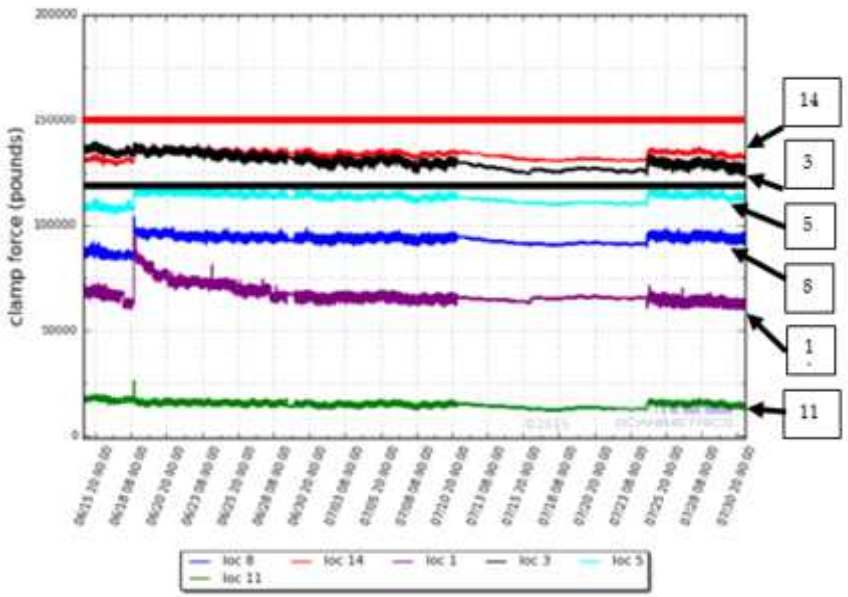
XPS Consulting & Testwork Services

Clamp Load Tests / Load Cell Position

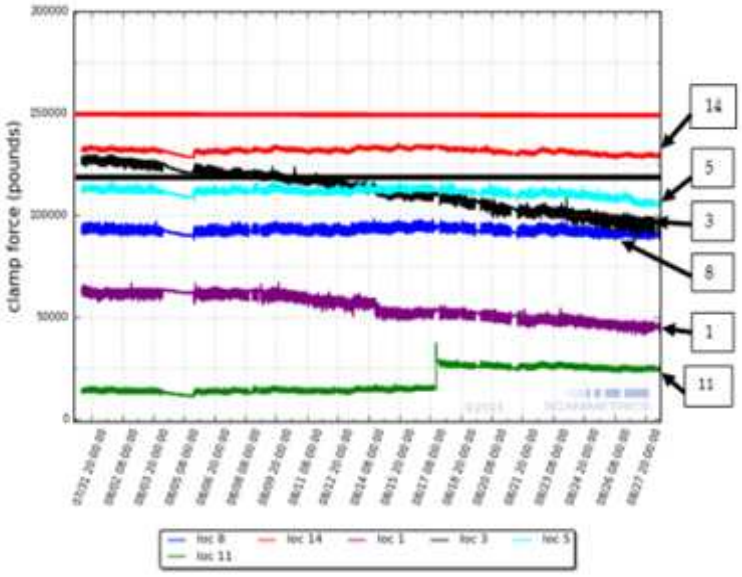


XPS Consulting & Testwork Services

Clamp load vs time



Clamp Forces – June/July



Clamp Forces – August

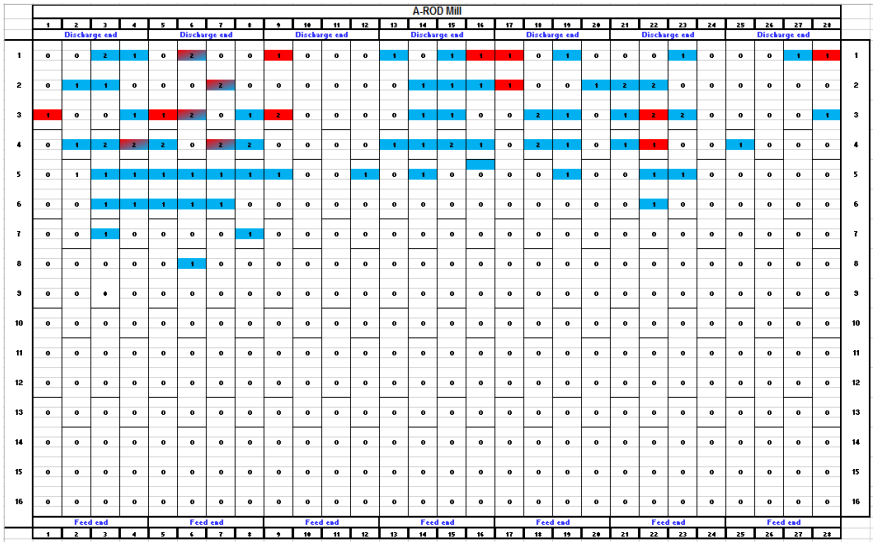
Clamp load test results

XPS Consulting & Testwork Services

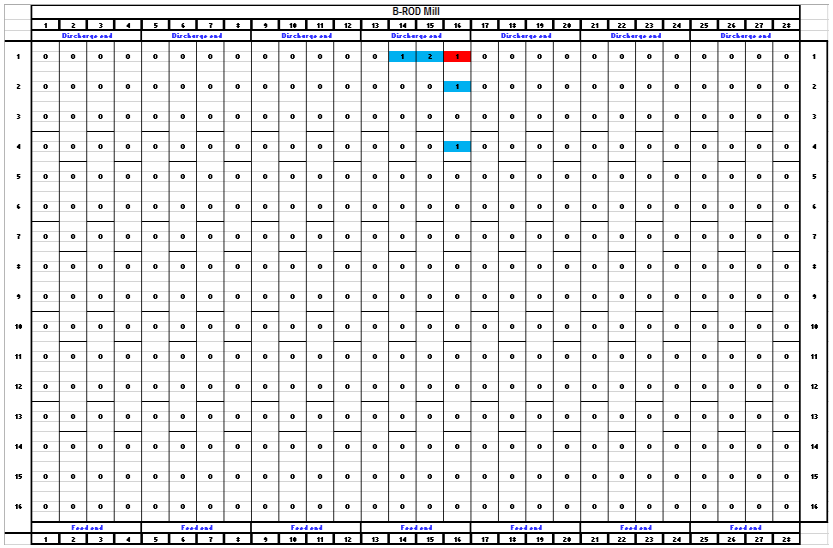
- All bolts relaxed with time, as it is evident by the loss of clamp load with time
- Bolts 1, 3 and 5 experienced the highest losses of clamp load. These three bolts were the closest to the mill discharge end.
- High loss of clamp load appeared is independent of initial clamp load but highly dependent on bolt position, as the highest losses were near the discharge end.

XPS Consulting & Testwork Services

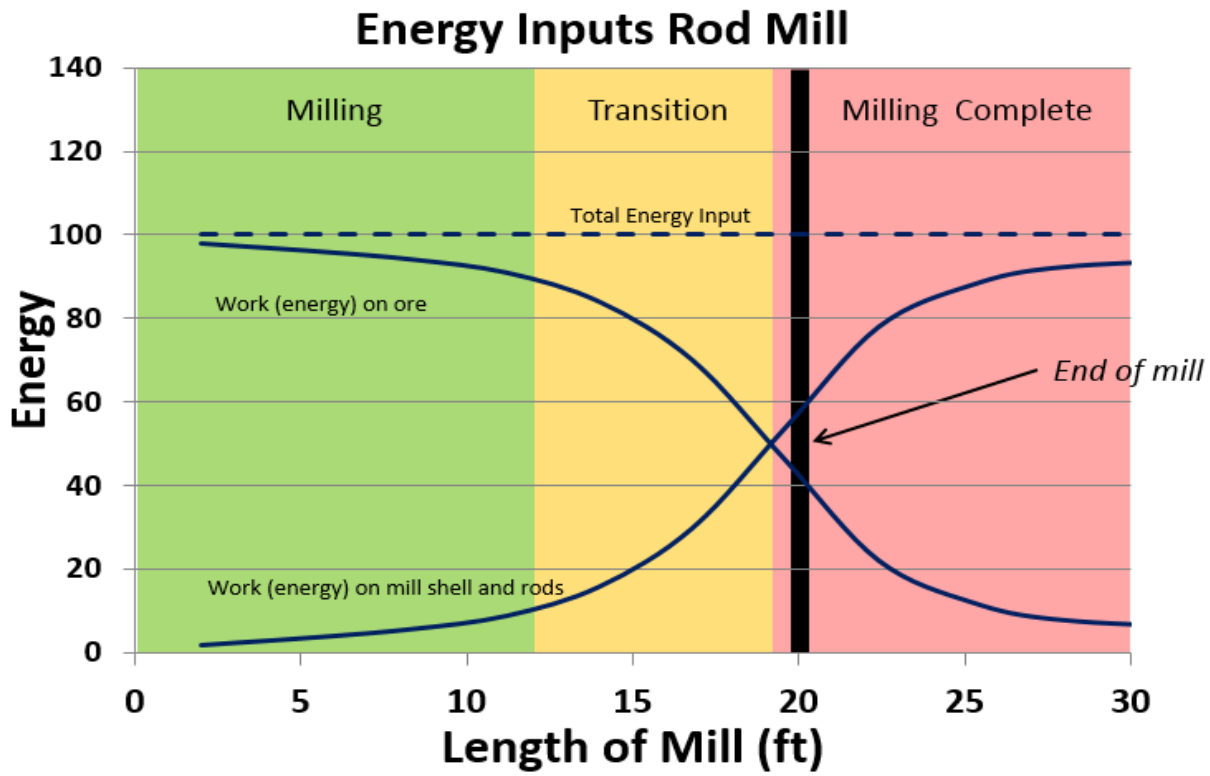
Failure positions in “A” and “B” mill



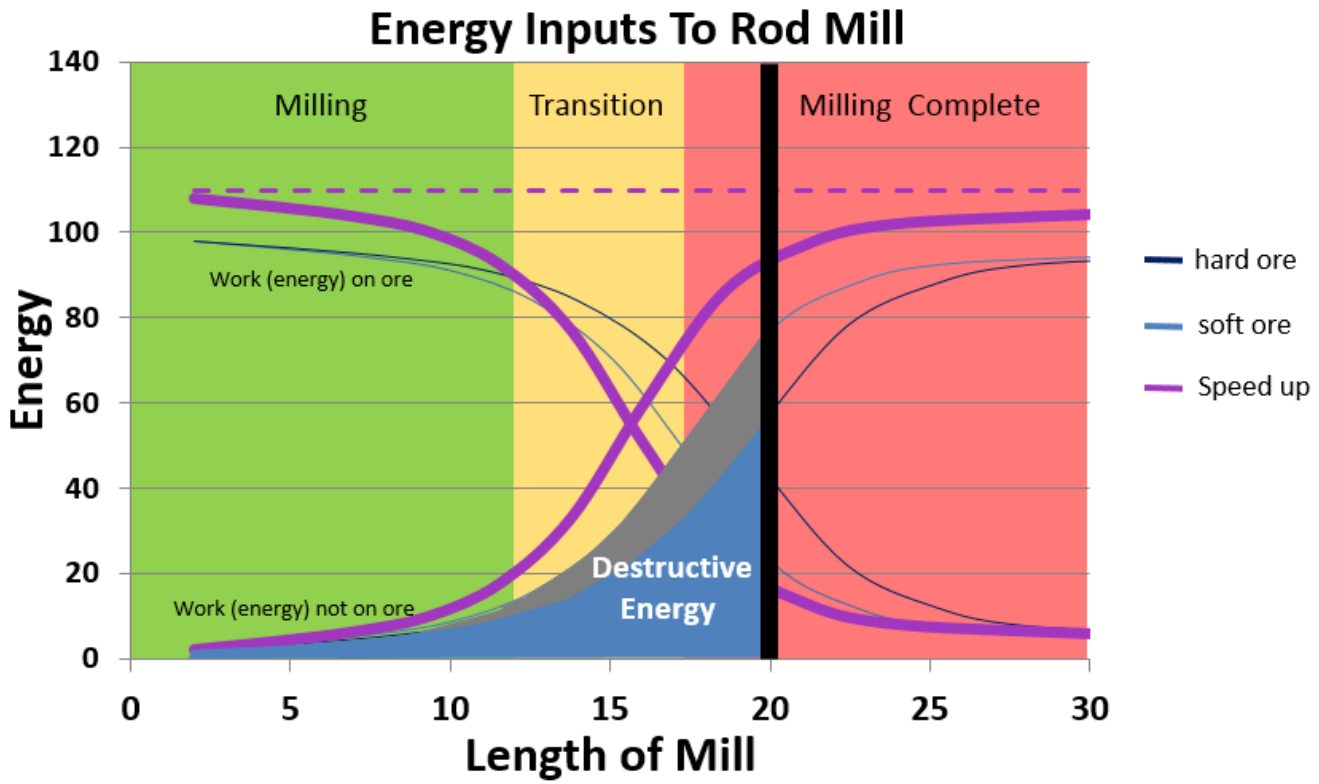
“A” mill



“B” mill


Energy Inputs Rod Mill
Milling
Transition
Milling Complete
Total Energy Input
Work (energy) on ore
Work (energy) on mill shell and rods
End of mill
Energy
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Length of Mill (ft)

Speed Up – Add More Energy



XPS Consulting & Testwork Services

Presentation Summary

- Bolt failures occurred by fatigue. The direction of fatigue crack propagation was in the direction of mill rotation
- Fatigue failures occur when external cyclic loads are higher than the bolt clamp load
- The rubber seal between the mill shell and bolt washer affect joint relaxation, and therefore loss of clamp load
- The initial clamp load of a bolt is affected by thread cleanliness and quality
- Better control of bolt clamp load reduced bolt failure rates.

XPS Consulting & Testwork Services

Presentation Summary

- Bolt failures was a function of bolt position rather than initial clamp load. Therefore, the failures appeared to be mostly related to bolt loosening due to the extent of impact and vibration at the discharge end of the mill

- An energy model has been proposed to explain the effect of ore hardness, mill speed, ore throughput and liner design on the energy distribution across the length of the mill as it relates to grinding and interaction between mill rods and shell liner

- Changes in liner design are underway to address energy distribution and reduce impact in the mill.