

To:
From: D. Smithman
Subject: F10 Drive Failure
Date: January 17, 2005

Cc:

SUMMARY

The drive on Finishing Mill Stand 10 failed on January 16, 2005 resulting in approximately 17 hours of lost production availability. The problem was found to be a worn belt which was replaced.

DETAIL DISCUSSION

An alert electrician noticed that the fence around the new motor room reactors was pulsing while on a motor room inspection during a short maintenance outage for Stand 8. He then noted that amp meters for Stand 10 were also fluctuating in a periodic fashion between 900 and 3300 amps with no bar in the mill. The motor is rated at 5400 amps. When he inspected the Stand 10 motor, he noted that sparking under the brushes was pulsing with the same frequency. The turn foreman was notified and the line shut down to investigate.

Investigation showed pitch bar markings on the commutator. These are burn marks over several of the copper bars that occur in regularly spaced groups around the circumference of the commutator. The spacing is usually the same as the spacing of the brush holder arms although it can be in multiples of that spacing in severe cases. It occurs because the excessive pulse of current burns the same spot under each bush arm as the armature rotates. The commutator was stoned to remove the burn marks and the mill restarted.

A single bar was run and the pulsing was noted again. This was when a more thorough investigation was initiated.

Once per revolution pulsing of this nature is indicative of an open armature problem, usually a broken riser. Since this can result in a destructive flashover, the motor was thoroughly inspected to determine if there was such a problem. Tests and results are given below.

<u>TEST</u>		<u>RESULT</u>	<u>COMMENT</u>
Visual inspection		No problems found	Brush and commutator pitch burning
Pole drops		No problems found	Drops from 6.2 to 7.0 Vac
Bar-to-bar		No problems found	
Brush arm spacing		Poor ⁽¹⁾	
Megger (500Vdc)	Armature	0.27 MΩ	Low, should be 1.5 or better
	Main shunt field	27.0 MΩ	
	Differential shunt field	0.0 MΩ	Bad, but field not used ⁽²⁾

- (1) The brush arm spacing is off and this is probably the cause of the routine sparking seen during operation and can result in excessive sparking. However there was nothing to indicate that this had changed recently and would've required many hours to correct.
- (2) This needs to be investigated. The differential compounding field is no longer used, but if there is more than one grounding point, induced current could result in unintentional field heating or possibly even affect field strength and lead to problems. But it wouldn't be the source of this problem.

Because there were no obvious problems with the motor, it was restarted to see if the problem reoccurred. With no bar in the mill, the pulsating sparking still occurred and the high current values reported earlier were also present. However, current traces showed that the pulsing was not occurring at the same speed as the shaft was rotating. The armature shaft was turning at 230 rpm or 3.83 Hz. The pulses were occurring at 2.85 Hz or 0.74 times per revolution.

While changing the resolver, some calculations were made to try to determine a cause for a 0.74 times per revolution phenomena. The speed ratio as determined to be the pulley sizes for the resolver shaft was $15.5/3.25=4.77$. This didn't provide any obvious connection. Next, the speed of the resolver belt was checked using 1 for the armature speed so as to normalize the result.



$$f = \frac{\pi * rpm_{pulley} * dia_{pulley}}{length_{belt}} = \frac{\pi * 1 * 15.5}{64} = 0.76$$

This provided a good match with the pulsing frequency, i.e., 0.74 is very close to 0.76, so the resolver belt was replaced. The pulsing ended and the motor currents went back to more historically reasonable values.

EPILOGUE

The old belt was found to have several damaged teeth in one area. Note the gouged areas on the right of the bottom teeth. This allowed the belt to slip and resulted in a false mill speed reference for the stand control system. The system was compensating for this by trying to speed up the motor once every $\frac{3}{4}$ of a revolution resulting in the high current and pulsating sparking.

