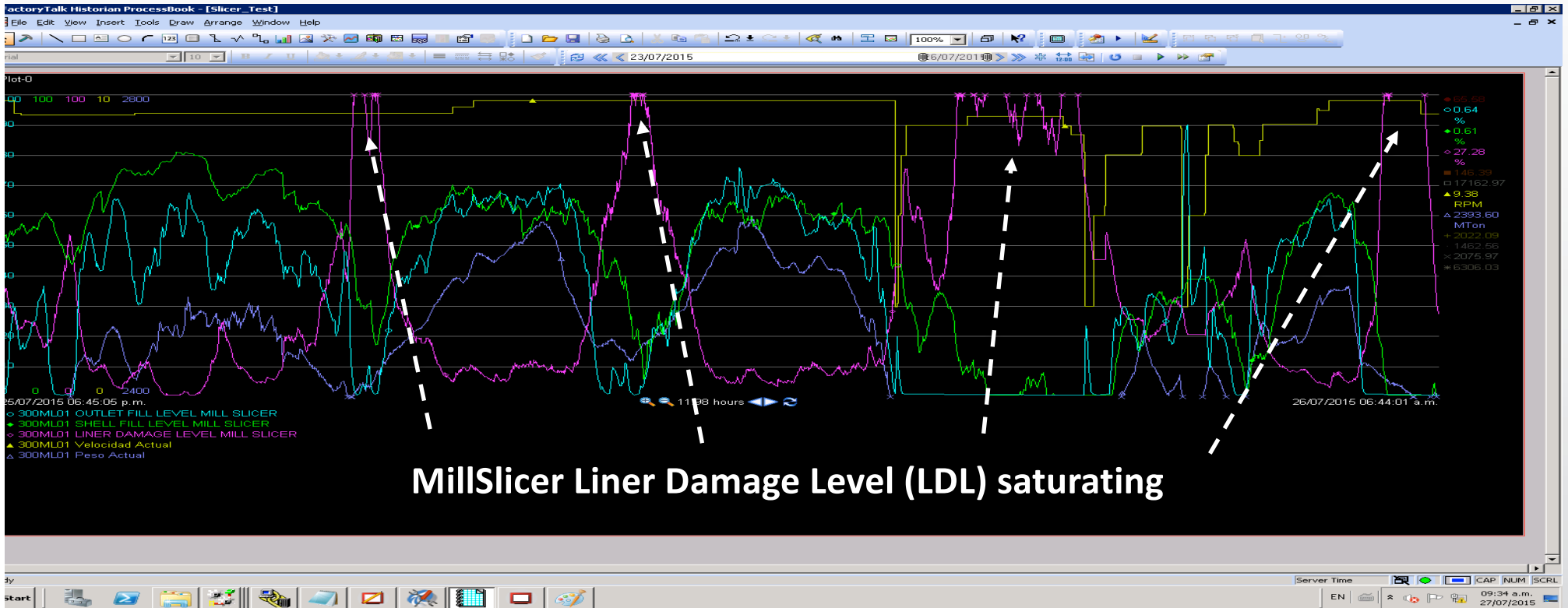


Typical Operation: Control Room, 12 Hours No Auto Speed Control



MillSlicer Liner Damage Level (LDL) saturating

LDL - pink

Shell FL - green

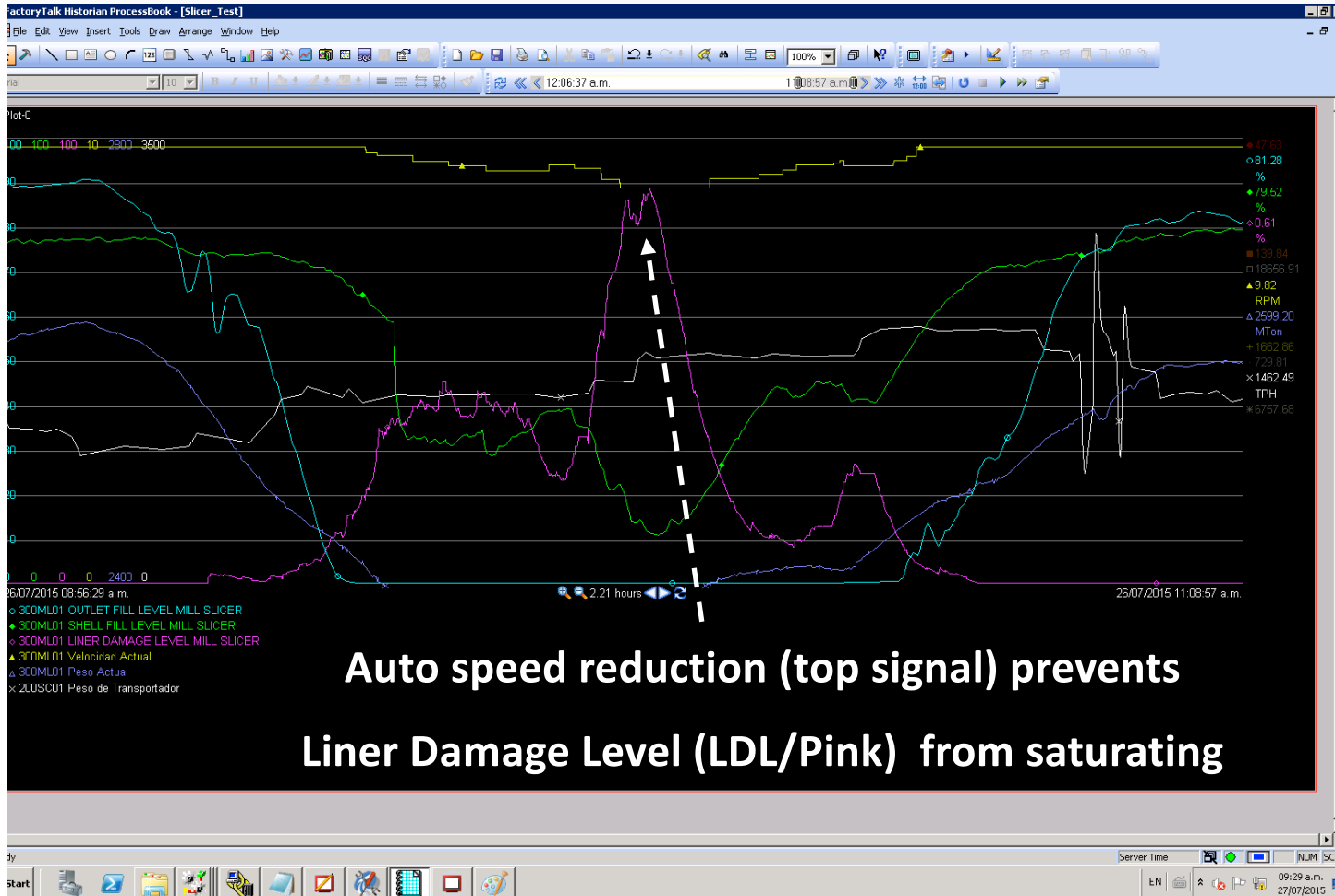
Outlet FL - blue

Bearing Pressure (weight) - purple

Speed - light brown

Mill is observed to be emptying and filling with Liner Damage (LDL) saturating for hours!

Auto Speed Reduction Based On LDL



2 Hour Trend:

- LDL - pink
- Shell FL - green
- Outlet FL - blue
- Weight - purple
- Speed - light brown
- Feed - White

LDL High and Pressure (weight) Low = auto speed reduction

Expert System LDL Integration

Speed		Weight		
		Low	Mid	High
LDL	Low	°	+	++
	Mid	--	-/+	+
	High	---	--	°

Speed		Weight								
		LOW			MID			HIGH		
		-Delta	Zero	+Delta	-Delta	Zero	+Delta	-Delta	Zero	+Delta
LOW	-Delta	°	°	°	°	°	+	+	++	+++
	Zero	°	°	°	°	°	+	+	++	+++
	+Delta	°	°	°	-	°	+	+	++	+++
LDL	-Delta	-	°	°	°	+	+	+	++	++
	Zero	-	-	°	-	°	+	+	++	++
	+Delta	--	-	°	-	-	°	°	°	°
HIGH	-Delta	---	--	-	°	°	+	°	°	°
	Zero	---	--	-	-	°	°	°	°	°
	+Delta	---	---	--	-	-	°	°	°	°

+++	Fast Increase
++	Medium Increase
+	Slow Increase
°	Zero
-	Slow decrease
--	Medium Decrease
---	Fast decrease

- Fuzzy Control: Three clusters with centers {17%, 40%, 60%}
- If weight < 2500 AND Density > 55% then the LDL is measured and allowed to reduce the speed. i.e. High condition: LDL > 35, Mid condition 15 < LDL < 35, Low condition LDL < 20. For a high condition, the speed is reduced proportionally from 0.05 to 0.1 RPMs every 4 minutes.

Expert System LDL Results for SAG1

	Comparacion Arranques Abril-Septiembre						
	Speed	TPH	Kw	Kwh/t	Weight	Ton/Rev	LDL
Abril	9.59	2125.95	15846.72	7.45	2537.12	3.70	46.17
Septiembre	9.37	2453.03	16279.66	6.64	2524.27	4.36	20.26
Delta	-2.22%	15.38%	2.73%	-10.97%	-0.51%	18.01%	-56.11%

SAG1 - April (No Speed Control) Results vs. September (LDL Speed Control) Results

- Shutdowns scheduled for end of March and August 2015 on SAG1. Above results are the month following each shut down.
- Average LDL signal decreases after auto-speed control is implemented in the expert system.
- Average speed for September is also significantly lower than that of April. However even with a lower speed monthly average, more TPH were generated in September with better Kwh/t results.

Improvements in Specific Power (Kwh/t) with a significant reduction in Liner Damage Level (LDL)