

Lessons learned in Delayed Coking units by the use of nuclear level technology.

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Coke Drum Level Measurement



Differences

- **Considerable difference between Neutron Back Scatter (NBS) and continuous**

NBS is point level

- **Measures difference in densities of hydrogen content**
- **High foam height and low hydrogen density will give the same output as a low foam height and high hydrogen density.**

Continuous measures anything that get between the source and detector

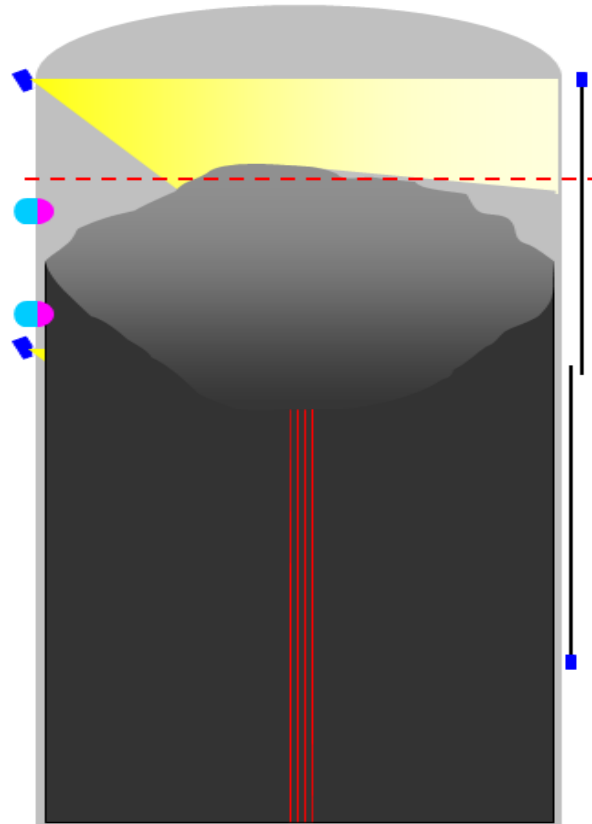
Differences

NBS tracks the increase of the density of hydrogen present Could be significant difference in readings between the NBS continuous level reading

- Due to the thickness of the foam layer which could be many feet thick at times and thin at other times
- Foam layers varies with many factors, such as
 - Type of crude
 - Fill rate (Charge rate, cycle time)
 - Operational procedures
 - Operating Temperature and Pressure
 - Recirculation Ratio
 - How anti-foam is injected and how long

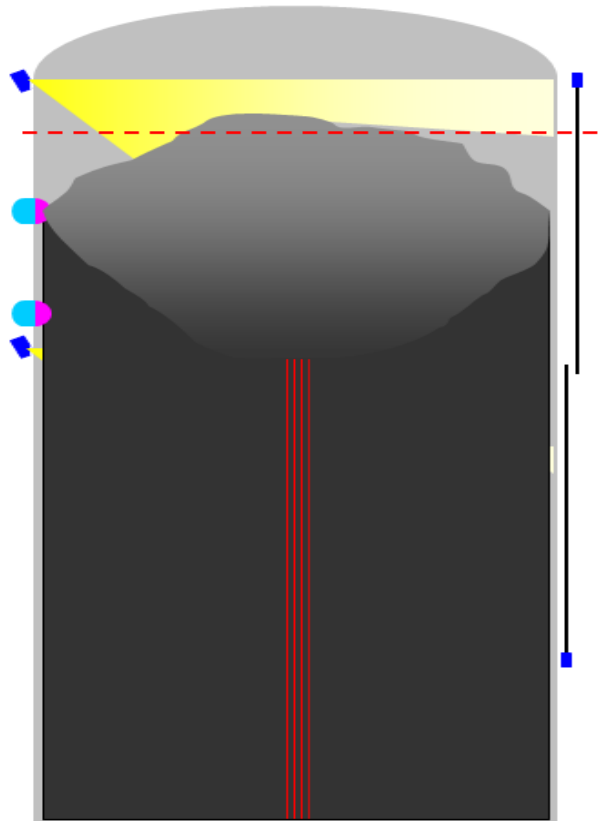
Continuous Level vs. NBS

**Continuous
level tracks top
of foam layer**



**NBS tracks
level at some
point where
foam density
increases**

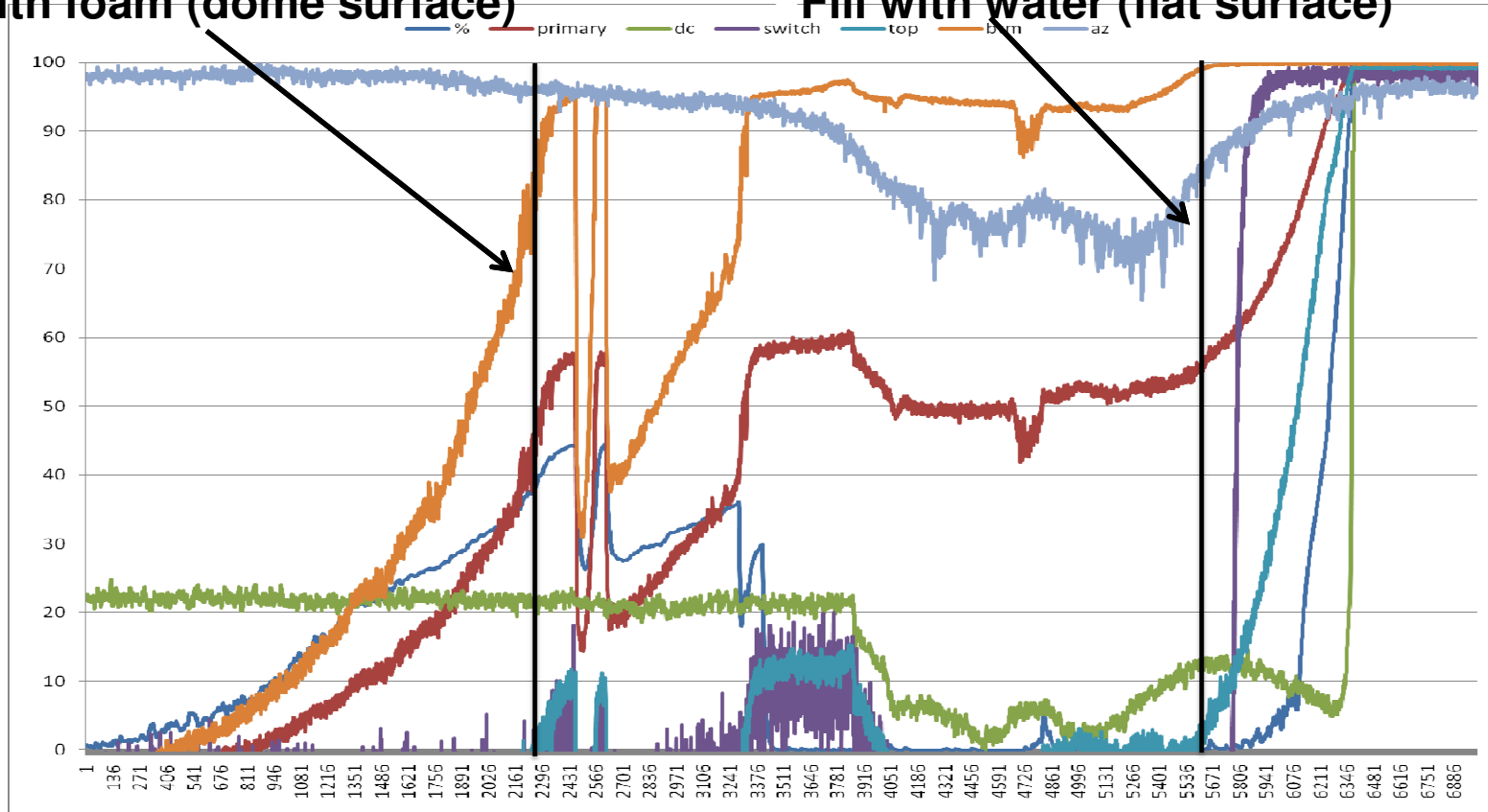
Continuous Level vs. NBS



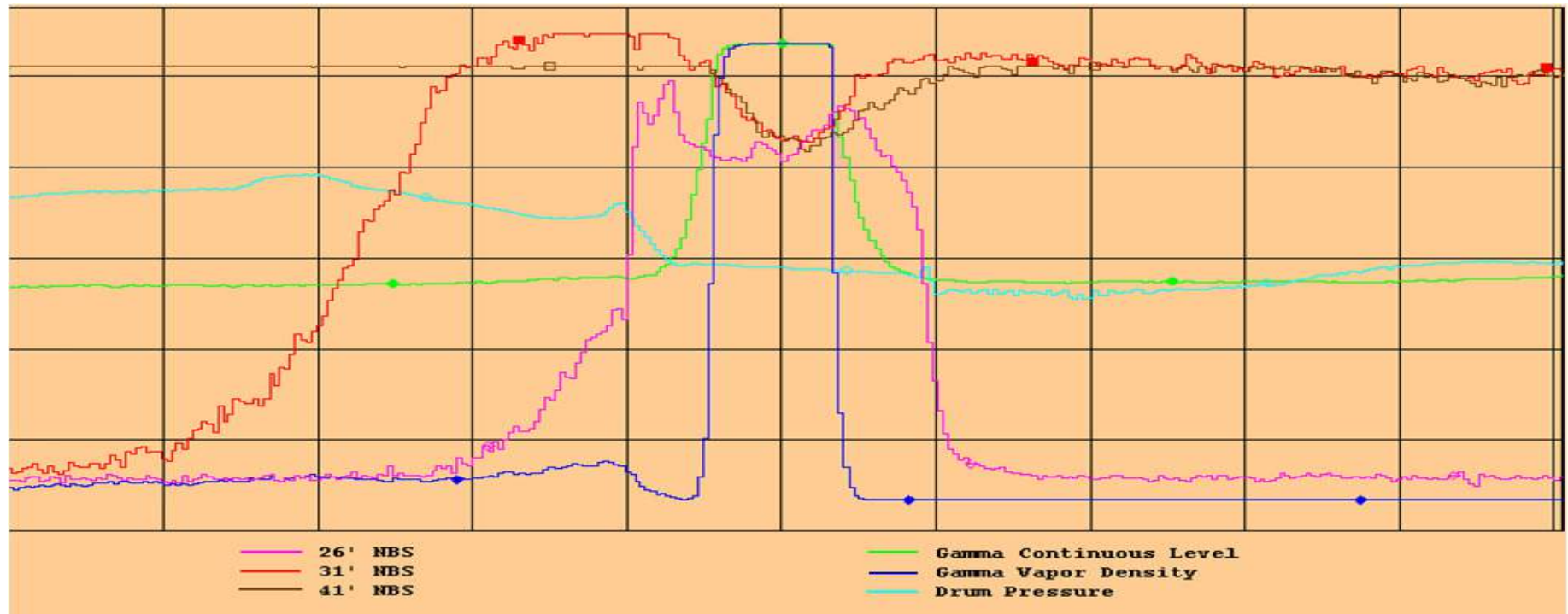
Levels showing “Foam Dome”

Fill with foam (dome surface)

Fill with water (flat surface)

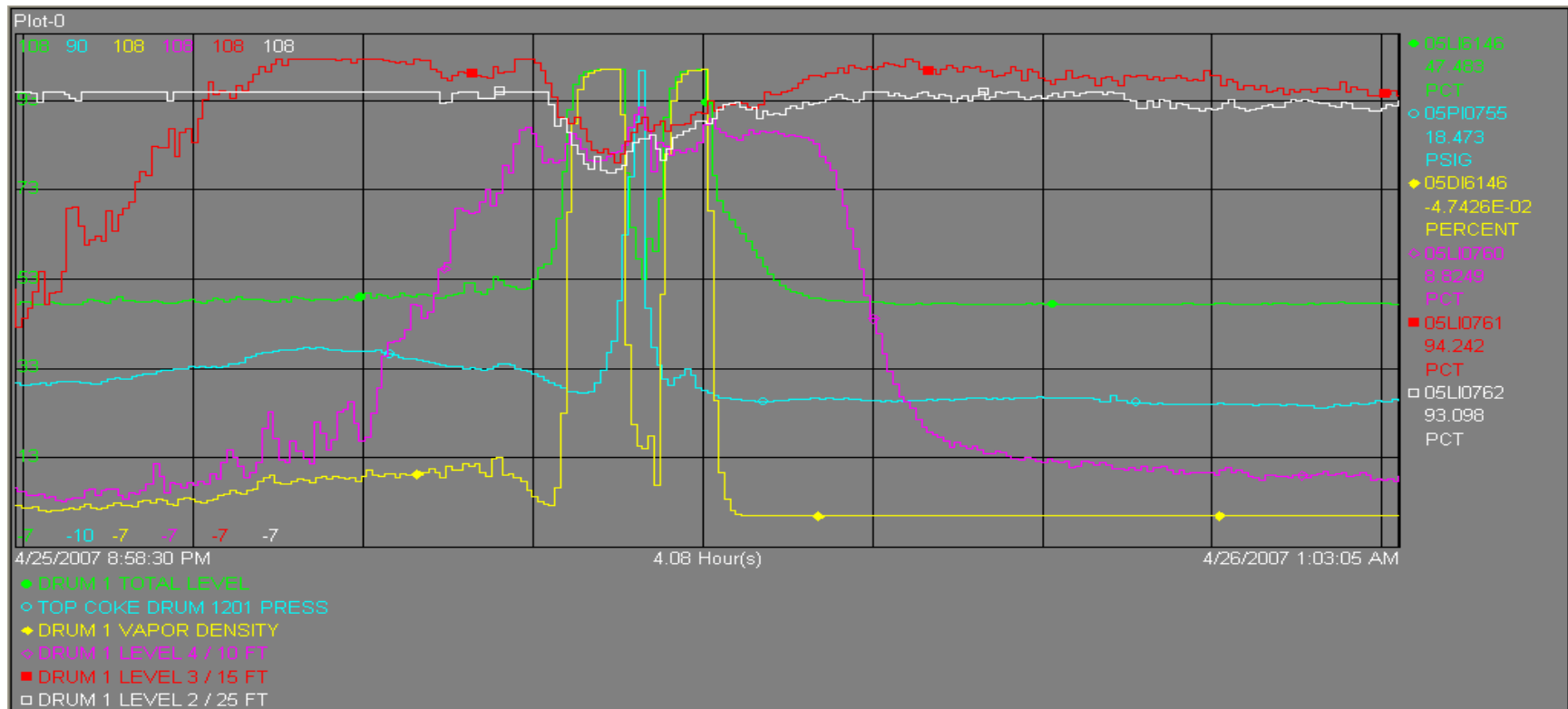


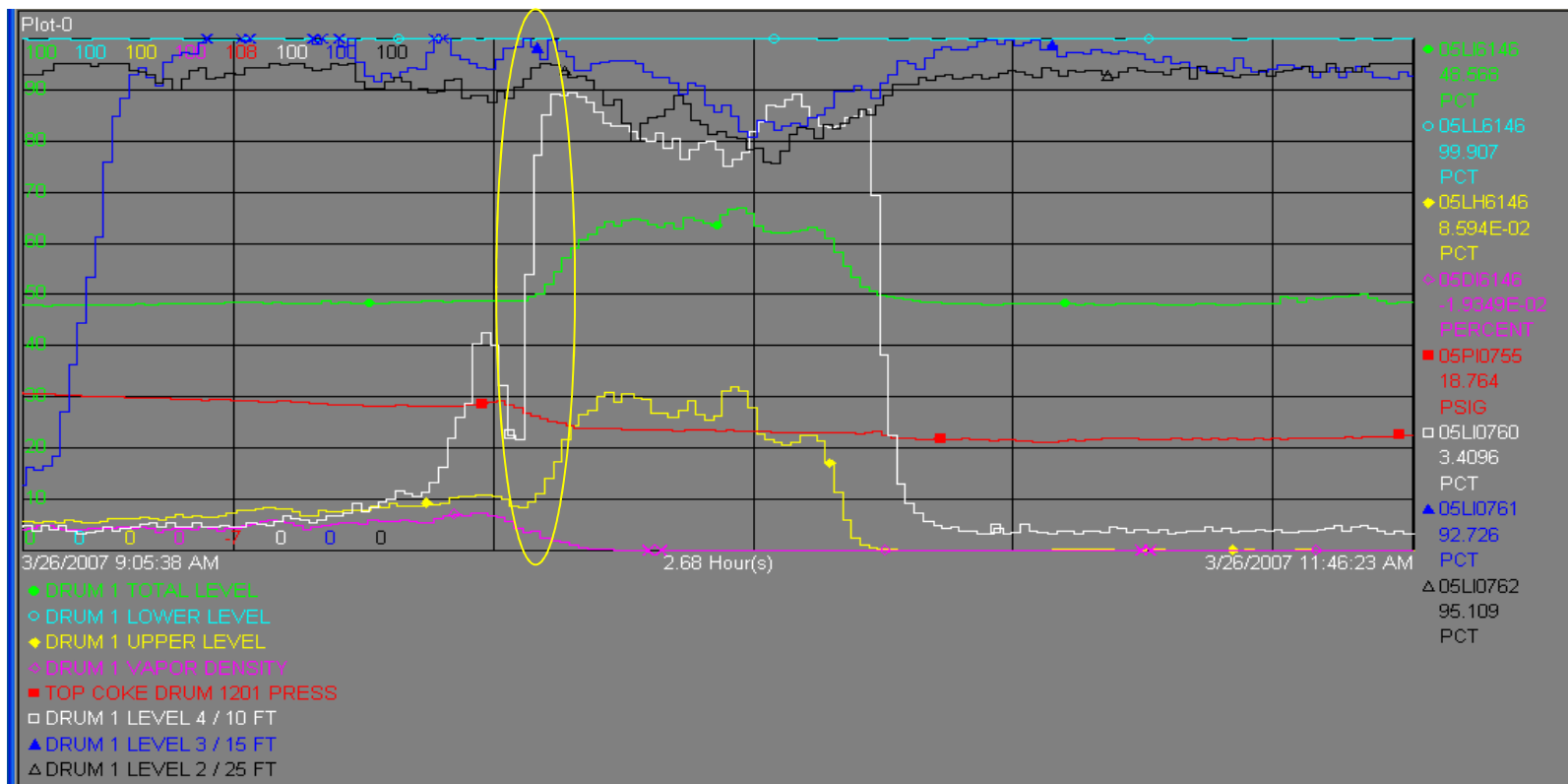
Typical Coke Drum Cycle



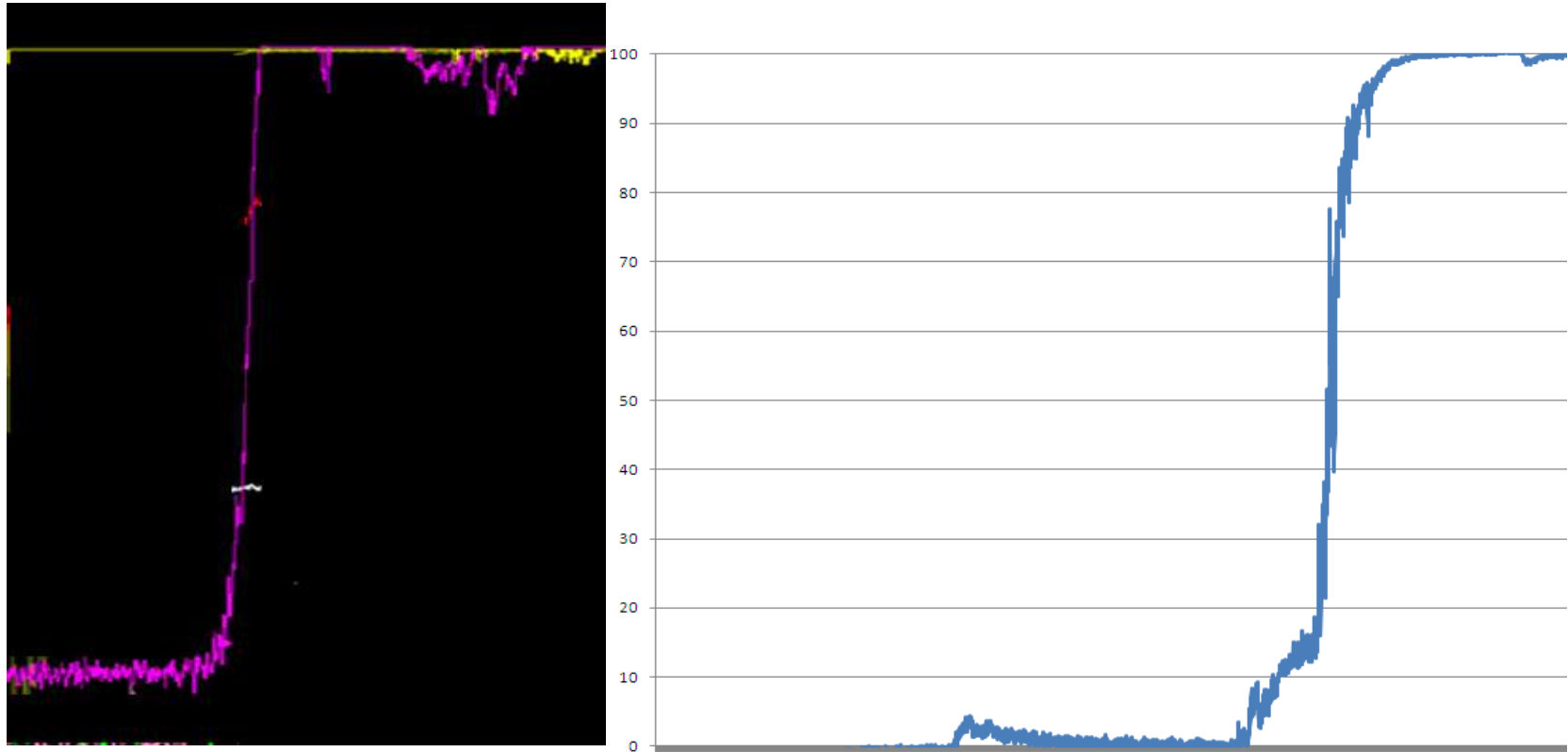
This graph shows a foam up after the switch and how the NBS responds vs how the continuous level responds. Switching of the drum occurs at Point 1. The NBSs (Purple, Red and Brown) starts a downward trend since the foam is increasing in height and not in hydrogen density. The same amount of hydrogen being spread over a larger area will decrease the overall hydrogen density in front of the NBSs.

Catching a Foamover

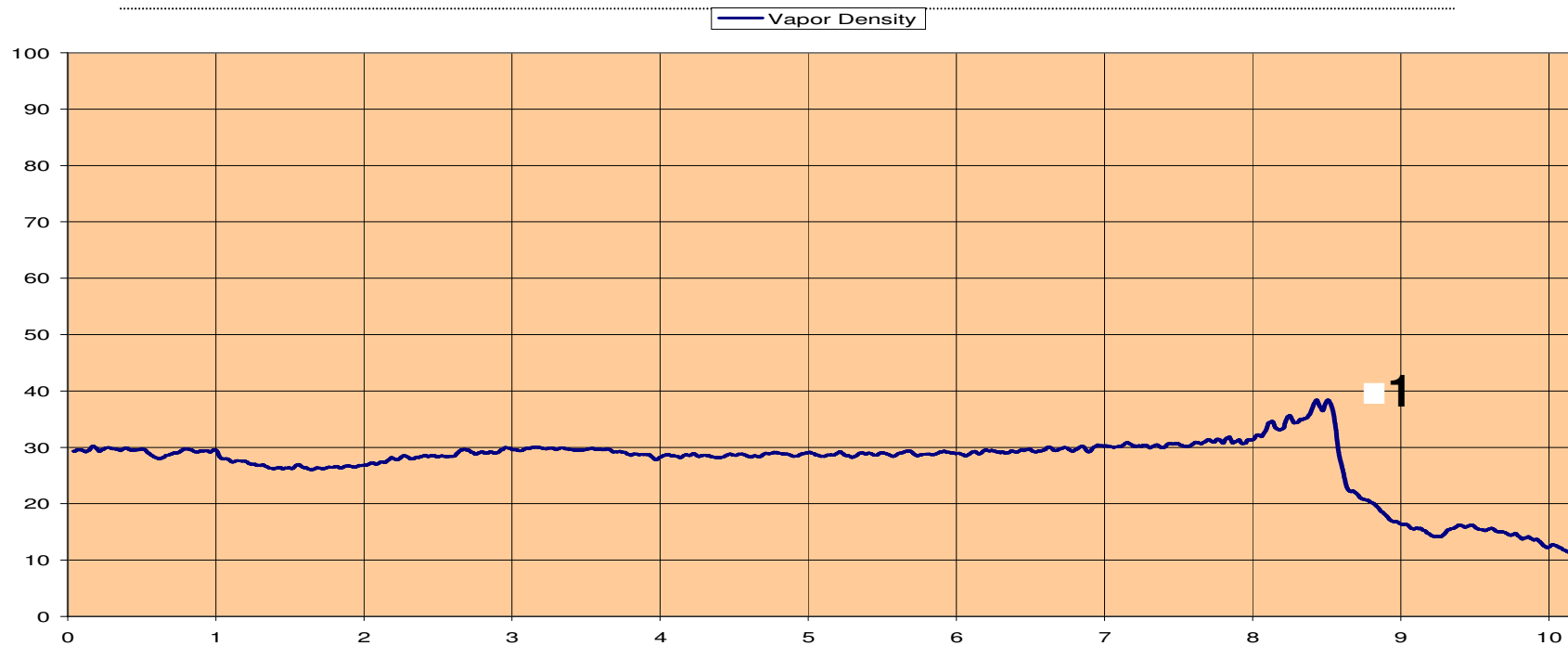




NBS output compared to Gamma Density

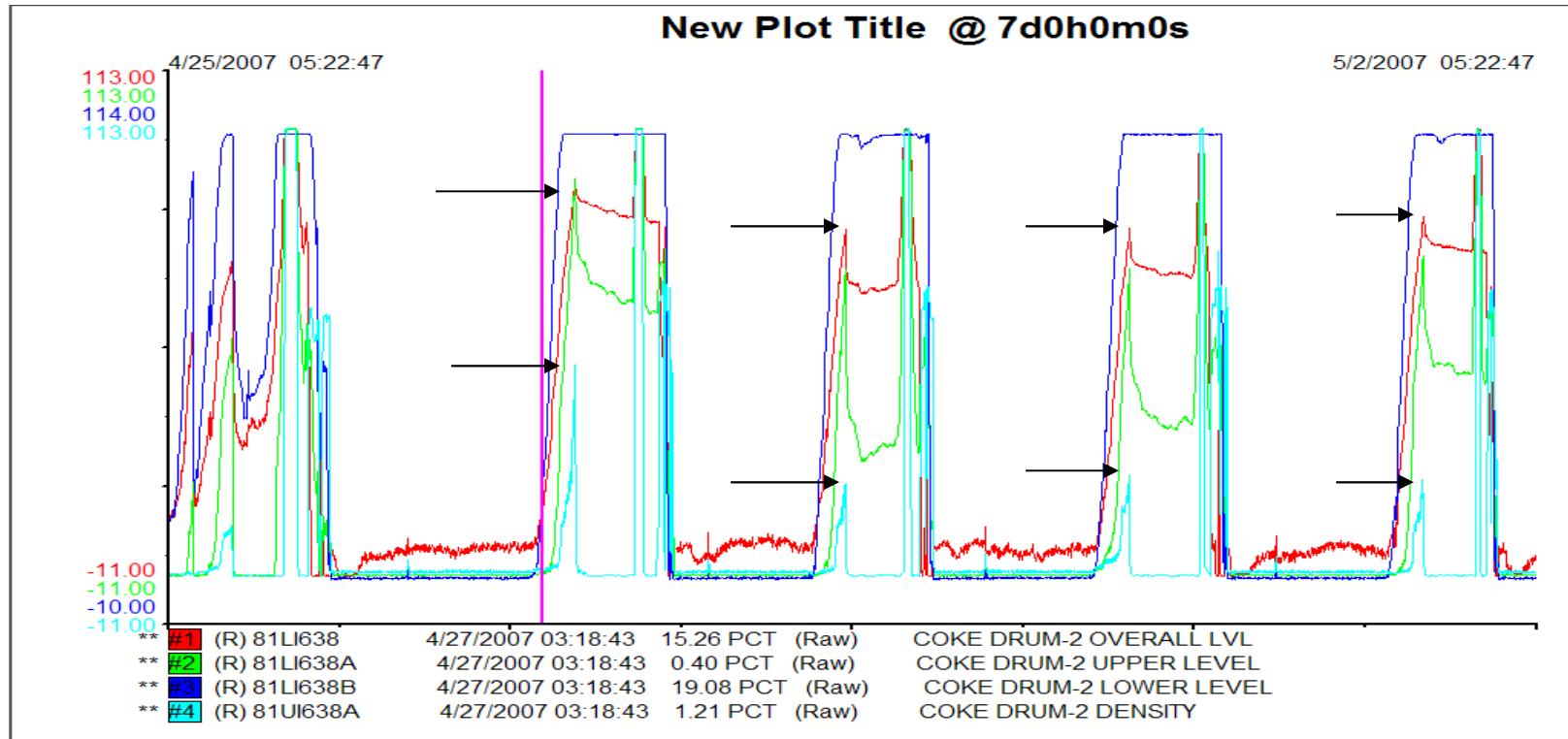


COKE DRUM CYCLE USING GAMMA TRANSMISSION SENSORS



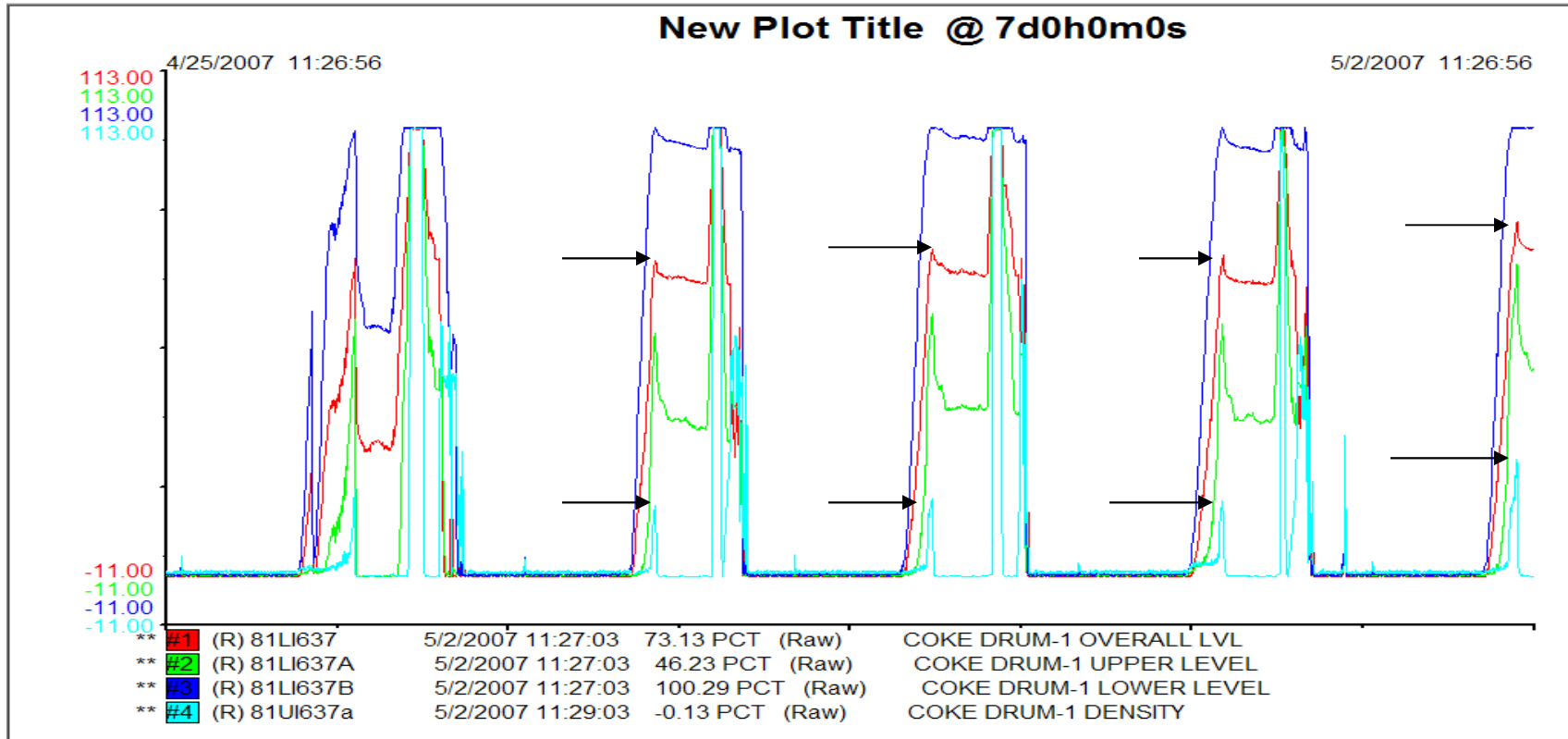
Vapor Density during the coking stays relatively constant except towards the end of the cycle when the level is at its highest. This is where it starts to measure how much particulate matter is being carried over. Gases velocities are high enough to entrain matter with them and overcome gravity. Switch out of the drum happens at Point 1.

Repeatability from Cycle to Cycle



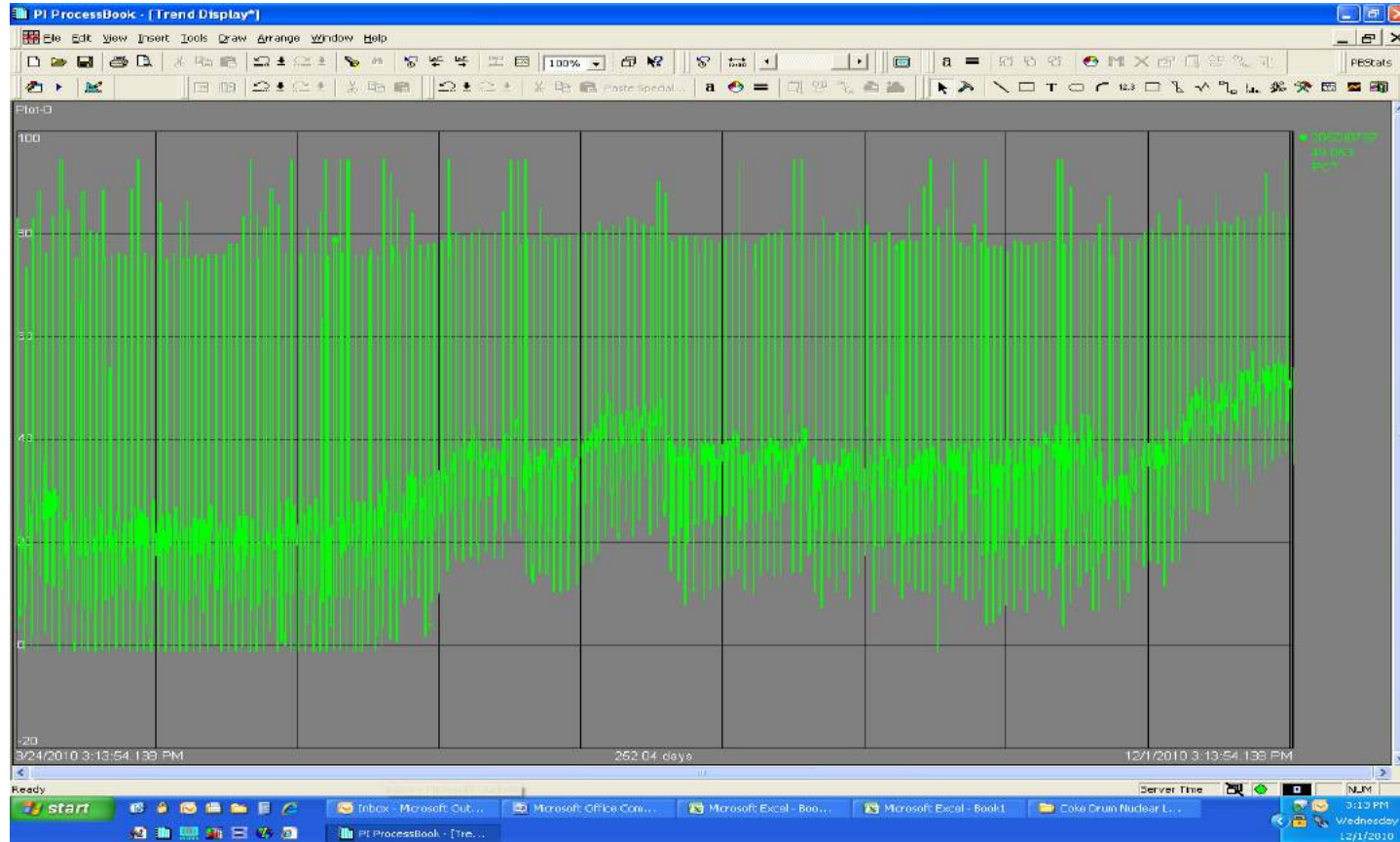
DRUM 2

Repeatability from Cycle to Cycle

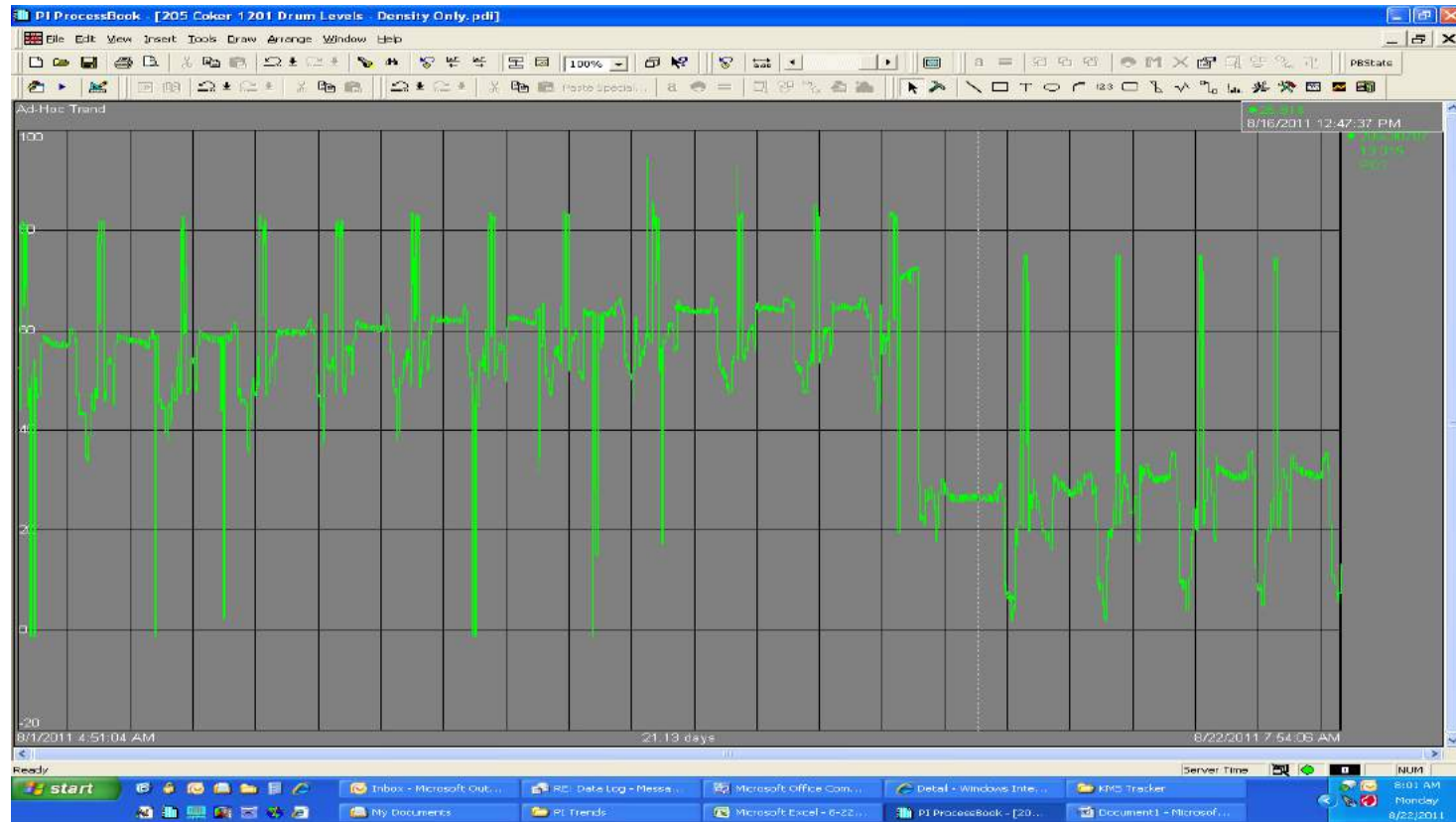


DRUM 1

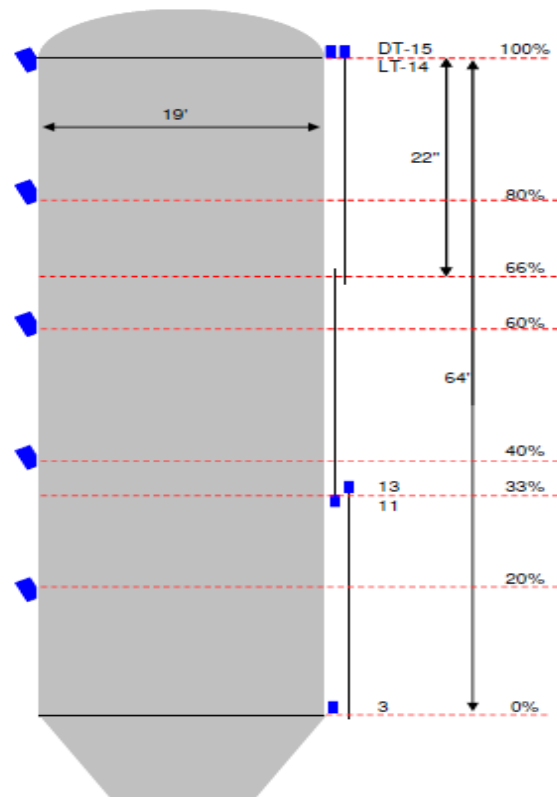
Buildup in vapor space



Buildup in vapor space

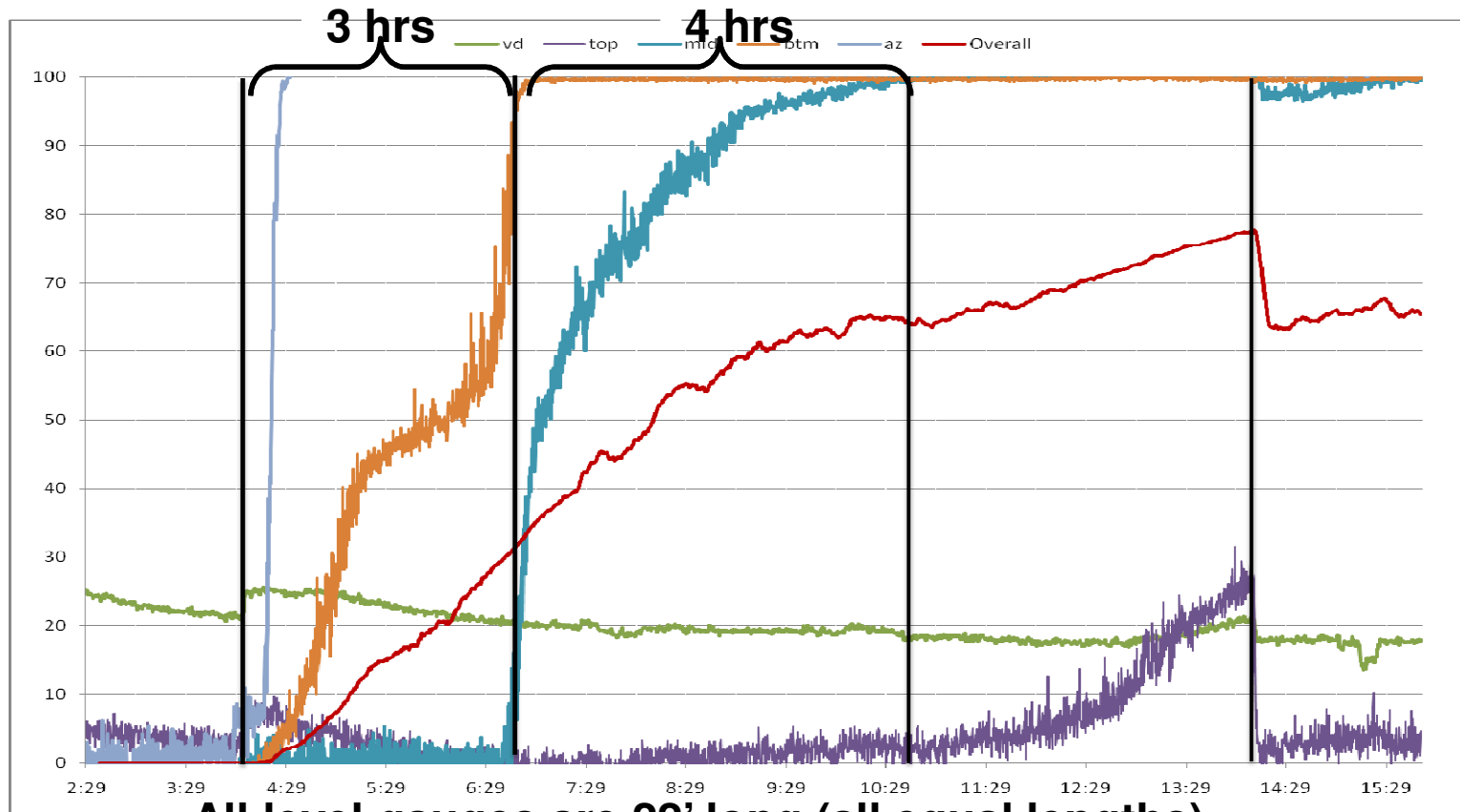


Level increase from Tangent to Tangent (not linear)



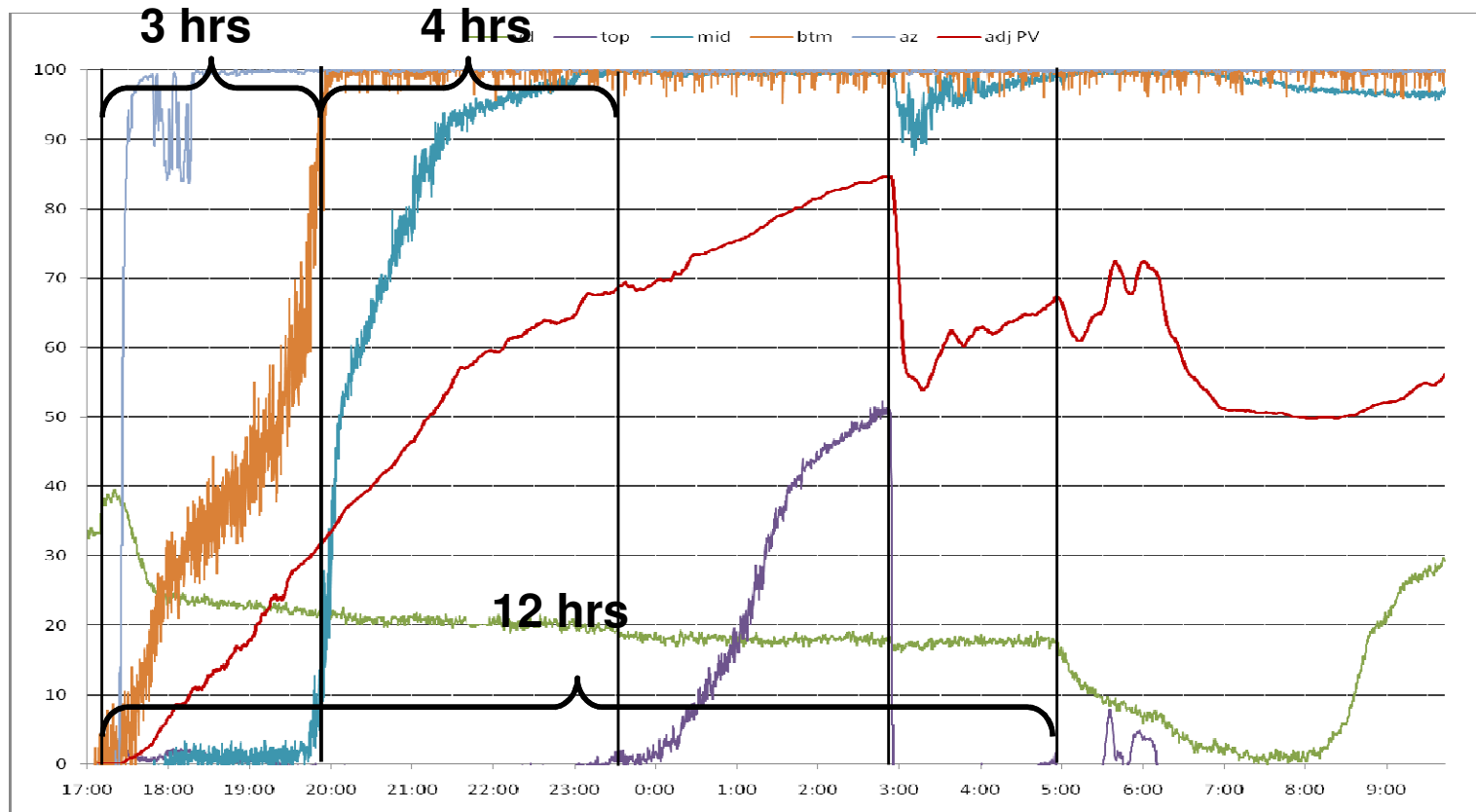
All level gauges are 22' long (all equal lengths)

Level increase from Tangent to Tangent (not linear)



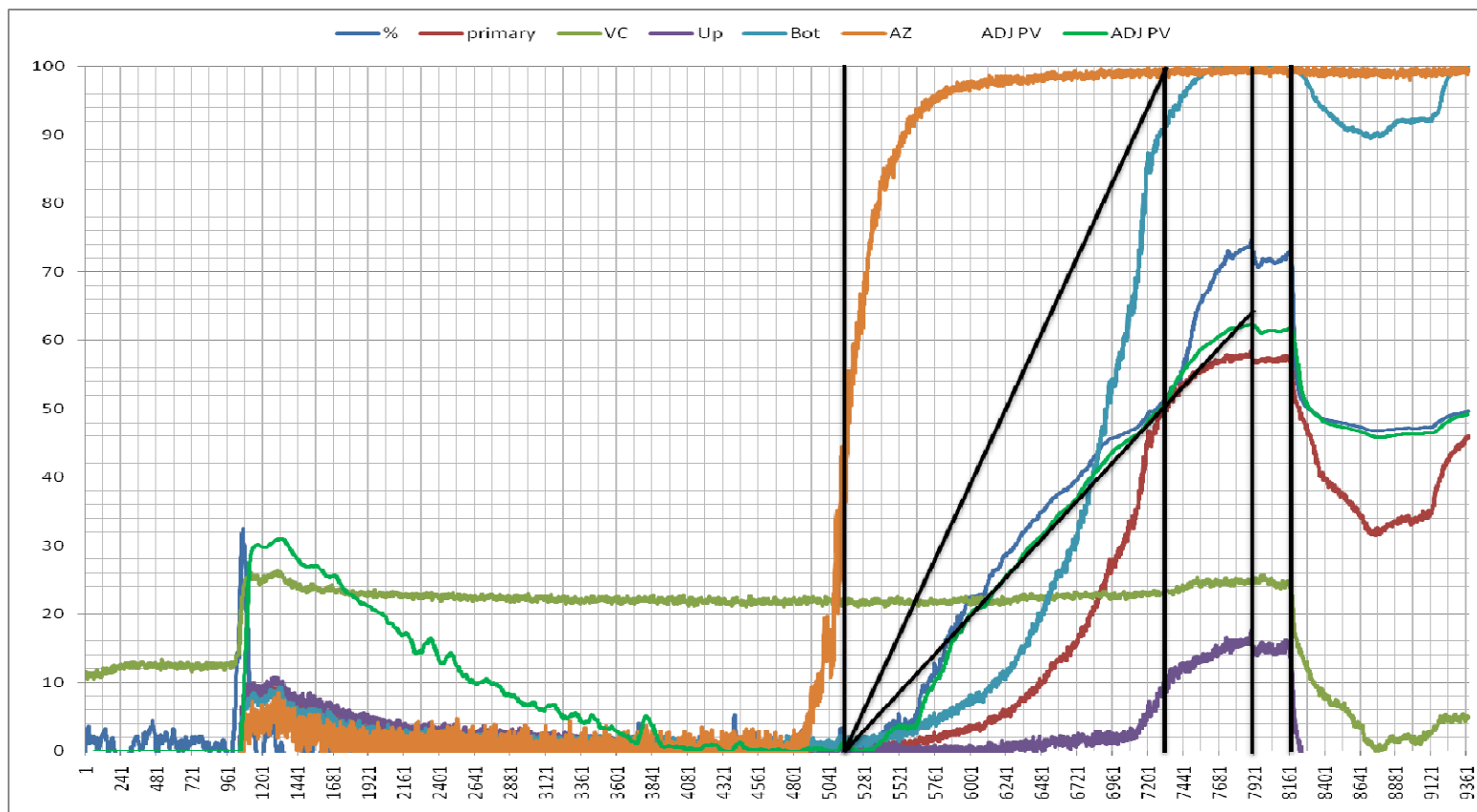
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Level increase from Tangent to Tangent (not linear)

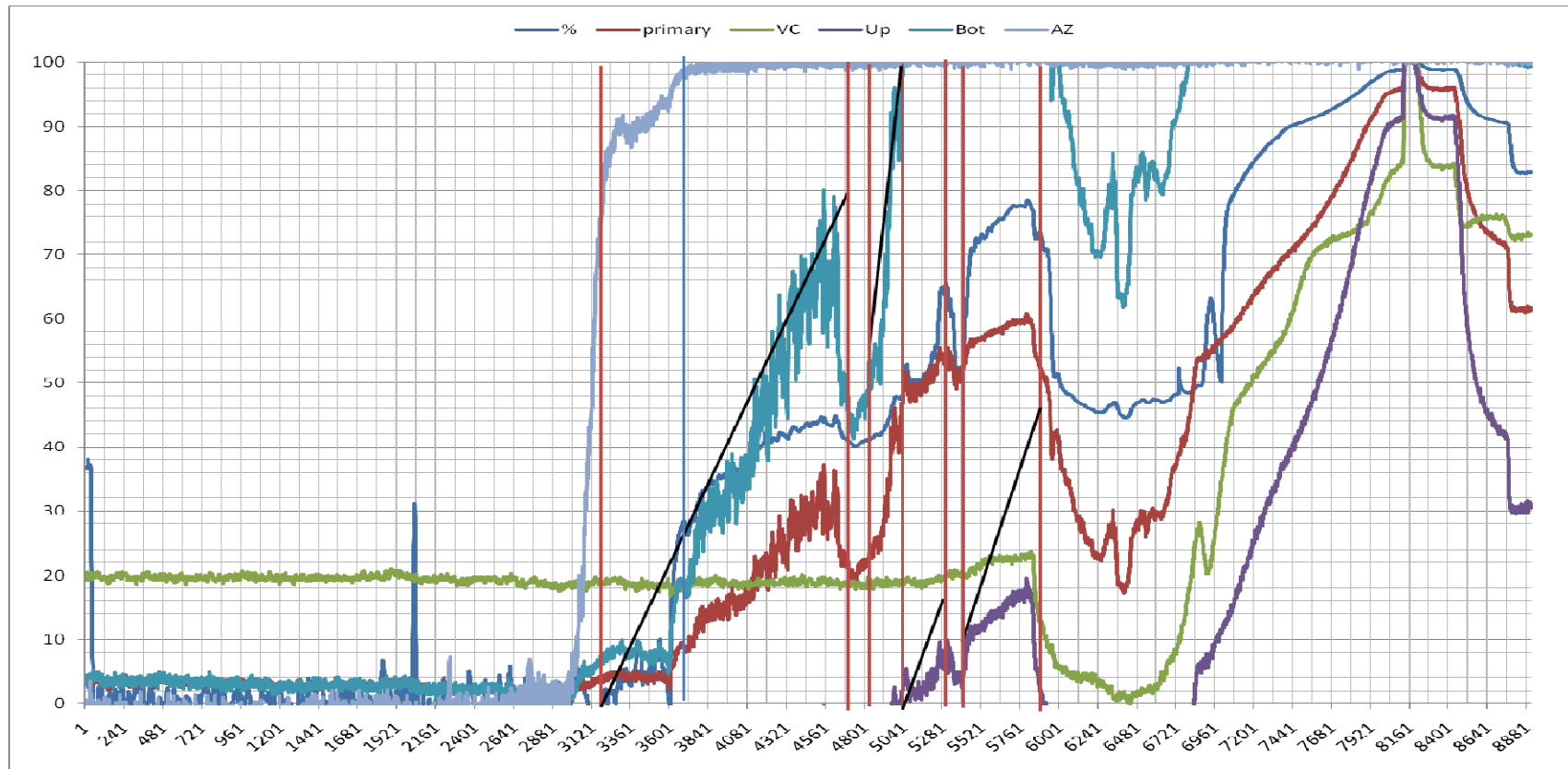


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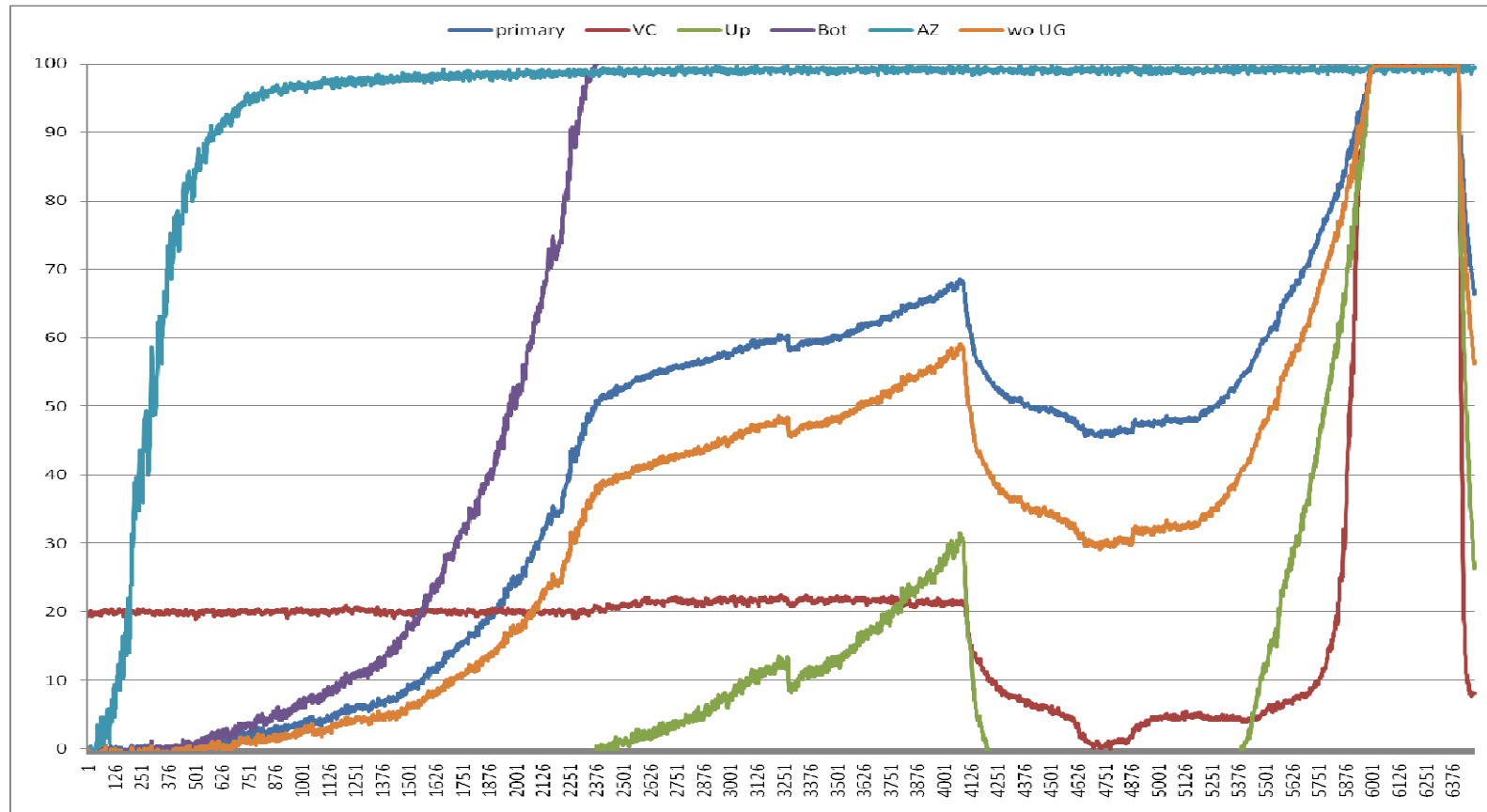
Caustic Overtreatment - Before



Caustic Overtreatment - During



Caustic Overtreatment - After



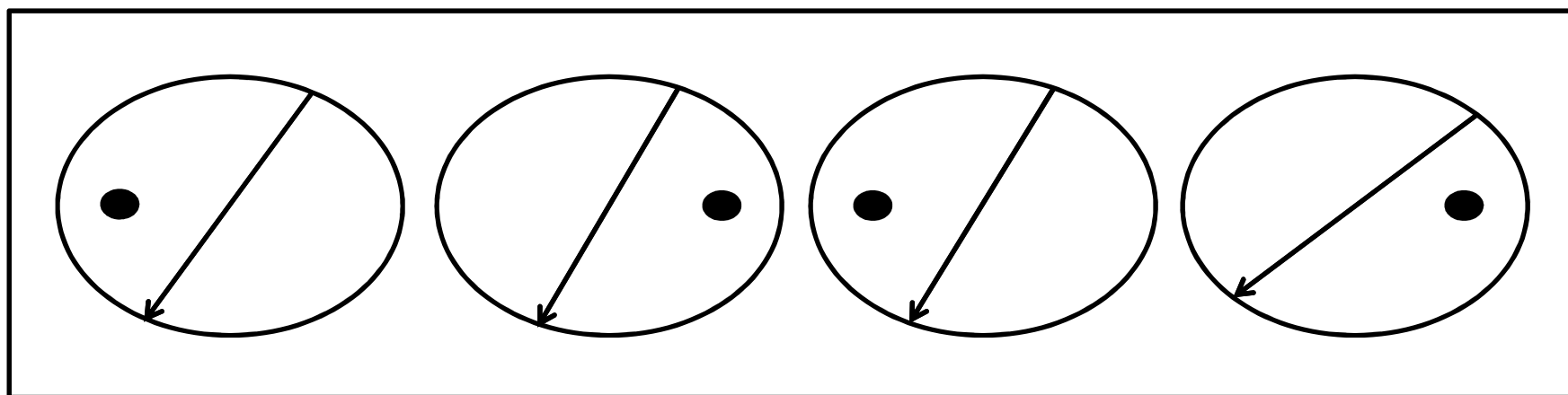
Gauge Arrangement

Drum1

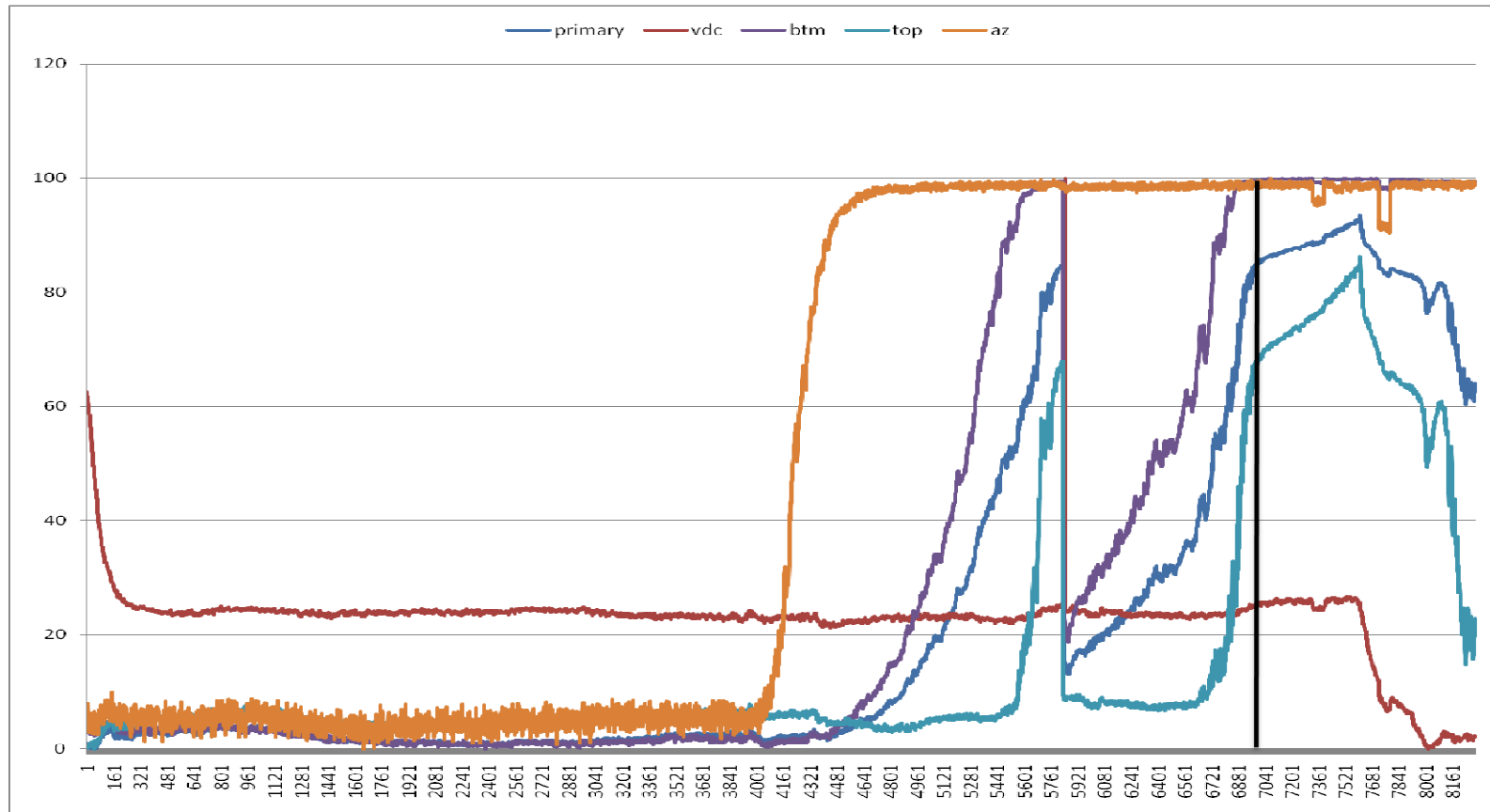
Drum 2

Drum 3

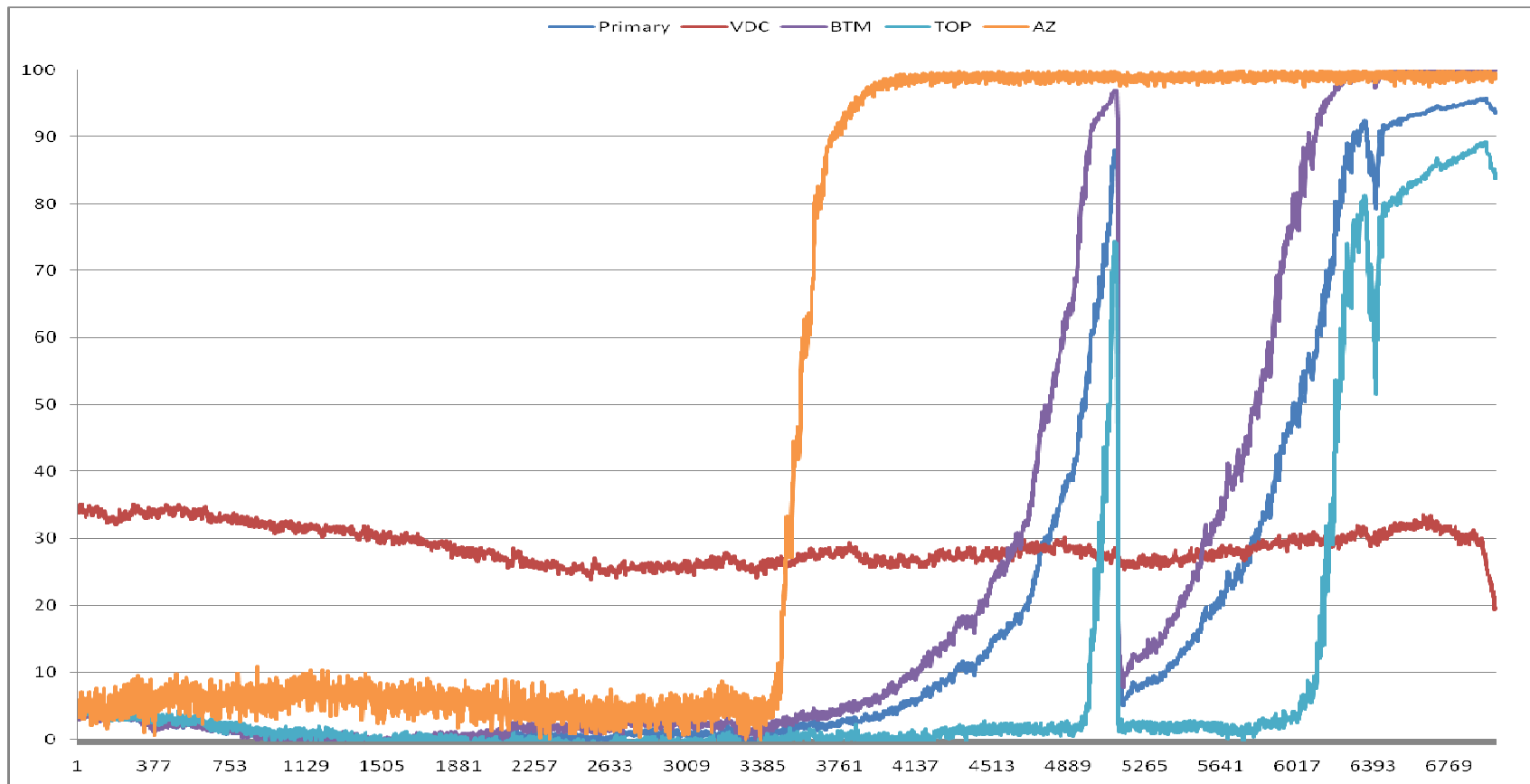
Drum 4



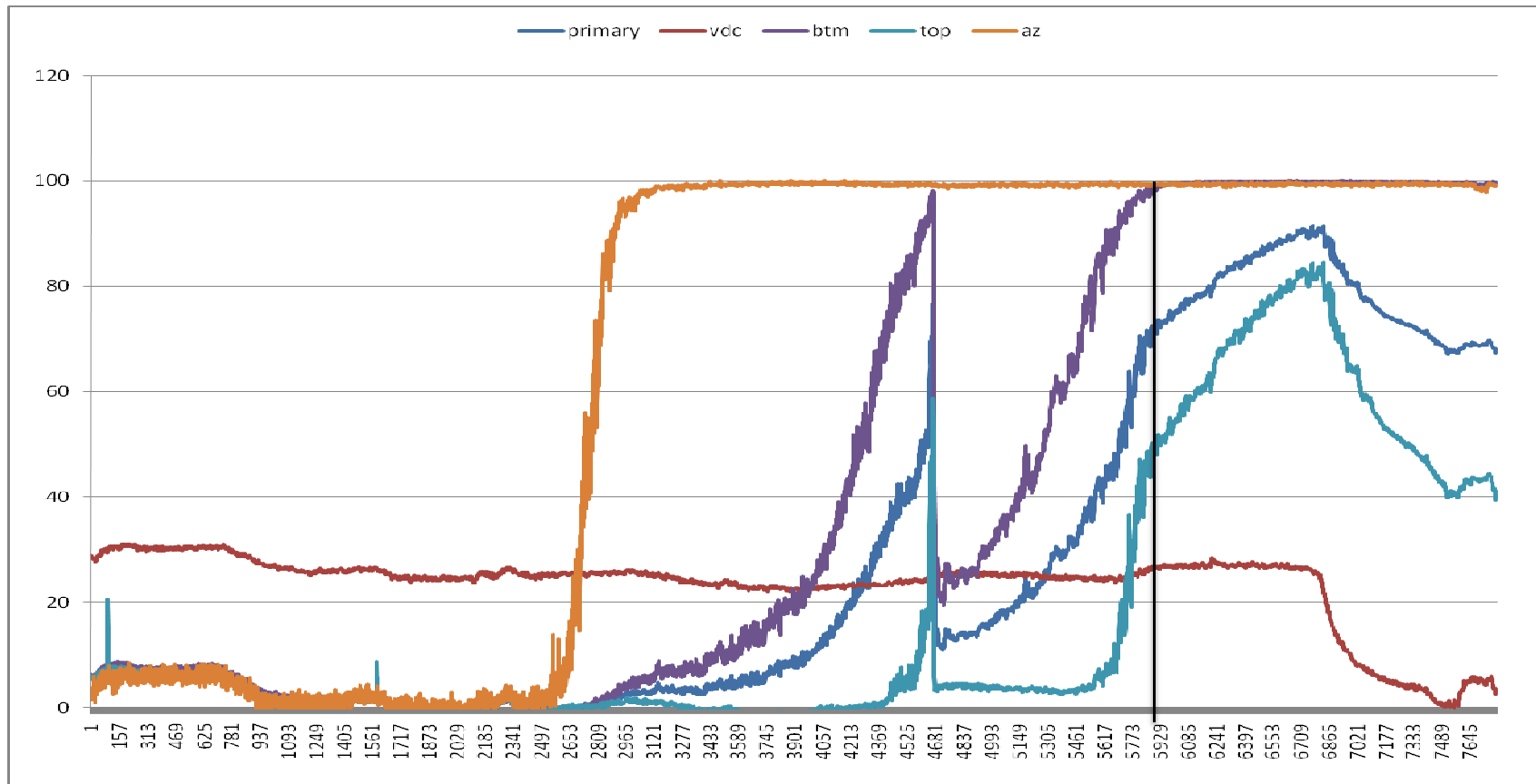
Drum 1



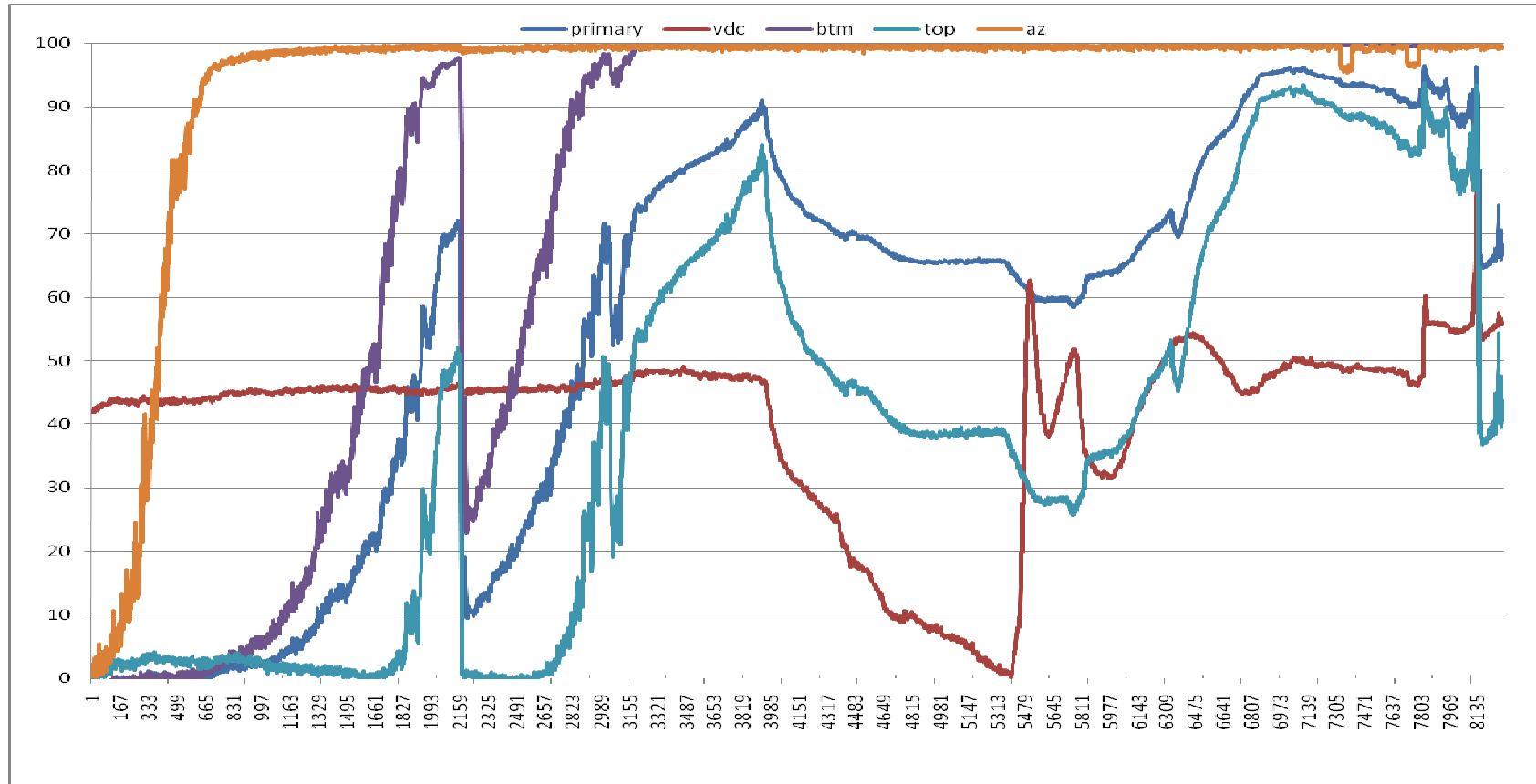
Drum 2



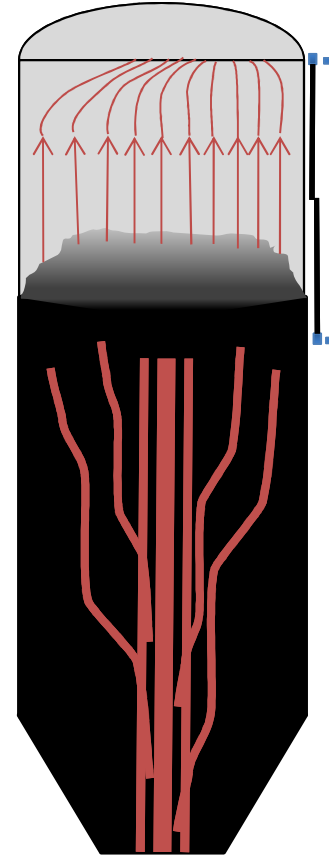
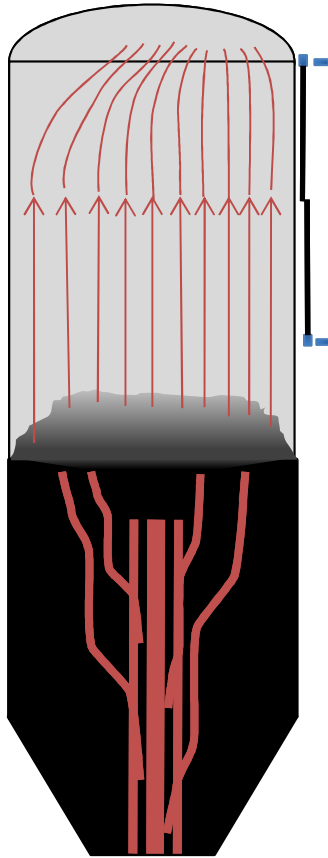
Drum 3



Drum 4



Vapor Flow



Conclusion

We have learned many things about the internal dynamics of fluid levels inside coke drums by the use of nuclear level and density technology.

Some things appear to be a “gauge issue” when in fact it is the process itself.