Natural Gas STAR
Production Technology Transfer Workshop
"Managing Venting for Liquids Unloading"

Reid Smith
Senior Climate Advisor - BP

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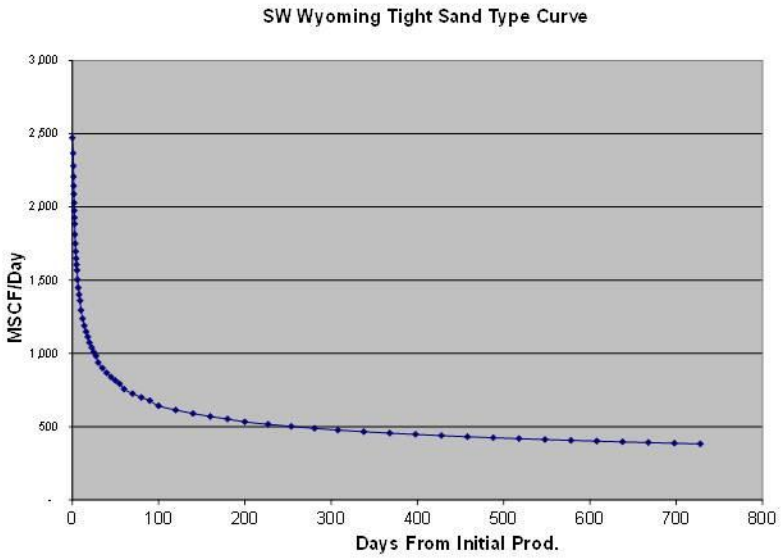
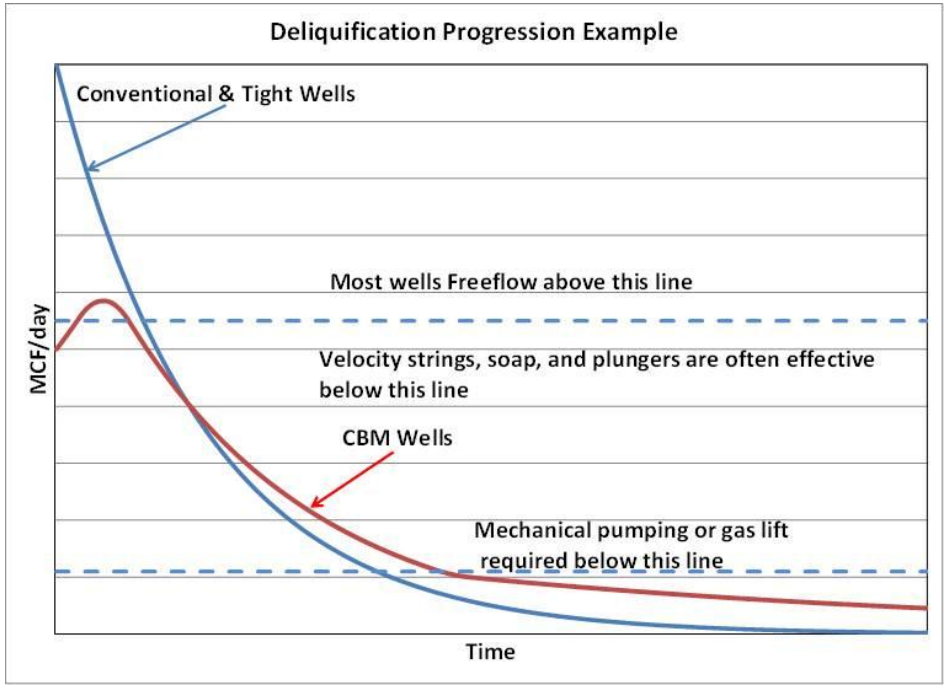
Gas Well Lifecycle



- Decline in reservoir energy and hence production begins as soon as a reservoir is put on production.
- Tight sand/reservoir wells illustrate this principle very well
- Wells produce liquids (water and hydrocarbon)
- Ability to lift liquids defines a gas well's economic life



- Early in a well's life it will free-flow without added assistance
- Once a well declines it will enter a period where liquids loading is an issue but lifting liquids still relies on reservoir energy
- Once reservoir energy is no longer adequate artificial lift will be needed

Liquids Loading -What and Why

Well Flow:

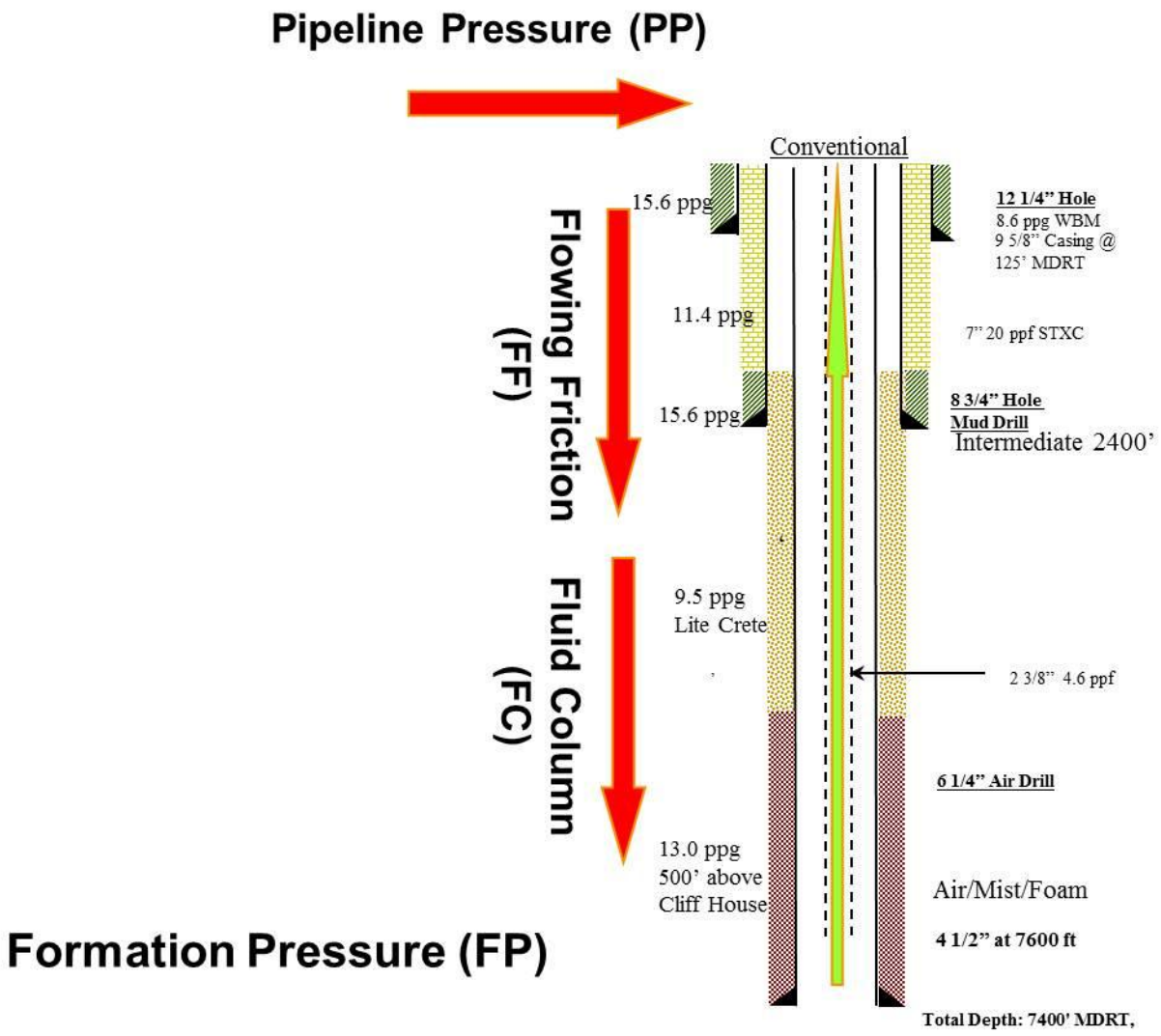
- Depends on Delta P
- Flow Rate is a f of Delt
- Rate Determines Velo
- Velocity Determines F

Formations:

- Deplete over Time
- Build P While Well is
- Shut-in Time is Impor

Energy/Flow and Liquid

- As differential betwee Production Flow will D
- When Flow & Velocity Becomes an Issue
- When PP + FF + FC =>
- Venting (removing PP) and Helps Lift Liquids



Why is venting wells a bad thing?

- **Vented gas is lost, never to be utilized as an energy source.**
- **Reservoir potential energy needed to lift liquids is depleted.**
- **Potential safety hazard.**
  - Combustible mixture in the air.
  - High velocity plunger strikes on the wellhead.
- **Greenhouse Gas emissions.**

Liquids Unloading Vent Management
San Juan Basin Example

The Base Premise is "The Reservoir Does Not Quit Working When a Well is Shut-in"

- **Particularly true for tight reservoirs with limited permeability – less so for other reservoir types**
- **"Smart" Automation"**
- **Both Plunger Equipped and No Plunger**
- **On-site PLC Based**
- **Custom Control Code – Based on "Turner" Lift**
- **RTU Transmission to Host**
- **~2300 Wells Under Control – Beginning in 2001; ~1/2 with Plungers**

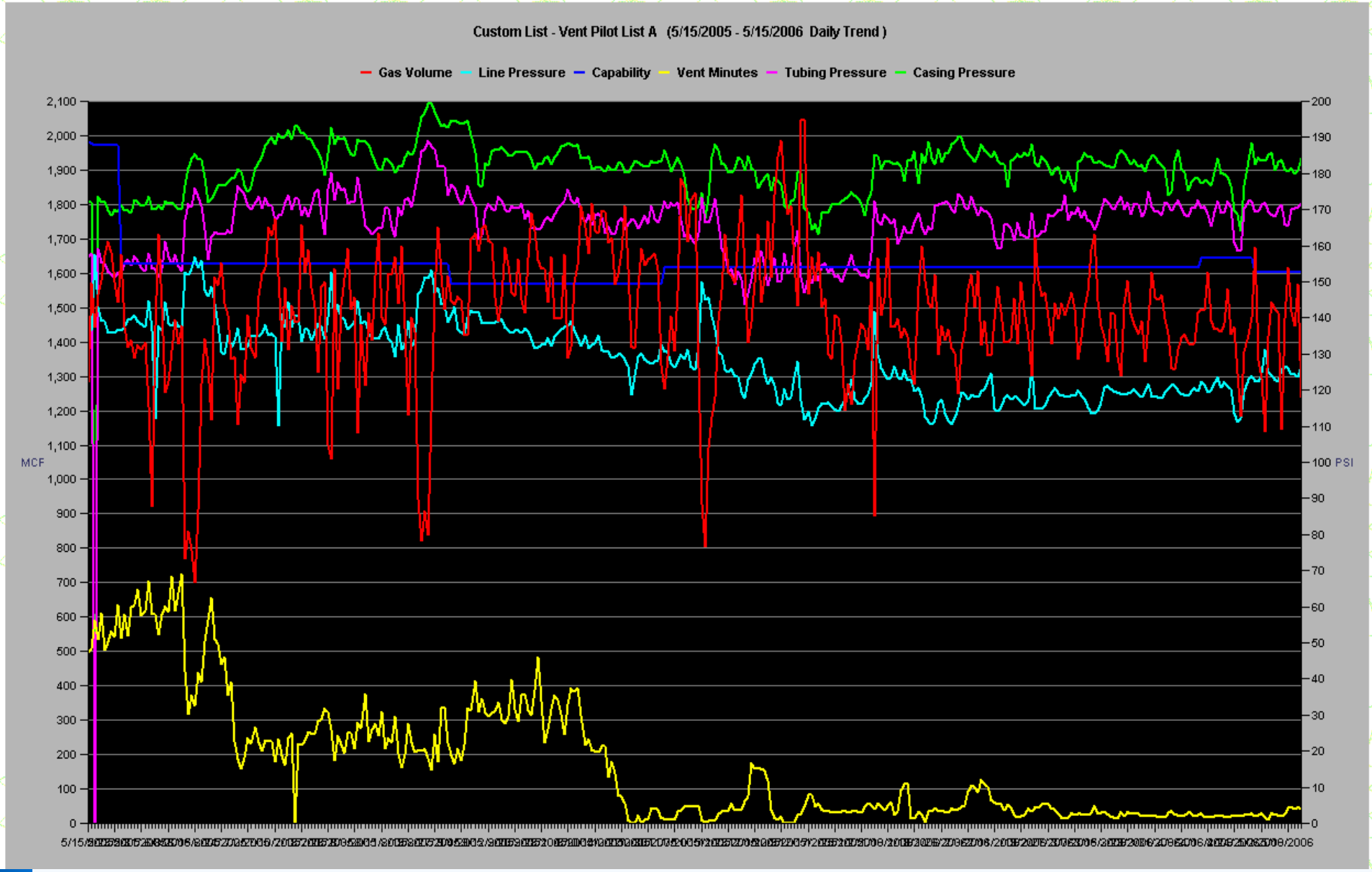
Initial Vent Reduction Project

- **<u>Automation project</u> designed and funded in 2000.**
  - Upgraded existing RTUs & host system.
  - Developed new well control algorithms based on Load Factor and Turner rate.
- **Pilot installations and testing in 2000.**
- **System sweep in 2001.**
- **Achieved roughly 50% reduction in venting from 2000 to 2004. Developed two pilot studies in order to make changes with some scientific control.**
- **Established a new procedure based on plunger lift expertise and pilot well analysis.**
- **Incorporated new procedure into 2nd pilot.**

Home Back Refresh Avg Casing/Tubing Pressures ☑

Start Date	End Date
2/12/2006	6/12/2006

Vent Pilot List A – Start 6/15/05
Applied Vent Procedure Set points 10/20/05



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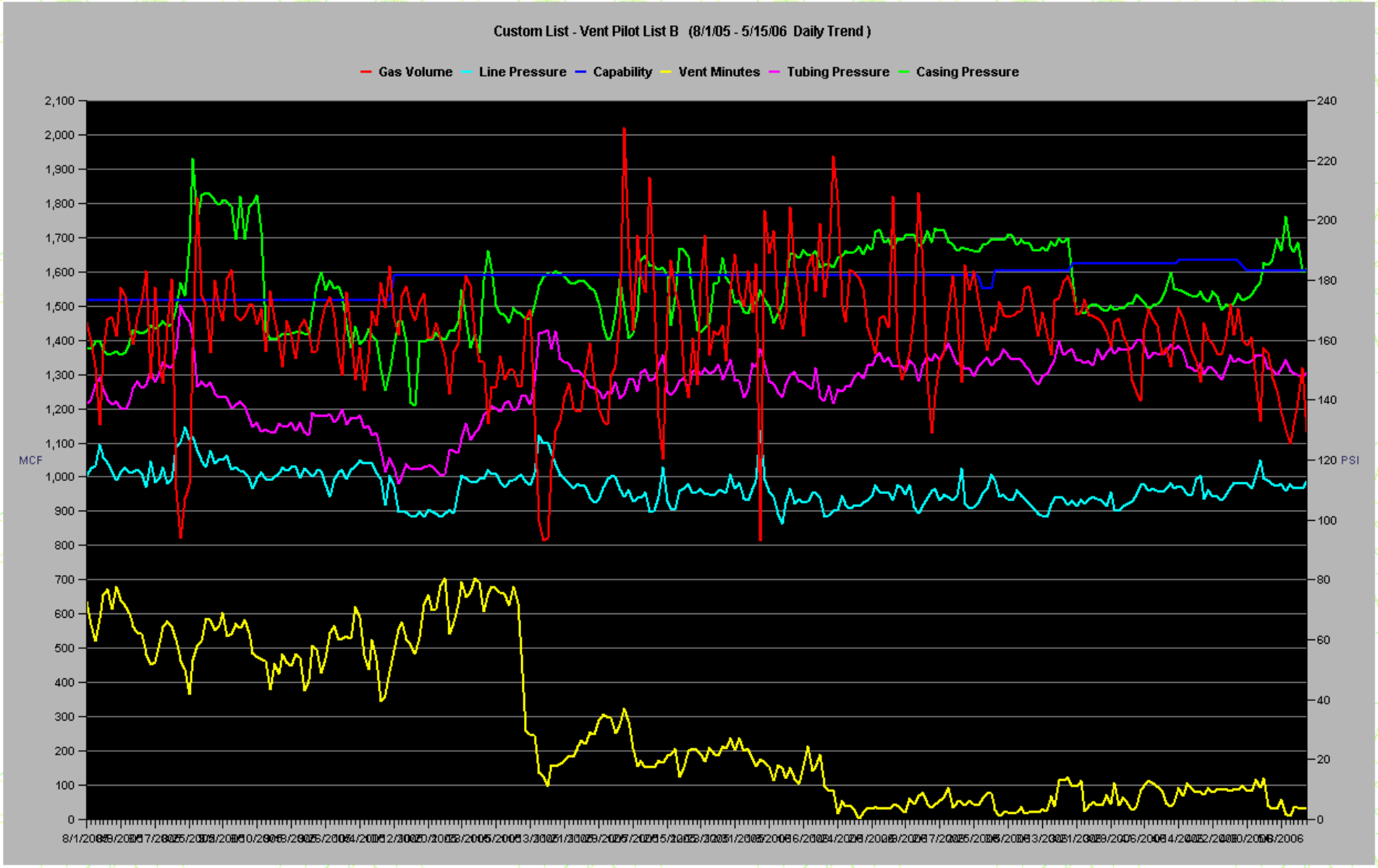
Start Date 2/12/2006 End Date 6/12/2006

Vent Pilot List B – Applied Vent Procedure Set points 11/10/05



And the solution was…

- Smarter automation (settings and code.)
- Minor maintenance changes at wellsite.
- New automation tools to help recognize problem situations.
- Making believers out of the staff and management.

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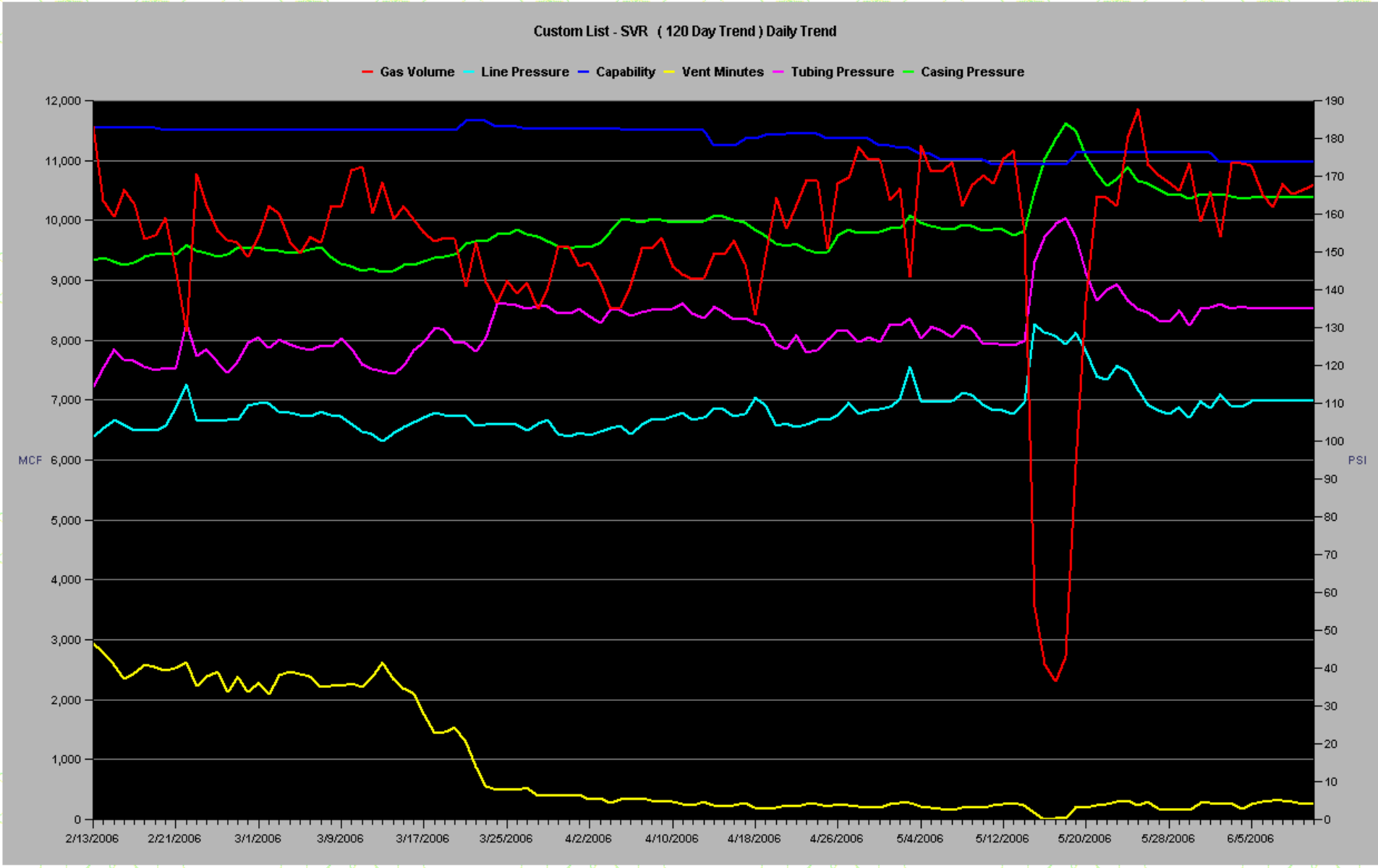
Start Date 2/12/2006 End Date 6/12/2006

SVR LIST 70 Wells – Apply Vent Procedure set points 3/16/06



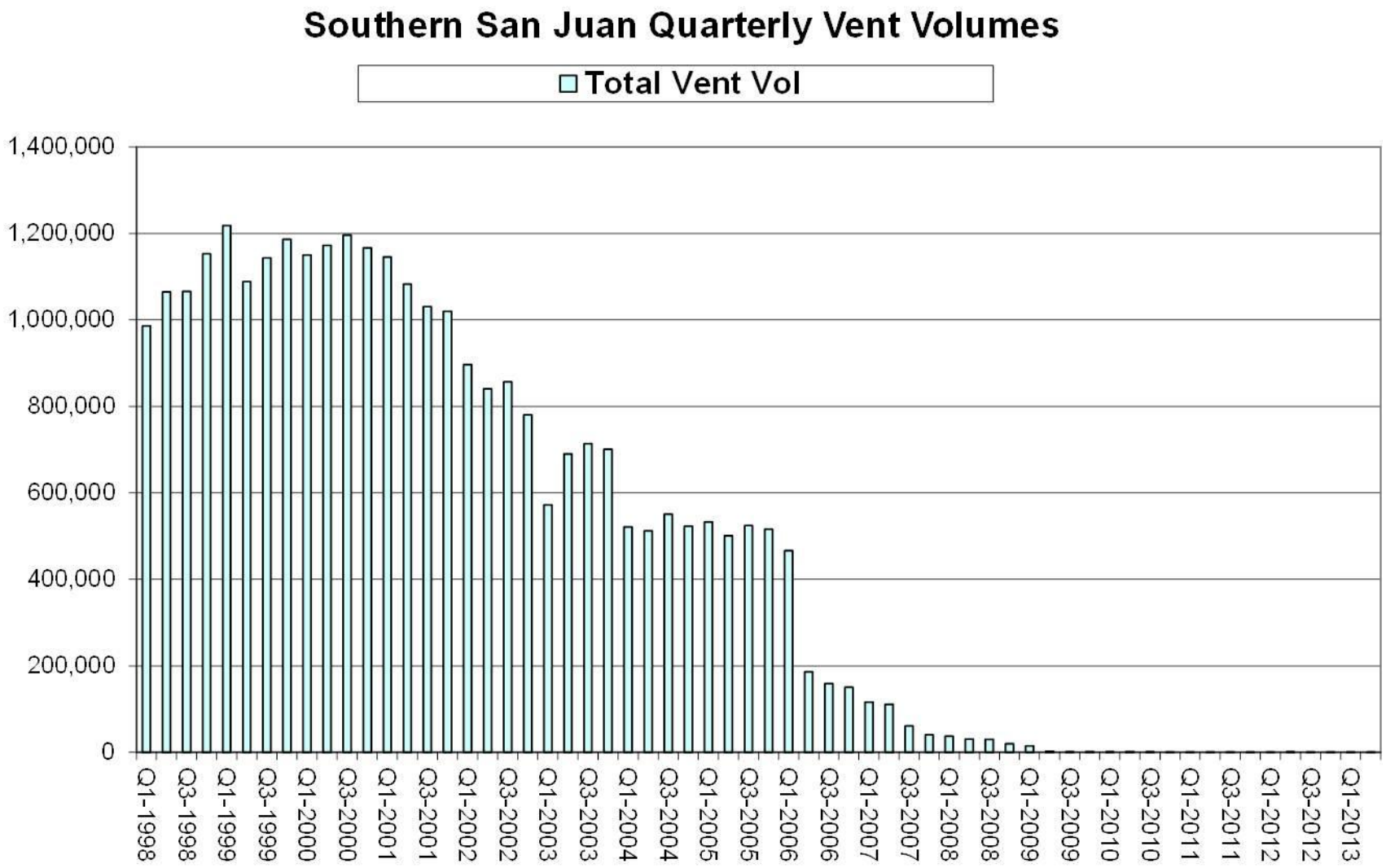
Myths

- There is always “another unique or different well”.
- After flow - venting is required to clean up the well.
- Increasing frequency of cycles cuts vent time.
- Tubing pressure can drop during shut-in.
- Reservoir does not have enough energy for plunger lift.

Lessons Learned

- Plunger velocities mean nothing if the well vents.
- A well can generally be run in “safe mode” and continue to produce.
- Load Factor is difficult to understand and evaluate.
- Need to have the option to adjust the Turner rate – critical velocity.

“Smart” Automation Results



Summary

- Great success >4 bcf/yr to <0.01 bcf/yr
- Technology is only a piece of the solution – also takes revised operational beliefs and practices.
- Requires focus – Teams deliver on current goals.
- Operational beliefs have shifted from “we must vent to produce” to “Venting is one of our last options.”
- Details of approach needs to be adapted to well & reservoir characteristics
- Will not work in all situations

Plunger Lift

- An inexpensive method to lift fluids from gas wells using a vertical pig.
- Requires energy buildup in the casing or near wellbore reservoir to lift the plunger to surface.
- Inadequate energy or too much fluid causes well to over load and die.
- Venting to atmosphere (zero pressure) instantaneously increases differential pressure allowing plunger to lift & well to flow.

http://www.youtube.com/watch?v=tF2-HL_Yxtc

http://www.youtube.com/watch?v=cSB90AuHQtg