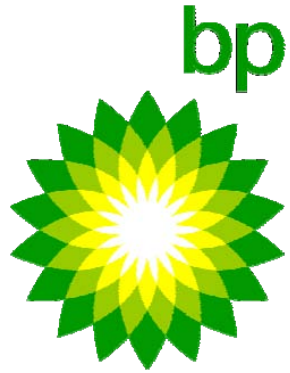


Plunger Well Vent Reduction Project

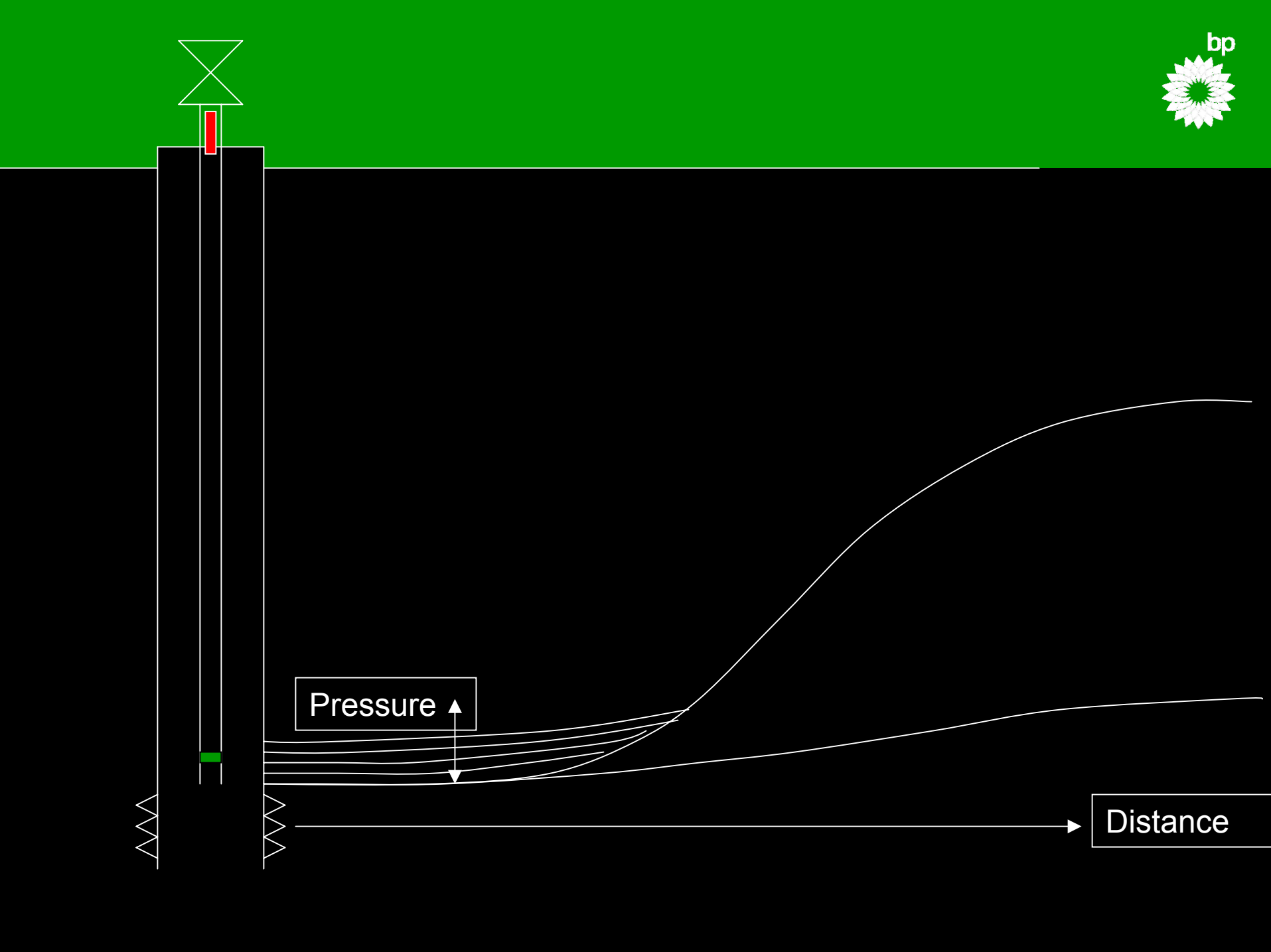
G.P.(Skip) Desaulniers

BP

2006 Natural Gas Star Workshop

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 well to flow.


bp
Pressure
Distance

Initial Vent Reduction Project

- Automation project designed and funded in 2000.
  - Environmental project – funding justified on basis of GHG mitigation commitments and gas loss value.
  - 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.

Why is venting wells a bad thing?

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

Issues

- ~1000 of the 2300 wells are plunger lift wells.
- Lose a well – order a swabbing unit to lift the liquids out of the well.
- Tight Gas consideration – inflow issues.

Actions Taken

- Interviewed control room staff and worked closely with the field automation team leader.
- 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.

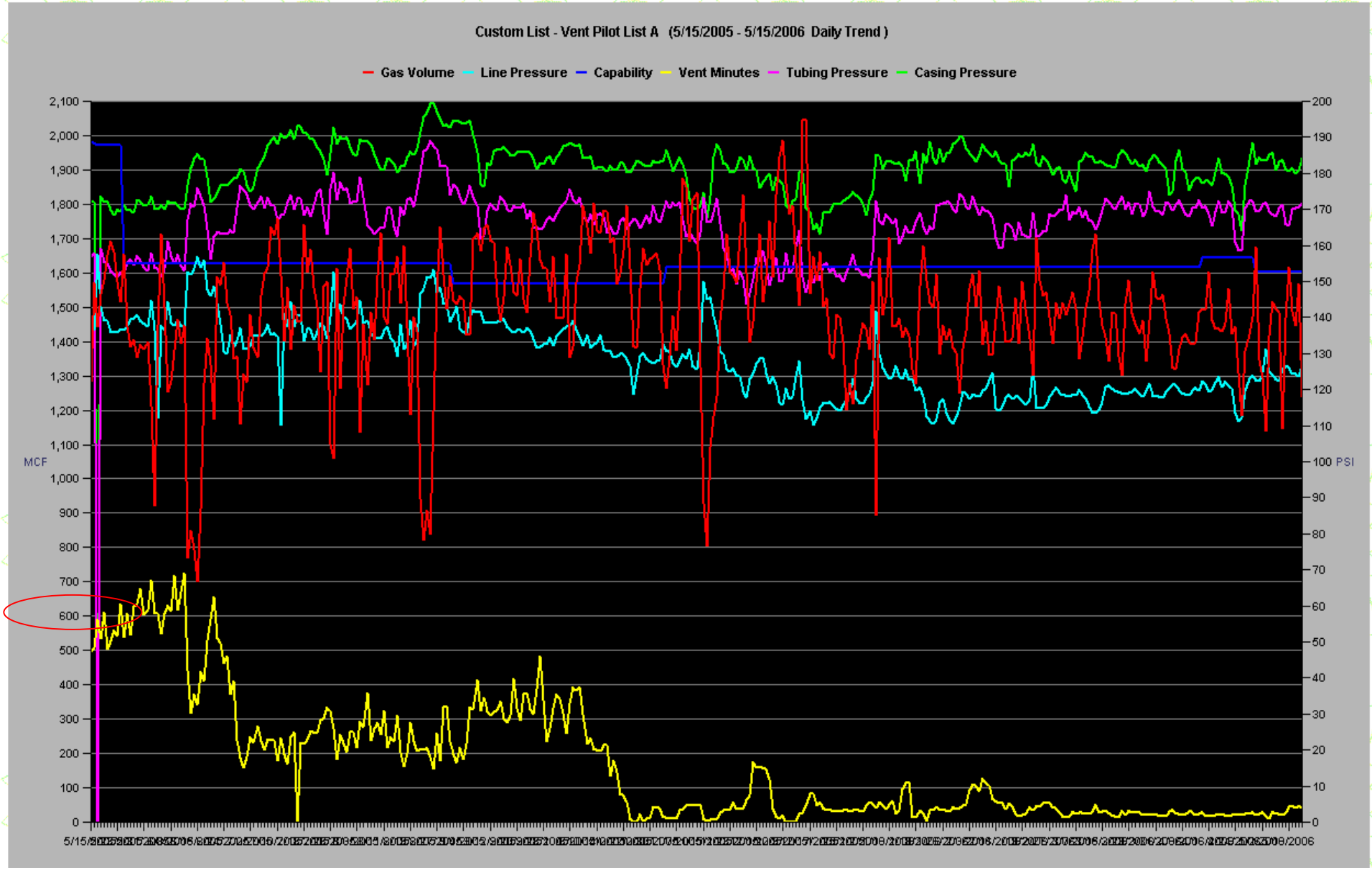
And the solution was…

- 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.

Home Back Refresh Avg Casing/Tubing Pressures

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

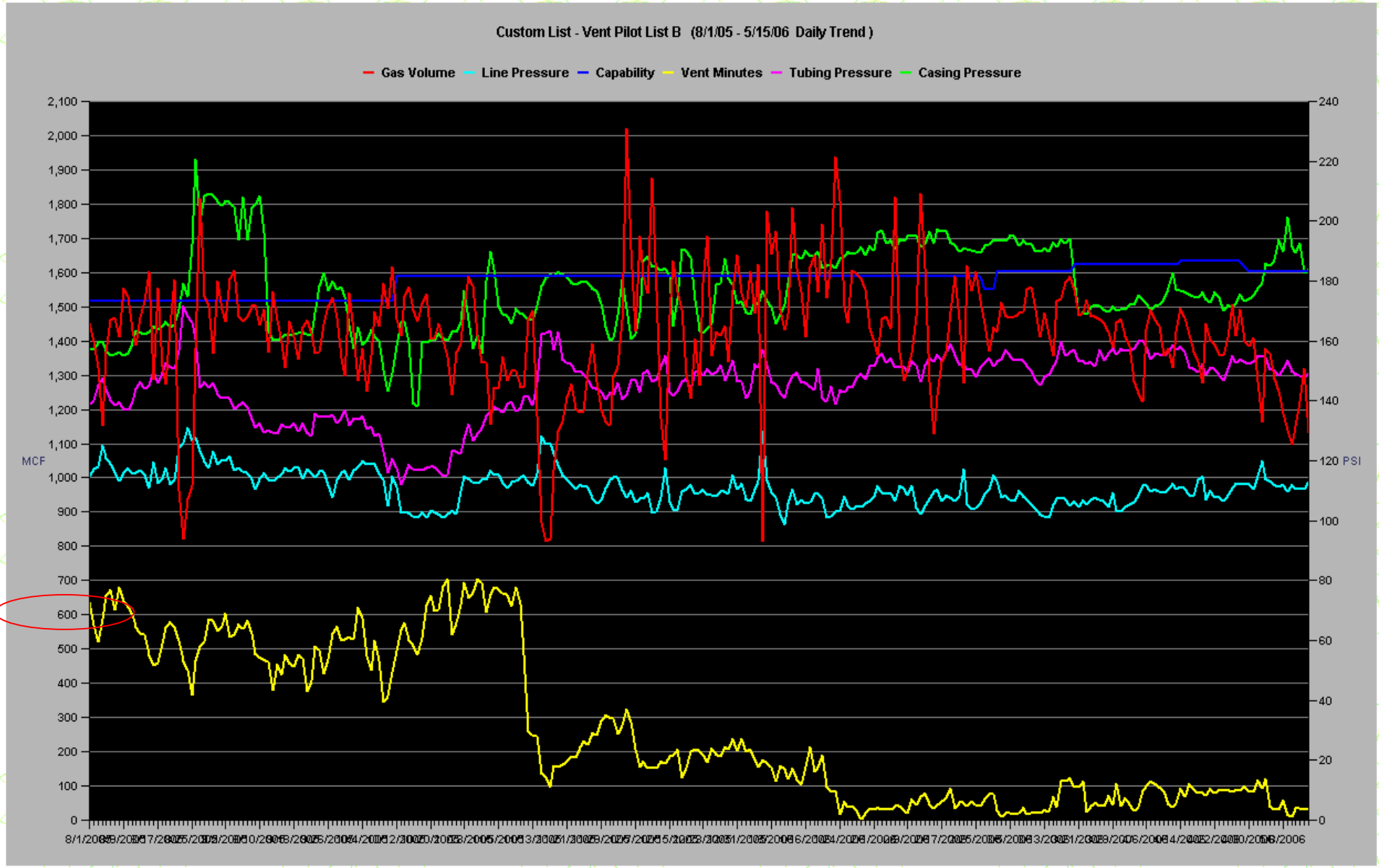
Vent Pilot List A – Start 6/15/05
Applied Vent Procedure Set points 10/20/05



Home Back Refresh Avg Casing/Tubing Pressures ☑

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

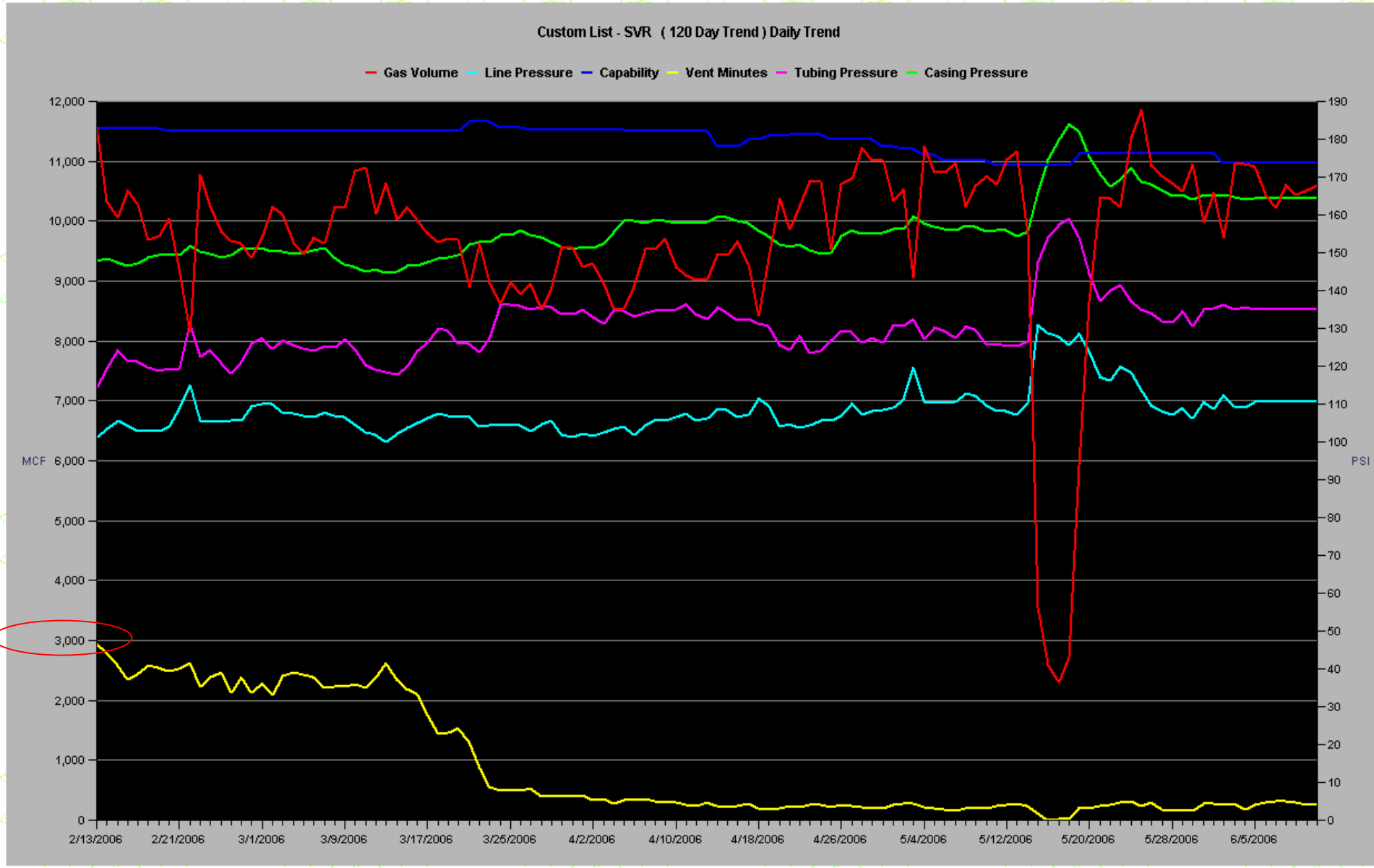
Vent Pilot List B – Applied Vent Procedure Set points 11/10/05



Home Back Refresh Avg Casing/Tubing Pressures ☑

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.

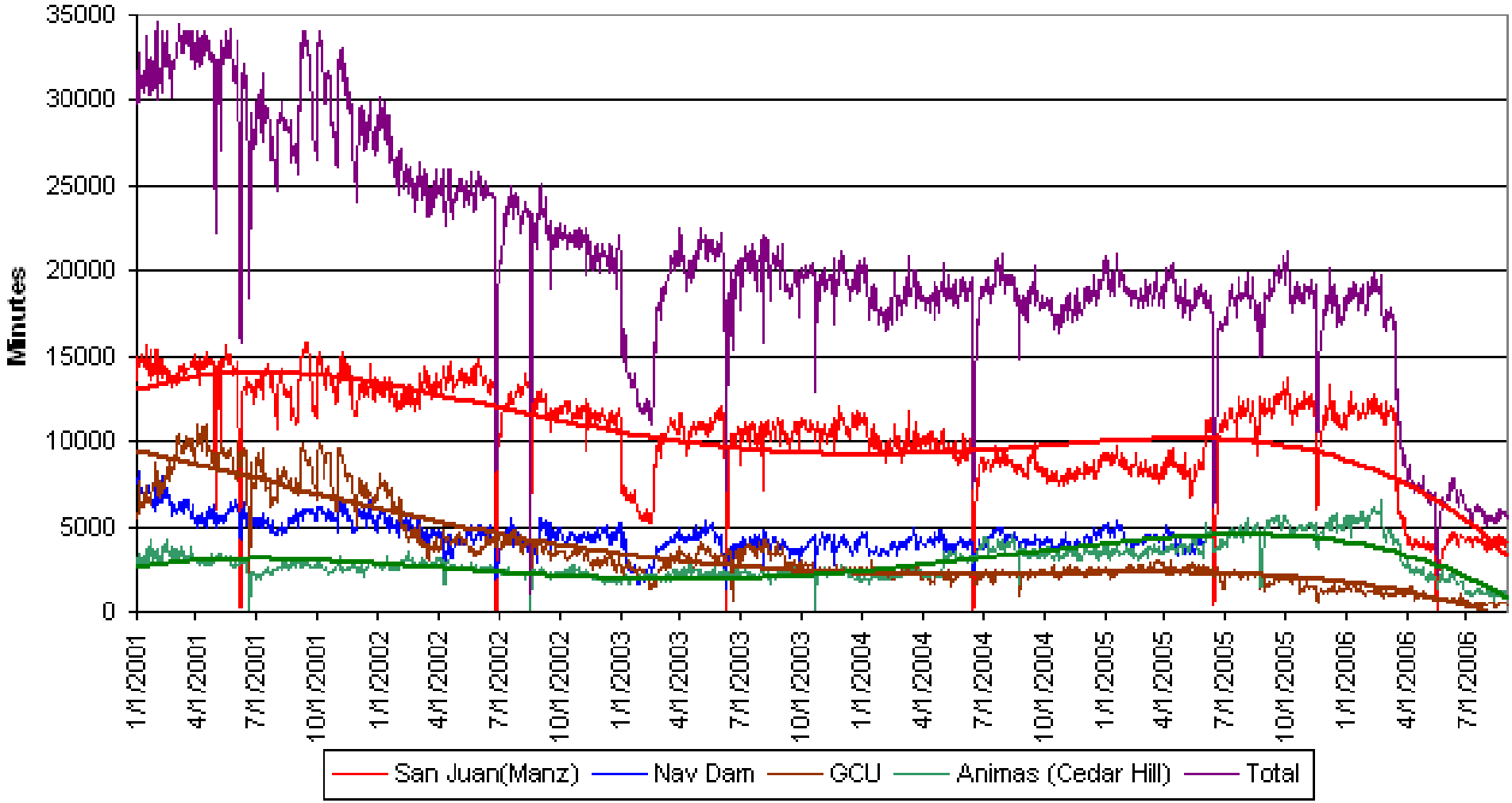
Lessons Learned

- 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.

New Tools / Awareness

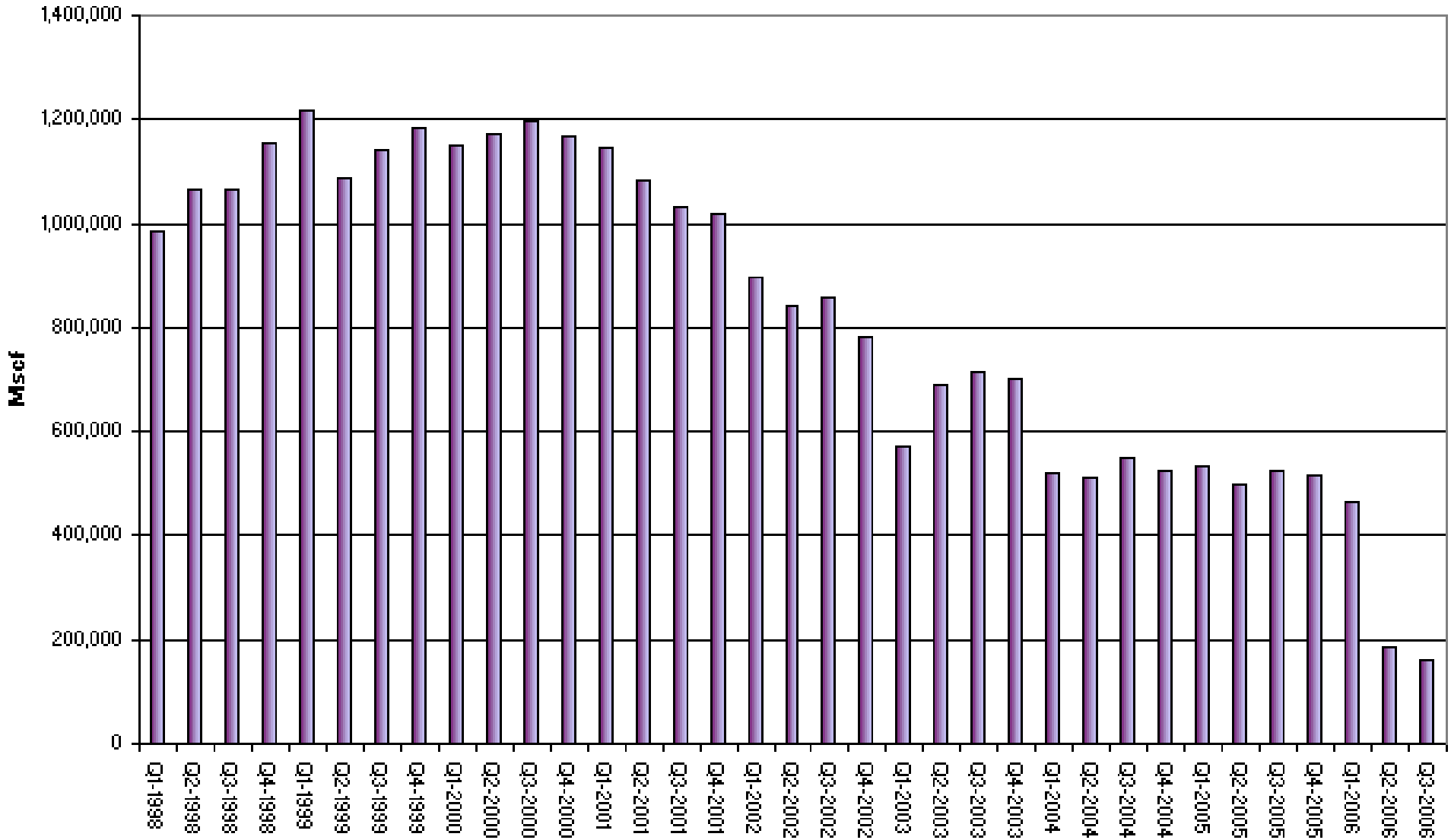
- **Added vent volume to all production plots**
- **Automated e-mail of vent volumes summaries**
- **Weekly review of vent volumes in production meeting**
- **Added daily vent volume application to FDA**
- **Flow time greater than sales valve open time display**
- **Increasing tubing – casing pressure differential report**

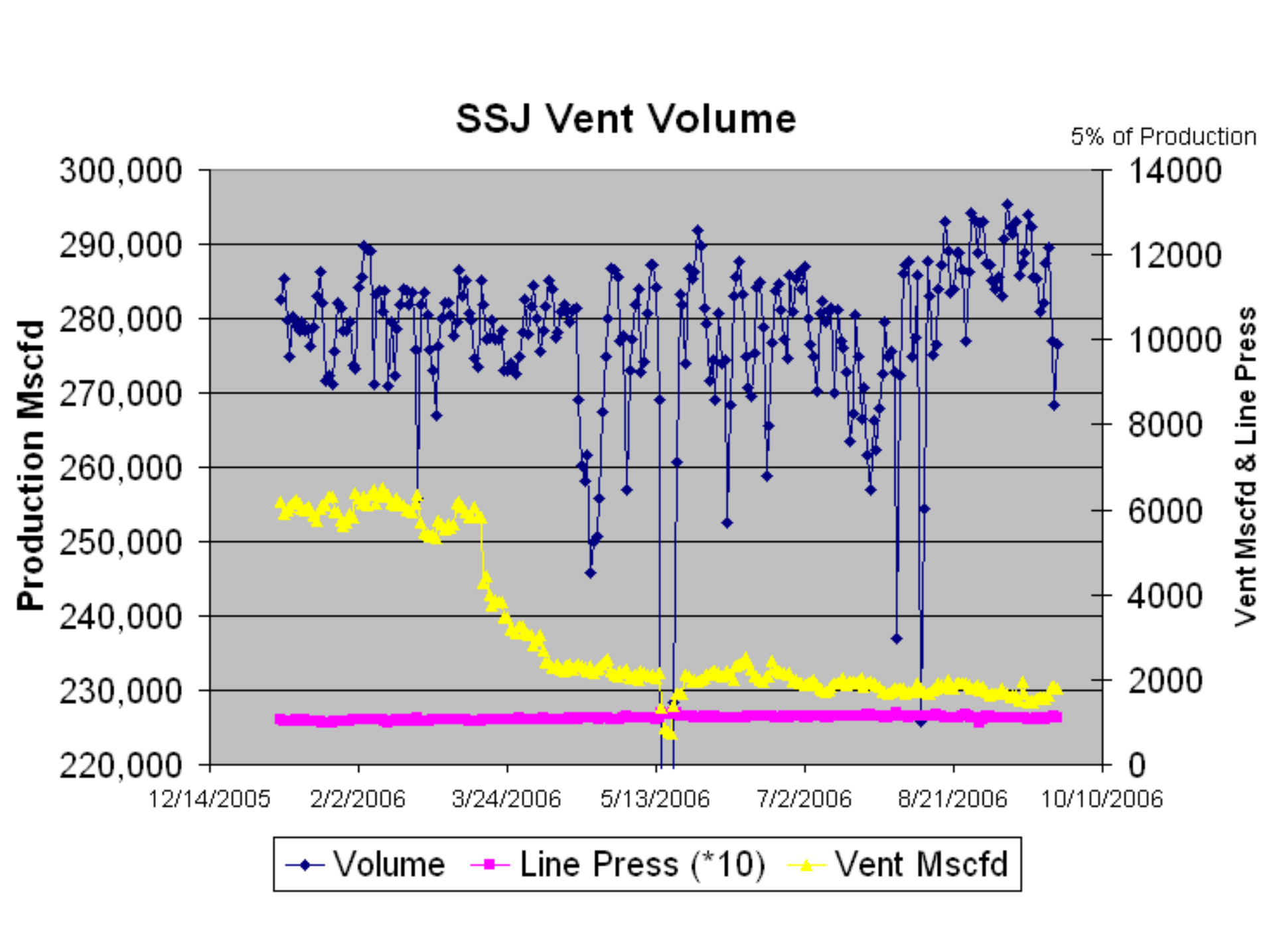
Daily Vent Minutes By Asset Team



Southern San Juan Quarterly Vent Volumes

Total Venting




SSJ Vent Volume
5% of Production
Production Mscfd
Vent Mscfd & Line Press
300,000
290,000
280,000
270,000
260,000
250,000
240,000
230,000
220,000
14000
12000
10000
8000
6000
4000
2000
0
12/14/2005
2/2/2006
3/24/2006
5/13/2006
7/2/2006
8/21/2006
10/10/2006
Volume
Line Press (*10)
Vent Mscfd

Summary

- **Great success thus far 4.0+ bcf/yr down to less than 0.8 bcf/yr**
- **Incremental reductions are increasing difficult**
- **Technology is only a piece of the solution - most significant recent reductions are due to revised operational practices**
- **Requires constant focus – Teams deliver on current goals**
- **Operational beliefs have shifted from “We must vent to produce” to “Venting is one of our last options”**