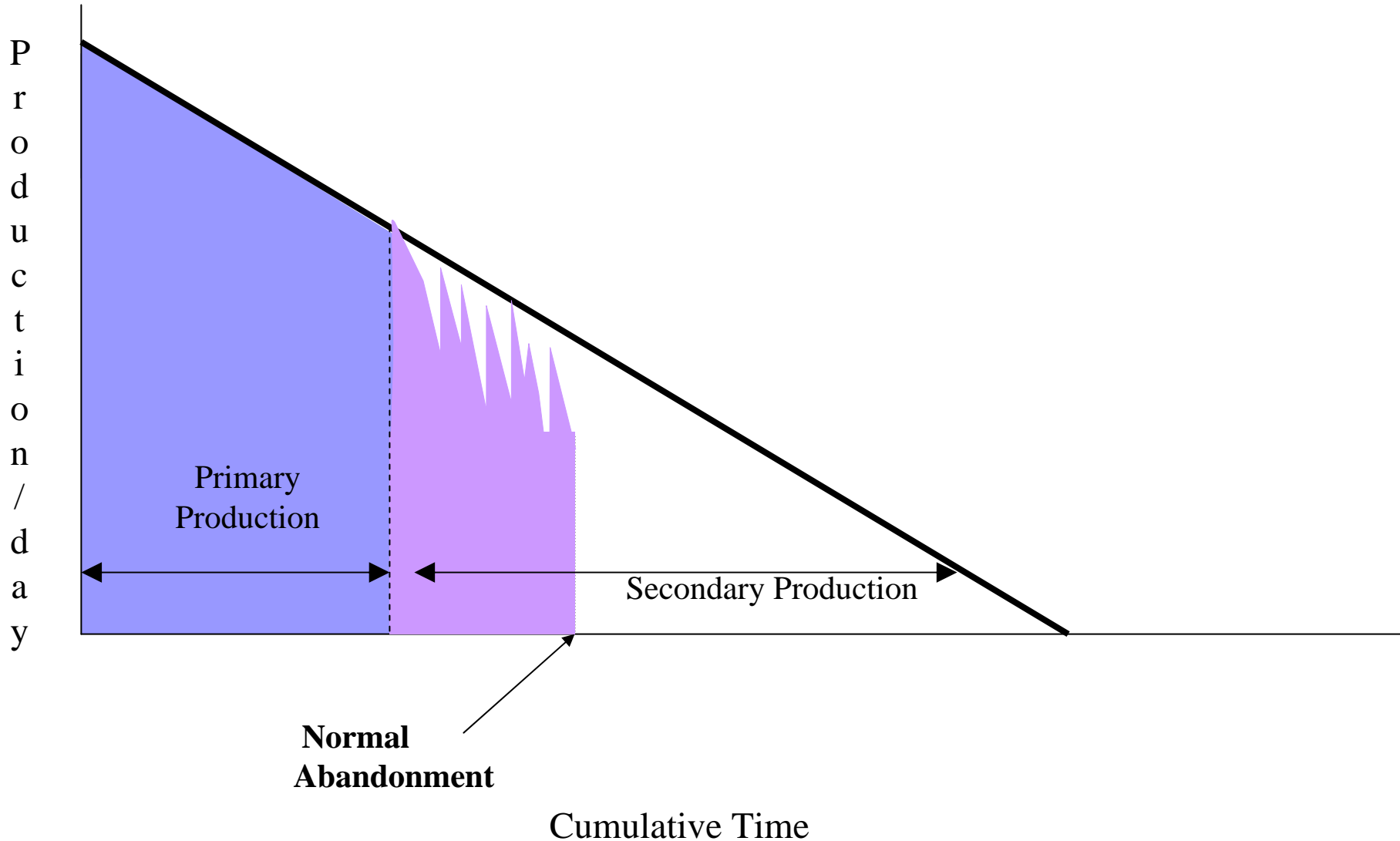


PTAC– Late Stage Gas Reservoir
Recovery Technology Forum and
Workshop

The Impact of Advanced Automation on
Production Optimization Techniques

November 25, 2003

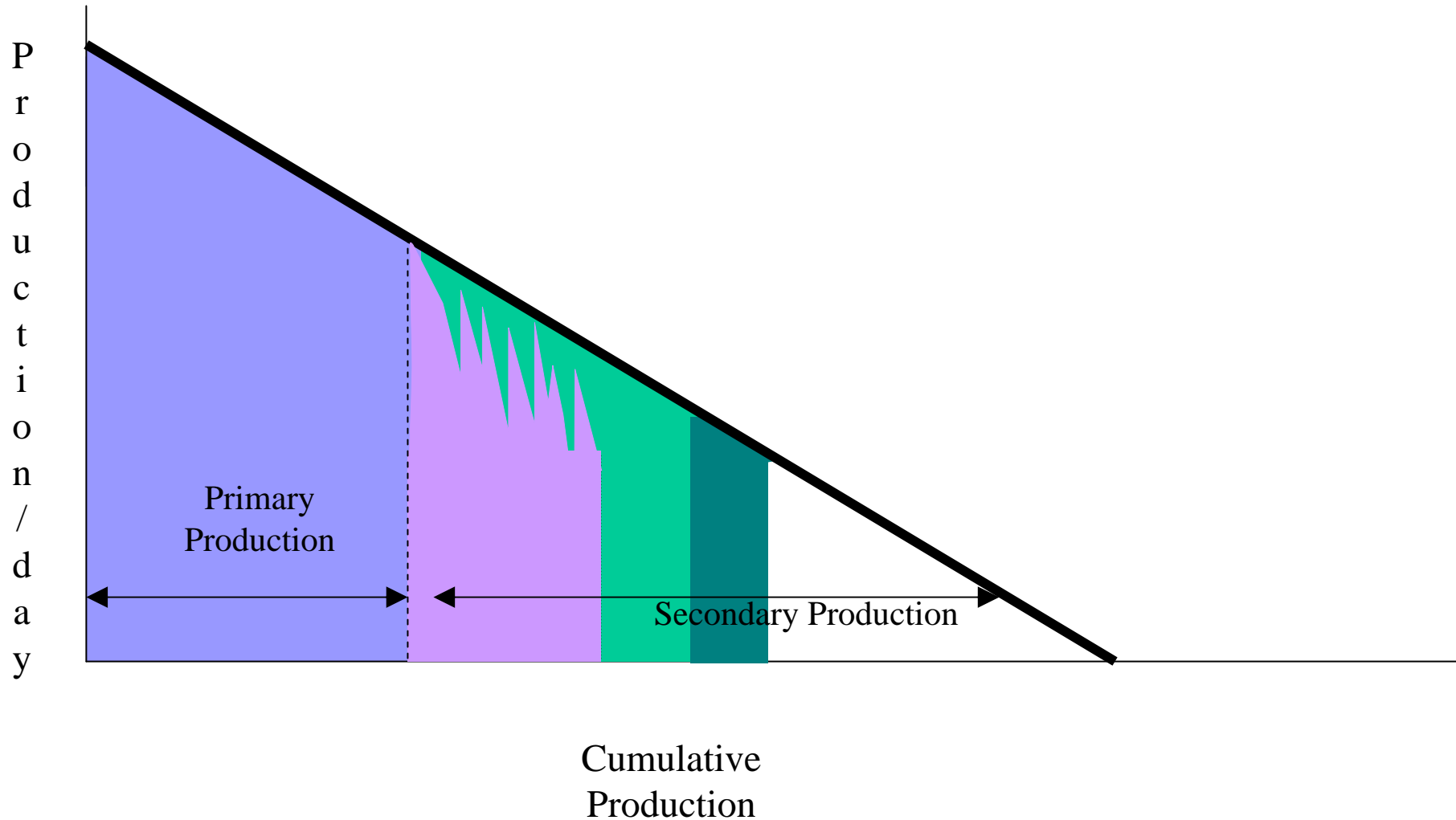
Well Lifecycle



Production Optimization Processes

1. Normal Plunger Lift Implementations
2. Casing “Slip Streaming” or Tubing Velocity Maintenance with Annular Flow
3. Casing/Tubing Switching with Plunger Lift in Tubing for Liquid Removal

How Much Is the Green Worth?



Historical Plunger Control

1. Timed Based
2. Casing/Tubing Differential (Pressure Based)
3. Flow Rate Set point (Flow Based)
4. Plunger Velocity
 - Or some combination

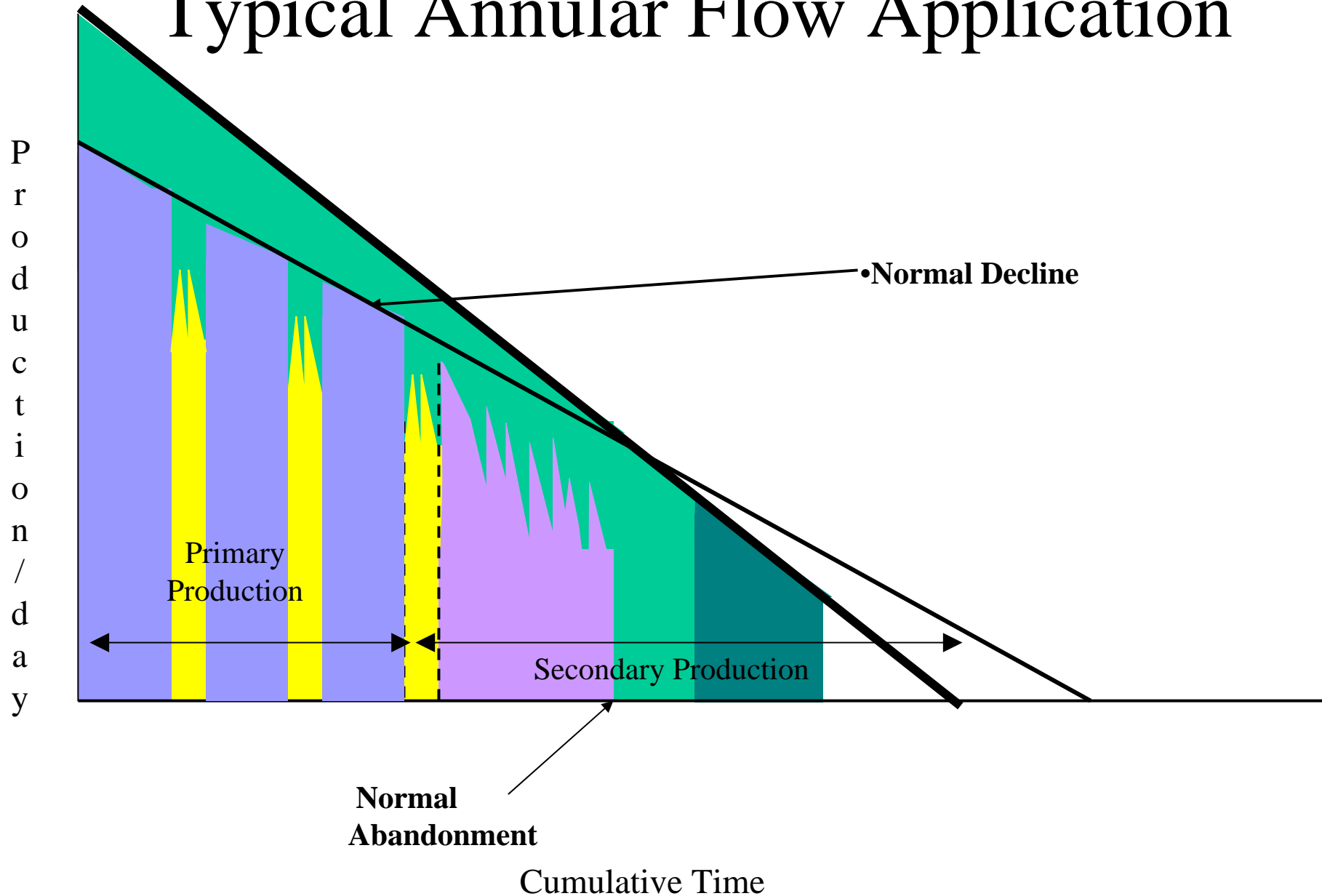
Fundamental Enhancements

1. Change the “Desired Result” to the basis of operation
 - “Net Gas” Basis
2. Layer all other related parameters and set points on top of the “net gas” basis
 - Proper plunger management requires “multiple modes” of operation
3. Enable the manipulation of parameters and set points to be “learned” or experimented with by software—relieving this responsibility from the human

Integrating New Concepts

1. Plunger Velocity Control Logic
2. Fluid “Pre-staging”
3. Flow Limitation
4. Integration With Compression

Typical Annular Flow Application



Annular Flow Processes

Addition of compression in late stages of gas reservoir recovery provided an opportunity to better leverage the compression asset

- Many times the implementation of compression created tubing friction losses that provided an opportunity for annular flow
- Compression alone did not resolve the problem and integration with plunger lift was required
- With the added assistance of compression to the plunger lift, annular flow was also possible.

Two Annular Flow Methods

1. Casing “Slip Streaming” or Tubing Velocity Maintenance with Annular Flow
 - Maintain critical rate up the tubing string while variably producing the annulus
2. Casing/Tubing Switching with Plunger Lift in Tubing
 - Flow both areas wide open and intermittently produce liquids to surface with plunger lift in tubing

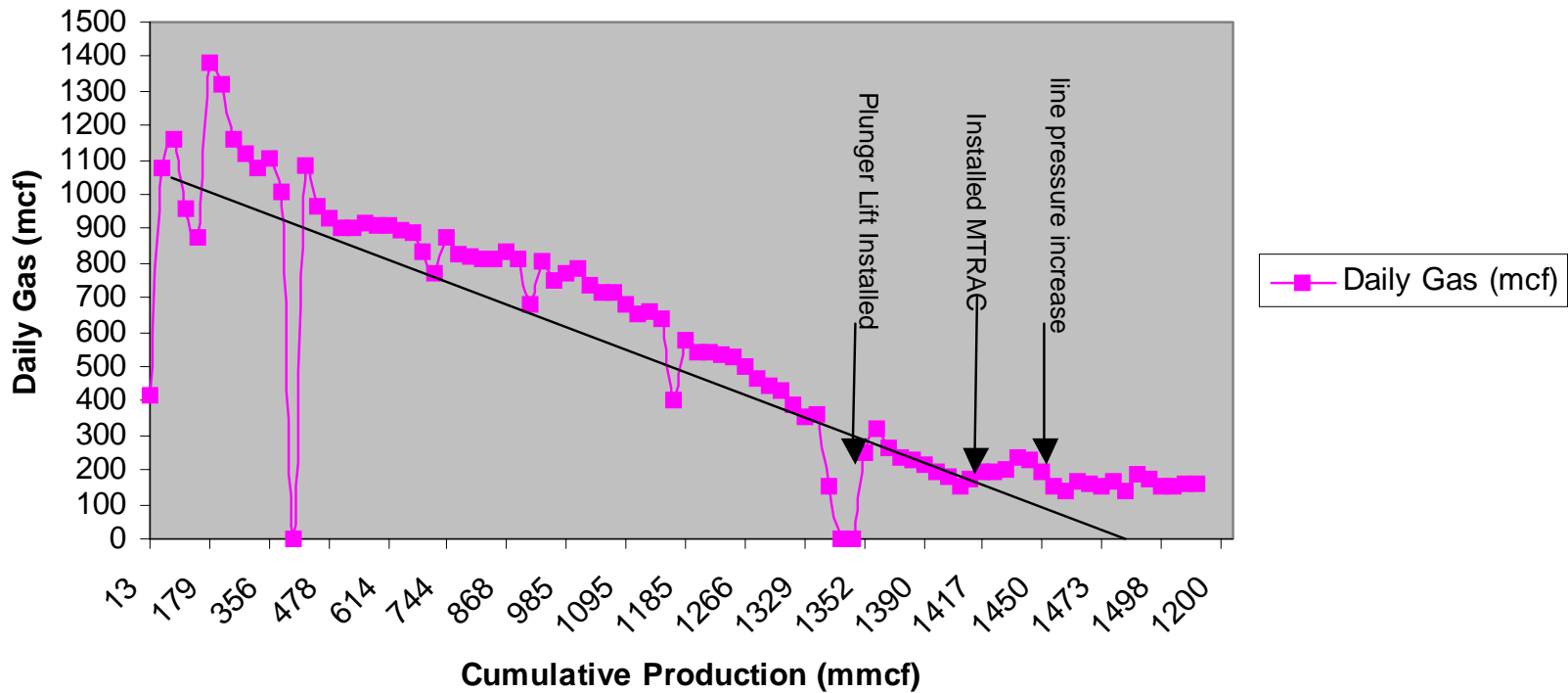
Challenges

In Late Stage Gas Reservoirs implementations always involved compression which created challenges

1. Compression management along with process—true integration involved making compression part of the process
2. Installations involving plungers required very sophisticated plunger velocity management and special fluid handling from annular space to tubing where plunger resides

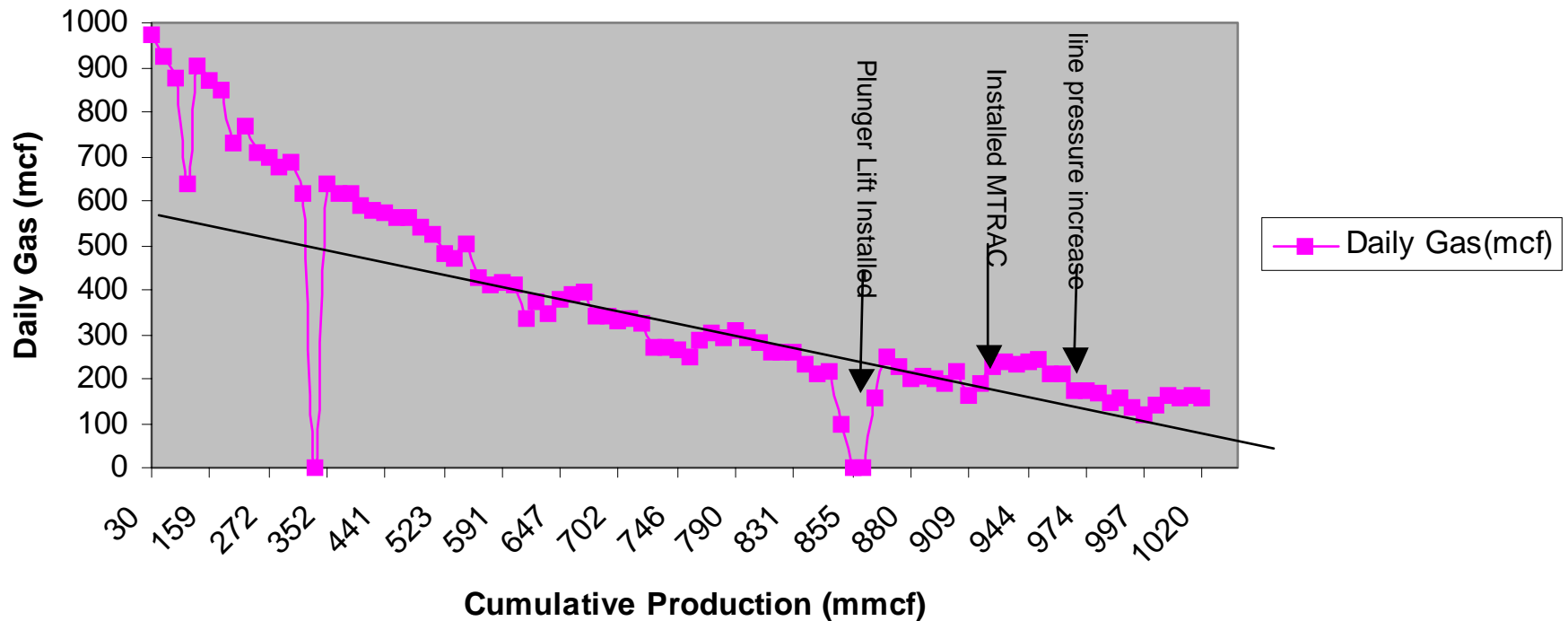
Long Term Pilot #1

Figure 2
Advanced Management of Non-Continuous Flow Control Process
with Plunger



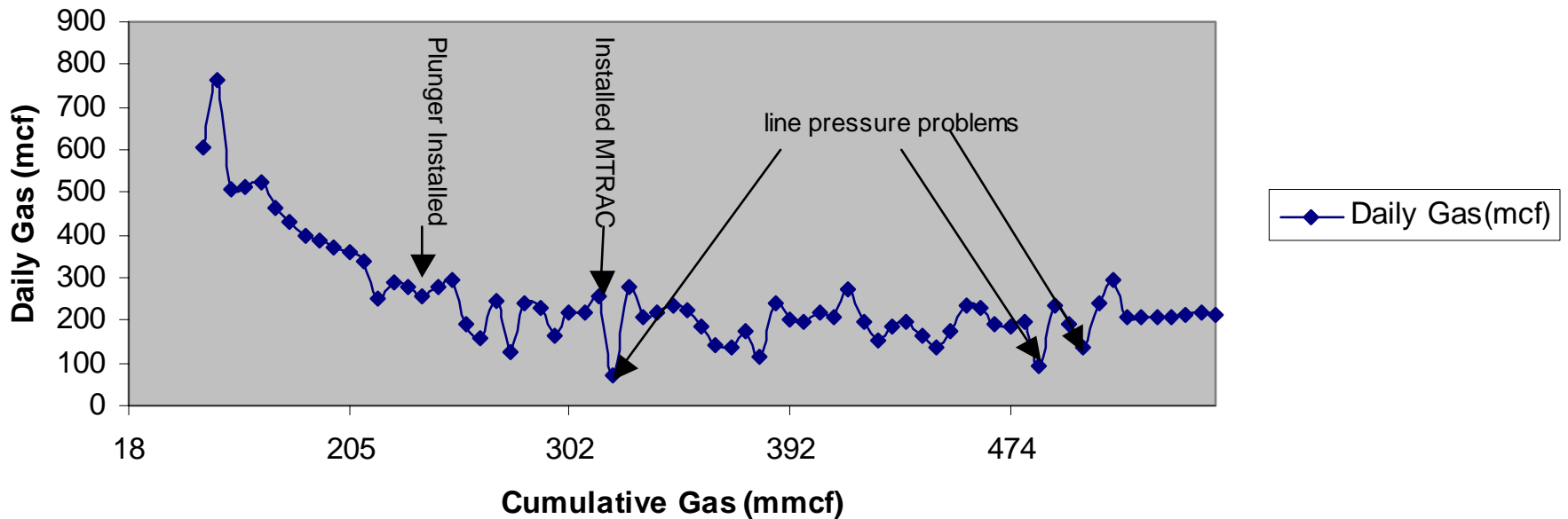
Long Term Pilot #2

Figure 3
Advanced Management of Non-Continuous Flow Control Process
with Plunger



Long Term Pilot #4

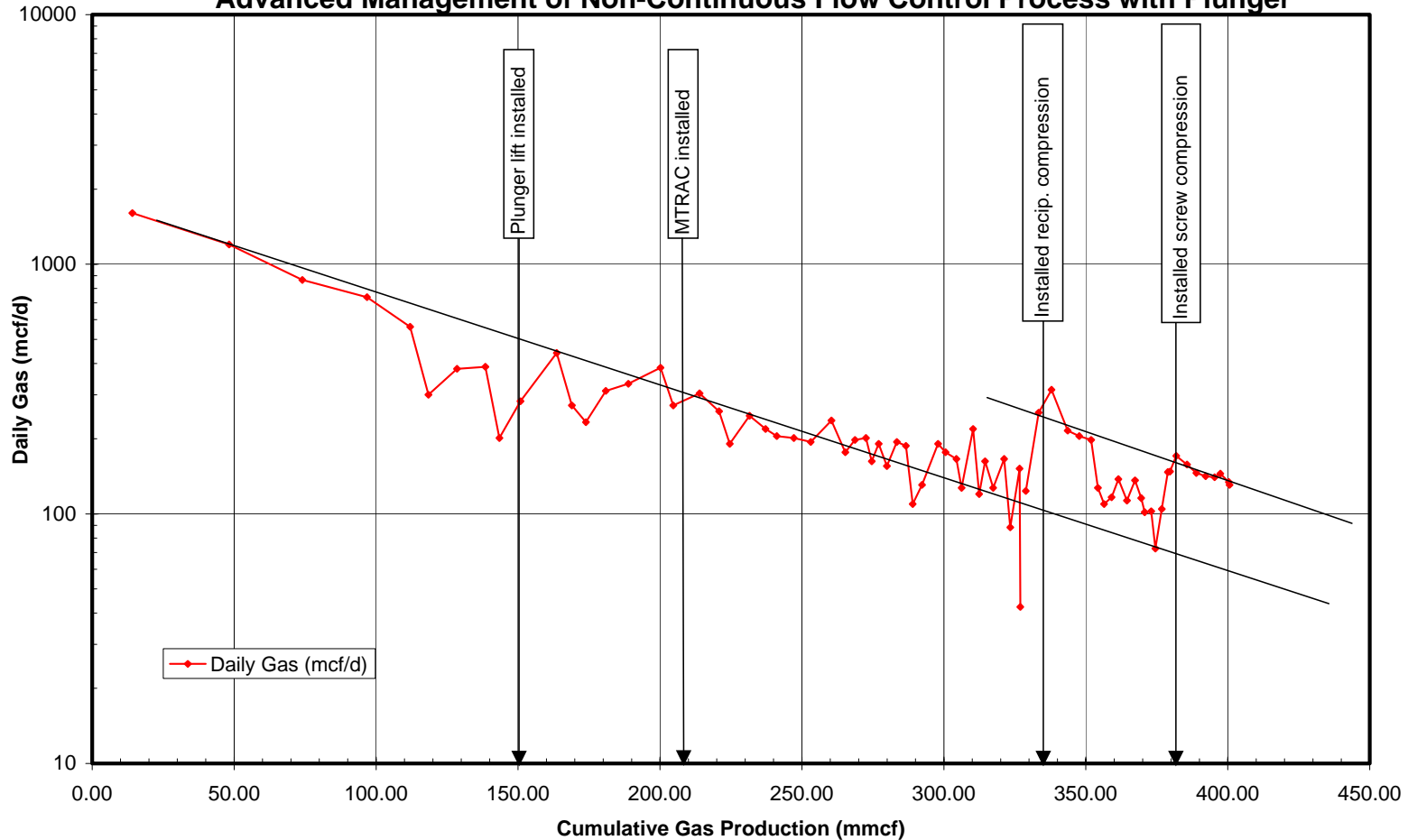
Figure 5
Advanced Management of Non-Continuous Flow Control Process with Plunger



Long Term Pilot #3

Figure 4

Advanced Management of Non-Continuous Flow Control Process with Plunger



Long Term Pilot #5

Spot Checks For Incremental Assessment

