

**REDUCING ANALYZER
COSTS USING STATISTICAL
QUALITY CONTROL**

DISCUSSION TOPICS

- What is Statistical Analysis (Formulas Used)
- Analyzer Systems, The 40,000 Ft View
- Statistical Quality Control (SQC)
 - Understanding Stability
 - Exploring Data Limits
 - Software Tools And Charting
- Examples Of Costs
- Potential Savings
- Exploring Predictive Failures
- Q&A's

Statistical Equations To Be Discussed

There Will Be a Test!

$$\text{if } \gamma = 0 \quad \text{and} \quad \xi = \frac{\Omega t}{2}$$

$$\frac{d^2 u_0}{dt^2} + [a - 2q_u \cos(2\xi)] u_0 = 0$$

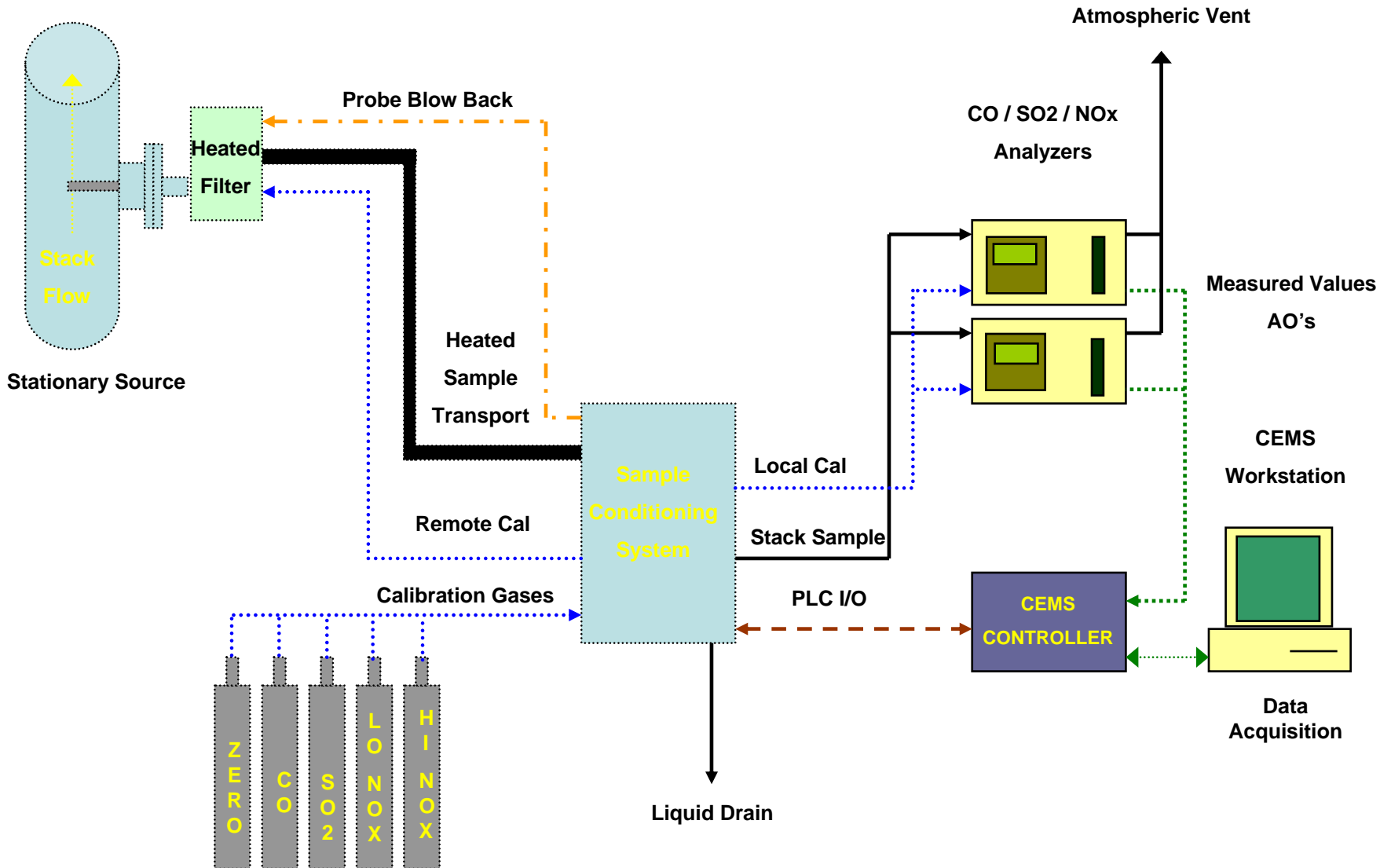
$(u_0 = r \text{ or } z)$

$$a_r = \frac{8z e U}{m(r_0^2 + 2z_0^2)\Omega^2}, \quad a_z = -2a_r, \quad a \propto U(\text{DC}) \ \& \ a \propto \left[\frac{m}{z} \right]^{-1}$$

THE COMPONENTS OF AN ANALYZER SYSTEM

- Sample Point
 - Extraction/Insitu
- Sample Transport
- Sample Conditioning
- Analyzer
 - CEMS/Regulatory
 - Process/On Line Measurements
 - Area Monitoring

Typical CEMS System Flow Paths And Signal Connections

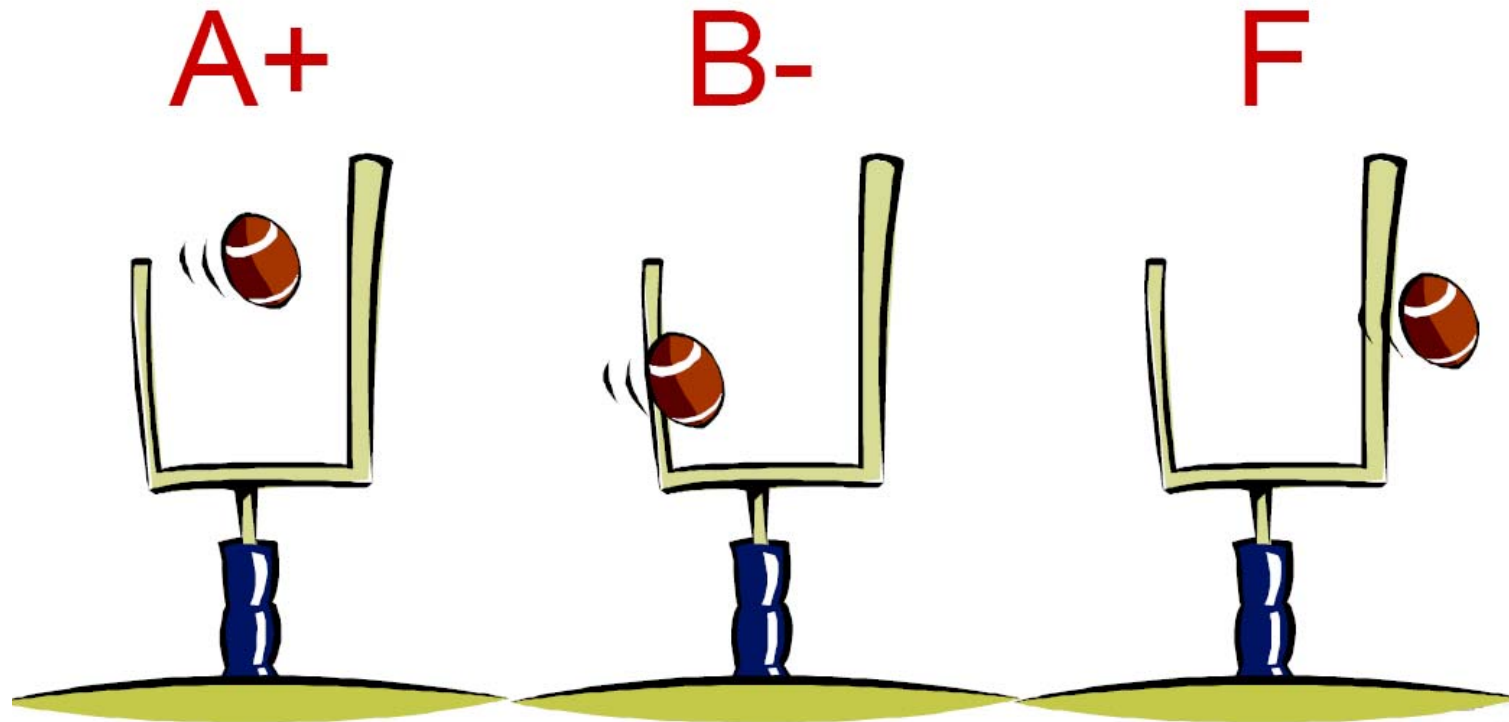


AN ANALYZER “SYSTEM” MUST BE:

- Compatible
- Timely
- Representative (Accurate)
- Reliable
- Cost-Effective
- Safe

... AND STABLE!

GRADING DATA STATISTICALLY



STATISTICAL QUALITY CONTROL (SQC)

- Mathematically Analyzing Data To Measure And Reduce Variability
- Defining The “Process” To Be Measured
- Defining The Constraints
 - Environmental, Engineering, Operating Limits
- Defining Measuring Procedures

SQC “PROCESS” DEFINED

An SQC process is defined as all equipment, hardware, software, procedures, utilities, and human actions used to record, plot, and study data for quality control.

STABILITY DEFINED

An analyzer system is considered stable when 98% of the recorded analyses falls within upper and lower control limits, does not exhibit any anomalies or cyclic trends, and the upper and control limits fall within the upper and lower specification limits.

TYPICAL CAUSES OF INSTABILITY

- Application/Engineering Errors
- Mechanical/Electrical Failures
- Process Upsets
- Human Error
- Routine Calibration (masks instability)

Analyzers Are One Of The Few Devices That The Measuring Element Is In Direct Contact With The Process To Be Measured.

STABILITY COSTS

Assume a process GC is accurate/on advance control 90% of the time and profits a company \$500,000 per year when on control.

- What is the profit by gaining 10% on line time?
 $\$500,000 \div 90\% = \$5,500$ for each % gained
- Gaining 10% accuracy/on line time = \$55,000/yr

MAINTENANCE COSTS

EXAMPLE OF A PROBLIMATIC ANALYZER

Assume a technician spends about 2 hours calibrating a single analyzer once/week for operational requirements (just because!).

• Work Order Generation & Planning	2 hrs
– Operator/supervisor input into SAP & approval	
• Permits	3 hrs
– Operations/Maintenance approval, signatures, etc.	
• Actual technician work	2 hrs
– Including documentation needs	
• Environmental review (CEMS)	.25 hrs
• Instrument Tech lost opportunities	2 hrs
• Total man-hours	9.25 hrs
• Overhead + hourly wages (per hour)	\$125/hr
• Single Calibration Event Cost	\$1,156
• Calibrated 50x during year - total costs	\$57,800/yr

POTENTIAL SAVINGS

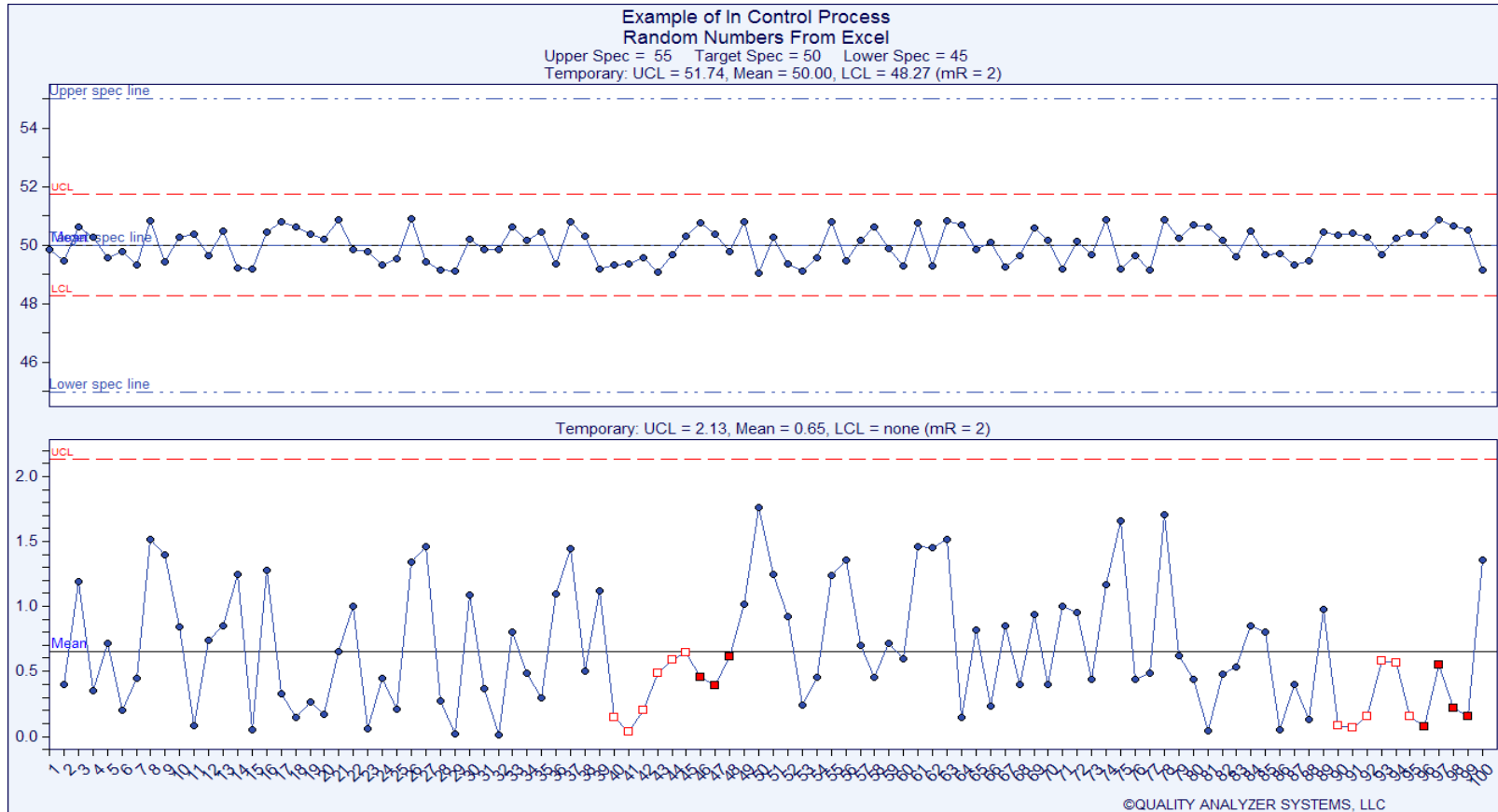
Using SQC to identify causes of instability with problematic analyzers.

RESULTS: Reducing Maintenance by 50% and eliminating loss of down time:

- Maintenance $\$57,800 \div 2 = \$28,900$
- 10% Increase of Process control = \$55,000
- **Net Yearly Gain = \$83,900/yr +**

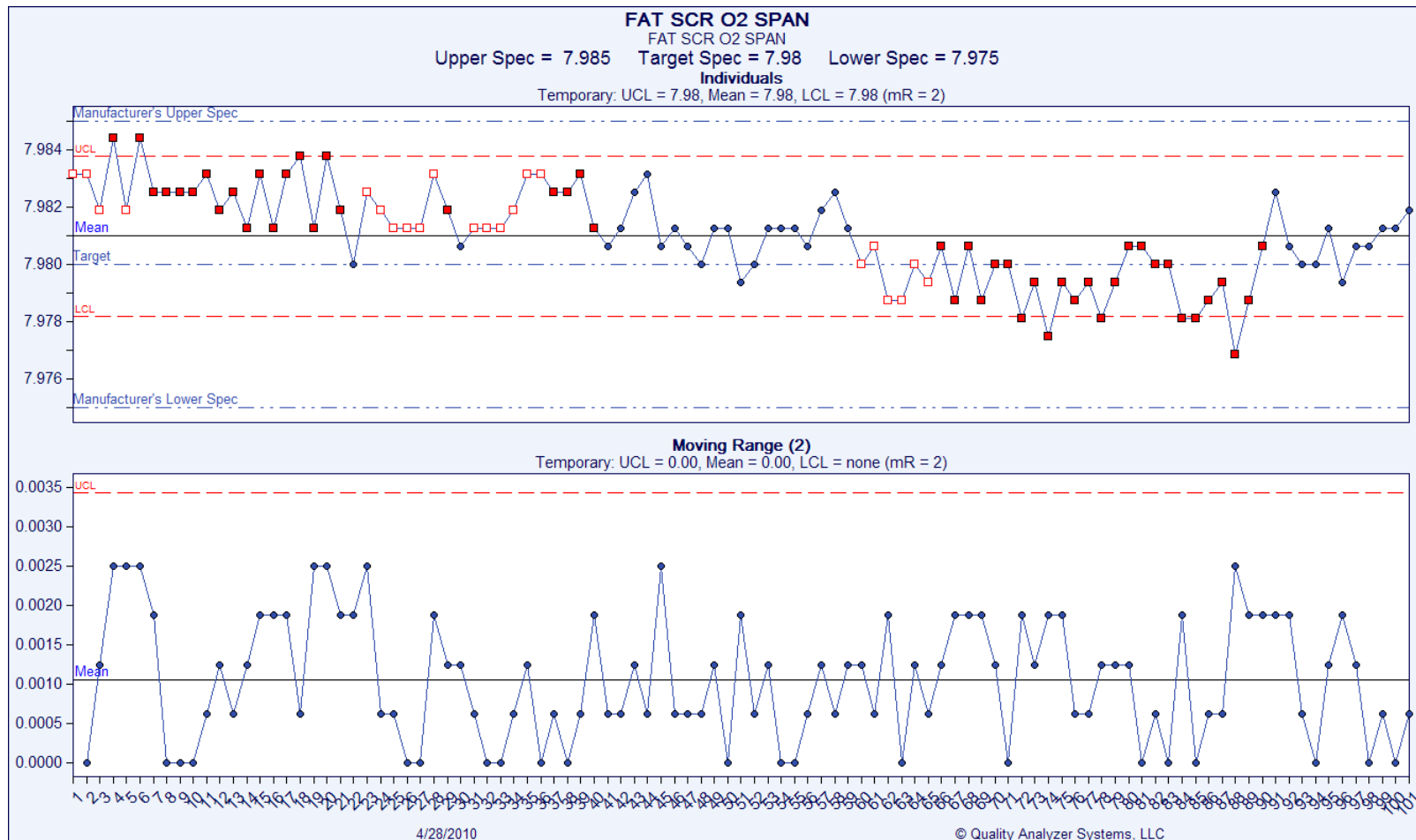
PROCESS IN CONTROL

Charting & Limits

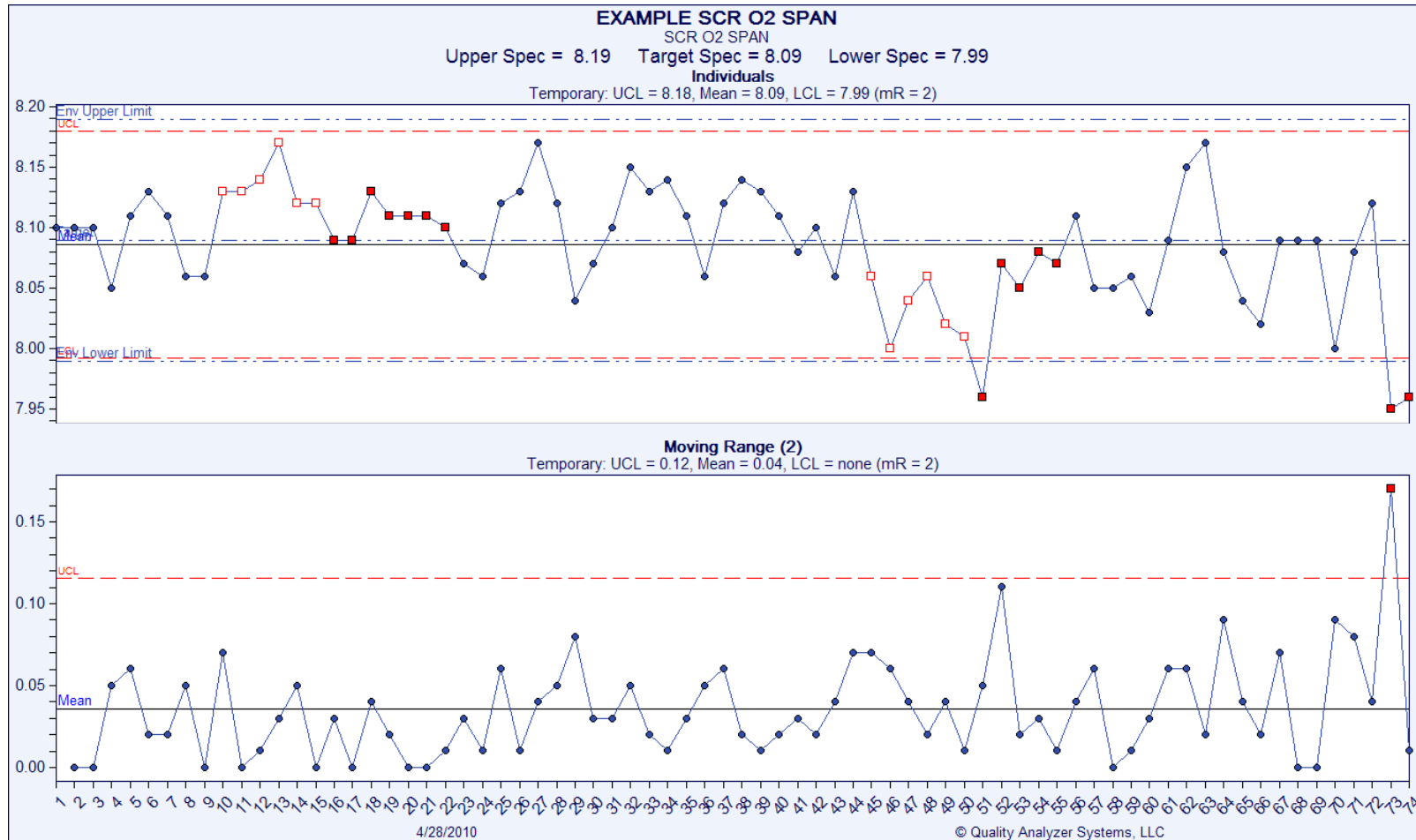


FACTORY ACCTPTANCE STABILITY TESTING

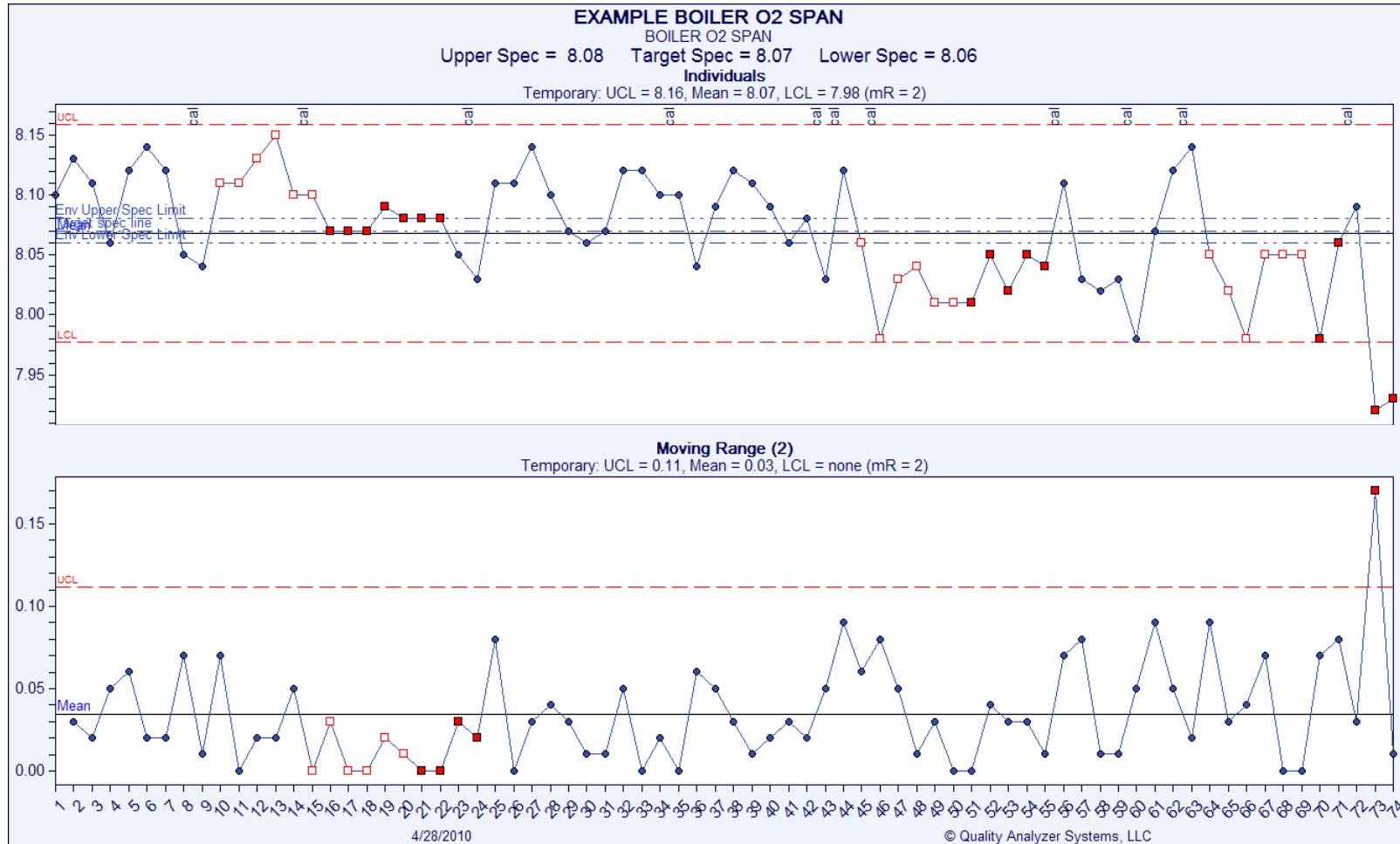
Selective Catalytic Reduction O2 CEMS



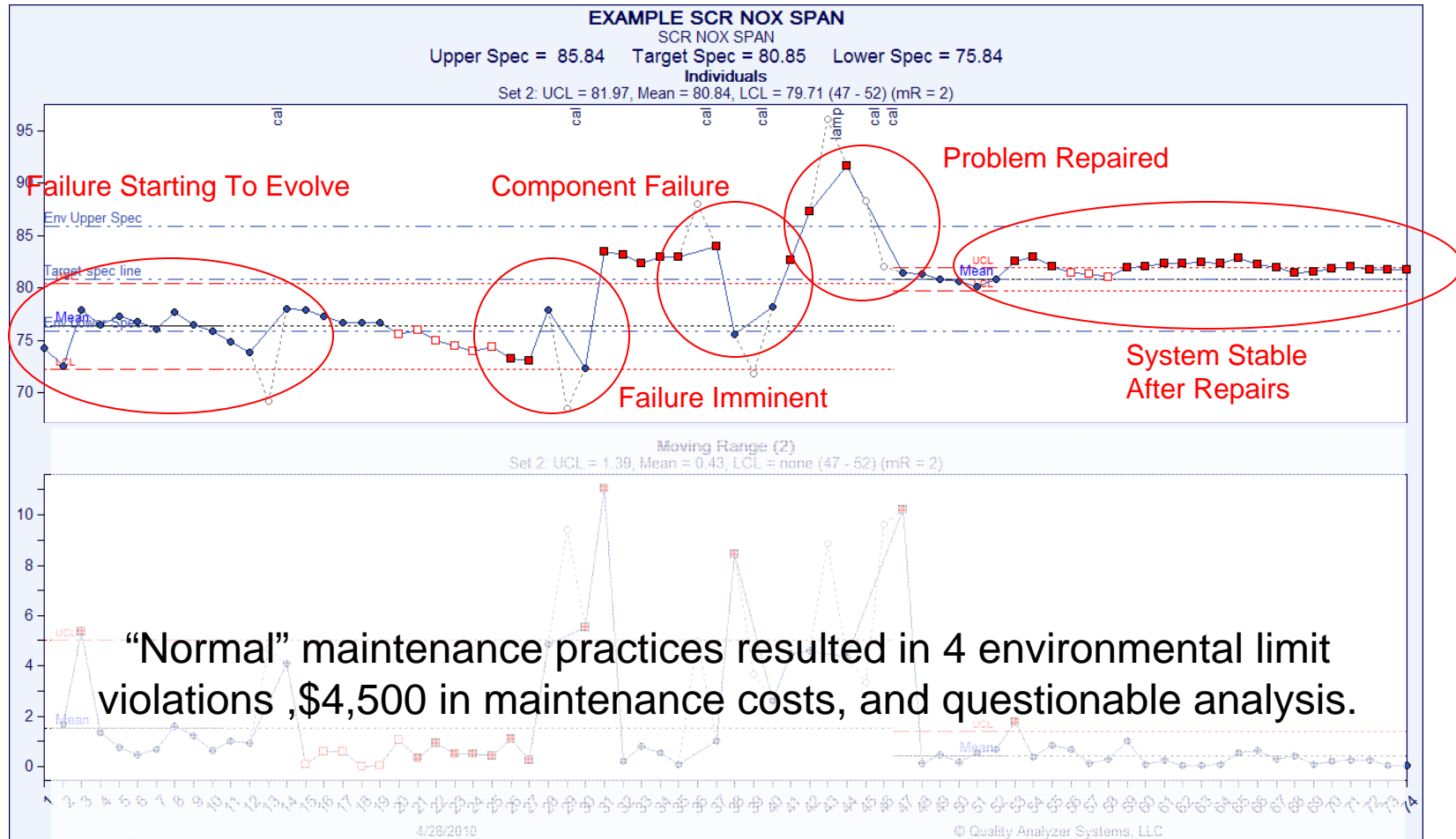
PROCESS MEETING SPECIFICATIONS



PROCESS OUT OF CONTROL AND OUT OF SPECIFICATION



PREDICTIVE FAILURE



SUGGESTED TECHNIQUES TO REDUCE ANALYZER COSTS

- Re-emergence Of Quality Control Practices And Developing Maintenance Procedures
- Automation Of Data Evaluation
 - Integration Of Asset Management Software Along With DCS Control
- FAT Procedures Defining Methods Of Testing And Specific Tests To Be Performed
- Asset Management Software

STATISTICAL ANALYSIS IS NOT BLACK MAGIC



It's Just A Logical Use
of Mathematics!

THANK YOU!