WHITE PAPER

Your Chlorine Sensor Is Lying to You — Here's 65 Days of Proof

How a UK Water Utility Exposed Systematic Over-Dosing Caused by Membrane Sensor Fouling — and What It Means for Your Plant

A Field Evaluation at Compton Durville Water Treatment Works, Wessex Water

October 2025 – February 2026

73 Operational Cycles | 65 Days of Continuous Data

Published by Halogen Systems, Inc.
halogensys.com

Executive Summary

The operators at Compton Durville Water Treatment Works thought their chlorine dosing was under control. Their Siemens Depolox membrane sensor showed residuals right at setpoint. The PID loop was doing its job. On paper, everything looked fine.

It wasn't.

When Wessex Water installed a Halogen Systems MP5 chlorine residual monitor alongside the Depolox in October 2025, the independent readings told a very different story. The MP5 — a self-cleaning, bare-electrode amperometric sensor requiring no membranes, no reagents, and no routine calibration — was deployed purely as a verification instrument. It wasn't controlling anything. It was just watching.

And what it saw over 65 days and 73 operational cycles was unmistakable: the actual chlorine residual in the treated water was rising steadily throughout every operating period — climbing roughly 10% from the start of each cycle to the end. The Depolox, fouled by iron deposits from the site's high-Fe borehole water, was progressively under-reading. The control system responded exactly as designed — by dosing more chlorine to chase an apparent shortfall that didn't exist.

This is the hidden cost of membrane sensor fouling: not a dramatic failure, but a slow, invisible drift that compounds with every hour of operation. By mid-cycle, the plant was routinely over-dosing by 5–6%, leading to unnecessary chemical spend, elevated disinfection byproduct risk, and a daily calibration routine that could never quite keep pace with the fouling rate.

The data revealed another telling pattern. On weekdays, when operators performed morning calibrations, the system partially corrected itself — only to drift again by the next cycle. On weekends, without that manual reset, fouling accumulated 20% faster. The Depolox wasn't broken. It was doing what membrane sensors do in challenging water: slowly losing accuracy as deposits build on the sensing surface.

Meanwhile, the MP5 required zero intervention for the entire five-month evaluation period. No calibration. No cleaning. No membrane changes. When technicians finally inspected the sensor at the end of the trial, the flow cell was stained from the iron-rich water, but the electrodes underneath the self-cleaning cap were spotless. A quick wipe of the exterior housing confirmed readings within 0.03 ppm of the Depolox average — without any of the maintenance burden.

This white paper presents the complete field analysis: the data, the fouling mechanism, the day-of-week patterns, the cost quantification, and the implications for any plant running membrane-based chlorine sensors in high-iron or high-manganese water. If your site has a history of monitoring difficulties — or if you've ever wondered whether your chlorine readings are truly accurate — the evidence from Compton Durville should give you pause.

Key Findings at a Glance

- **Zero maintenance required:** MP5 operated for 5 months with no calibration, no cleaning, and no intervention of any kind
- **+10.67% chlorine rise per cycle:** MP5-measured residual climbed from 0.604 ppm to 0.671 ppm (first-to-last 10-minute averages) during each operating period
- **Root cause identified:** Iron fouling on Depolox membrane causes progressive under-reading, triggering compensatory over-dosing by the PID control system
- **~5–6% average over-dose:** Linear fouling accumulation at 0.53%/hour translates to a mid-cycle overdosing average of 5.3%
- **Weekend effect confirmed:** Fouling accumulates 20% faster without weekday operator calibration
- **Depolox maintenance burden:** Biweekly strip-down cleaning plus daily calibration totaling ~17 hours over the evaluation period

Site Background

Installation Context

Compton Durville Water Treatment Works is a Wessex Water facility treating borehole water with elevated iron (Fe) content. The site has experienced chronic issues with chlorine residual monitoring, having previously evaluated both Kuntze and ATi amperometric probes before selecting the current Siemens Depolox system.

Current System Configuration

- **Chlorine control:** Siemens Depolox amperometric membrane probe
- **Monitoring device under evaluation:** Halogen Systems MP5 chlorine residual monitor (installed October 2025)
- **Control logic:** Depolox provides feedback for PID control of chlorine dosing
- **MP5 function:** Independent monitoring only (not integrated into control loop)

Operational Pattern

- Daily cycle: Plant shuts down 09:00–15:00 (6 hours)
- Operating period: 15:00–09:00 next day (~18 hours net operation)
- Startup behaviour: At restart, low flow causes chlorine spike (fixed dosing into low flow); settles after ~5 minutes

MP5 Installation and Observations

Installation Date

October 24th, 2025

Initial Observations at Startup

When the plant restarts, a characteristic chlorine residual spike is observed:

- Raw readings spike to between 3–10 ppm
- Over 5 minutes, signal settles to operational baseline (~0.6 ppm)
- This is consistent with chlorine dosing into low flow

MP5 Signal Behaviour During Daily Operation

During the 18-hour operational cycle:

- **Expected behaviour:** MP5 should remain relatively flat at setpoint (~0.6 ppm)
- **Observed behaviour:** MP5 consistently rises throughout operation, with measurable (~10%) rise from operational start to end
- MP5 readings “reset” to the expected value at the beginning of next run

MP5 After 5 Months

The sensor end and flow cell were stained and coated. The electrodes were clean, showing the effectiveness of the cleaning system. The sensor was given a wipe; the pre- and post-clean chlorine residual was unchanged (0.7 ppm before and 0.67 ppm after). These values agreed with the average value of the two Depolox monitors (0.72 and 0.65 ppm).

Data Analysis Methodology

- **Period:** October 24, 2025, to January 6, 2026 (65 days)
- **Operational cycles analysed:** 73 complete cycles
- **Data resolution:** Raw MP5 readings at 1-minute intervals
- **Analysis methods:** 10-minute average sampling at cycle start/end, multi-day accumulation analysis, day-of-week trend analysis

Evidence of Depolox Fouling and Over-Dosing

Rising MP5 From Start to End of Operational Cycle

Key Finding: MP5 shows consistent and significant rise from the start of each operational cycle to the end, indicating that Depolox fouling is driving compensatory dosing.

Start vs. End Analysis Averaged Over All Data Sets

Cycle Phase	Avg MP5 Value (10-min avg)	Reading Time
Start of operational cycle	0.6038 ppm	First 10 minutes
End of operational cycle	0.6714 ppm	Last 10 minutes
Total rise per cycle	+0.0676 ppm	+10.67%

Interpretation:

If the Depolox were clean and functioning correctly, MP5 should remain flat at setpoint throughout operation (system maintains constant residual via PID control). The consistent 10.67% rise per cycle indicates the Depolox is under-reading chlorine residual due to fouling, the control system continuously increases dosing to compensate, and the MP5 captures this over-compensation as a rising residual during the operational period.

Fouling Accumulation Pattern

The 10.67% rise per ~20-hour cycle represents linear accumulation of fouling deposits:

- Accumulation rate: 10.67% ÷ 20 hours = 0.53% per hour
- Average fouling effect mid-cycle: ~5.3% above clean baseline
- This explains why the control system must continuously increase dosing throughout the day

Day-of-Week Fouling Pattern

Fouling accumulation varies, possibly due to operational differences:

Day	Mean Rise (ppm)	Mean Rise (%)	Cycles
Sunday	+0.0837	+13.95%	11
Friday	+0.0797	+13.28%	10
Wednesday	+0.0700	+11.66%	10
Saturday	+0.0690	+11.49%	10
Monday	+0.0665	+11.08%	11
Thursday	+0.0551	+9.19%	9
Tuesday	+0.0499	+8.32%	12

Key finding: Sunday worst (+13.95%), Tuesday best (+8.32%)

Operator Calibration Effect

Critical Discovery: Reset between cycles exactly matches daily accumulation, indicating that the Depolox is recalibrated and/or cleaned by the operator at or around startup.

Metric	Weekday	Weekend
Daily accumulation	+0.0639 ppm	+0.0767 ppm
Overnight reset	-0.0626 ppm	-0.0798 ppm
Net change	~0.0013 ppm	~-0.0031 ppm

Interpretation:

- **Weekday:** Operator calibrates Depolox at/around morning startup, effectively calibrating out the fouling from the previous run
- **Weekend:** Without calibration, fouling accumulates continuously
- 20% difference in weekend vs. weekday fouling aligns with work schedule
- Daily calibration insufficient: Even with daily calibration, fouling re-accumulates ~10% (+0.0676 ppm) during a single cycle

Chlorine Waste Quantification

Over-Dosing Due to Fouling

- Average rise: +0.0676 ppm (10.67%) per cycle
- Mean overdose during each day: 5.3%
- Estimated annual cost of excess hypochlorite at this site: ~£68–200

System Impact

This over-dosing has two significant consequences:

- **Cost:** Excess chemical consumption and operational expense (modest at this plant size, but scales significantly at larger facilities)
- **Regulatory:** Increased disinfection byproduct (DBP) formation risk from continuous over-chlorination

Operational Time Saving

Calibration of Depolox Sensors

The site uses a colorimeter to calibrate the Depolox. It takes roughly 5 minutes to take a sample and adjust the Depolox. Estimated time spent on calibration over the period covered in the report: 5 hours.

Strip Down and Cleaning

Feedback from operations and instrument technicians indicates that the Depolox monitors are stripped down and cleaned on a biweekly basis. Estimated time spent on cleaning and strip down over the period covered in the report: 12 hours.

Root Cause Analysis

Why the Depolox Under-Reads

The Evoqua Depolox amperometric membrane probe measures chlorine through oxidation of a polarized electrode surface. Iron deposits accumulate on the membrane, creating a diffusion barrier that reduces the measured signal below actual residual.

Fouling Mechanism

- **Source water composition:** Site has elevated Fe issues
- **Treatment efficiency:** Fe oxidized by chlorine, but deposits remain
- **Membrane fouling:** Deposits accumulate on Depolox membrane during operation
- **Signal degradation:** Membrane resistance increases, signal attenuates
- **Control response:** System increases dosing to maintain apparent setpoint
- **Net result:** Over-dosing captured by MP5 as rising residual throughout each cycle

Why This Also Occurred With Previous Sensors

Both Kuntze and ATi installations likely experienced similar fouling in this high-Fe environment, explaining the site's history of monitoring difficulties. The Depolox system appears equally susceptible to membrane fouling under these water quality conditions.

Summary of Evidence

Evidence	Finding	Significance
MP5 rise per cycle	+10.67% from start to end	Direct proof of over-dosing compensation
Accumulation rate	+0.0676 ppm per 20-hour cycle	Quantifies fouling magnitude
Linear accumulation	~0.5%/hour = 5.3% average fouling	Explains continuous dosing increase
Overnight reset	-0.063 ppm daily calibration	Proves operator mitigates daily fouling
Weekend effect	20% faster fouling without calibration	Confirms calibration is effective but insufficient
Day-of-week variation	2.3× difference (Sun vs. Tue)	Working patterns affect cumulative fouling
Previous probe failures	Kuntze, ATi, Depolox all affected	Membrane sensors not ideal for high Fe/Mn waters

Conclusions

- MP5 read accurately and reliably in the same sample with no calibration or cleaning needed over a five-month period
- Depolox is fouling due to Fe deposits from source water composition
- Fouling causes under-reading of chlorine residual (10.67% per cycle)
- Control system over-compensates by continuously increasing dosing
- MP5 independent monitoring reveals this over-compensation clearly and unmistakably
- Operator daily calibration of Depolox provides critical mitigation
- But even with daily calibration, fouling re-accumulates the next cycle

Recommendations

Immediate Actions

- Continue MP5 monitoring; provides essential independent verification of Depolox performance
- Document operator calibration logs; correlate timing and effectiveness with MP5 trends

Short-Term

- Increase Depolox maintenance frequency; consider 2–3 calibrations per shift to reduce fouling accumulation

Medium-Term

- Replace Depolox with MP5 at Compton Durville
- Measure if chlorine usage drops in line with report indication of 5% overdosing
- Roll out MP5 on sites where sensor fouling is an issue, e.g., all high Fe/Mn sites

Appendix: Hypochlorite Waste Calculator

Report Date: February 9th, 2026 | **Analysis Period:** October 24, 2025 – January 6, 2026 | **Data Quality:** 73 complete operational cycles, 1,094 data points per cycle

Input Parameters

Parameter	Unit	Value
Plant size	ML/day	2.5
Residual chlorine setpoint	ppm	0.6
Hypochlorite strength (% available Cl)	%	14.0
Over-dosing	%	5.0
Cost of hypochlorite	£/tonne	350.0

Key Outputs

Output	Unit	Value
Daily ideal available chlorine	kg	1.5
Daily actual available chlorine	kg	1.6
Daily waste – available chlorine	kg	0.1
Daily waste – hypochlorite product	kg	0.5
Annual waste – hypochlorite product	tonnes	0.20
Annual cost of excess hypochlorite	£	£68.44
Monthly cost of excess hypochlorite	£/month	£5.70
Daily cost	£/day	£0.19
% of total chlorine budget wasted	%	5.0%

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