The Future of Compressed Air Control

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Air Compressor Controls Mandates

Protect the compressor

Deliver required pressure / flow

Minimize energy use

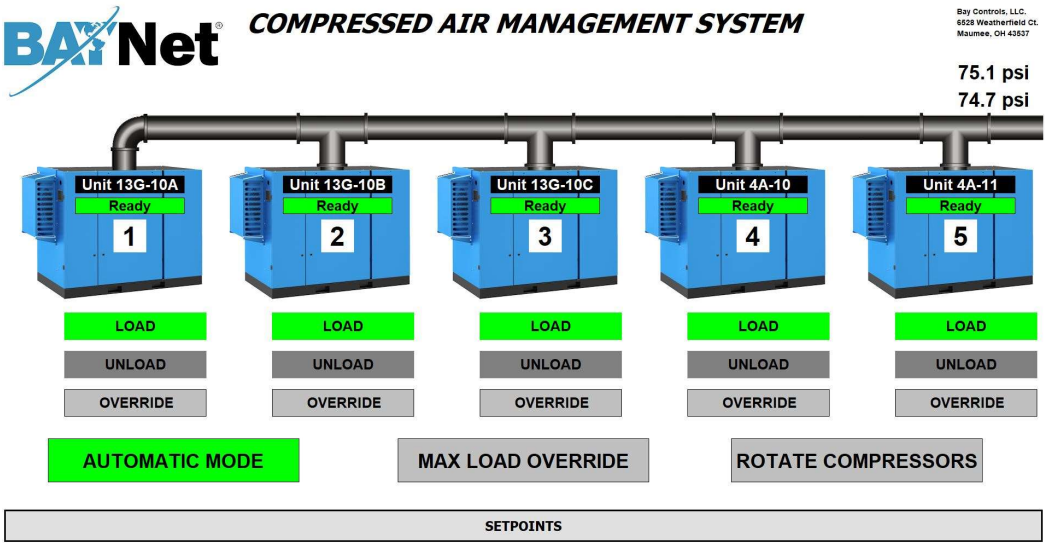
Air Compressor Controls Overview and Comparison…

What's Out There Now

Features / Capabilities	OEM	PLC Standalone	PLC Piggyback	Purpose Built
Universal Compatibility	No	Yes	Yes	Yes
Multi-Compressor Control	Sometimes	No	Yes	Yes
Hardware	Proprietary	Open	Open	Proprietary
Software	Proprietary	Proprietary	Proprietary	Proprietary
Monitoring	Yes	Yes	Yes	Yes

What's Working in the Industry

- **Machine protection**
- **Pressure regulation** (single-compressor)
- **Multi-compressor control** (when it's implemented)



Areas for Improvement

- Multi-compressor control (stranded assets)
- System pressure regulation
- Pressure set backs (during production and non-production)
- Auto start / stop
- Data-driven operation and maintenance

Where Do We Go From Here?

- Increased automation: start/stop, surge testing/tuning, pressure set backs, etc.
- Improved / integrated compressor performance benchmarking
- Performance-based maintenance via reminders and/or performance thresholds
- Demand-side integration and optimization

Automation: Let the Machines Do Their Jobs

Performance Capabilities for the Next Generation of Controls

- Automated valve characterization and tuning
- Automated (semi-automated) surge tuning
- Adaptive schedules and pressure set backs

Benchmarking:

How is Your Compressor / System REALLY Performing?

Making compressed air system data more **actionable**

- Adding context to monitoring data: how does the performance compare to:
  - Historical performance
  - Industry standards
  - Rated performance
  - Sister sites/plants
- Quantify the benefits / potential savings from improvement

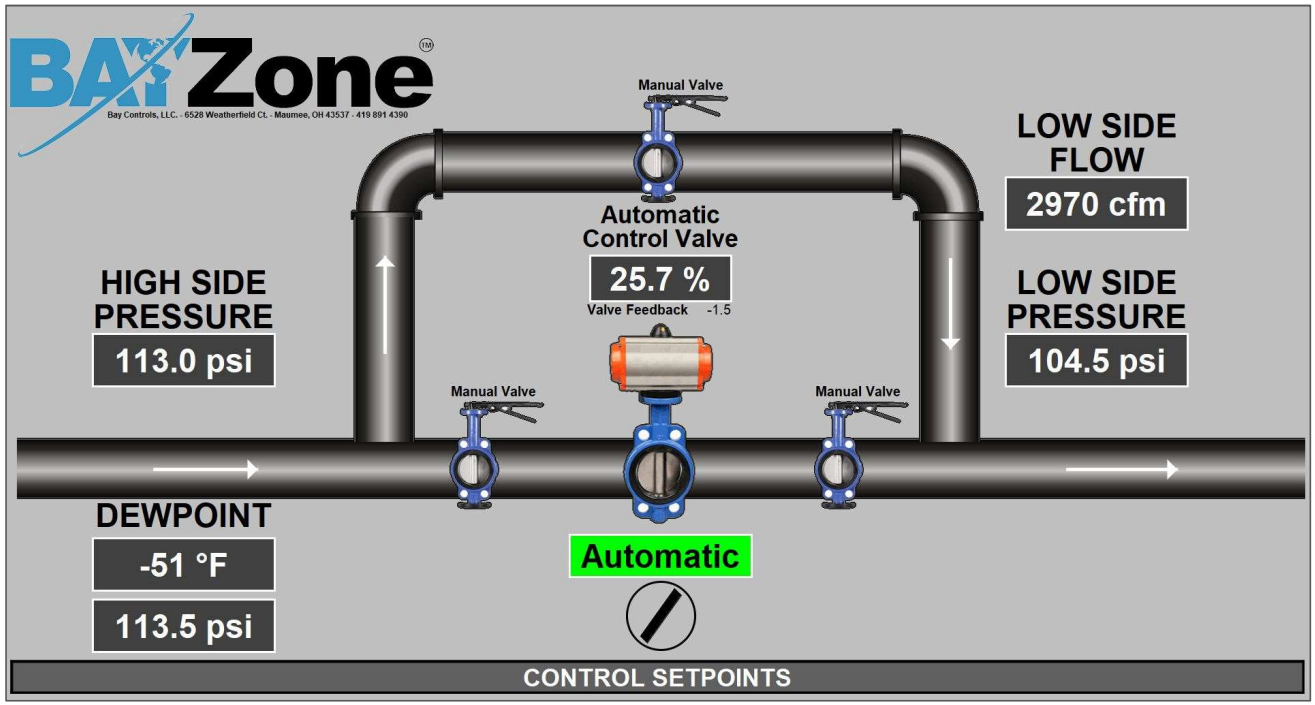
Performance-Based Maintenance and Overhauls

Surge Test Type	Design		11/25/2011		3/1/2014		7/6/2019		Deviation to Design%
	Pressure	kW/Amps	Pressure	kW/Amps	Pressure	kW/Amps	Pressure	kW/Amps	
Natural Test	165	105	161	106	155	104	141	101	13.2%
High Pressure Test	120	85	121	87	119	90	120	94	11.1%
Operating Pressure Test	100	70	101	72	103	78	100	78	11.4%
Low Pressure Test	80	55	81	57	78	58	80	62	12.7%

- Utilize existing instrumentation (avg. Bay-controlled centrifugal has 45-50 monitoring points)
- Compressor efficiency/performance:
  - Stage compression ratio (current vs. design)
  - Surge test history
- Automated, performance-based alerting based on design and industry standards for various compressor components
  - Inlet filters
  - Intercoolers and aftercoolers
  - Bearings

Demand-Side Integration and Optimization

- Divide demand side into distinct pressure zones based on end-use requirements (as appropriate)
- Control zoning valves independently based on production schedules / air requirements



Savings Potential: 15-30%

HP End Use: 105 psi (45%)
LP End Use: 89 psi (55%)

How Do We Take the Next Steps?

- Keep it simple (UI and automation)
- Show, don't tell (UI and presentation of data)
- Make best practices the default (auto stop/setback)
- Ensure controls failure ≠ production failure (redundancy and expected failure modes)

Questions and Contact Information

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