Control Strategy Integration

Implementation at Kalamazoo Water Reclamation Plant

Outline

- Operations & Process Control Cooperation
- Control Strategy Implementation Examples
- Aeration System Control Strategy

Operations & Process Control Cooperation

Operations & Process Control Cooperation

Benefits

- Better Operations Sequences
- Increased Understanding
- Accurate Information

Value of Accurate Process Information

Composition

- Timely Decisions
- Effectiveness of Treatment
- Loading to Process

Value of Accurate Process Information

Level

Pressure

Temperature

Flow

- Flow-pacing
- Smooth Treatment Transitions
- Automate Processes

Control Strategy Implementation Examples

Primary Pumping Integration

Automated Influent Pumping

- Full Flow Range by Empirical Testing
- Negative Deadband Benefits

Secondary Loading Integration

COD/BOD Analyzer

- ***Correlate Demand***
- ***BOD & COD Flexibility***

Secondary Phosphorus Loading Integration

PE Soluble Phosphorus Analyzer

- ***Know Phosphorus Loading Now***
- ***Timing Ferric Dosing Better***
- ***Potential to Know Nutrient Balance Now***

Secondary Phosphorus Removal Integration

ML Soluble Phosphorus Analyzer

- ***Treatment Effectiveness***
- ***Timing***

TE Soluble Phosphorus Analyzer

- ***Know Actual Discharge***
- ***Correlate***

Secondary Ammonia Removal Integration

ML Ammonia Analyzer

- ***Treatment Effectiveness***

TE Ammonia Analyzer

- ***Daily Maximums Permit***

TE Nitrate Analyzer

- ***Degree of nitrification***

Tertiary Disinfection Integration

Disinfection

- ***Flow-paced Hypochlorite Dosing***
- ***Creative Flow Programming***
- ***Residual Chlorine Analyzers***

Tertiary Dechlorination Integration

Sodium Bisulfite Dechlorination

- ***Flow-paced Bisulfite Dosing***
- ***Dosing Flexibility***
- ***Travel Time Coordination***

Belt Press Sludge Feed Integration

Thickened Solids Pumping

- ***Pump Assignment Flexibility***
- ***Phosphorus Nutrient Balance***
- ***Co-Mingled Sludge Ratio***

Aeration System Control Strategy

Aeration System Changed

Upgrade to BNR in 2011

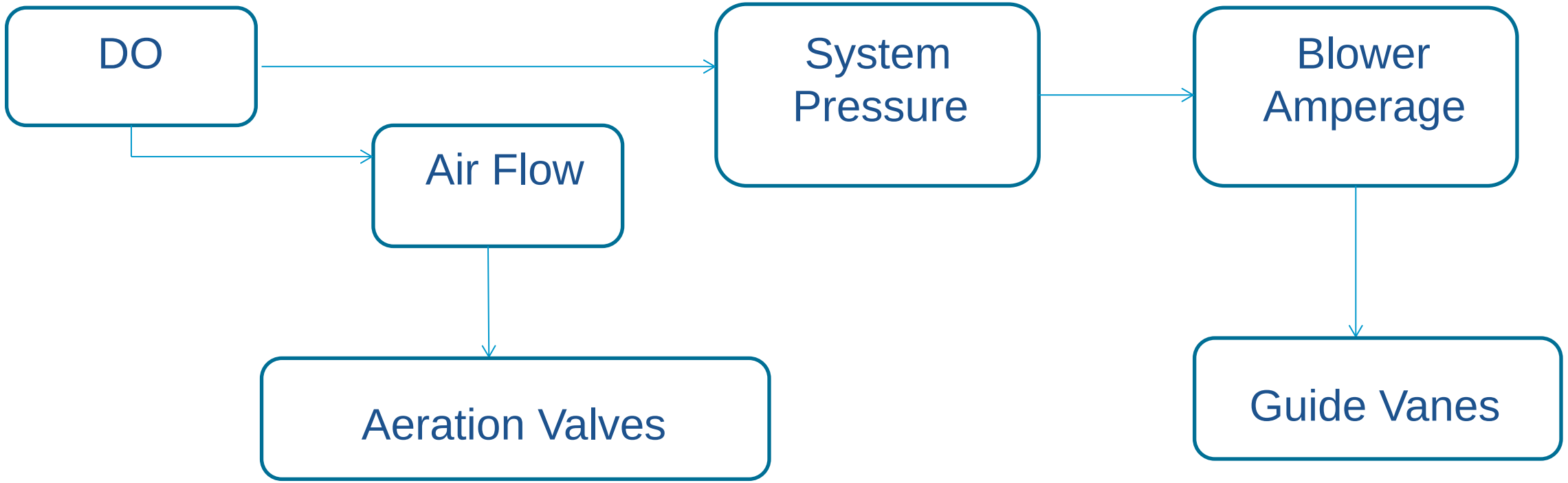
- Fine bubble diffusers
- Anaerobic, anoxic, aerobic zones
- Replaced 2 of four 2500 HP blowers with two 1350 HP blowers.

- Cascade control already embedded in the control strategy.
- Opportunity to learn new control strategies and understand better what we already we using.

Aeration Control Integration

Control Challenges

Cascade Control Challenges



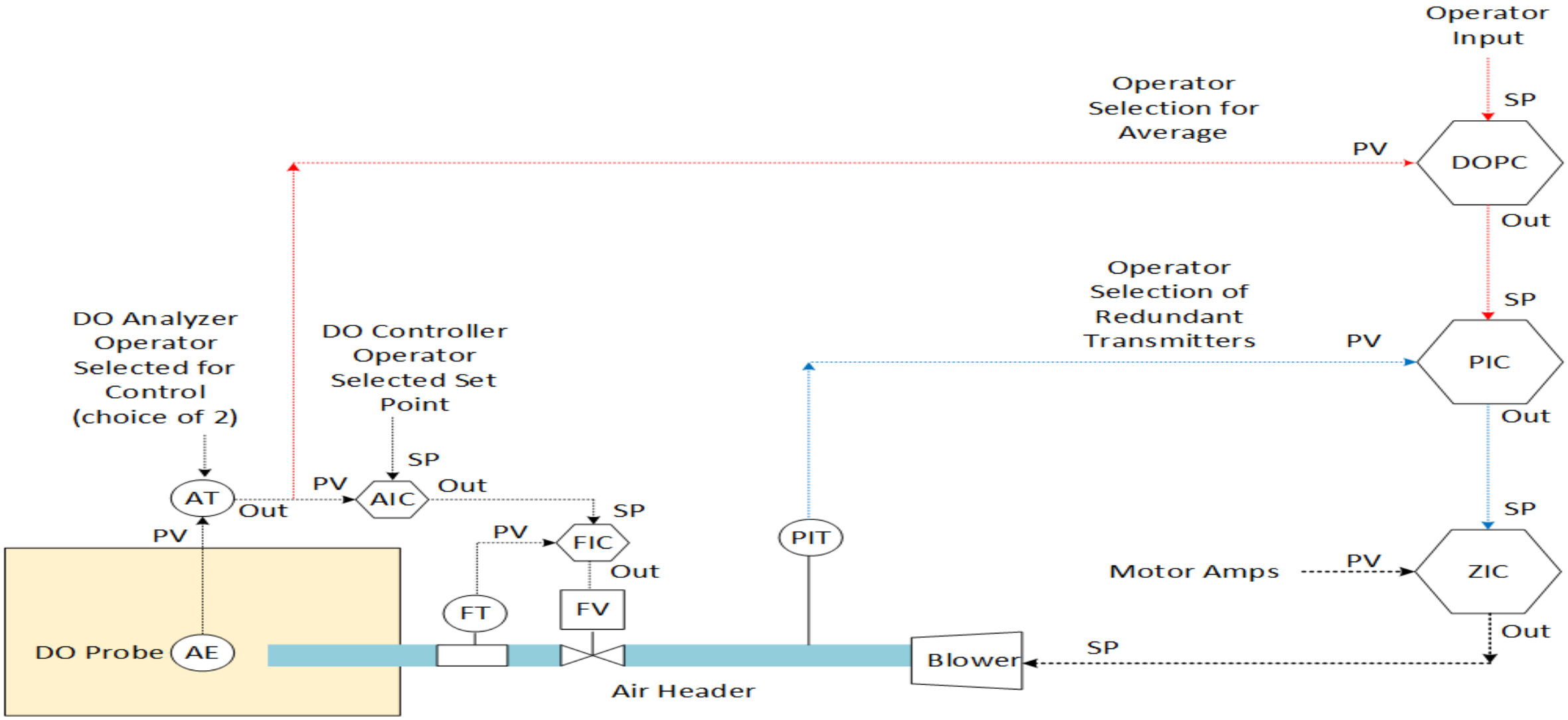
Cascade Control Principles

Understand Timing

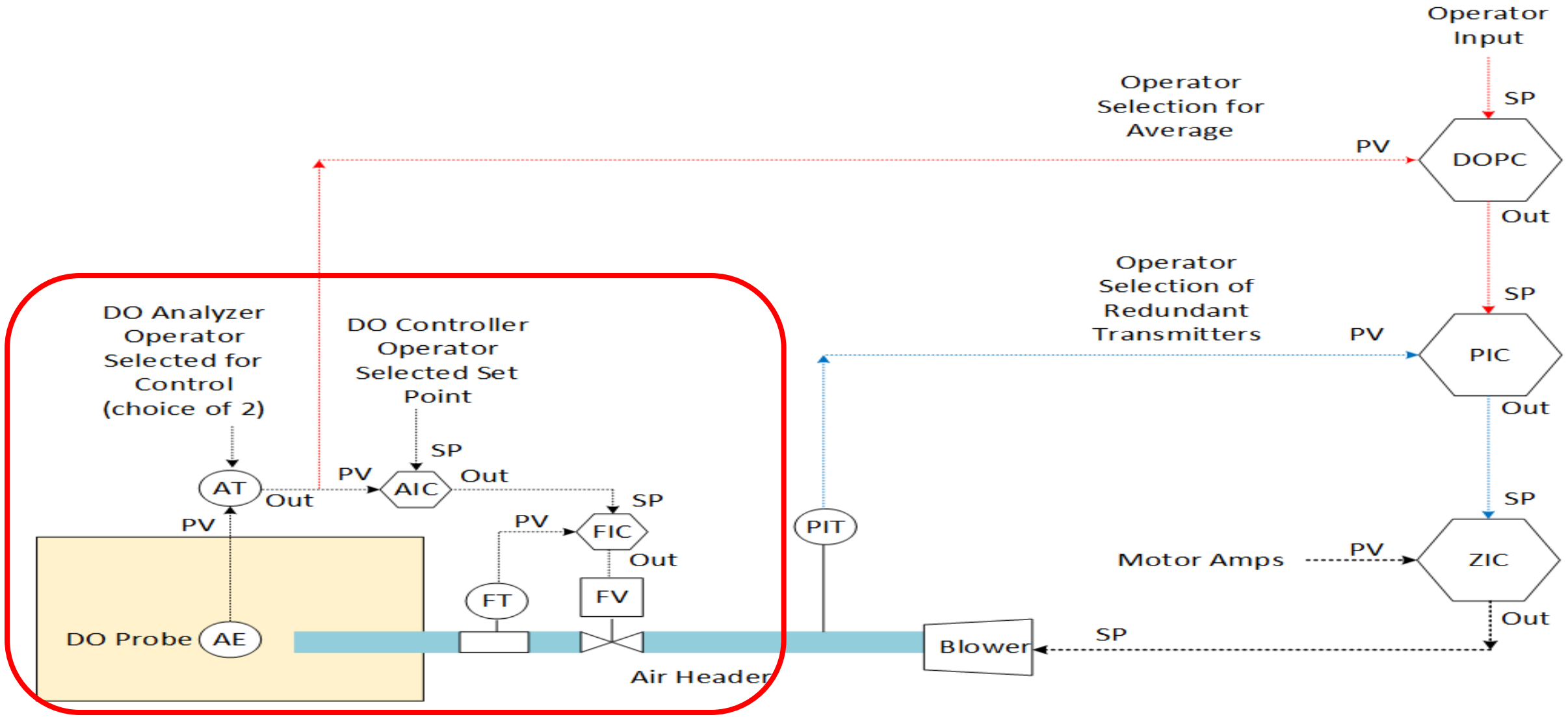
- Controller driving the set point

⟹ at least 3X faster than receiving set point

Basic Aeration Control

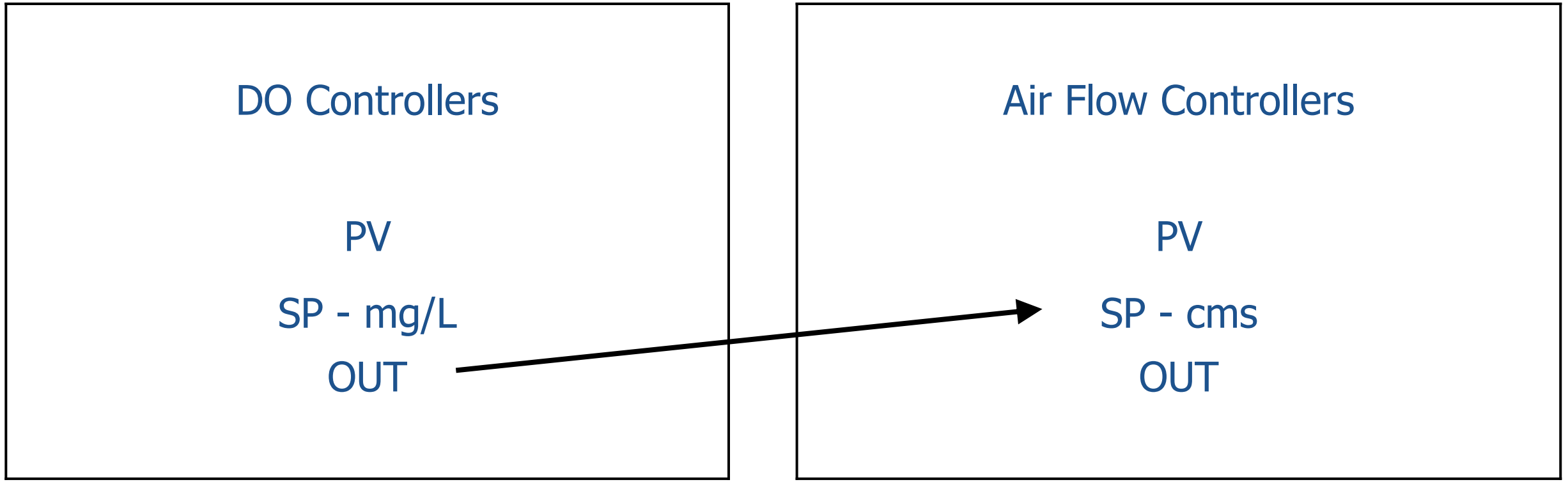


DO and Air Flow Control



DO Probe

DO Control Loop



requests air needed

sets air flow set point

↕ air valves

changes system pressure

DO Controller Optimization

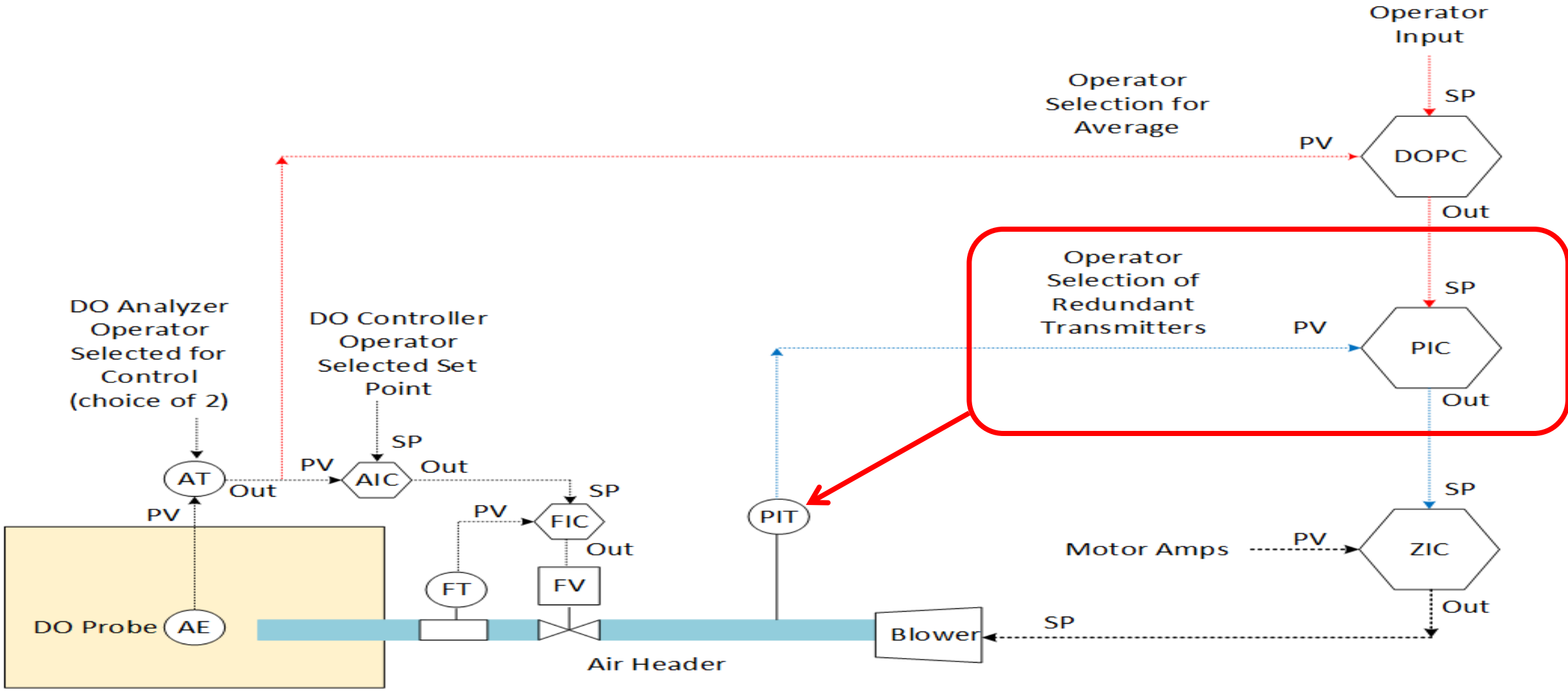
- ***Select Probe for Control Option*** - select front **or** back DO probe to be used to control output to air flow controller.
- ***Output Rate of Change*** - set gain, reset time, and control zone for speed of output to air flow controller.
- ***Output Range*** - set high/low air flow range to avoid controller wind up or wind down.
- ***Timing*** - set output ranges based on demand.

Air Flow Controller

Air Flow Controller Optimization

- ***Output Rate of Change*** - set gain, reset time, and control zone for speed of output to aeration control valve.
- ***Output Range*** - set high/low valve travel range to avoid controller wind up or wind down.
- ***Timing*** - set output ranges based on demand.

Aeration Pressure Control

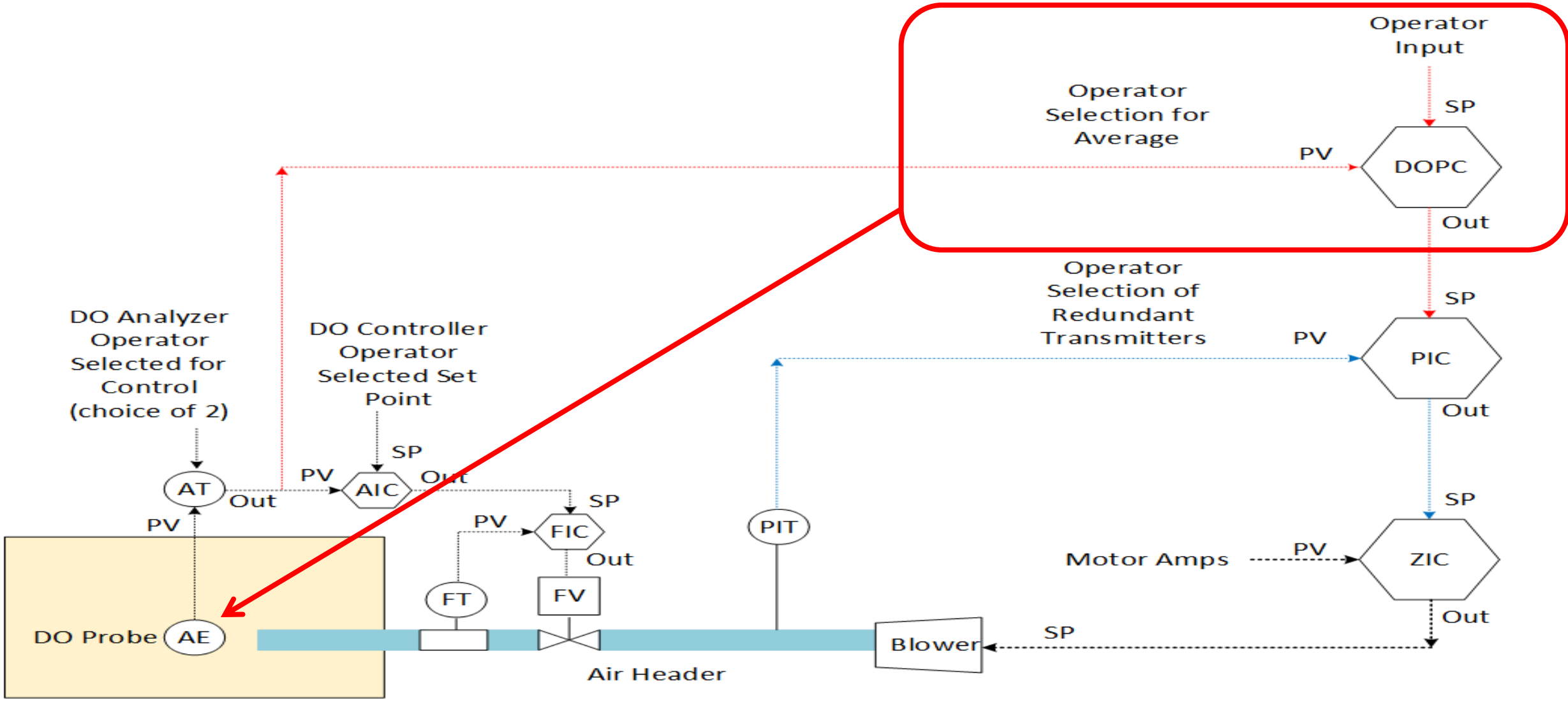


Aeration System Pressure Sensor

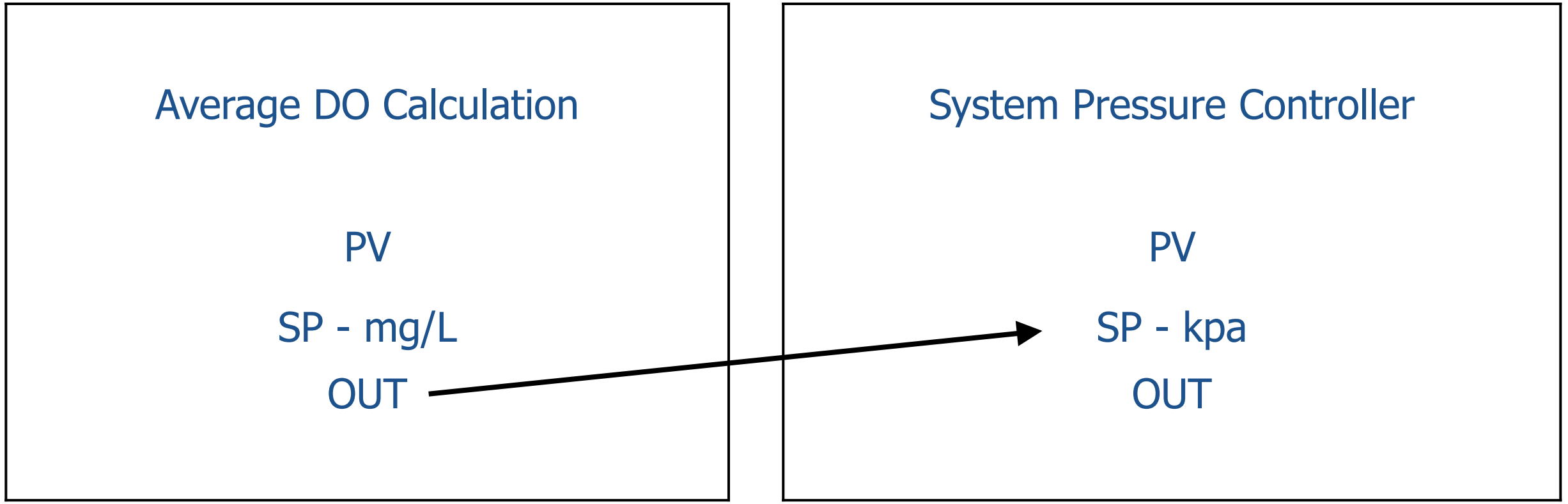
Pressure Sensor Influences

- ***Aeration valve position***
- ***Number of blowers in service***
- ***Blower guide vane positions***

Aeration Pressure Control



Pressure Control Loop



Requests pressure needed

to increase or decrease air.

Sets pressure set point within selected pressure range.

DO Average Calculation Options

- Calculate an average DO based on front end DO probes.
- Option given to select front end or back end DO probe for the average calculation.
- Flexibility for supervisor to influence blower air output.

Average DO Control Flexibility

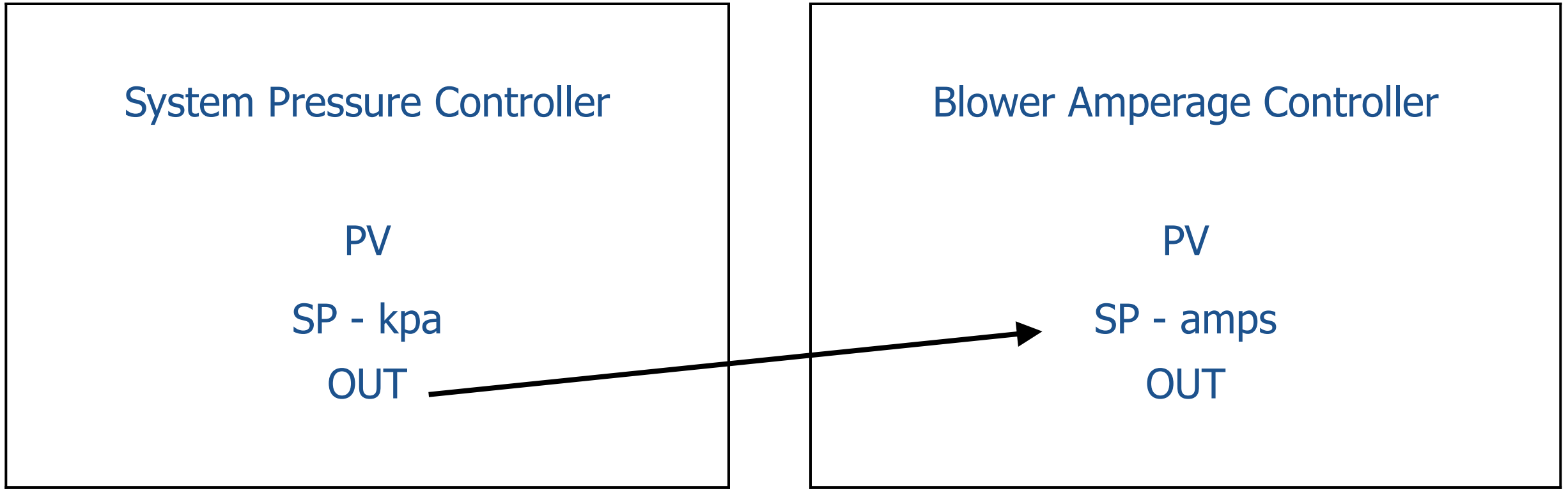
Individual Aeration Tanks		
	Front DO	Back DO
	mg/L	mg/L
Aer 3	3.6	4.5
Aer 4	3.6	4.0
Aer 5	3.8	**2.0**
Aer 6	3.9	**2.2**
Aer 7	3.2	3.4
Aer 8	3.3	3.2
Aer 9	3.1	2.6
Avg	**3.5**	
SP	**3.2**	

Average DO Calculation		
	Front DO	Selected DO
	mg/L	mg/L
Aer 3	3.6	3.6
Aer 4	3.6	3.6
Aer 5	3.8	**2.0**
Aer 6	3.6	**2.2**
Aer 7	3.2	3.2
Aer 8	3.3	3.3
Aer 9	3.1	3.1
Avg PV	**3.5**	**3.0**
Avg SP	3.2	3.2
Output to Pressure Controller	**decrease**	**increase**

Pressure Control Optimization

- ***Adjustable Average DO Calculation*** – creates pressure setpoint within adjustable 5 kpa range.
- ***Output Rate of Change***
- ***Output Range***
- ***Pressure Relief Feature*** – reduces pressure setpoint if high alarm reached.
- ***Timing*** - set output ranges based on demand. Supervisor able to make manual changes to increase rate if needed.

Blower Amperage Control



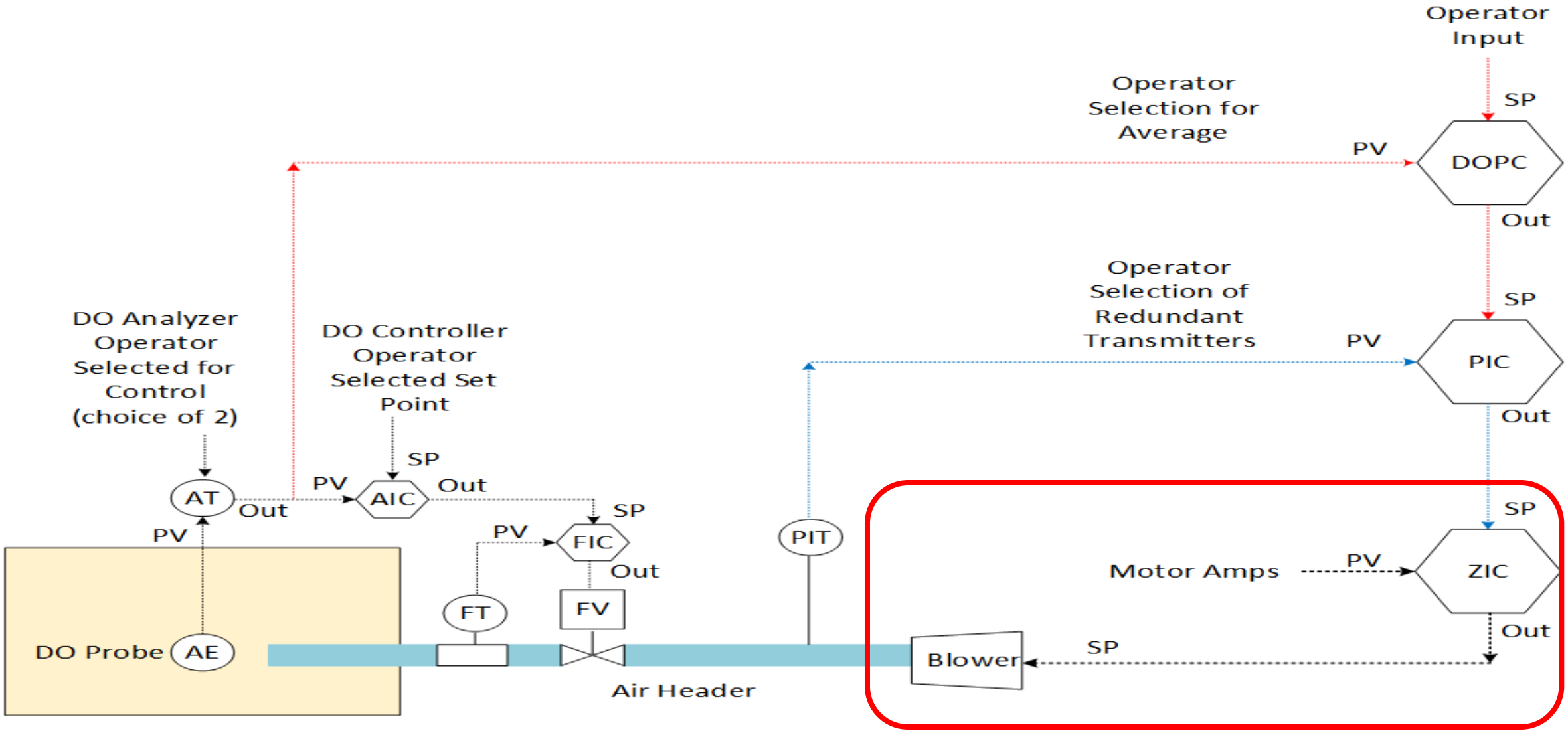
Requests blower amperage needed to increase or decrease blower air output.

Sets amperage set point within selected range. Output sent to guide vanes.

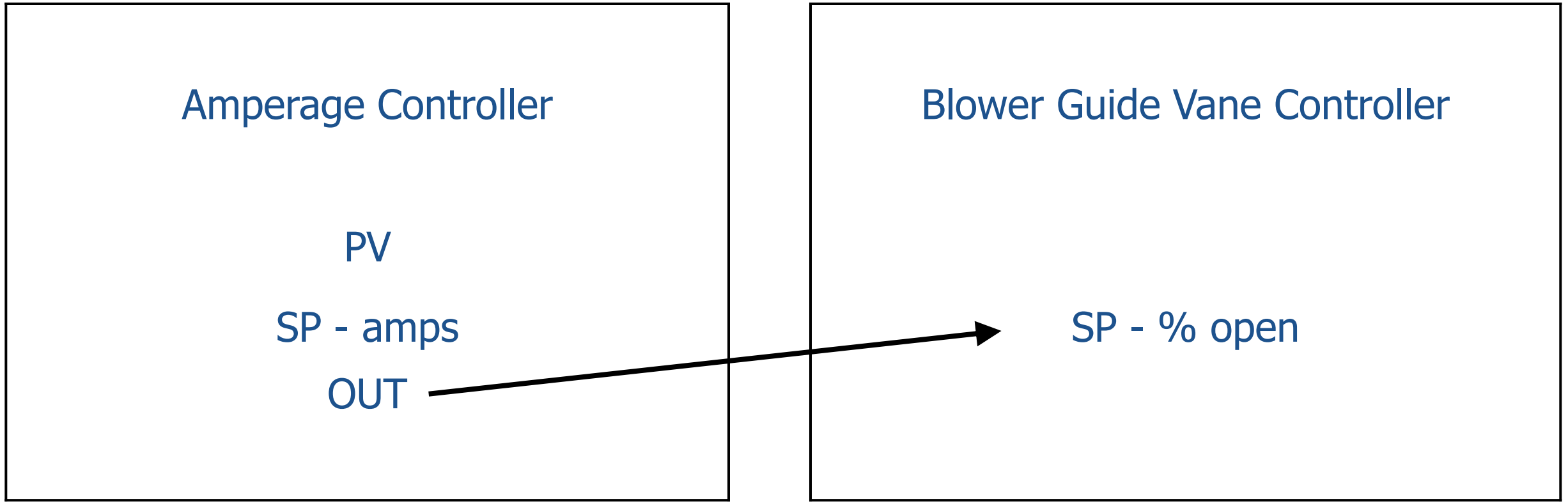
2500 HP Blowers

1350 HP Blowers

Basic Aeration Control



Guide Vane Control



Requests guide vane change

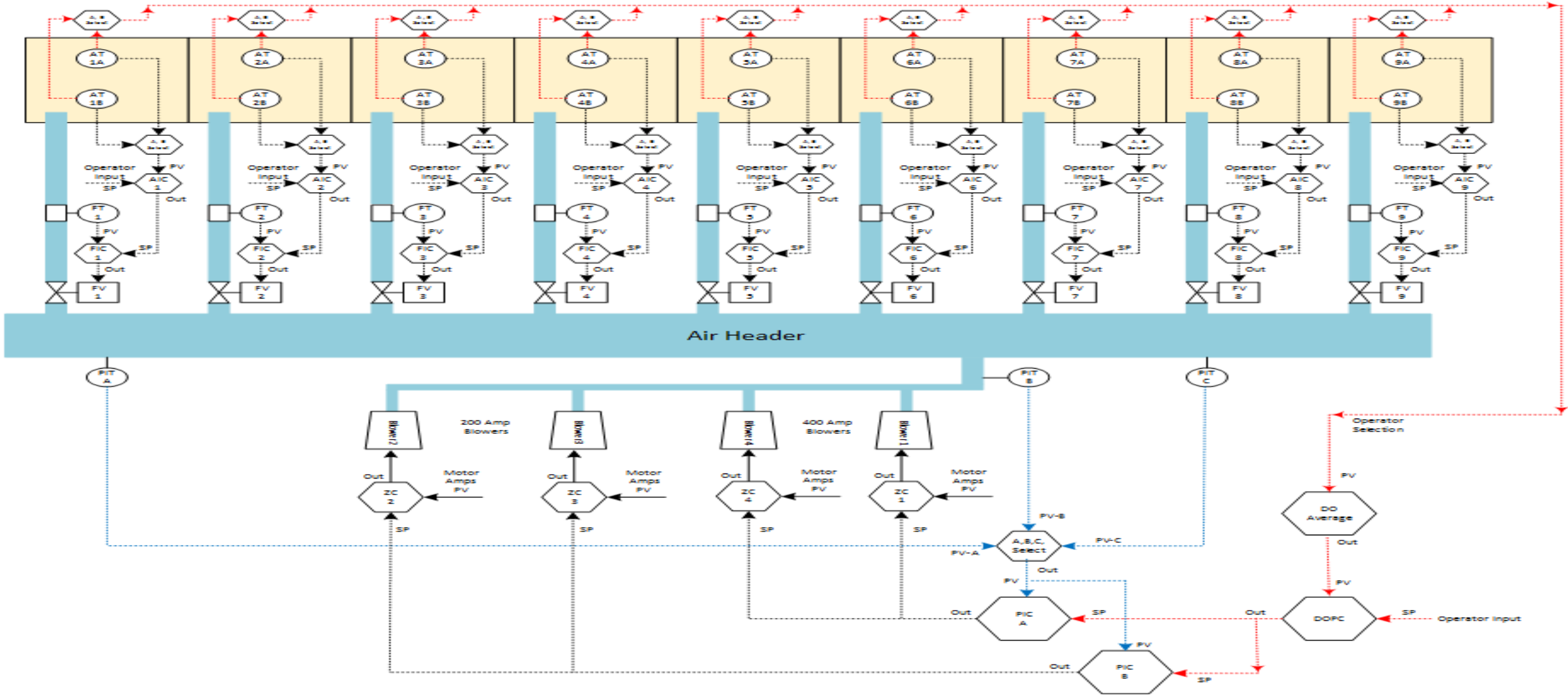
to increase or decrease air.

Adjusts guide vanes according to manufacturer specifications.

Blower Guide Vane Control Challenges

- Two different blower sizes.
- Two different guide vane controls.
- Work with manufacturer to optimize performance.

Aeration Control Configuration



Thanks for Listening.

Questions?