

# Compressor Automation in Midstream-Gathering

Why Automate Gathering Units?

What are the Benefits?

What are the Costs?

How to Measure Success

# Overview

- Introduction & Overview
  - Dominion Resources
    - Dominion Energy
      - Dominion Transmission – G&P
- Why Automate Gathering Units?
- What are the Benefits?
- What are the Costs?
- How to Measure Success
- Summary of Results

# Dominion Resources, Inc.

- energy producer and transporter
- 27,600 megawatts of generation
- 12,000 miles of natural gas transmission, gathering and storage pipeline
- 6,000 miles of electric transmission lines
- 942 billion cubic feet of storage capacity
- retail energy customers in 13 states
- Corporate headquarters: Richmond, VA
- NYSE: D ([www.dom.com](http://www.dom.com))

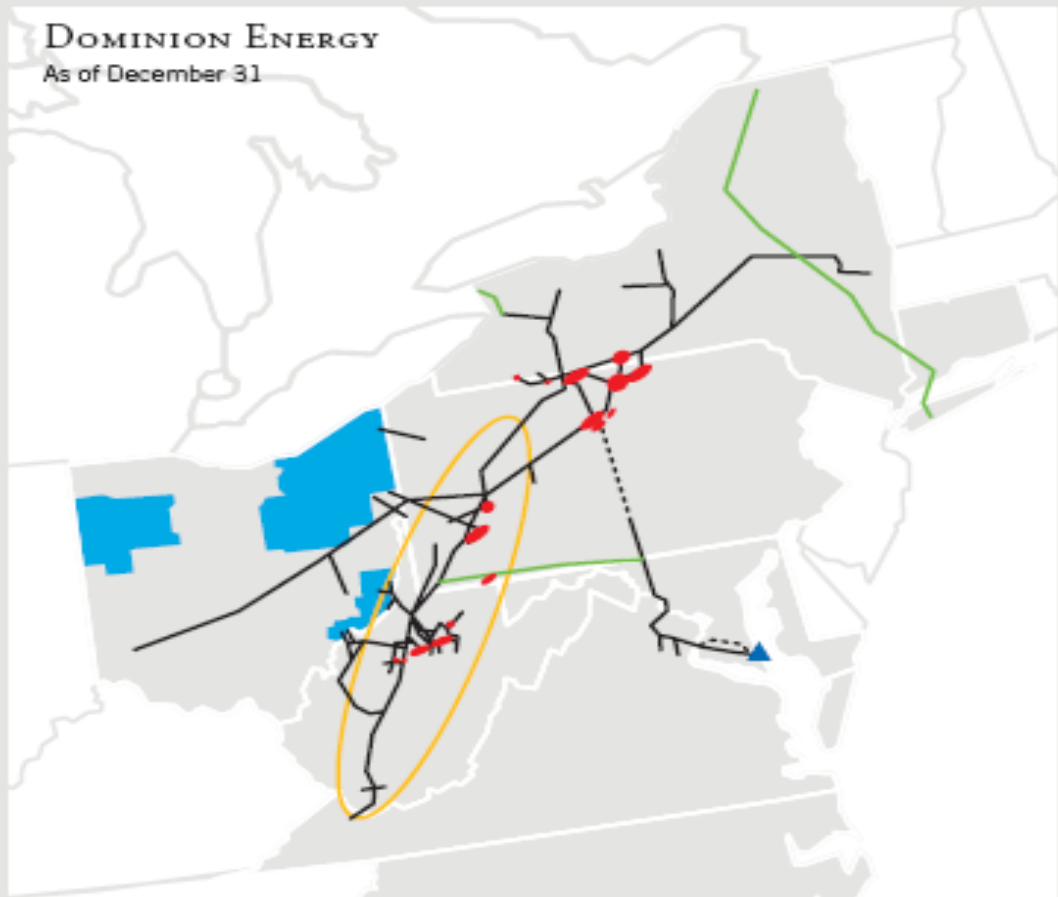


# Dominion Energy

- Natural Gas Transmission
- Natural Gas Distribution
- Natural Gas Storage
- Producer Services
- LNG Operations
- Operations in Ohio, Pennsylvania, West Virginia, Virginia, Maryland and New York.

# DOMINION ENERGY

As of December 31

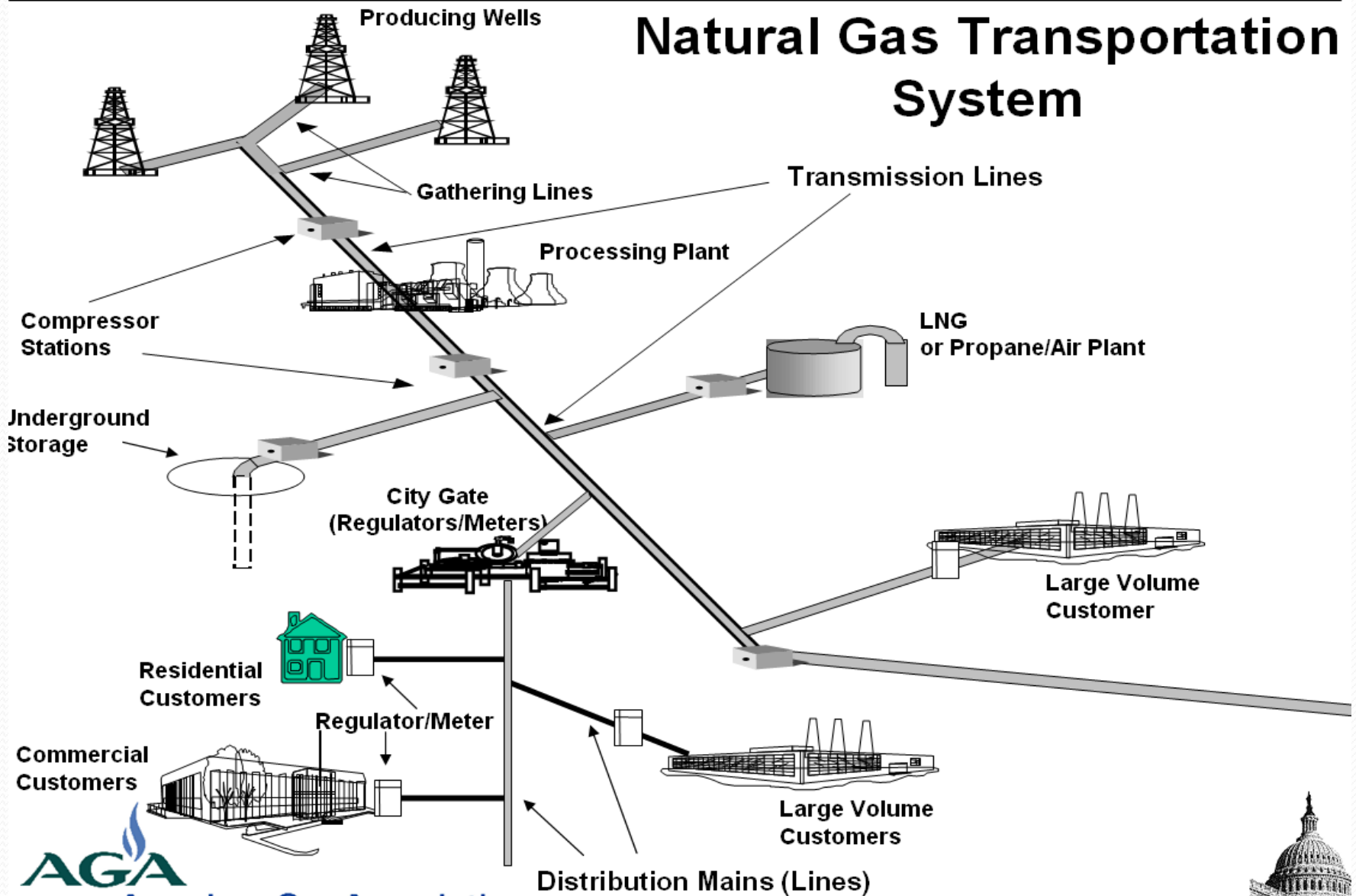


- Natural Gas Transmission Pipelines
- Cove Point expansion pipeline — completion planned in 2008.
- Natural Gas Transmission Pipelines (Partnership)
- Natural Gas Underground Storage Pools
- ▲ Cove Point LNG Facility
- Regulated Natural Gas Distribution (OH)
- E&P Producing Area



**Dominion**

# Natural Gas Transportation System



# Why Automate Gathering Units?

## Statement of the Problem

- Unmanned Gathering Stations Run 24/7
- Objective - Avoid Shutdowns – Reduce Engine Load
  - Maximize Throughput
  - Minimize Callouts & Overtime
- Operators Set Load to 75%-85%
- Guaranteed Loss of 15%-25% of Throughput

# What are the Benefits?

## Proposed Problem Solution

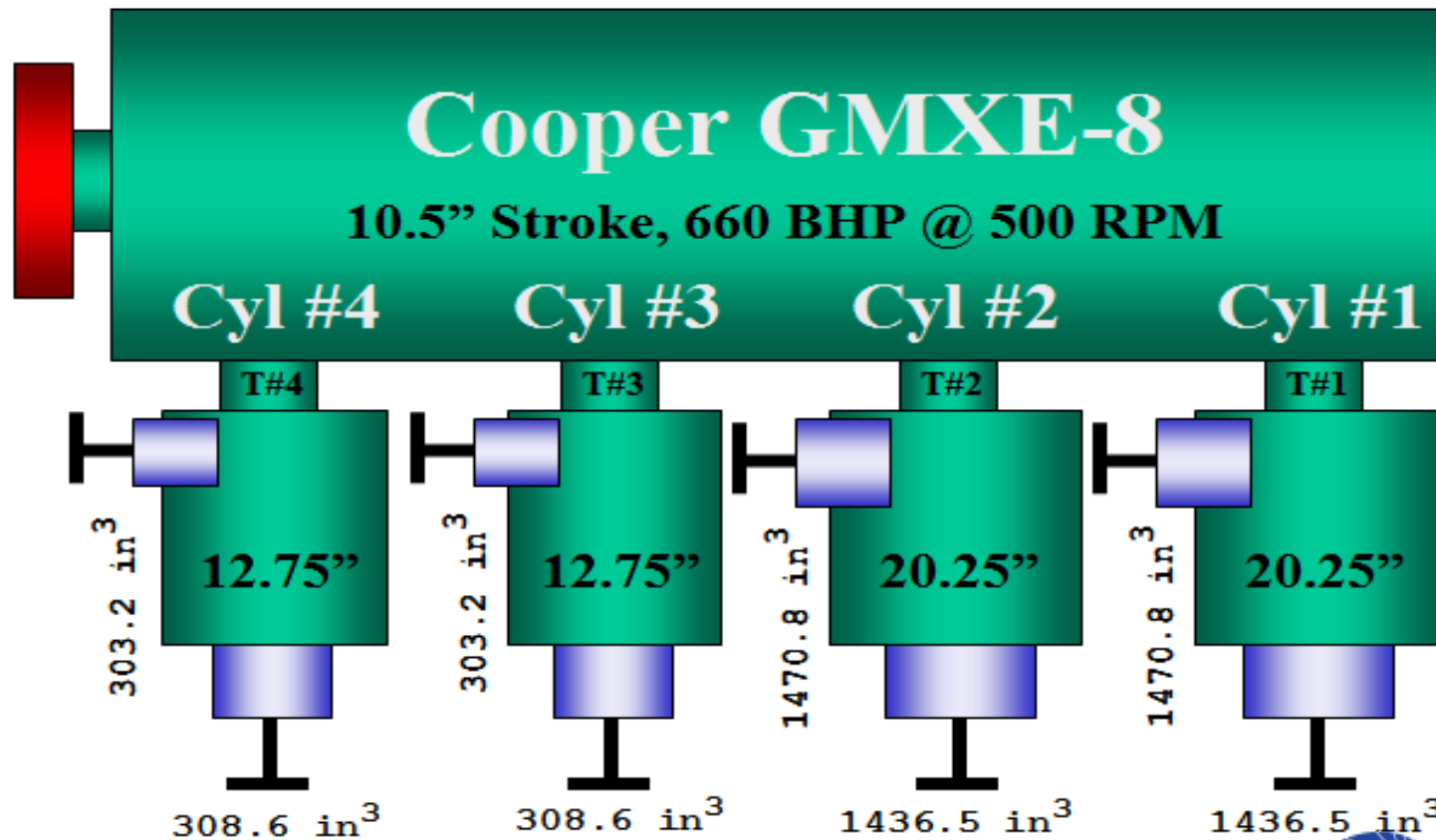
- Automate Compressor Loading
  - Maximize Loading & Therefore Throughput
  - React to Pressure Disturbances Automatically
    - Ball Passage
    - Other Stations Experiencing Shutdowns
  - Minimize Shutdowns
  - Reduce Unplanned Maintenance
    - No Overloading
    - Automatic Temperature Controls

# What are the Costs?

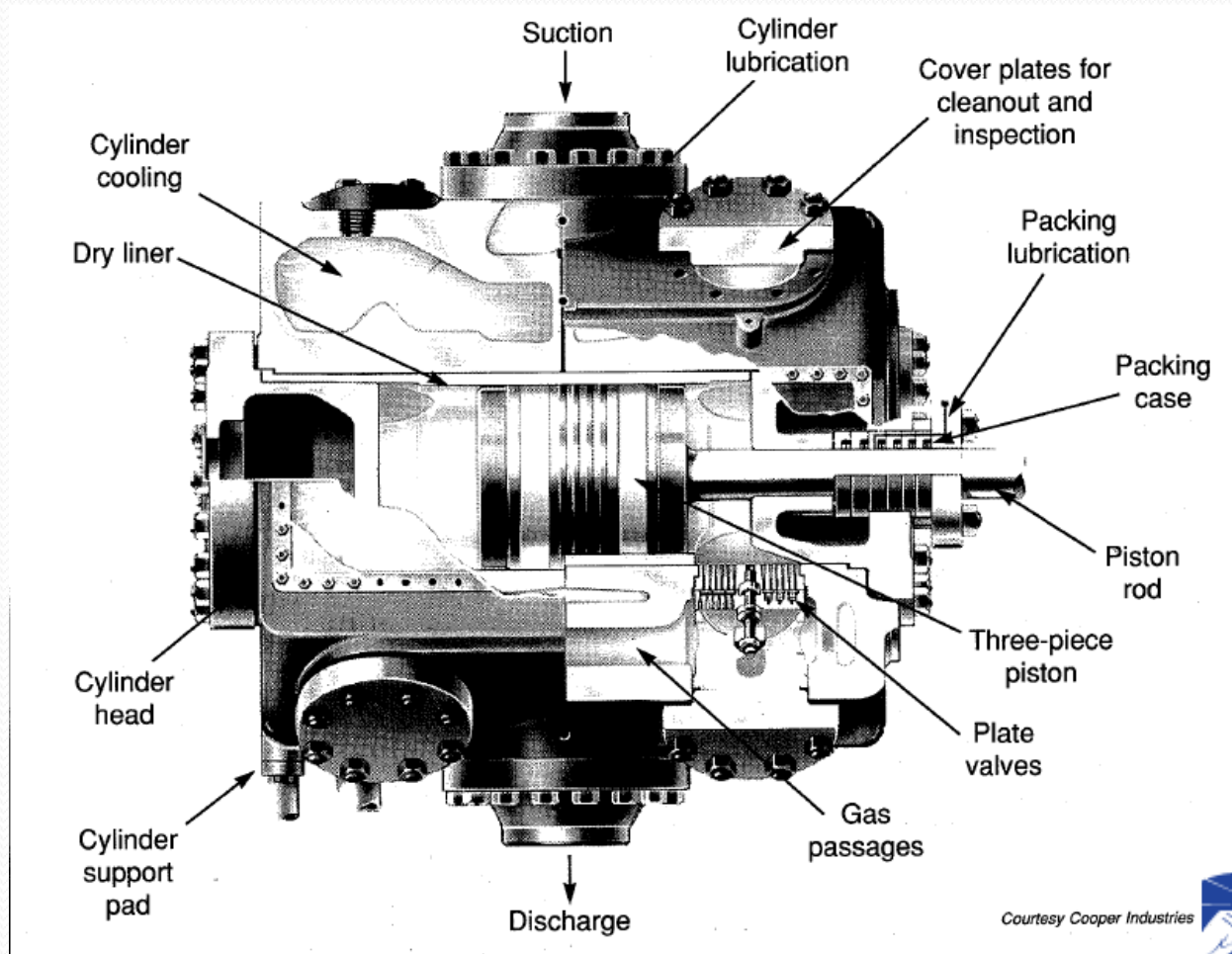
## Solution Requirements

- Replace Manual Controls with Pneumatic Actuators
- Pneumatic Pockets Require More Station Air
- Required Increased Electrical Service
- Backup Generators Required for More Air
- Control System Required
  - Load Prediction & Control
  - Speed Control
  - Temperature Control
  - Remote Monitoring & Reporting

# Example Compressor Unit



# Double-Acting Piston Cylinder



Courtesy Cooper Industries



**Dominion**

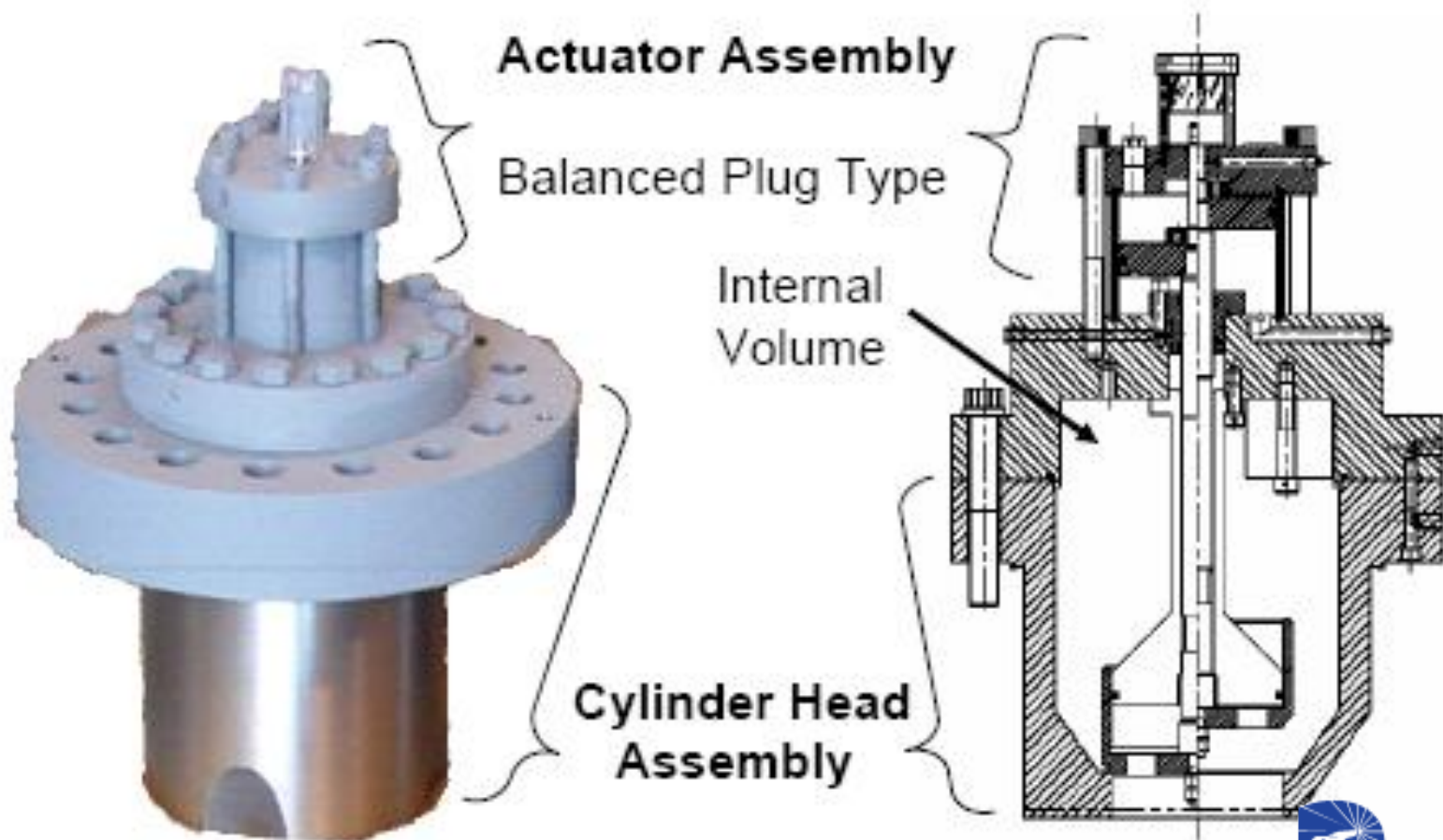
# Head-End Pockets – Manual vs. Automated



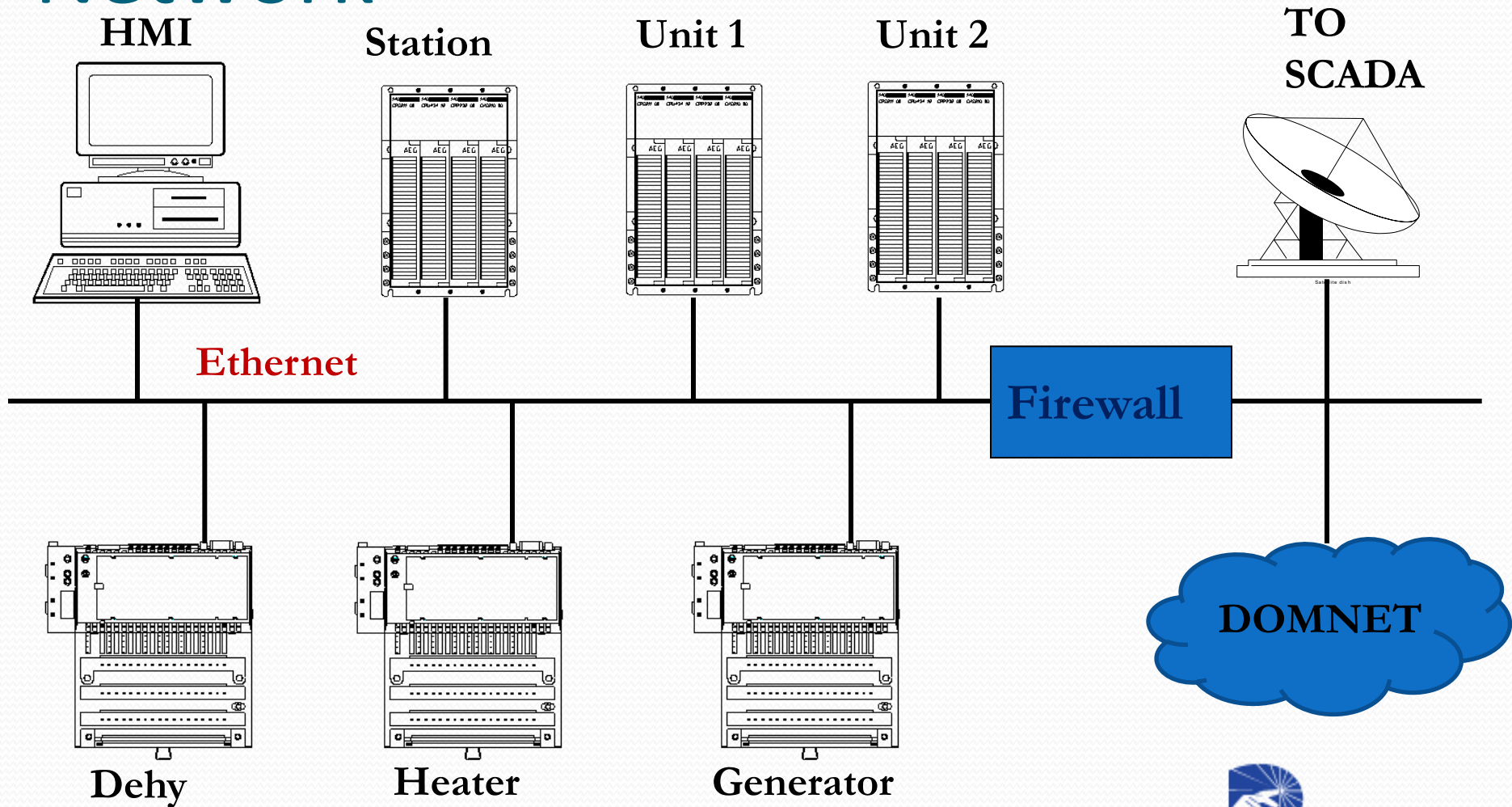
# Low-Stage HE Pocket Close-up - Manual vs. Automated



# Pneumatic Actuator

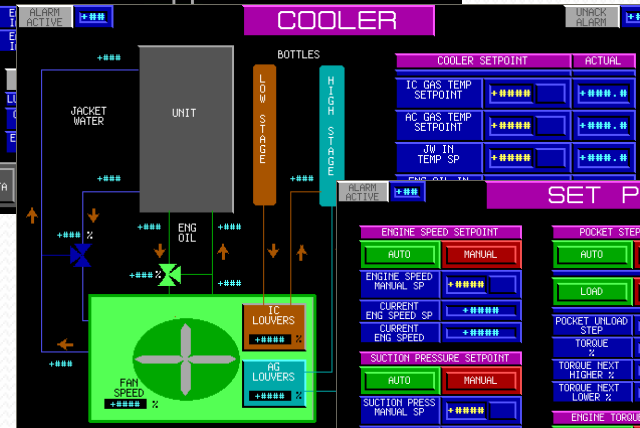
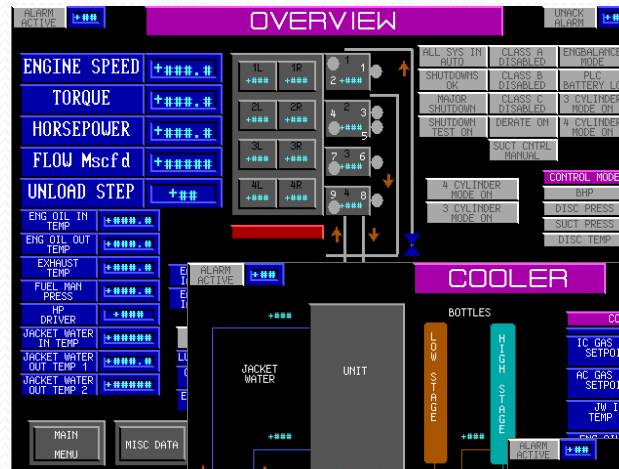


# Typical Compressor Station Control Network

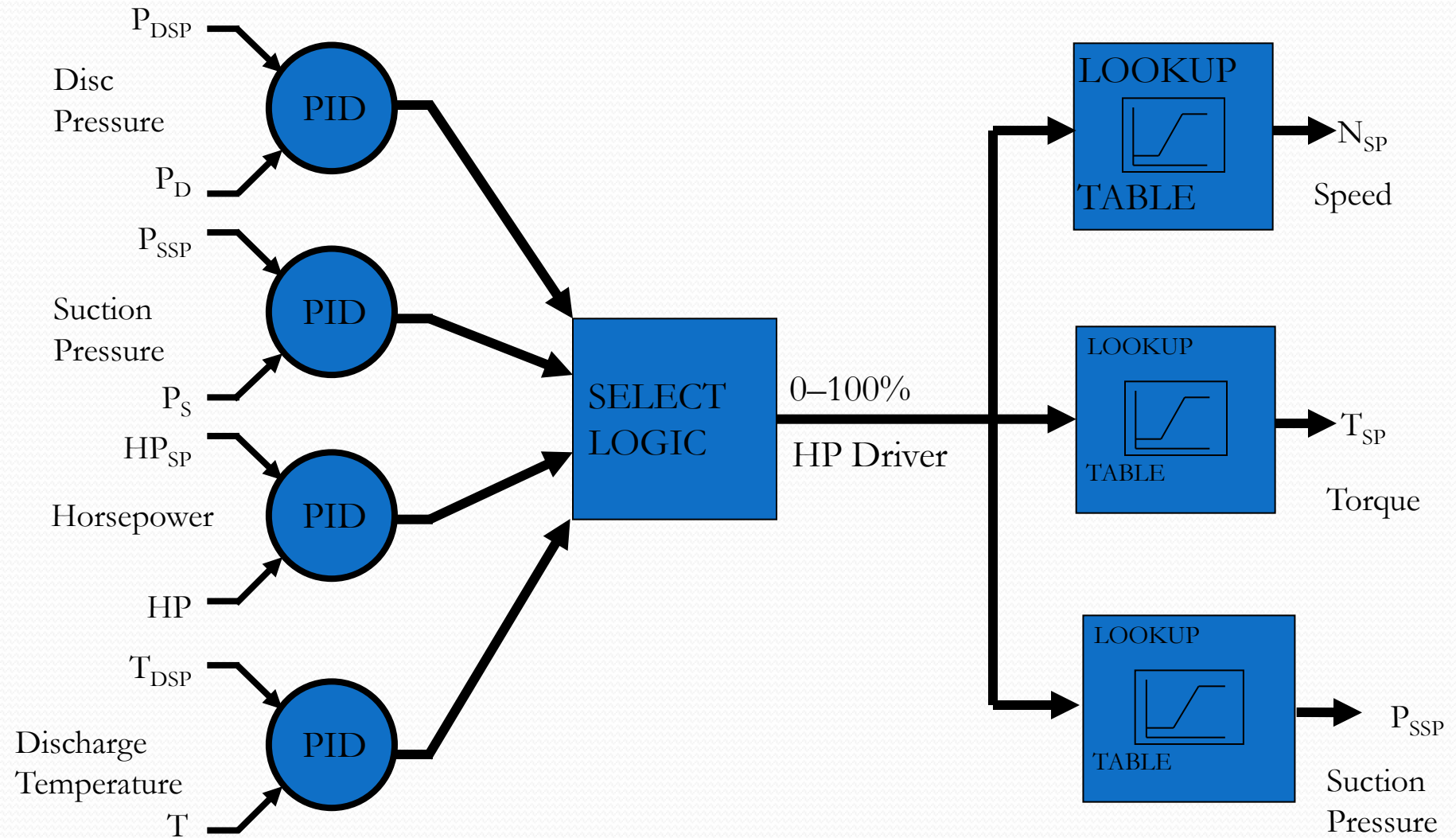


# Example Unit Display

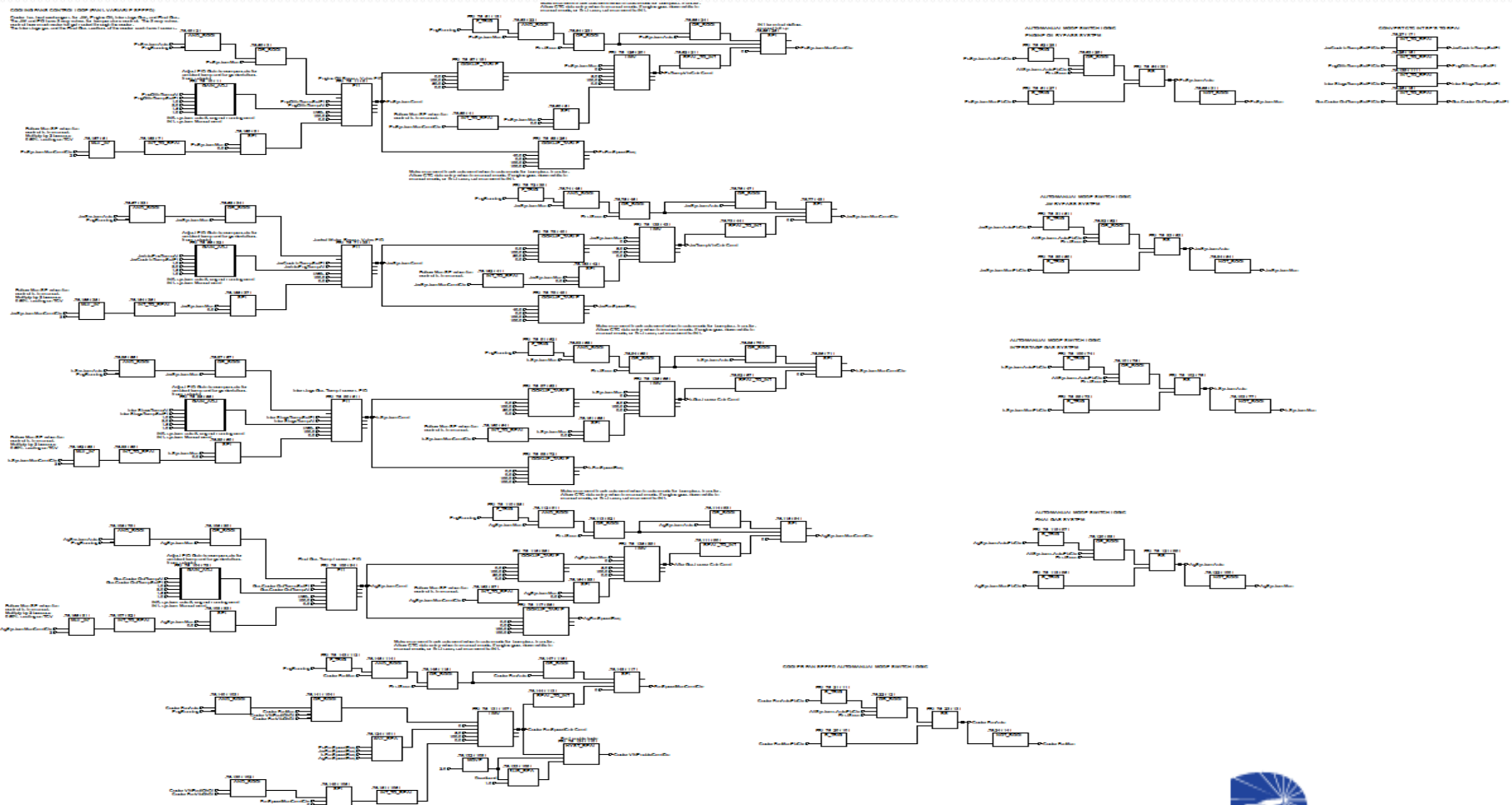
- Man-Machine-Interface (MMI) – CTC Touch Screen



# Multi-mode Control



# Control Code



# How to Measure Success - Controls Compared to Manual Ops Example

Model #	# Safe Points Used	Total Flow for All Test Points (MMscf)	Avg. Flow Safe Points	% Change from Base	Notes
0	701 out of 1376	2703.25	3.86	0.0%	Currently Operating Mode
1	1376	5503.19	4.00	103.6%	Automate Suction Throttling, and leave pockets in manual control.
2	1376	5453.17	3.96	101.7%	Automate Load Step Control, and leave suction throttling in manual control.
3	1376	6378.28	4.64	135.9%	Automate Load Step Control, and automate Suction Throttling control.
4	1376	4958.88	3.60	83.4%	Automate Suction Throttling control, and only use one 1 <sup>st</sup> Stage Cylinder.
5	1376	5611.06	4.08	107.6%	Automate Load Step and only use one 1 <sup>st</sup> Stage Cylinder.
6	1376	6632.06	4.82	145.3%	Automate Load Step and Suction Throttling control, and only use one 1 <sup>st</sup> Stage Cylinder.

# How to Measure Success - Post-Construction Results

- 3 Stations – 1 Ajax, 2 Cat/Ariels, 1 Wh. Sup. Separable
  - Automation Increased Production over Manual Ops
  - 1 Ajax - Repaid Investment within 8 months
  - Cat/Ariel + Wh.Sup. - Quickly Recouping Investment
  - 1 Cat/Ariel – Slightly Increased Production
- 2 Stations – 5 Cooper Integrals, 2 Cooper Integrals
  - High Oil Temperatures
  - Cooler Issues
- New Cooler Project is Required to Realize Full Benefits

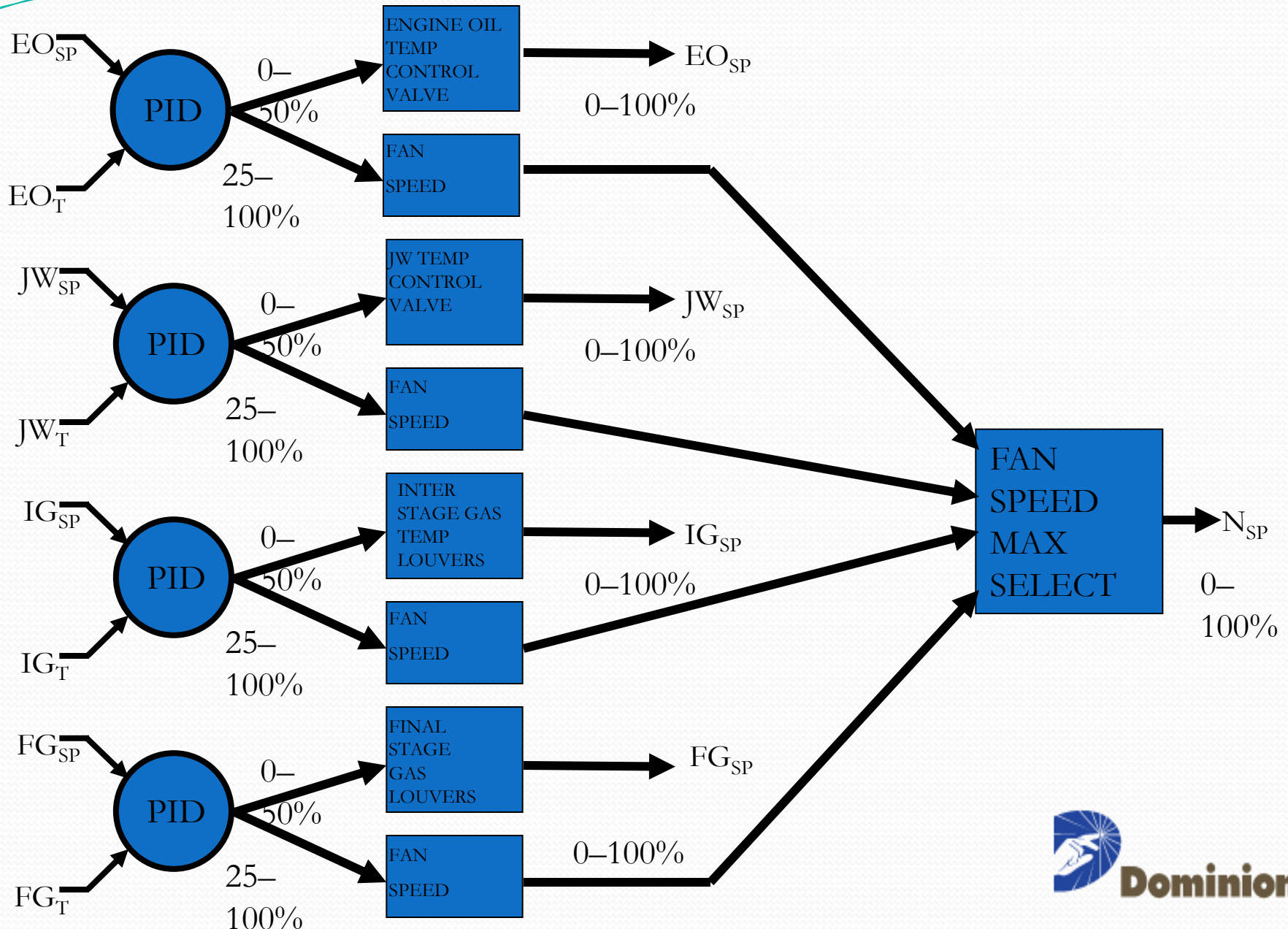
# Old Coolers – JW, EO, IG, & FG



# New Coolers – Separate Functions



# Multi-mode Control



# How to Measure Success Recorded Improvements

Throughput Improvement	
Engine Run Hours	
Avg Monthly Improvement	
C – 5 integral units – 3300 HP	4.2%
D – 1 separable unit – 1665 HP	1.2%
K – 2 separable units – 2050 HP	9.4%
L – 2 integral units – 1320 HP	6.1%
W – 2 integral units – 1200 HP	1.2%
Average	4.4%
Wtd Avg	4.7%

# Summary

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- What are the Costs?
  - Solution Requirements
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  - Initial Results Based Upon Increased Production
  - Final Results Based Upon Decreased Maintenance

Questions?