BLOWER & VACUUM BEST PRACTICES

blowervacuumbestpractices.com

Pros & Cons of Centralized Vacuum Systems

Sponsored by

Tim Dugan, P.E., *Compression Engineering Corporation*
Keynote Speaker

For your free subscription, please visit
www.blowervacuumbestpractices.com/magazine/subscription.

BLOWER & VACUUM BEST PRACTICES

blowervacuumbestpractices.com

Pros & Cons of Centralized Vacuum Systems

Tim Dugan, P.E., *Compression Engineering Corporation*
Keynote Speaker

The recording and slides of this webinar will be made available to attendees via email later today.

PDH Certificates will be e-mailed to Attendees within two days.

Sponsored by

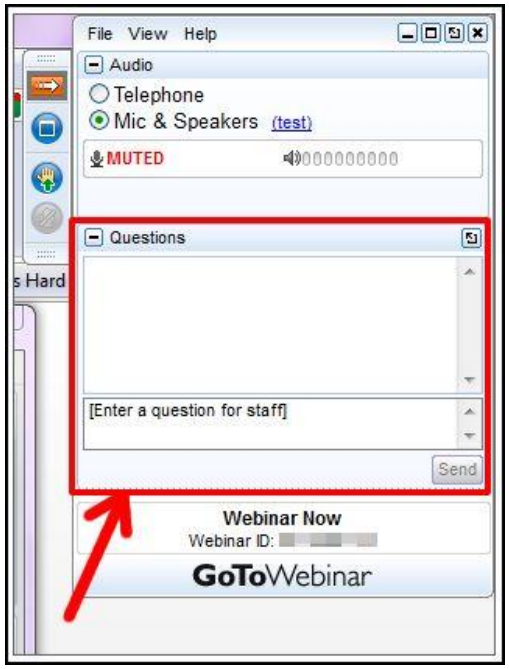
BUSCH Vacuum Pumps and Systems

Atlas Copco

For your free subscription, please visit
www.blowervacuumbestpractices.com/magazine/subscription.

BLOWER & VACUUM BEST PRACTICES
blowervacuumbestpractices.com

Q&A Format



- Panelists will answer your questions during the Q&A session at the end of the Webinar.
- Please post your questions in the Questions Window in your GoToWebinar interface.
- Direct all questions to Blower & Vacuum Best Practices Magazine

Sponsored by

BUSCH Vacuum Pumps and Systems

Atlas Copco

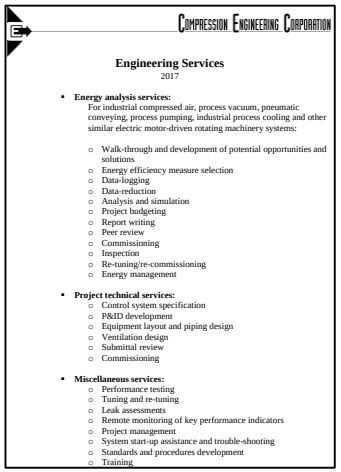
For your free subscription, please visit www.blowervacuumbestpractices.com/magazine/subscription.

BLOWER & VACUUM

BEST PRACTICES

blowervacuumbestpractices.com

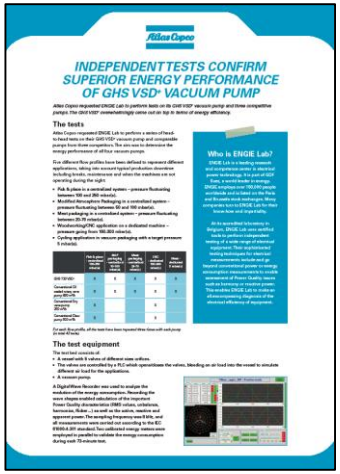
Handouts



COMPRESSION ENGINEERING CORPORATION

Engineering Services
2017

- **Energy analysis services:**
  For industrial compressed air, process vacuum, pneumatic conveying, process pumping, industrial process cooling and other similar electric motor-driven rotating machinery systems:
  - Walk-through and development of potential opportunities and solutions
  - Energy efficiency measure selection
  - Data-logging
  - Data-reduction
  - Analysis and simulation
  - Project budgeting
  - Report writing
  - Peer review
  - Commissioning
  - Inspection
  - Re-tuning/re-commissioning
  - Energy management
- **Project technical services:**
  - Control system specification
  - P&ID development
  - Equipment layout and piping design
  - Ventilation design
  - Submittal review
  - Commissioning
- **Miscellaneous services:**
  - Performance testing
  - Tuning and re-tuning
  - Leak assessments
  - Remote monitoring of key performance indicators
  - Project management
  - System start-up assistance and trouble-shooting
  - Standards and procedures development
  - Training



BLOWER & VACUUM
BEST PRACTICES
blowervacuumbestpractices.com

All materials presented are educational. Each system is unique and must be evaluated on its own merits.

BLOWER & VACUUM BEST PRACTICES

blowervacuumbestpractices.com

Pros & Cons of Centralized Vacuum Systems

Introduction by *Rod Smith*, Publisher

Blower & Vacuum Best Practices Magazine

Sponsored by

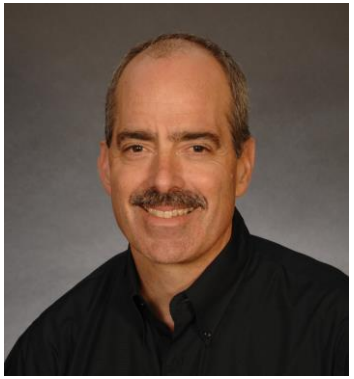
BUSCH Vacuum Pumps and Systems

Atlas Copco

For your free subscription, please visit
www.blowervacuumbestpractices.com/magazine/subscription.

BLOWER & VACUUM BEST PRACTICES
blowervacuumbestpractices.com

About the Speaker



Tim Dugan, P.E.
Compression Engineering Corp.

- President and Principal Engineer of Compression Engineering Corporation

- Over 25 years of experience in the industry

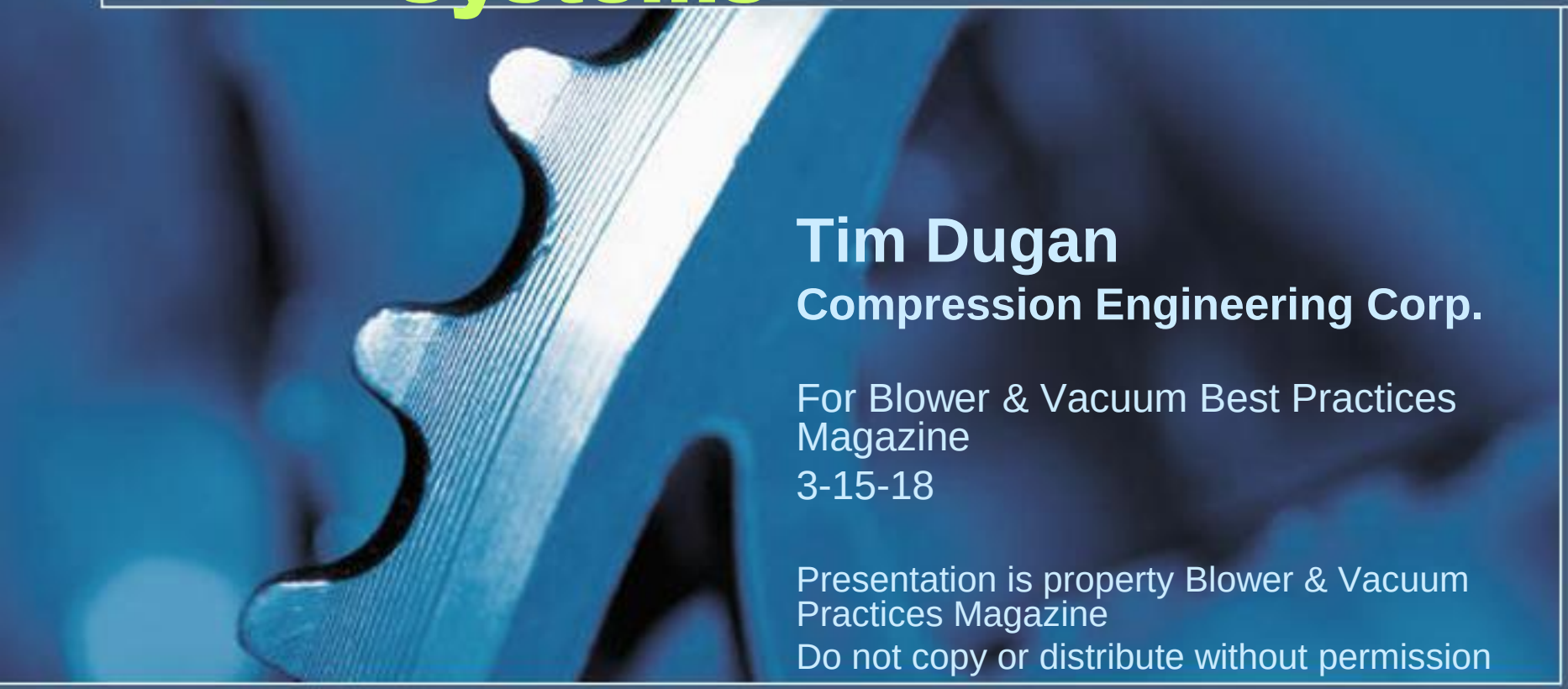
Sponsored by

BUSCH Vacuum Pumps and Systems

Atlas Copco

For your free subscription, please visit www.blowervacuumbestpractices.com/magazine/subscription.

Pros & Cons of Centralized Vacuum Systems

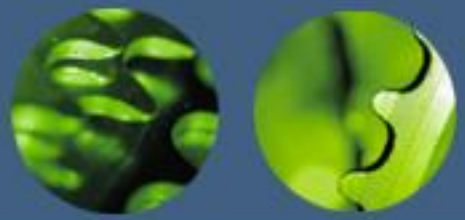


Tim Dugan
Compression Engineering Corp.

For Blower & Vacuum Best Practices Magazine
3-15-18

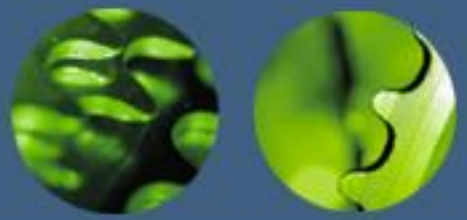
Outline

- Pros of Centralization
- Cons of Centralization
- Types of Systems & Centralization Issues
- Performing a Vacuum Audit to Design a Centralized System



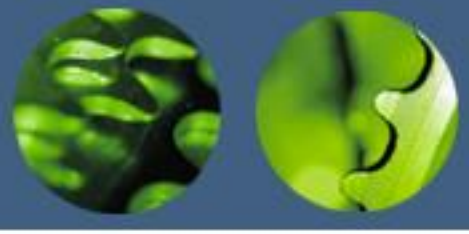
Pros of Centralization

- Fewer Vacuum Pumps Running on Average, Saving Energy and Maintenance $.
- Very Likely, Fewer Overall Installed Vacuum Pumps, Reducing Maintenance.
- Less Maintenance Time When All Pumps Are in One Location.
- Better Reliability. One Redundant Pump Backs up All.
- Ability to do Preventive Maintenance During Production (If One Spare Pump is in System).
- Single Source Responsibility Possible (Vacuum Pump Distributor Rather Than Production Equipment OEM).
- “Centralization” Can Happen Functionally, Leaving Some Units Where They Are.



Cons of Centralization

- Utility Room Space Required to Centralize.
- High Cost to Replace All Units and Centralize. Existing Units Are a Sunk Cost w- Production Equipment.
- Complexity vs One Pump per Production Area. Now You Need Piping, Storage, Controls, etc.
- Different Vacuum Levels and Condensable Gases Might Make Centralization More Complex or Impractical, Requiring Filtration, Separators, and Control Valves.
- If Different Vacuum Levels Are Needed, Centralized System Will Pull to Lowest Vacuum, Wasting Some Energy.

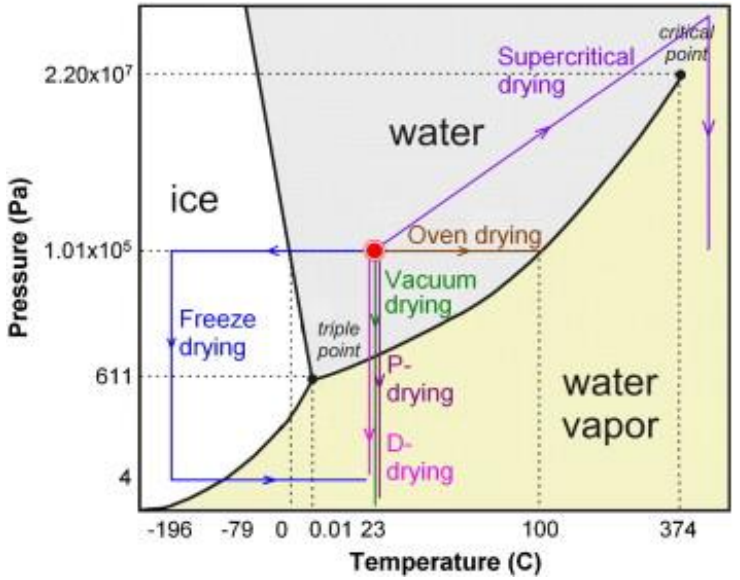


Types of Systems

- Mass Sensitive Applications
- Static Pressure Sensitive Applications

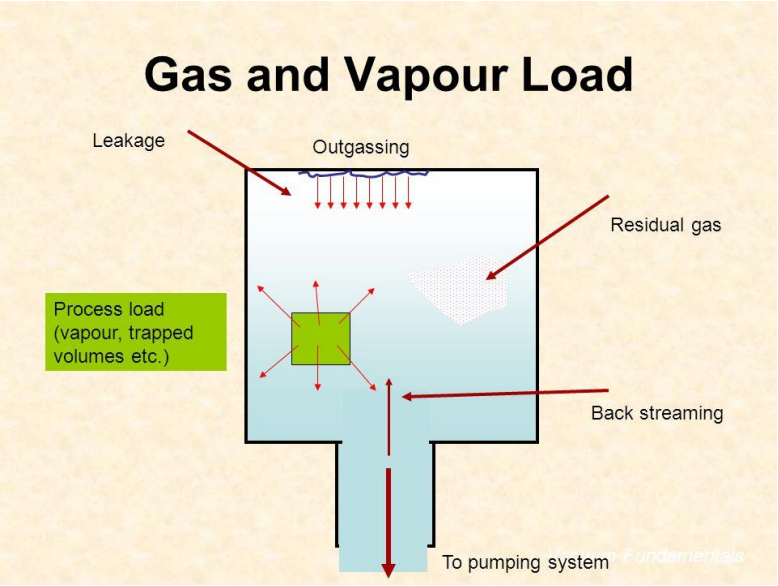
Mass Sensitive Applications

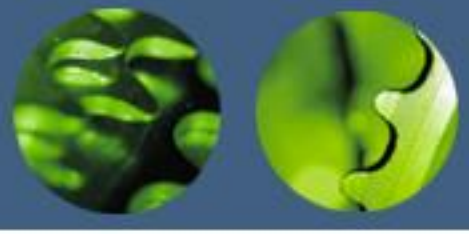
- You Need to Pull a Certain Mass Out of a Process
- Flashing a Liquid to a Gas. Example:
- Vacuum & Freeze Drying – Need to Remove Moisture at Lower "Boiling" Temperature. For Heat-Sensitive Materials Like Foods or Pharmaceuticals.
- PD Rotary Pumps Used



Mass Sensitive Applications

- Outgassing of a Solid. Example:
- Plastic Vessel Under Vacuum. If “Hydroscopic”, Like Nylon, You Are Boiling Off Water. If Not, Like Teflon, It Still Outgases at Low Pressure.
- Oil Sealed Positive Displacement Rotary Pumps Used
- Oil Sealed Positive Displacement Rotary Pumps Used, Sometimes w- Roughing Blower



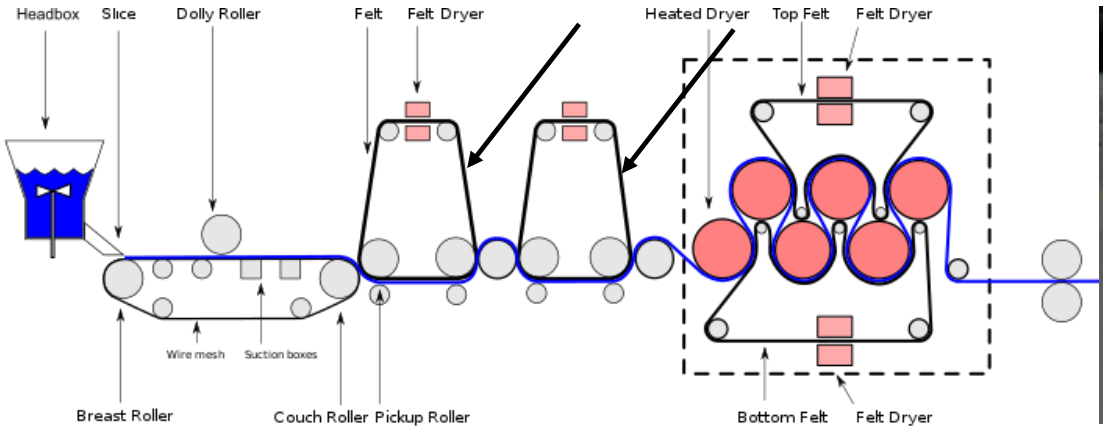


Mass-Sensitive Centralization Issues

- Calculate Mass Required for Each Process.
- Calculate Pressure Required for Each Process.
- Determine if Pressures Required Are Similar.
- Determine if Condensed Gases Are Similar re. Corrosion, Oil-Compatibility, Etc.
- If Pressures and Compatibility Are Similar, Centralization Might be Practical.

Pressure Sensitive Applications

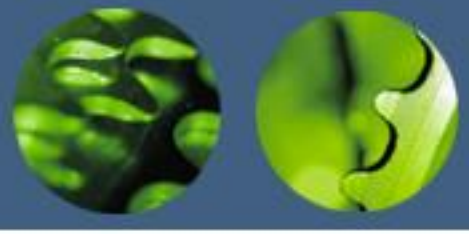
- Dewatering a Porous Material. Example:
- Paper Machine Felt Dewatering with “Uhle Boxes”.
- Just the Right Vacuum (Pressure Differential) Needed for Optimal Water Removal and Felt Life.
- Large Positive Displacement (Liquid Ring) Vacuum Pumps Typically Used



Wet End Wet Press Section Dryer Section Calender Sectio

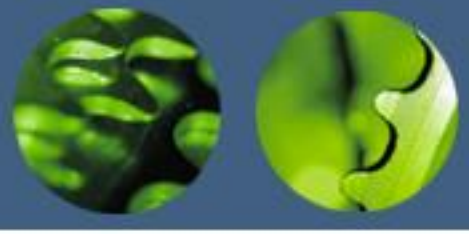
Pressure Sensitive Applications

- Creating Mechanical Force. Example:
- CNC Routing of Furniture Front Panels.
- Enough Pressure Differential Needed to Keep Piece from Moving While Being Machined.
- Medium Vacuum PD Pumps Used, Typically Screw and Vane



Pressure-Sensitive Centralization Issues

- Calculate Velocity Required for Each Process, in Full Flow Range.
- Design Piping for Min / Max Velocities.
- Include Mass Ratio of Material to Gas in Calculations.
- Calculate Flow Rate Needed for Each.
- Calculate Pressure Loss in Piping and Vacuum Required at Pump Inlet for Each.
- If Vacuum Req’d is Similar, Centralization Might be Practical.

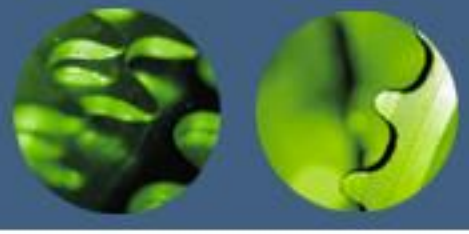


Example of Easy Centralization

- Medium Vac, All Processes Similar, Piping Runs to Common Location Similar.
- Design Centralization (simple, vendor can support):
  - Piping: Looped, large enough for max flow of all processes
  - VSD on at least one vacuum pump recommended
  - Storage: Sufficient for controls (depends on pump size, VSD, etc)
  - Master controls. If a VSD, keep in “trim” all the time, “target” algorithm.
  - Consider adding back-up vacuum pump or new VSD vacuum pump.

Example of Easy Centralization – All New

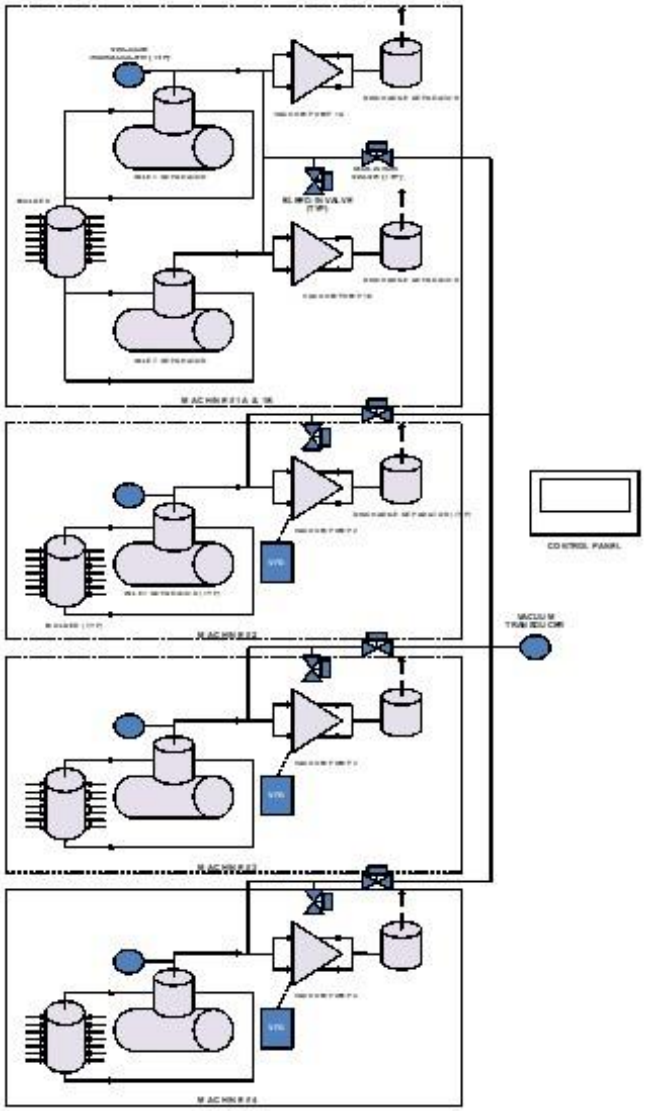
- This example is new skid, vane vacuum pumps.
- Vacuum pump skid includes pumps and master controls, and storage.
- Just install one piping loop, interlock demands with isolation valves, and install skid.



Example of Difficult Centralization

- Medium Vac, All Processes Different, With Process Controls That Require Independent Adjustment.
- Design Centralization (complex, custom engineered):
  - Common Header Needed
  - Valve Controls for Separate Pressure Control
  - Vacuum Pumps to Run at Lower Pressure Than Lowest Process.
  - Custom master controls. If a VSD, keep in “trim” all the time, “target” algorithm.
  - Consider adding back-up vacuum pump or new VSD vacuum pump.

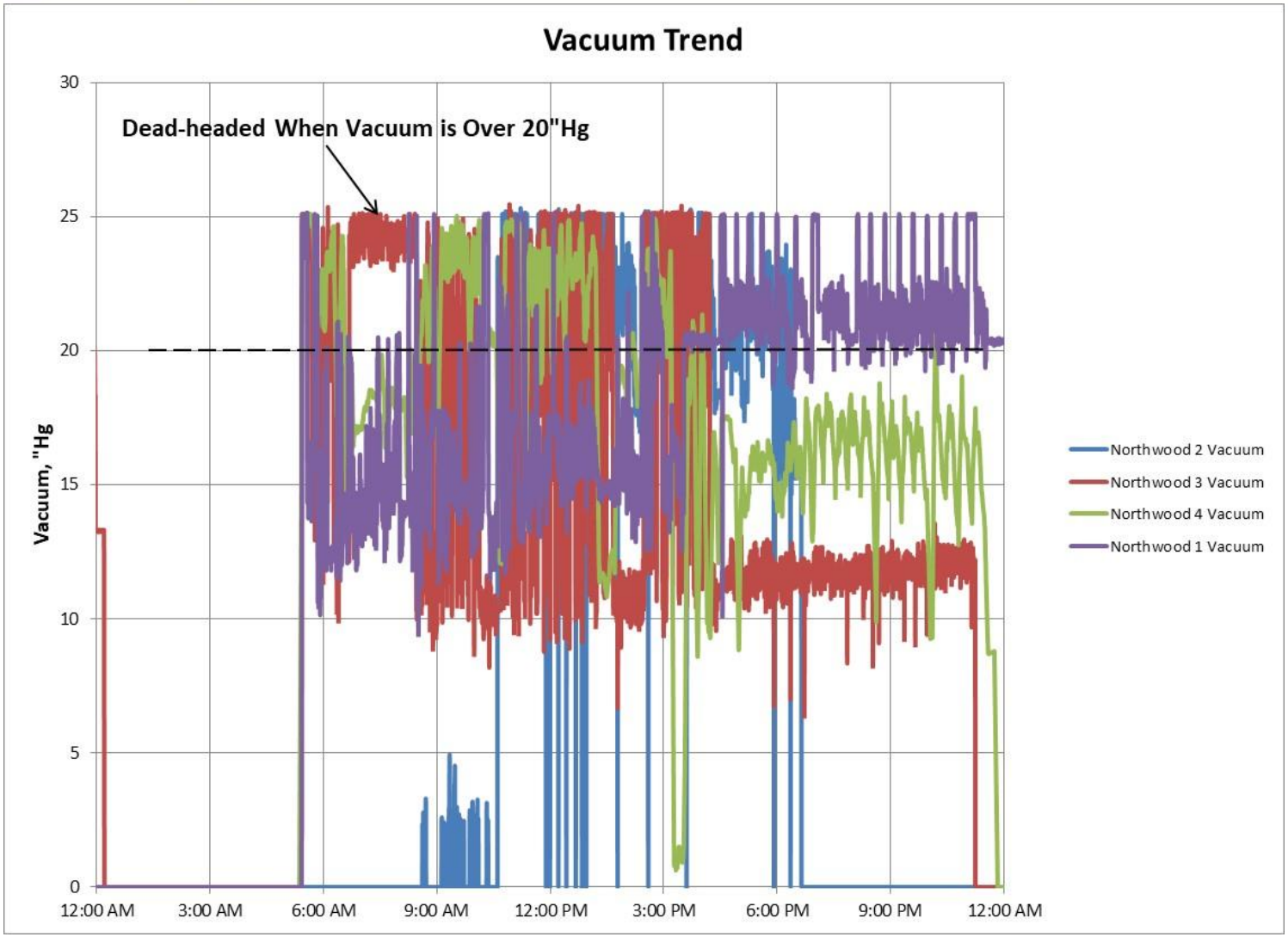
Diagram of Difficult Centralization



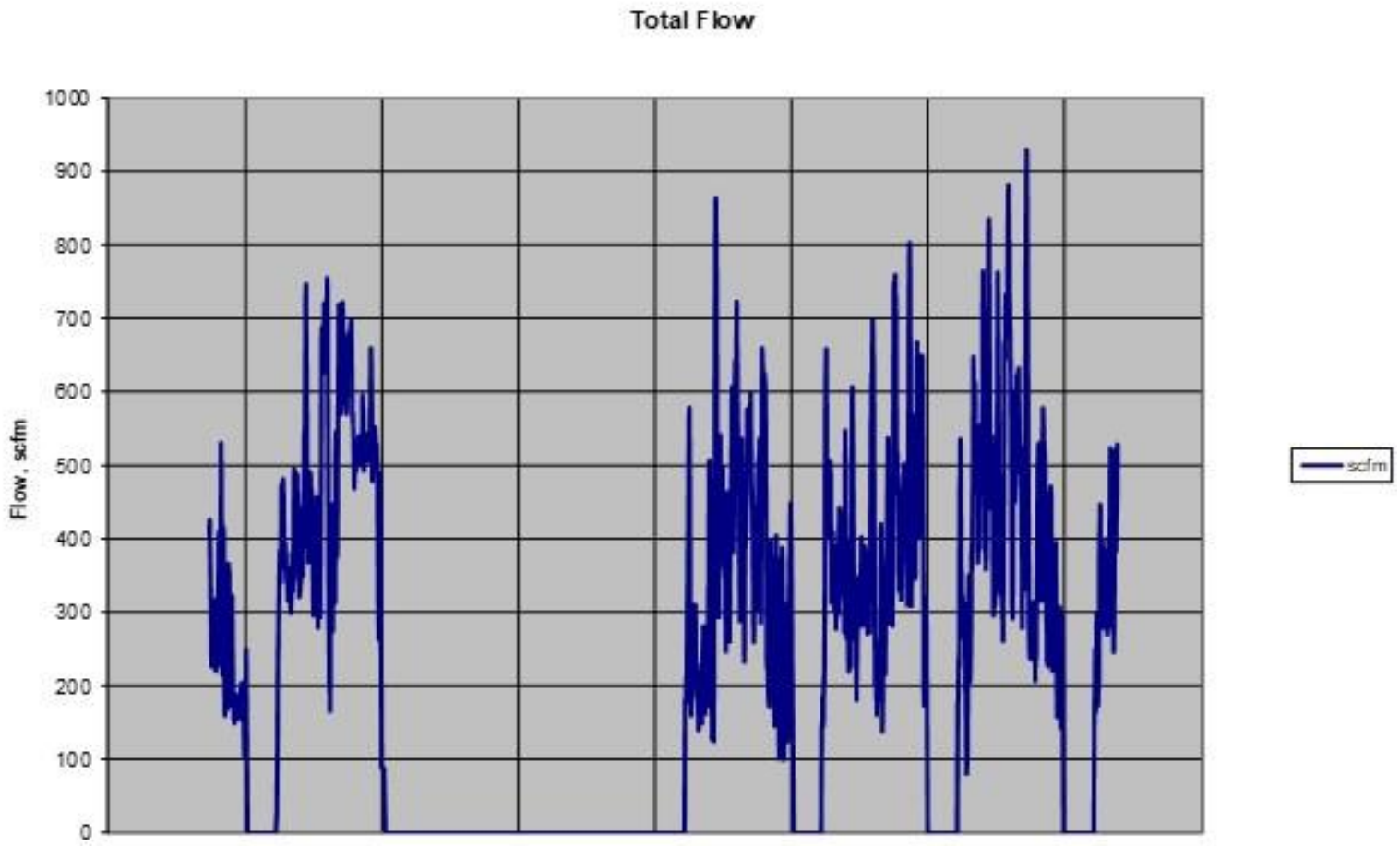
Performing a Vacuum Audit

- For Each Process, Measure Vacuum (Pin).
- At Each Vacuum Pump, Measure Pin and Power. Data-log.
- From Pin and Vac Pump Curve, Calculate Volume Flow at Pump Inlet in “icfm” or “m3/hr”, at the vacuum pump inlet.
- From Pin and Volume Flow, Calculate Mass flow = (Patm – Pin) / Patm.
- Adjust Mass Flows (if Not Choked Flow) at New Vacuum.
- Sum Flows to Develop Total Mass Flow Requirement.
- Calculate Total Volume Flow Needed From Mass and Pressure (Vacuum) Actually Required.
- Plot System Performance Curve.

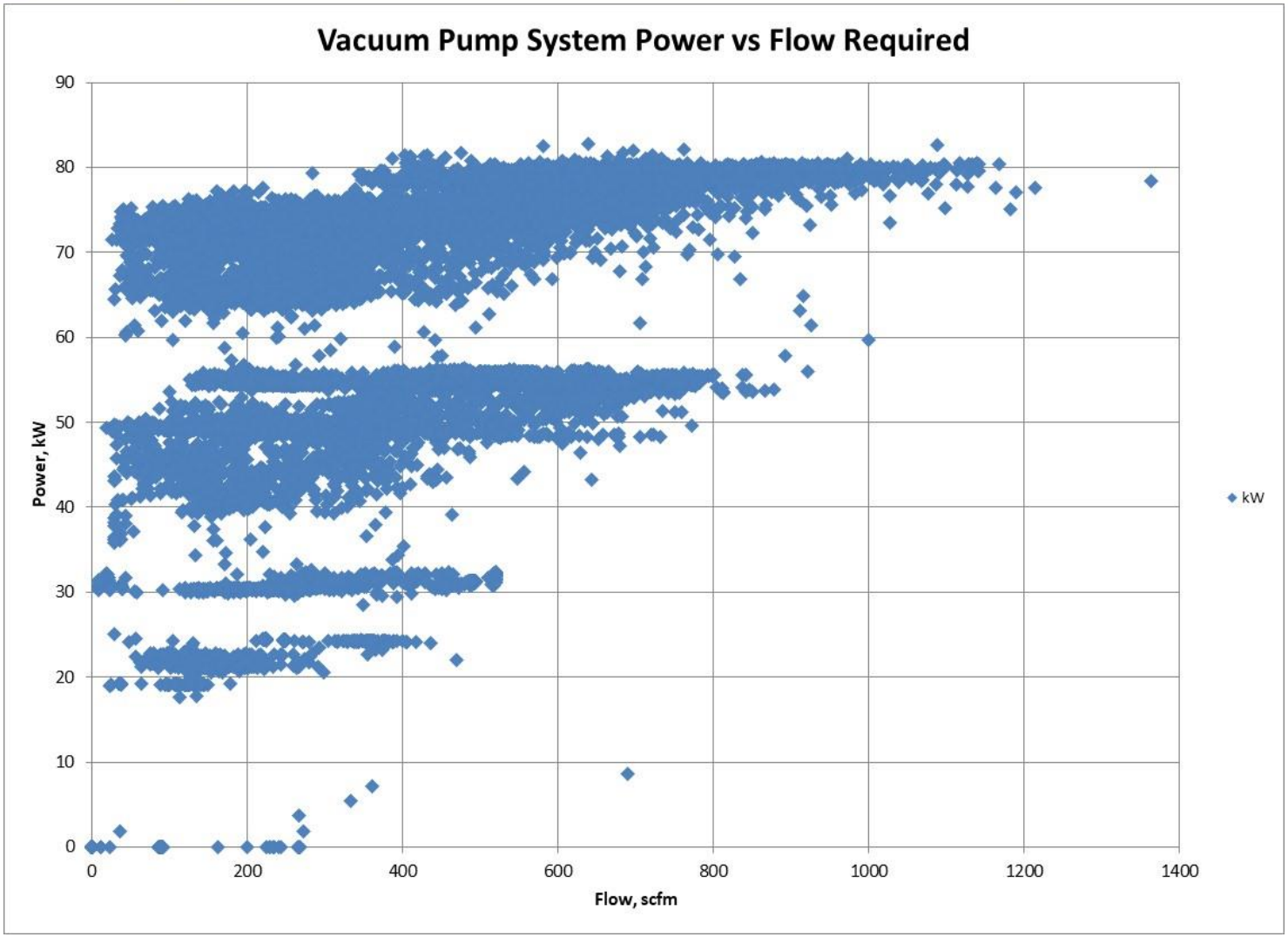
Evaluate Operation From Data

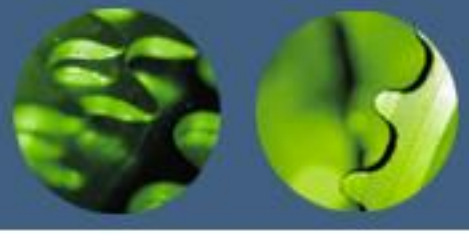


Determine Part-load Efficiency Opportunity



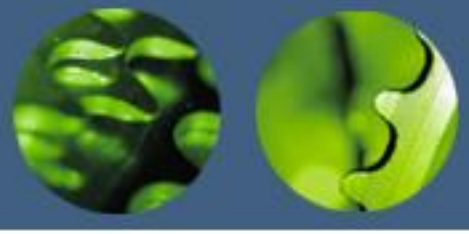
Curve Shows Part-load Efficiency Opportunity





Designing A Centralized System

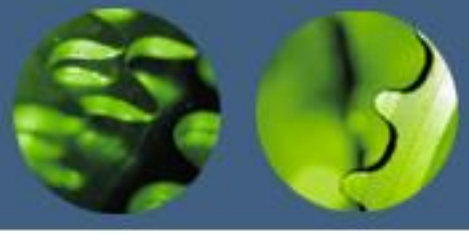
- Size Piping Header Based on Pressure Differential & Max Flow
- Size Tank Based on Controls, Type of Pump, and Pressure Differential
- Select Master Controller
- Wire Start and Load Contacts to Each Pump
- Interlock Demands with Controller (Auto Shut Off When Production Cell is Off)
- Possibly Put VFD on One or More Pumps – Depends on How Tightly Pressure Needs to be Controlled



Energy Savings from Centralization

- Multiple Dead-headed vacuum Pumps Can Take More Than 50% Power at No Flow
- Centralization Runs Just the Required Pumps at Any Time
- Overall Savings Can be Significant

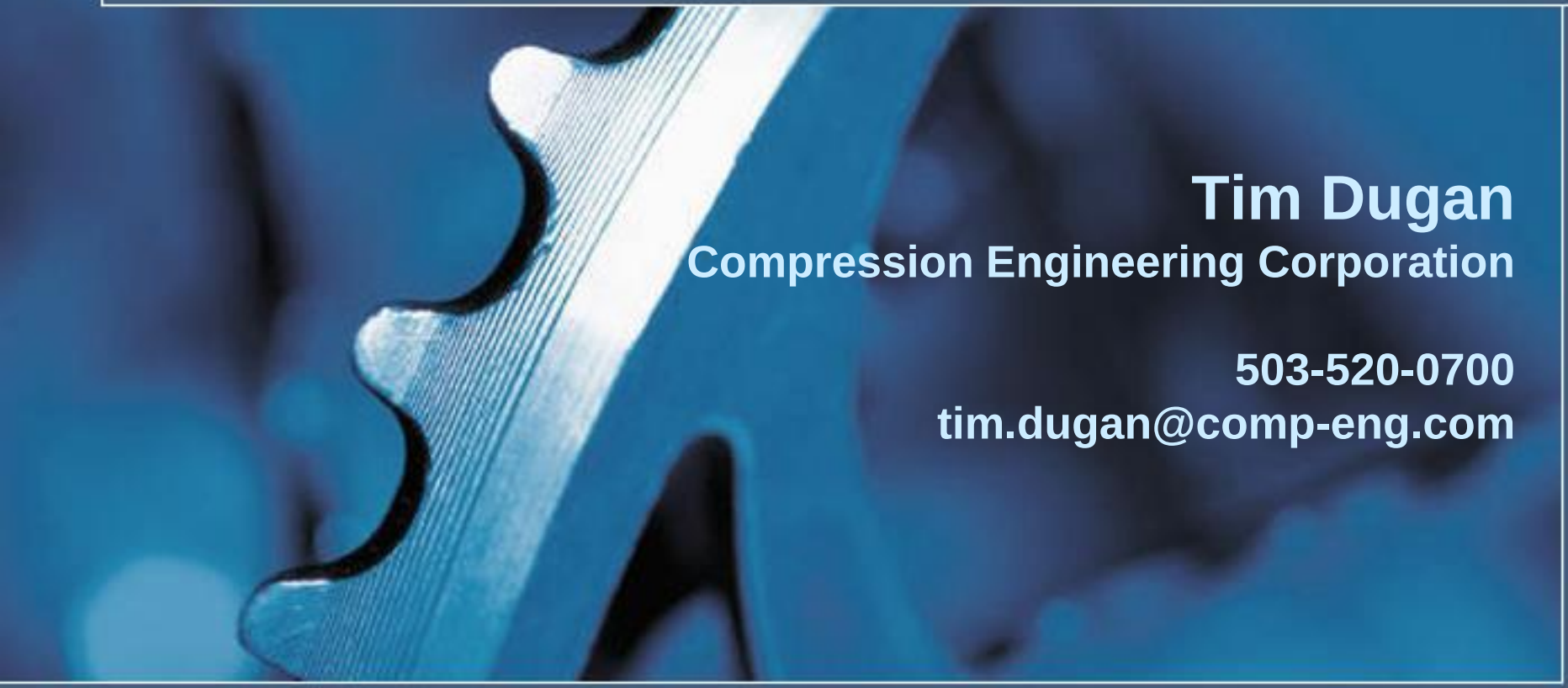
Curve Shows Part-load Efficiency Opportunity



Summary

- **Pros of Centralizing Vacuum Systems**
  - Lower energy, more reliable, less maintenance
- **Cons of Centralizing Vacuum Systems**
  - More complex, costly, space
- **Types of Systems & Centralization Issues:**
  - Mass-Sensitive Systems
  - Pressure-Sensitive Systems
- **Performing a Vacuum Audit to Design a Centralized System**
  - Measurement
  - Calculations
  - Basis of Design, Savings and Incentive Calculation

Thank you



Tim Dugan
Compression Engineering Corporation

503-520-0700
tim.dugan@comp-eng.com

BLOWER & VACUUM BEST PRACTICES
blowervacuumbestpractices.com

About the Speaker

VJ Gupta
Busch USA

- Systems Engineering Manager for Busch USA

BUSCH
Vacuum Pumps and Systems

For your free subscription, please visit
www.blowervacuumbestpractices.com/magazine/subscription.

How to Assess Central Vacuum Systems – Pros & Cons

Webinar: Pros & Cons of Centralized Vacuum Systems

VJ Gupta, Systems Engineering Manager

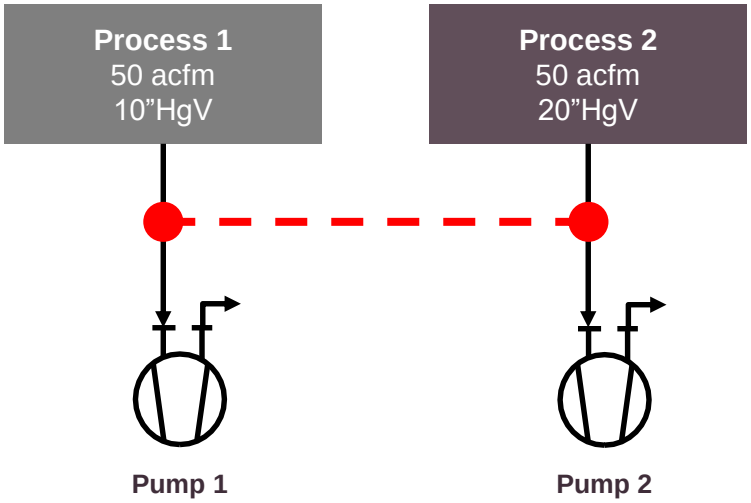
March 15, 2018

Central Vacuum Systems
A Proven Concept

- We have designed, supplied and installed central vacuum systems for 40 years!
- Thousands of central vacuum systems installed globally.
- Industries Served:
  1) Food
  2) Plastics
  3) Wood
  4) Semiconductor
  5) Printing
  6) Solar
  7) Many more……
- Busch central systems have successfully provided great benefits and savings with the following features:
  - ✓ Controls with Variable Speed Drives (VSD) and/or cascading logic
  - ✓ With or without vacuum buffer tanks
  - ✓ Systems optimized to support multiple applications with different vacuum levels
  - ✓ Utilizing different pump technologies within the same central system for efficiency gains

Central Vacuum Systems Assessment

Centralizing Applications with Different Vacuum Levels Require Special Considerations!



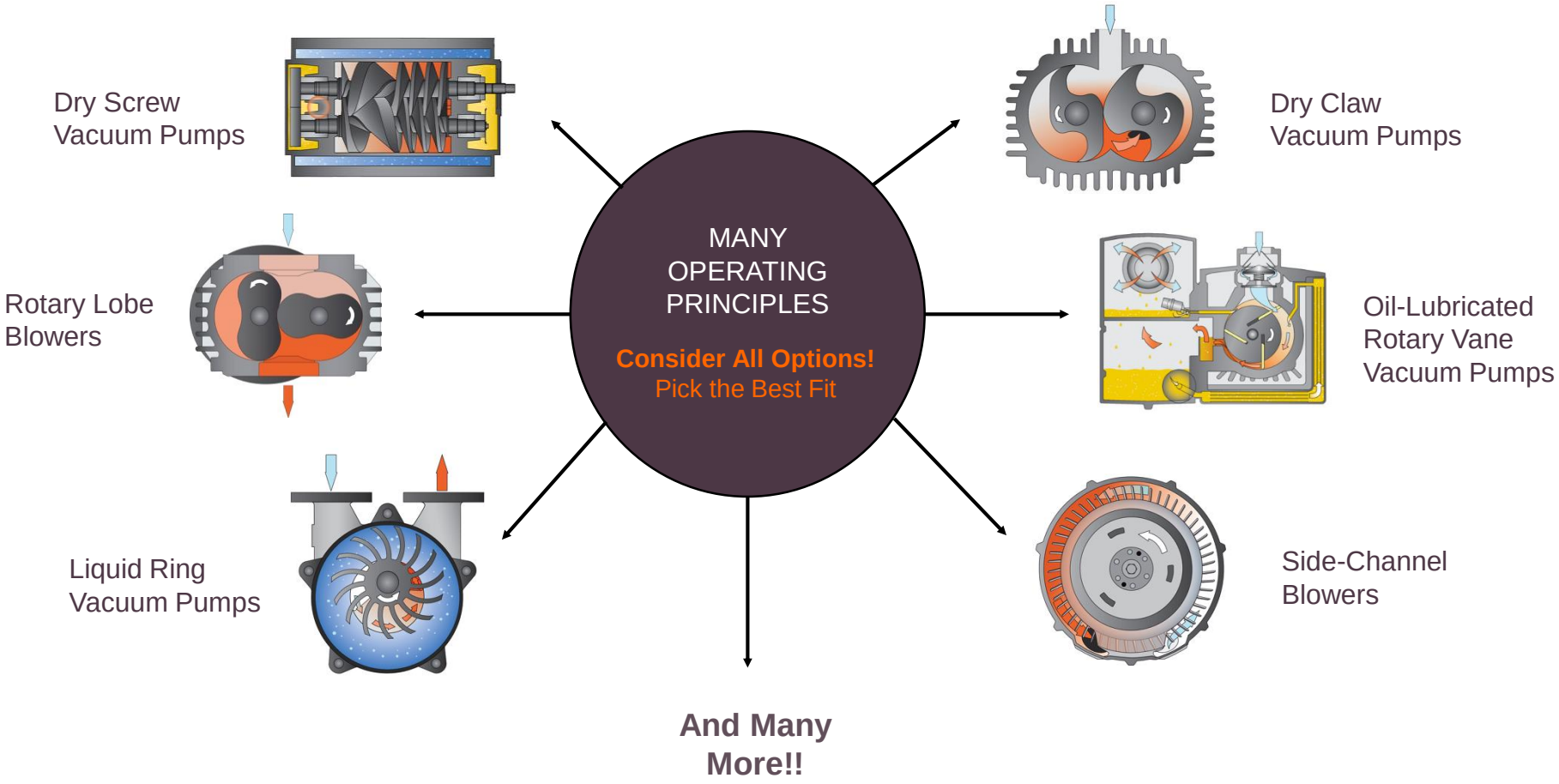
	Pumping Capacity (acfm)
Process 1; at 10”HgV	50
Process 2; at 20”HgV	50
Process 1 + Process 2; at 20”HgV	~~100 ?~~ 150

› Industries with Applications that require different vacuum levels within the same plant:

Industry	Application (less vacuum required)	Application (more vacuum required)
Food	Pneumatic Conveying of Waste Product	Vacuum Packaging
Semiconductor	House Vacuum	Process Vacuum
Plastics	Pneumatic Conveying of Pellets	Calibration Table
Printing	Trimming Machine	Printing Machine
Solar	Pick & Place	Laminating

Central Vacuum Systems
Pros: (+) Many Pump Technologies Available

Each Operating Principle has its Optimum Vacuum Operating Range wherein it provides Maximum Efficiency!



Central Vacuum Systems
Pros…

(+) Return on investment (ROI)

- With proper design, can prove a return on investment on a cost of ownership basis demonstrated by energy saving and increased productivity.
- Design can allow for a reduction in maintenance costs (both material and labor)

(+) Plant efficiency & expandability

- Productivity gains with reduced evacuation times or increased cycle rate.
- Frees up floor space!
- Provides instantaneous vacuum and only the required vacuum level.
- Additional applications can easily be added and central units can be expanded.

Central Vacuum Systems
Pros…

(+) Utility Efficiency

- Electrical Savings– pump sizing and controls design is key!
- Heat Reduction in production areas.
- Heat recovery from central system exhausts.

(+) Uptime

- Maintenance can be planned & performed while a multi-pump system continues to run.
- Spare capacity can ensure continuous operation in the event of pump failure.

Central Vacuum Systems
Pros…

(+) Environmental

- Sound removed to desired remote location & controllable.
- Heat removed to a desired remote location & containable.
- Removes messy pumps & discharge from floor area (more hygienic).
- Great appearance.

(-) Design Risk

Reason –

- If the central vacuum system is down, plant loses vacuum altogether.

Possible solutions –

- Design features can be considered to minimize impact. For example:
  - Redundancy including spare pump(s)
  - Manual pump start capability without any controls or VSD

(-) Initial Investment or CAPEX

Reason –

Must consider capital costs. For example:

- Piping
- Buffer tanks
- Dedicated machine rooms
- Controls
- Pumps etc.

Possible solutions –

- Conduct a preliminary study to determine budget feasibility.
- Existing pumps can be utilized to reduce costs.

Central Vacuum Systems
Cons…

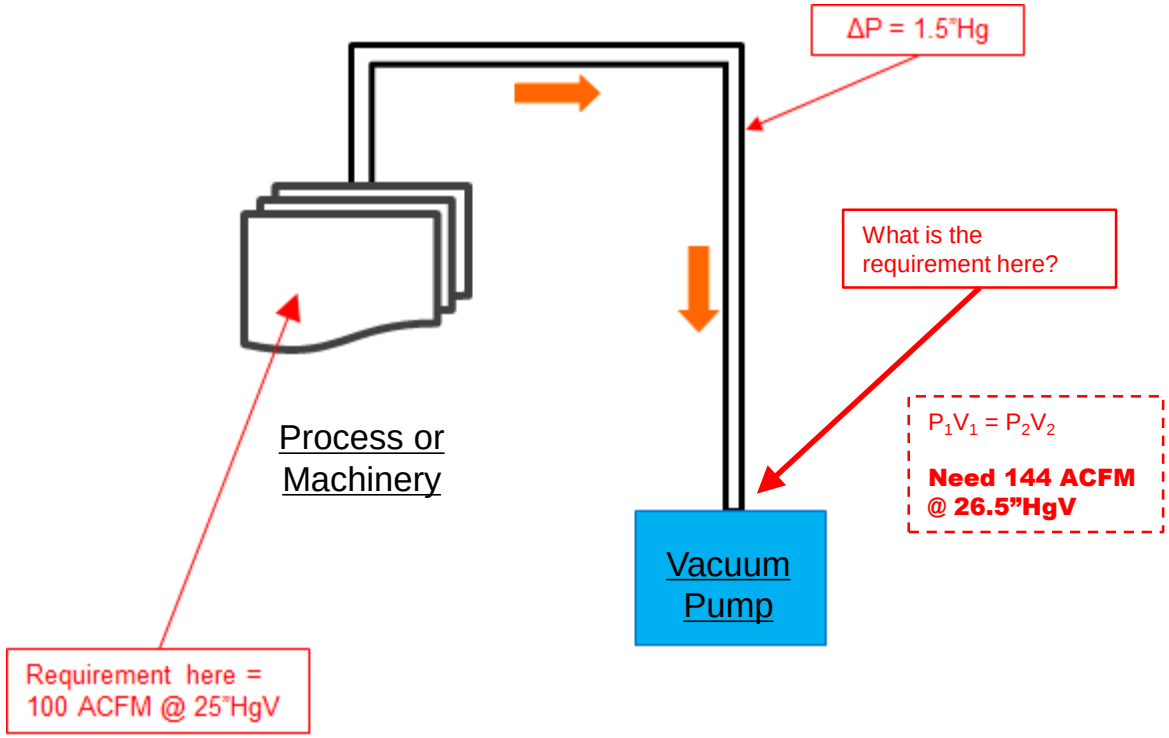
(-) Wrong Advice!

Reason –

- Sizing and Designing central vacuum systems requires knowledge and expertise.

Possible solutions –

- Look for suppliers with an installed base of successfully running central vacuum systems.



(-) Performance Accountability Risk

Reason –

- Most OEM (machine supplier) supply the vacuum pumps only, not a central vacuum system. And they assume full responsibility for performance and productivity.
- But piping, tanks, controls and additional equipment often supplied by others.
- Who is responsible for overall performance?

Possible solutions –

- Successful installations require very close cooperation between vacuum system supplier and local OEM.
- OEM machine design and central vacuum system design needs to be synchronized for optimal performance.

(-) Layout Flexibility Risk

Reason –

- Existing central system piping may limit future OEM machine relocations.

Possible solution –

- Initial piping layout can consider future expansions with available connection points.

Central Vacuum Systems
Should I Centralize?

Ask yourself…..

- Can I benefit from Energy Savings or Rebates?
- Could I use more Floor Space in my production area by removing Point-of-Use (POU) pumps?
- Do I need Faster Pumpdown to my operating vacuum level using my existing pump?
- Is a Continuously Running vacuum system beneficial for me?
- Does my plant have processes with Different Vacuum Level requirements?
- Do my operators complain about high Noise levels?

Central Vacuum Systems
In Summary

Let the Pros Outweigh the Cons!!

- Every Customer's plant requirements are unique. Usually, there are different processes in one plant with different vacuum requirement levels.
- Only centralize machines that make economical sense!
- There is no "One Size Fits All" solution! An Optimal Centralized System is custom tailored to meet customer needs.
- Conduct a complete study to determine customer requirements. Busch can help with this!
- Consider all available options, i.e. various pump technologies, control schemes, buffer tanks, pipe header sizing, VSD etc.
- **Central systems can be a great solution but needs to be done right….**
- **You need to work with an expert who can help with the detailed analysis and offers custom tailored solutions with minimal risks.**

Thank you!

For more information about Busch Vacuum Pumps and Systems, please visit: **www.buschusa.com**

VJ Gupta

Systems Engineering Manager for Busch USA
Office: (757) 502-7084 • Cell: (757) 373-0099
vj.gupta@buschusa.com

BLOWER & VACUUM BEST PRACTICES
blowervacuumbestpractices.com

About the Speaker

Walter See
Atlas Copco

- Product Marketing Manager for the Industrial Vacuum Division of Atlas Copco Compressors

Atlas Copco

For your free subscription, please visit
www.blowervacuumbestpractices.com/magazine/subscription.

INSTALLATION GUIDELINES FOR A CENTRALIZED VACUUM SYSTEM

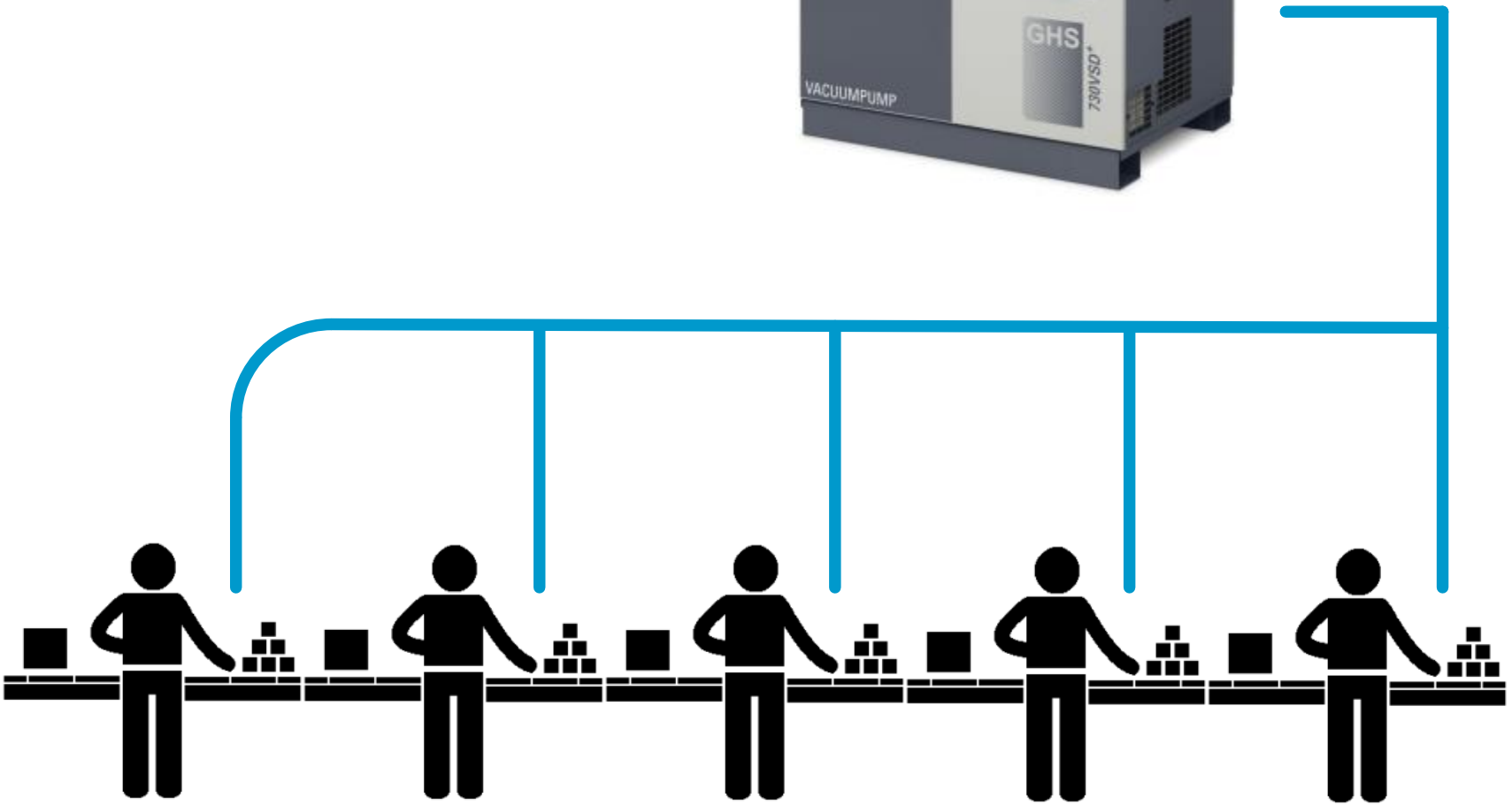
Walter See

Product Marketing Manger

Atlas Copco

POINT OF USE VACUUM

CENTRALIZED VACUUM

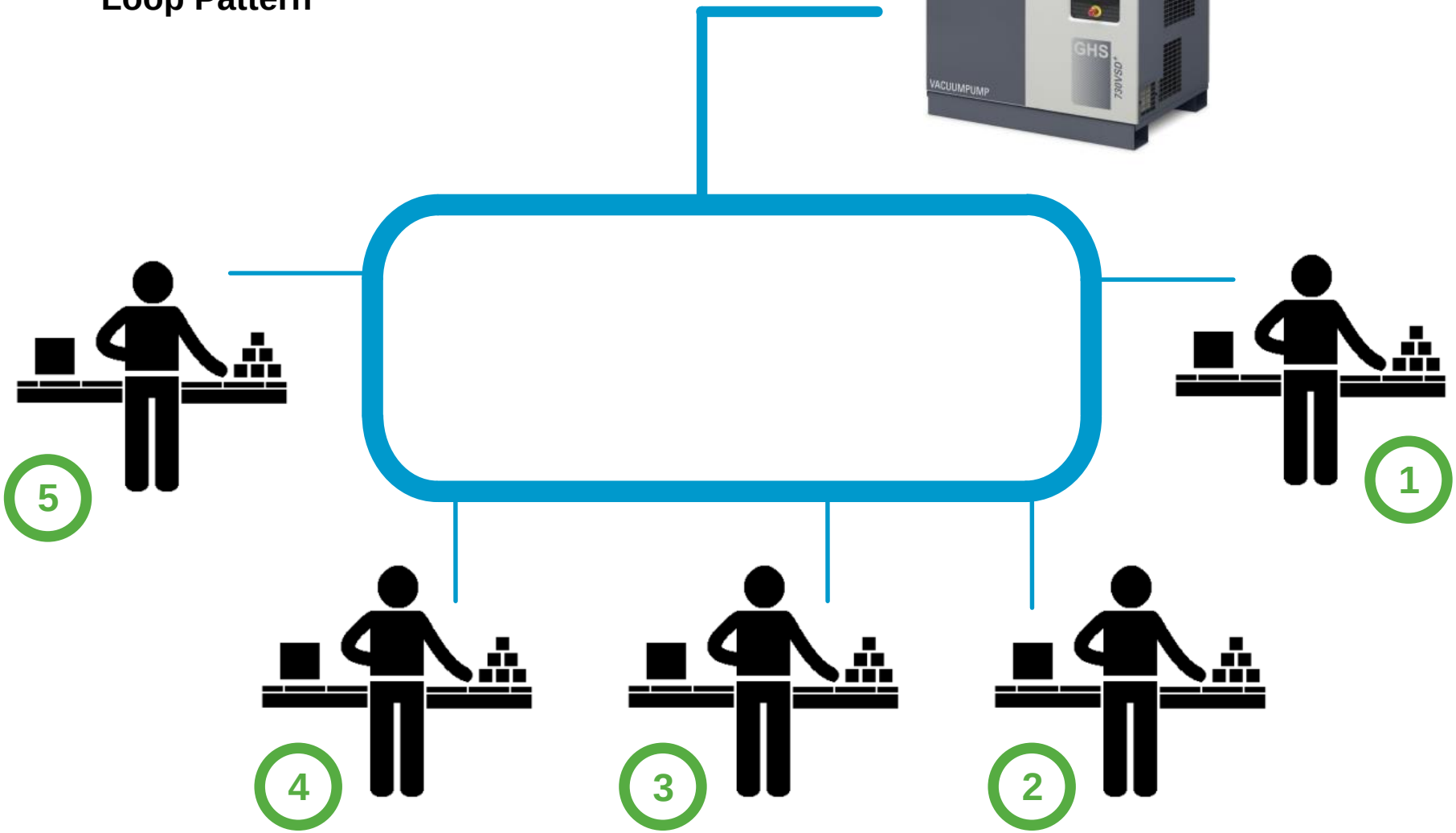


CENTRALIZED VACUUM - PIPING SYSTEM

Will pressures be equal?

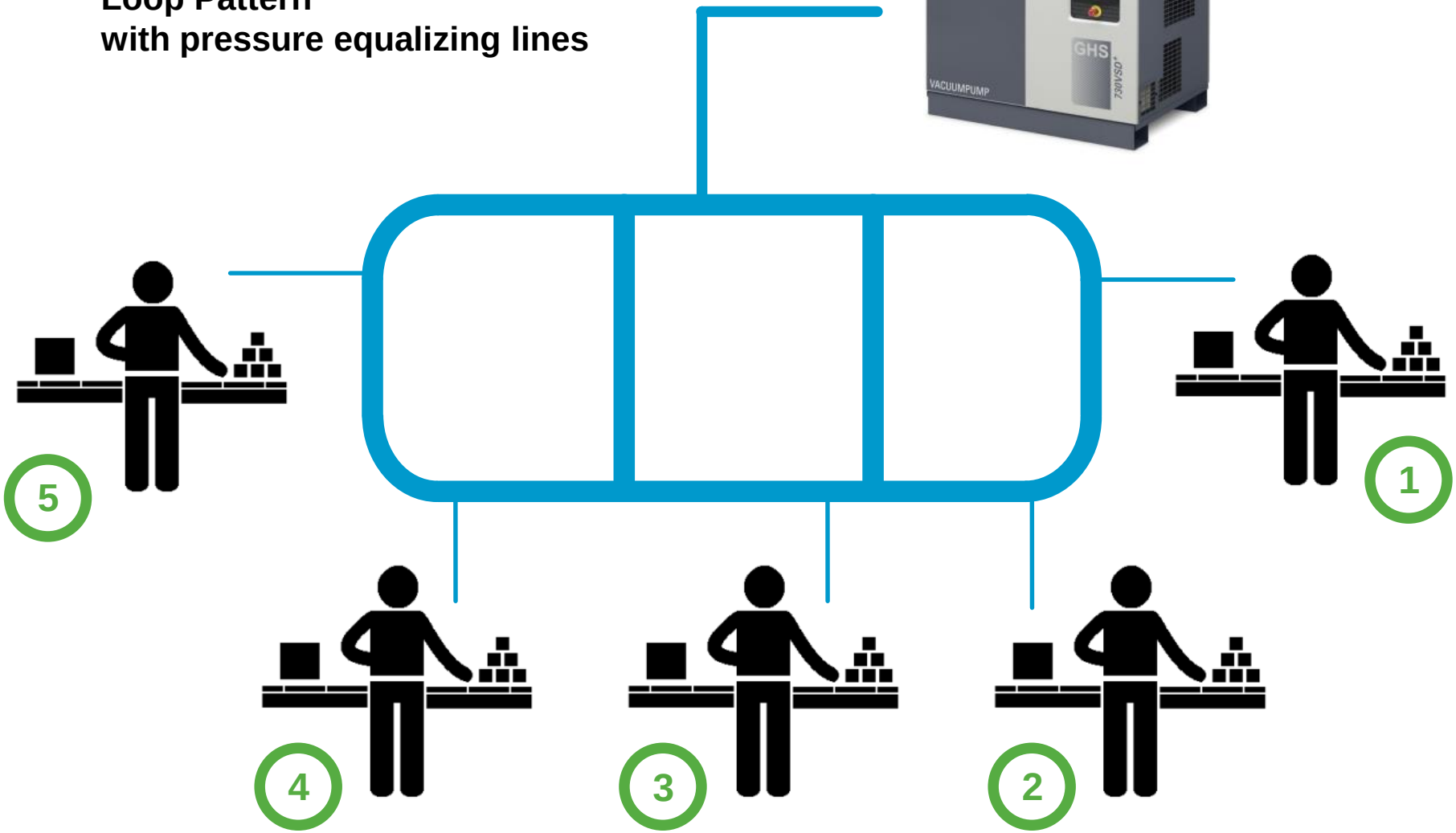
CENTRALIZED VACUUM - PIPING SYSTEM

Loop Pattern



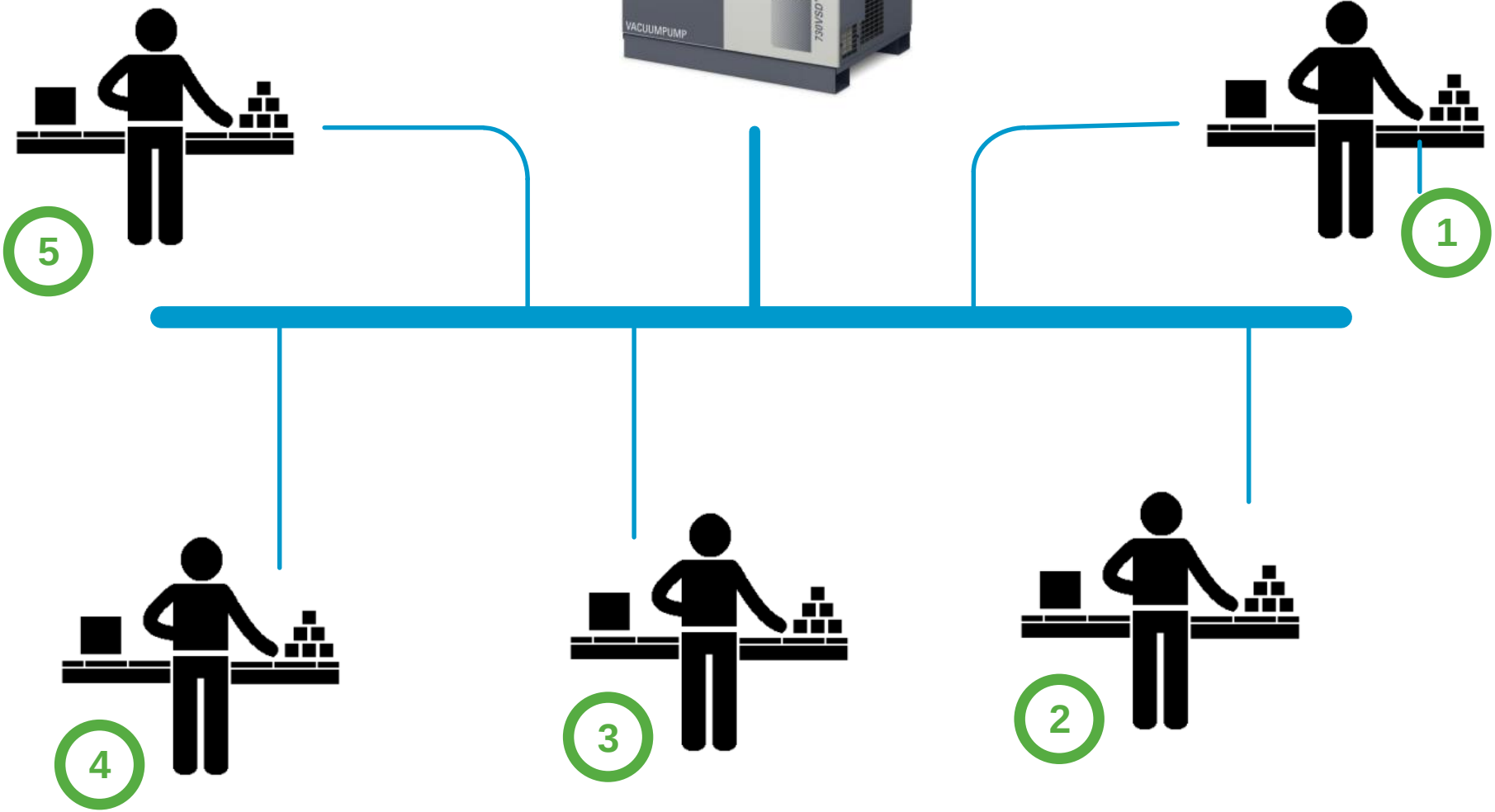
CENTRALIZED VACUUM - PIPING SYSTEM

Loop Pattern
with pressure equalizing lines



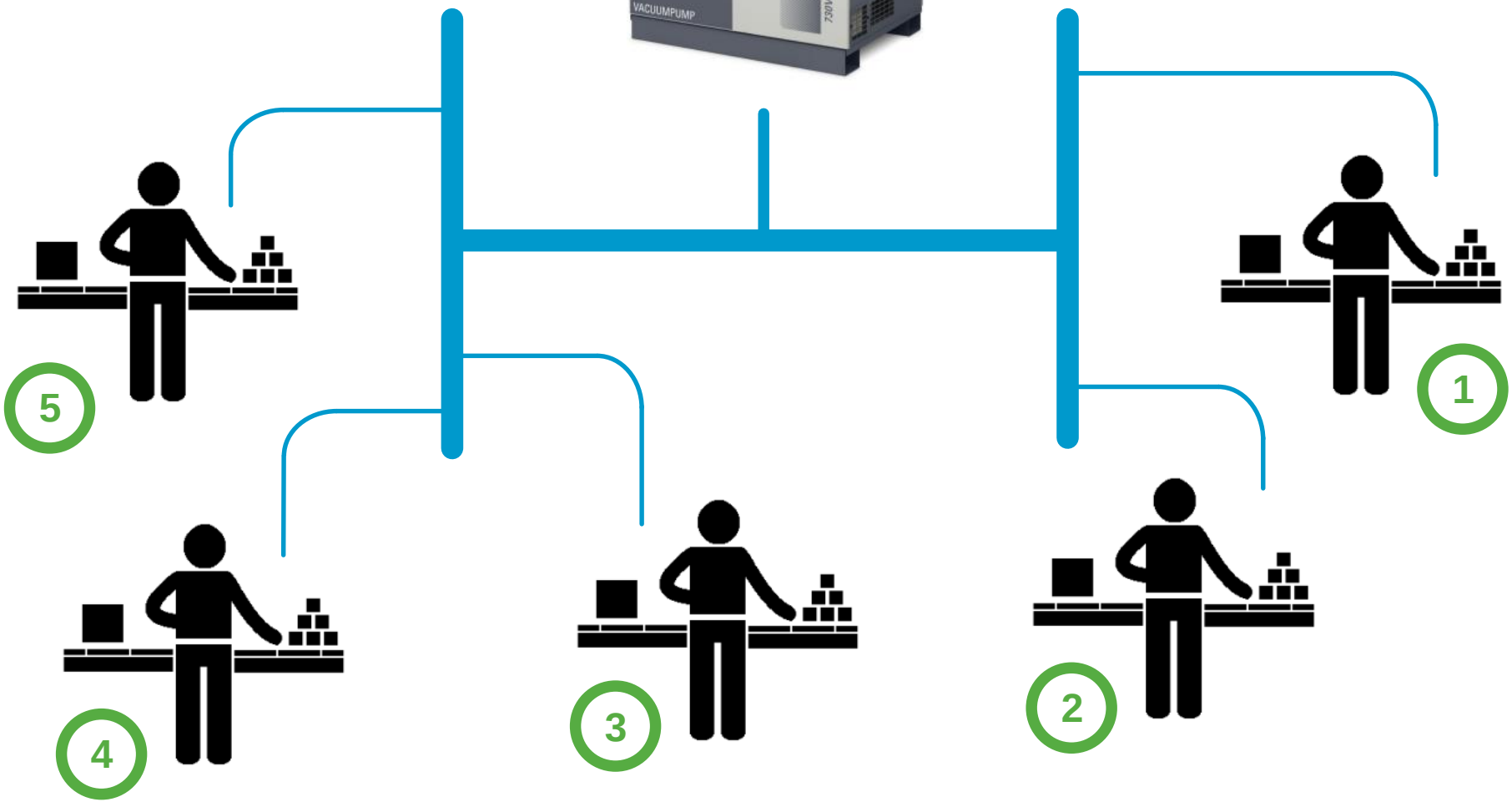
CENTRALIZED VACUUM - PIPING SYSTEM

Trunk Pattern



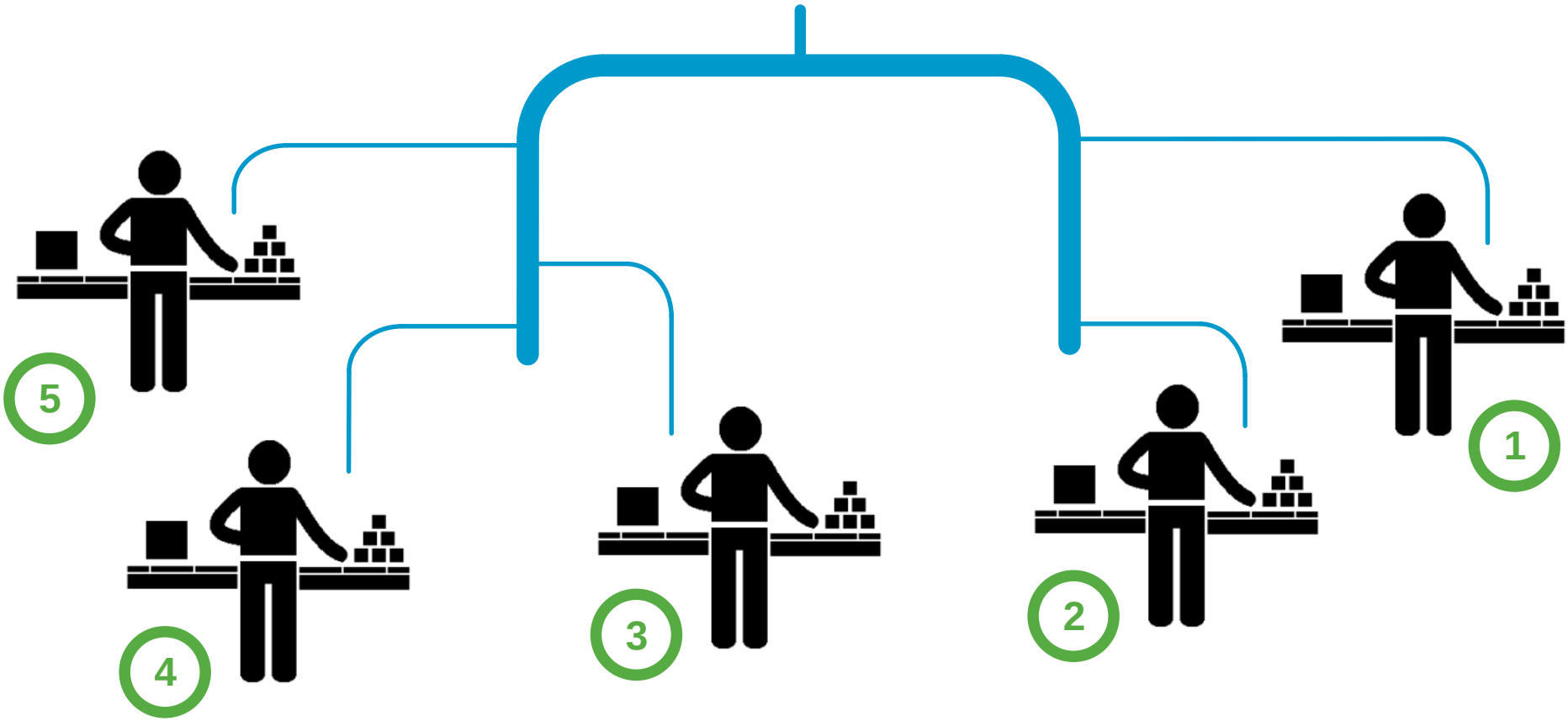
CENTRALIZED VACUUM - PIPING SYSTEM

H Pattern



CENTRALIZED VACUUM - PIPING SYSTEM

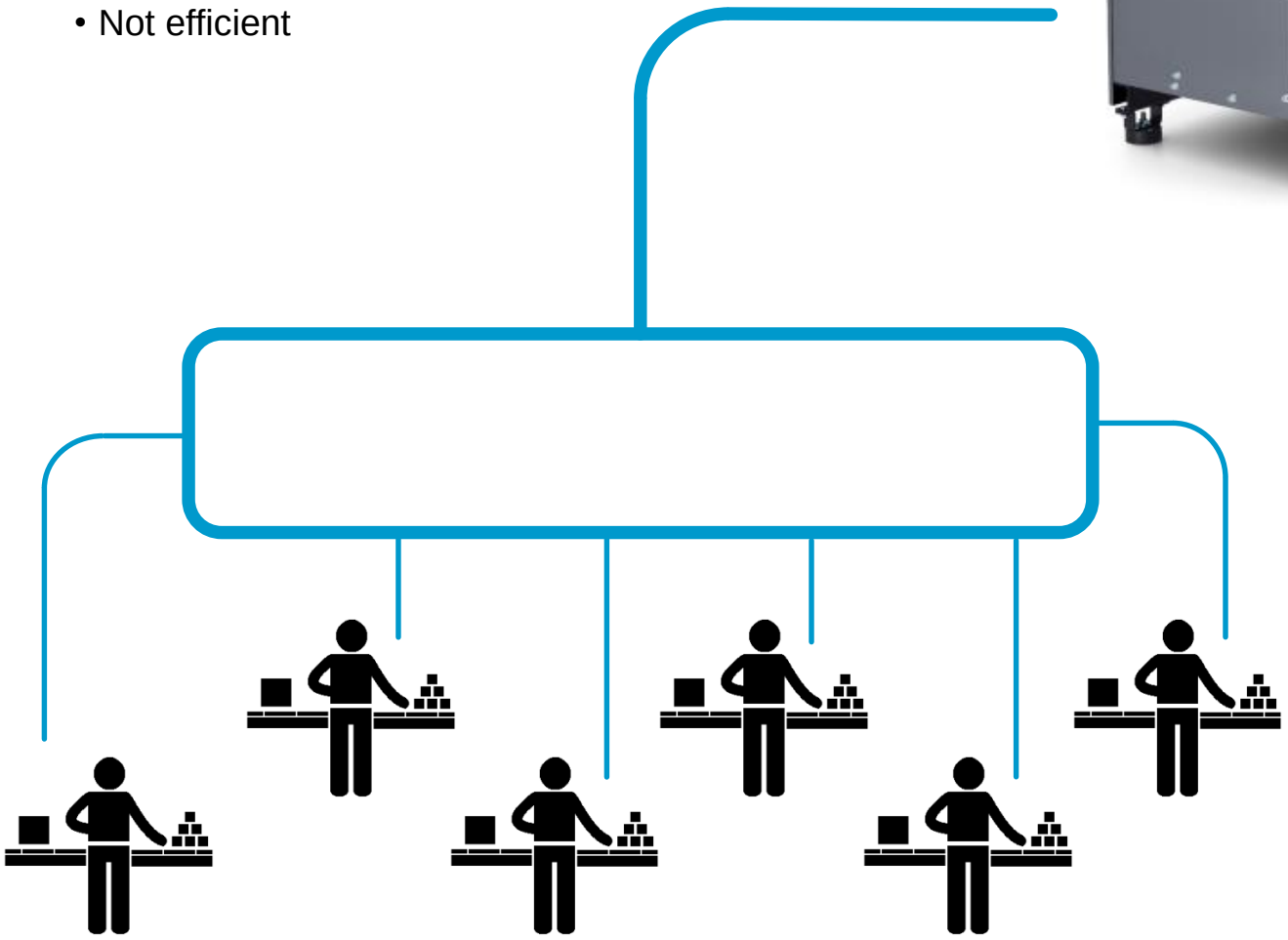
U Pattern



CENTRALIZED VACUUM – CONTROL STRATEGY

Single Fixed Speed Pumps

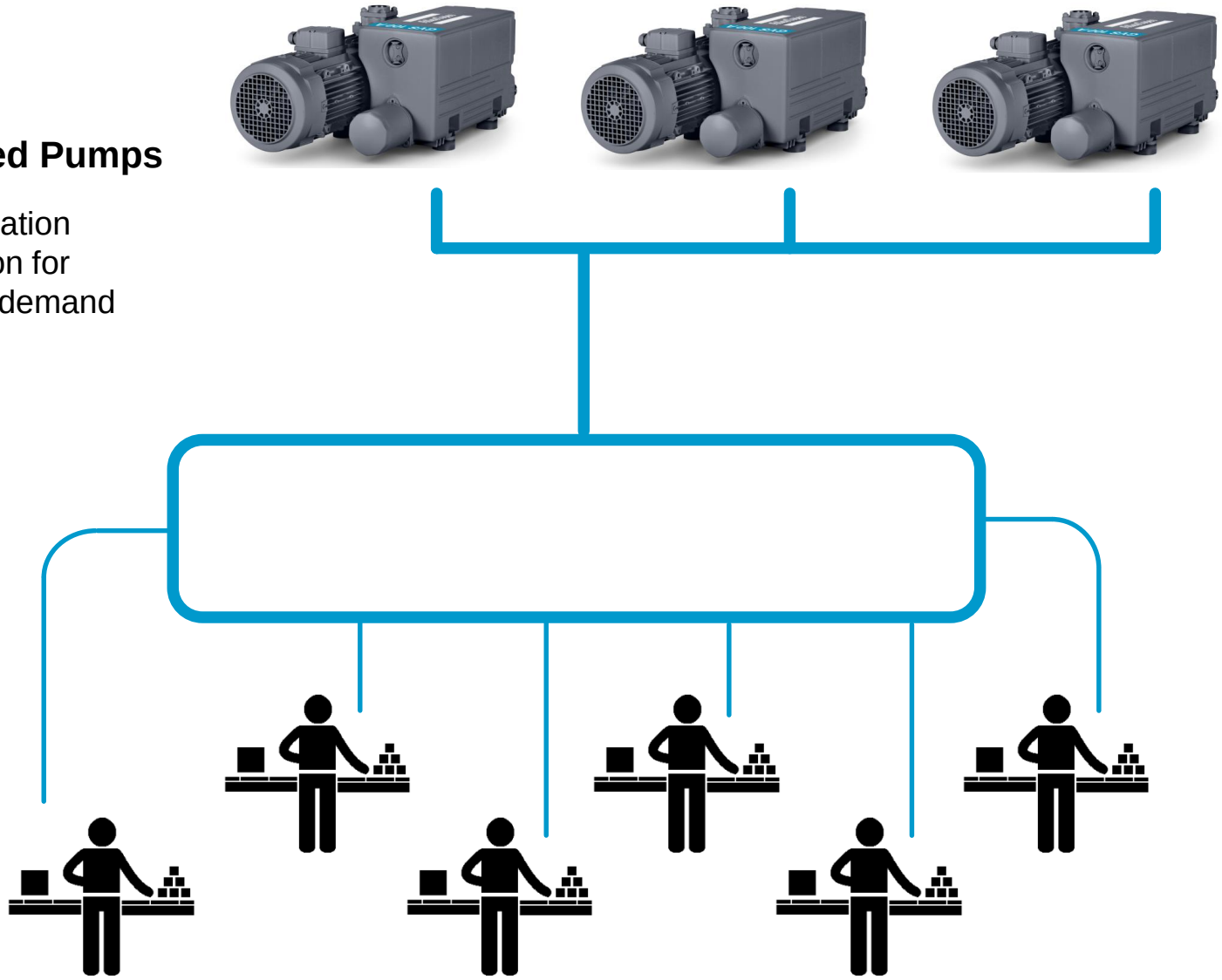
- Inconsistent pressure
- No redundancy
- Not efficient



CENTRALIZED VACUUM – CONTROL STRATEGY

Multiple Fixed Speed Pumps

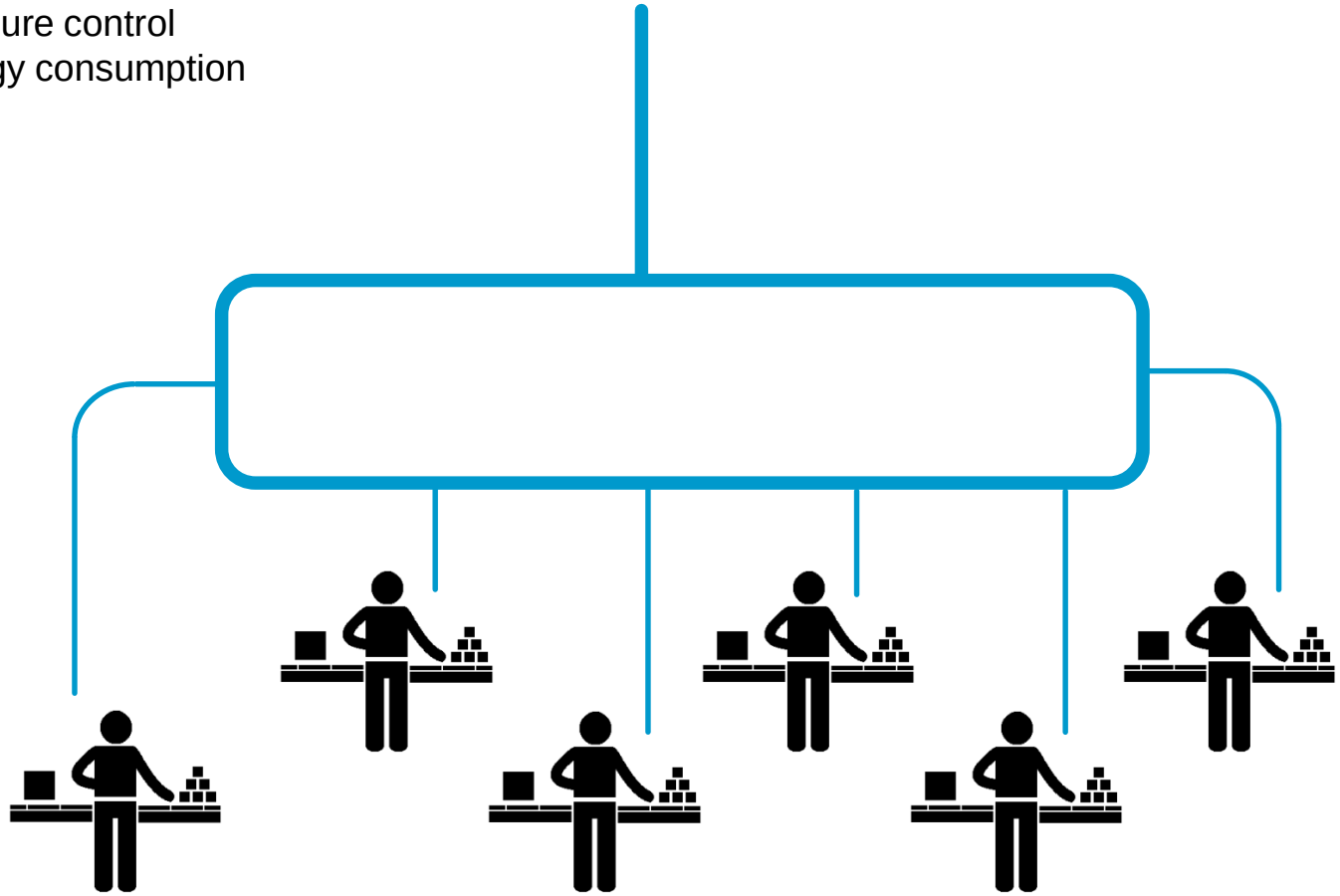
- Redundancy/alternation
- Not the best solution for balancing variable demand



CENTRALIZED VACUUM – CONTROL STRATEGY

Single VSD Pump

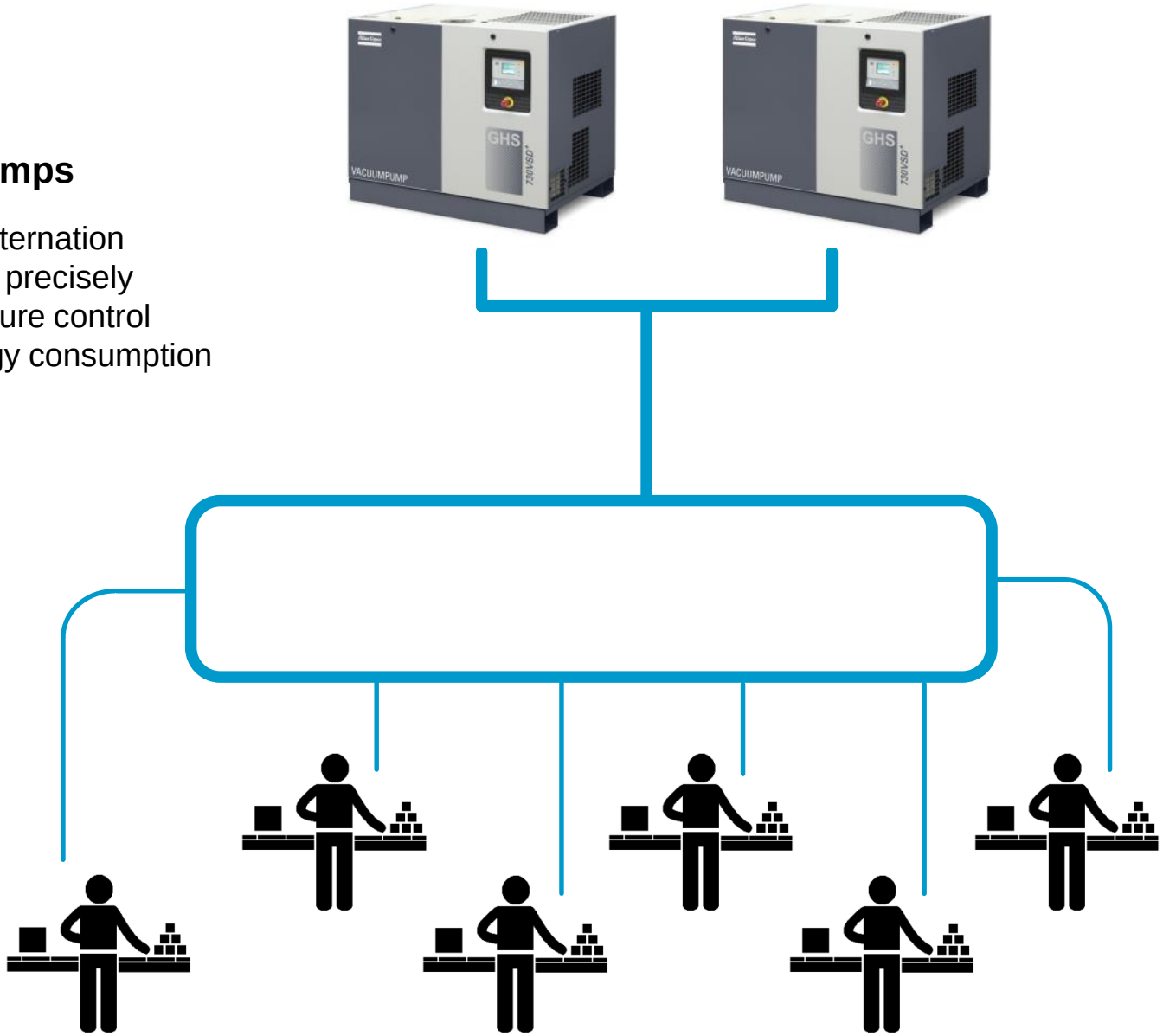
- Match demand precisely
- Accurate pressure control
- Reduced energy consumption



CENTRALIZED VACUUM – CONTROL STRATEGY

Multiple VSD Pumps

- Redundancy/alternation
- Match demand precisely
- Accurate pressure control
- Reduced energy consumption



Thank you!

Walter See

Product Marketing Manager

Industrial Vacuum Division

Atlas Copco Compressors LLC

412-605-2261

walter.see@us.atlascopco.com

www.atlascopco.us

COMMITTED TO SUSTAINABLE PRODUCTIVITY

BLOWER & VACUUM BEST PRACTICES

blowervacuumbestpractices.com

Pros & Cons of Centralized Vacuum Systems

Q&A

Please submit any questions through the Question Window on your GoToWebinar interface, directing them to Blower & Vacuum Best Practices Magazine. Our panelists will do their best to address your questions, and will follow up with you on anything that goes unanswered during this session. **Thank you for attending!**

Sponsored by

BUSCH Vacuum Pumps and Systems

Atlas Copco

For your free subscription, please visit www.blowervacuumbestpractices.com/magazine/subscription.

BLOWER & VACUUM BEST PRACTICES

blowervacuumbestpractices.com

Thank you for attending!

The recording and slides of this webinar will be made available to attendees via email later today.

PDH Certificates will be e-mailed to Attendees within two days.

Sponsored by

BUSCH Vacuum Pumps and Systems

Atlas Copco

For your free subscription, please visit www.blowervacuumbestpractices.com/magazine/subscription.

BEST PRACTICES

2018 EXPO SEPTEMBER 17-19 CHICAGO O'HARE, IL

COMPRESSED AIR / VACUUM / COOLING

CABPEXPO.COM

THE INAUGURAL 3-DAY CONFERENCE & EXPO!

IMPROVING PLANT PROFITABILITY THROUGH INDUSTRIAL UTILITY OPTIMIZATION

Industry self-provides the key industrial utilities of compressed air, vacuum, blower and cooling. BEST PRACTICES 2018 EXPO focuses on the significant opportunities presented by these inter-related utilities, **to reduce kW and water intensity – per unit of production.**

For more information and registration, please visit **www.cabpexpo.com.**

Date

September 17-19, 2018

Location

Chicago O'Hare Crowne Plaza Hotel

COMPRESSED AIR
BEST PRACTICES
airbestpractices.com

March 2018 Webinar

Safe Quality Food Standard: 5 Compressed Air Criteria

Sponsored by

TRACE Analytics
the compressed air testing experts

BEKO

Phil Kruger
Harris Equipment
Keynote Speaker

Tuesday, March 20, 2018 – 2:00 PM EST
Register for free at
www.airbestpractices.com/magazine/webinars