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Medical Vacuum

Choosing the Technology

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Topics of Discussion

- Sizing of Vacuum
- Combined and Dedicated Systems for Vacuum and WAGD
- Features/Benefits of different technologies
- HEPA Filters

Codes

NFPA 99: Health Care Facilities –

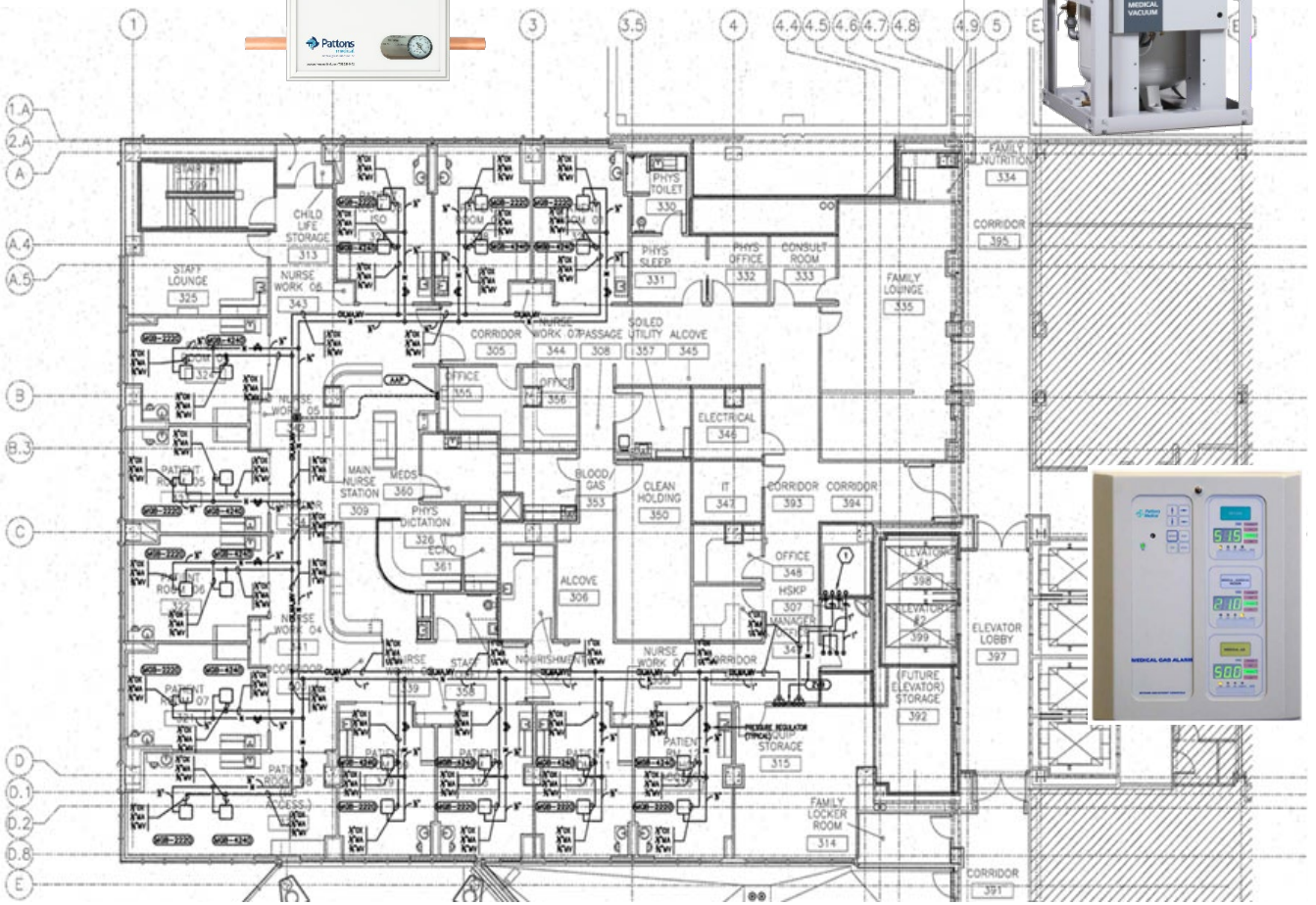
Complete rules for the safe application of electrical systems, gas and vacuum systems, and environmental systems, along with materials and emergency management practices.

The 2018 edition has the most recent developments in medical equipment and processes as well as new methods to reduce fire, explosion, and electrical hazards.

Medical Vacuum Delivery

Facilities can use a Medical Vacuum Package to provide Medical Vacuum.

The vacuum is delivered through distribution piping system that ends with a medical vac or WAGD (Waste Anesthesia Gas Disposal) outlet in the room.



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Medical Vacuum Outlets

Outlet locations and quantities are governed by American Institute of Architectural (AIA) Guidelines for Design and Construction of Hospitals and Healthcare Facilities

Medical WAGD Outlets

WAGD outlets are required where N2O is being administered

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Definition: VACUUM

Medical Vacuum is

typically used for evacuation in surgical procedures. Also found for suction of patients in the ICU. Found in same facilities as medical air. Operates at 22-24" Hg

WAGD Vacuum is

Waste Anesthetic Gas Disposal is the evacuation of patient exhalation from being sedated with Nitrous Oxide.

Lab Vacuum is

normally a less stringent variation of medical vacuum

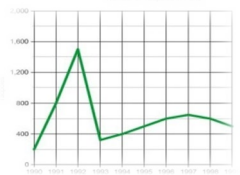
used in industrial laboratories, clinical laboratories, universities, and health testing facilities

Dental Vacuum (Oral EVAC) is

Provides the dental units with a suction action used for the removal of particles, debris and liquids from the oral cavity. Does not pull as deep a suction as medical vacuum. Only 10- 12"Hg

Factors that determine the "Best Technology for the Application"

- What will the demand profile of the facility look like?
  - Constant demand ?
  - Low/High Peaks



- NFPA requires "worse case" scenario sizing. Results in "oversized" systems
- Is the facility going to have a Vac and WAGD combined systems or separate systems
- What about sustainability of the facility?
- What are the maintenance practices?
- Are there energy considerations?
- What is the budget criteria, willing to invest?
- Any upcoming construction projects

Dedicated WAGD Vacuum Pumps must be Claw

Vacuum and WAGD combined Vacuum Systems

- Using 1 Vacuum Pump to pull suction for both the medical vacuum and WAGD lines
- Scenarios allowed by NFPA 99 for Combined Systems
  - Combining the Vacuum line and WAGD line outside the OR going through 1 valve in the ZVB and 1 line going to vacuum pump
  - Bringing both the Vacuum line and WAGD line through separate valves in the ZVB then combining in 1 line back to the 1 Vacuum Pump
  - Bringing both the Vacuum line and WAGD line through separate valves in the ZVB running both back to the 1 Vacuum Pump and combining at the pump.

The Oxygen Concentration of the Combined Line has to be less than 23%

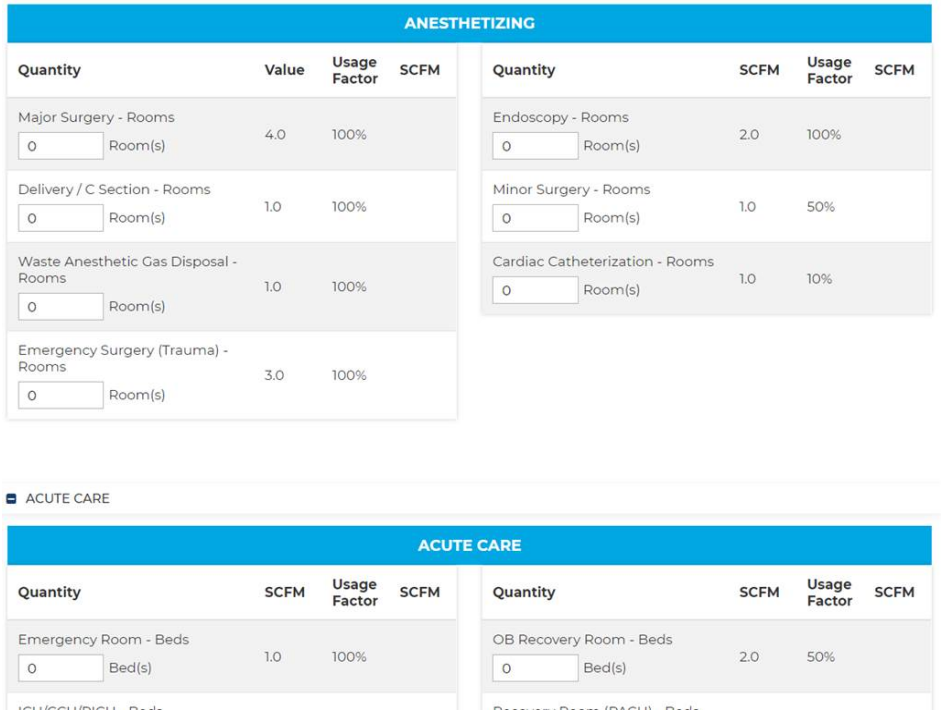
Calculating the Demand

Many studies have been done determining the load required for medical vacuum pumps.

The sizing can be calculated using several methods.

The U.S. Typical method is the standard calculation for medical vacuum in the United States. To calculate by this method the following steps are taken:

1. Count all outlets which will be served by this system by occupancy.
2. Multiply by simultaneous use factor
3. Add the sum of all occupancy



ANESTHETIZING

Quantity	Value	Usage Factor	SCFM
Major Surgery - Rooms: 0 Room(s)	4.0	100%	
Delivery / C Section - Rooms: 0 Room(s)	1.0	100%	
Waste Anesthetic Gas Disposal - Rooms: 0 Room(s)	1.0	100%	
Emergency Surgery (Trauma) - Rooms: 0 Room(s)	3.0	100%	

Quantity	SCFM	Usage Factor	SCFM
Endoscopy - Rooms: 0 Room(s)	2.0	100%	
Minor Surgery - Rooms: 0 Room(s)	1.0	50%	
Cardiac Catheterization - Rooms: 0 Room(s)	1.0	10%	

ACUTE CARE

ACUTE CARE

Quantity	SCFM	Usage Factor	SCFM
Emergency Room - Beds: 0 Bed(s)	1.0	100%	

Quantity	SCFM	Usage Factor	SCFM
OB Recovery Room - Beds: 0 Bed(s)	2.0	50%	

Calculator found on
https://www.pattonsmedical.com/design-expert/

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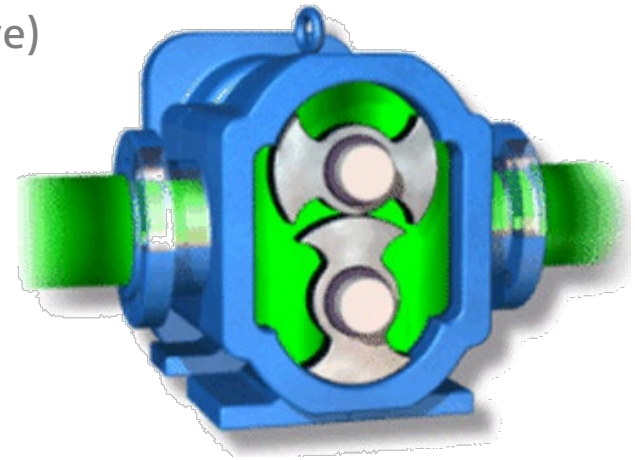
Traditional Vacuum Technologies

- Contactless Claw
- Lubricated Rotary Vane
- Dry Rotary Vane
- Liquid Ring

Contactless Claw Technology

Key Considerations:

- Gear Oil Replacement
- Good candidate for VFD (energy efficiency alternative)
- Vacuum Level considerations 24"Hg
- Low Maintenance
- Higher Cost of Equipment
- Noise Considerations
- WAGD evac pump if Fomblin is utilized



Synchronizing Gear Oil	Weekly 5,000 hours/Annually	Check oil Change oil
Pump Bearings 2-8.7 hp 15 hp	 Not Required 6 months	 Not required Grease B side bearings
Motor Coupling	Annually	Remove motor to inspect coupling for wear. Replace as needed.

Medical Vac – Oil-Less Rotary Claw Space Saver

- ✓ NFPA 99 Compliant
- ✓ 2 – 10 hp
- ✓ Single Point Connection
- ✓ HMI Controls
- ✓ Lowest Maintenance Cost
- ✓ Ease of Maintenance with accessible drain
- ✓ Variable Frequency Drive
- ✓ O_2 Safe Available

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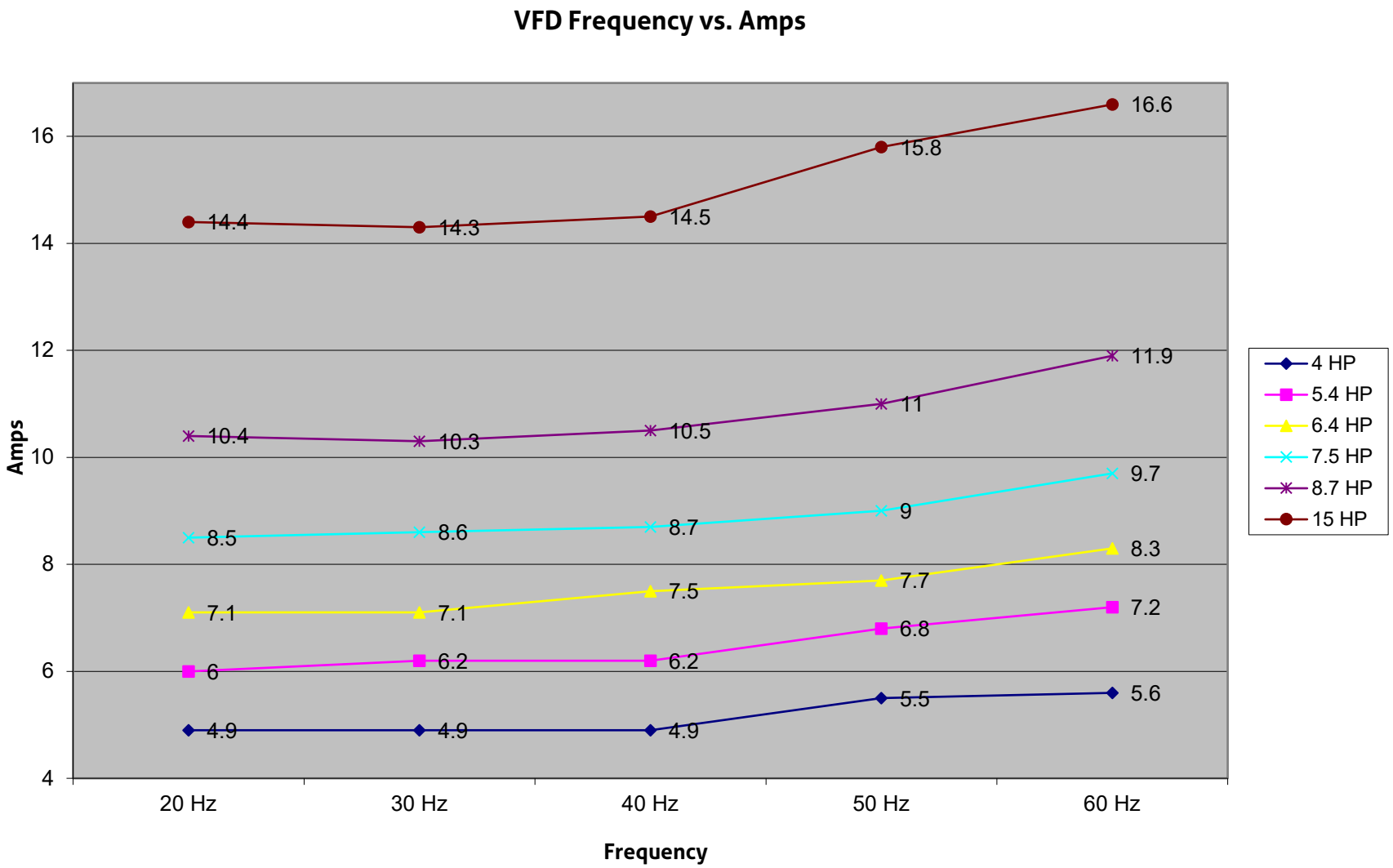
BENEFITS OF VFD WITH CLAW VACUUM

Medical Vacuum – VFD Controls

- 1 VFD per system
- Lower energy costs by adjusting speed to match vacuum demand
- Soft start ramps motor gradually to reduce in rush current and extend the coupling and motor life
- Lower noise levels
- Lower operating temperature
- Reduces generator size requirements
- Network connection from PLC to VFD
- Backup failure mode

Medical Vacuum – VFD Controls (Claw)



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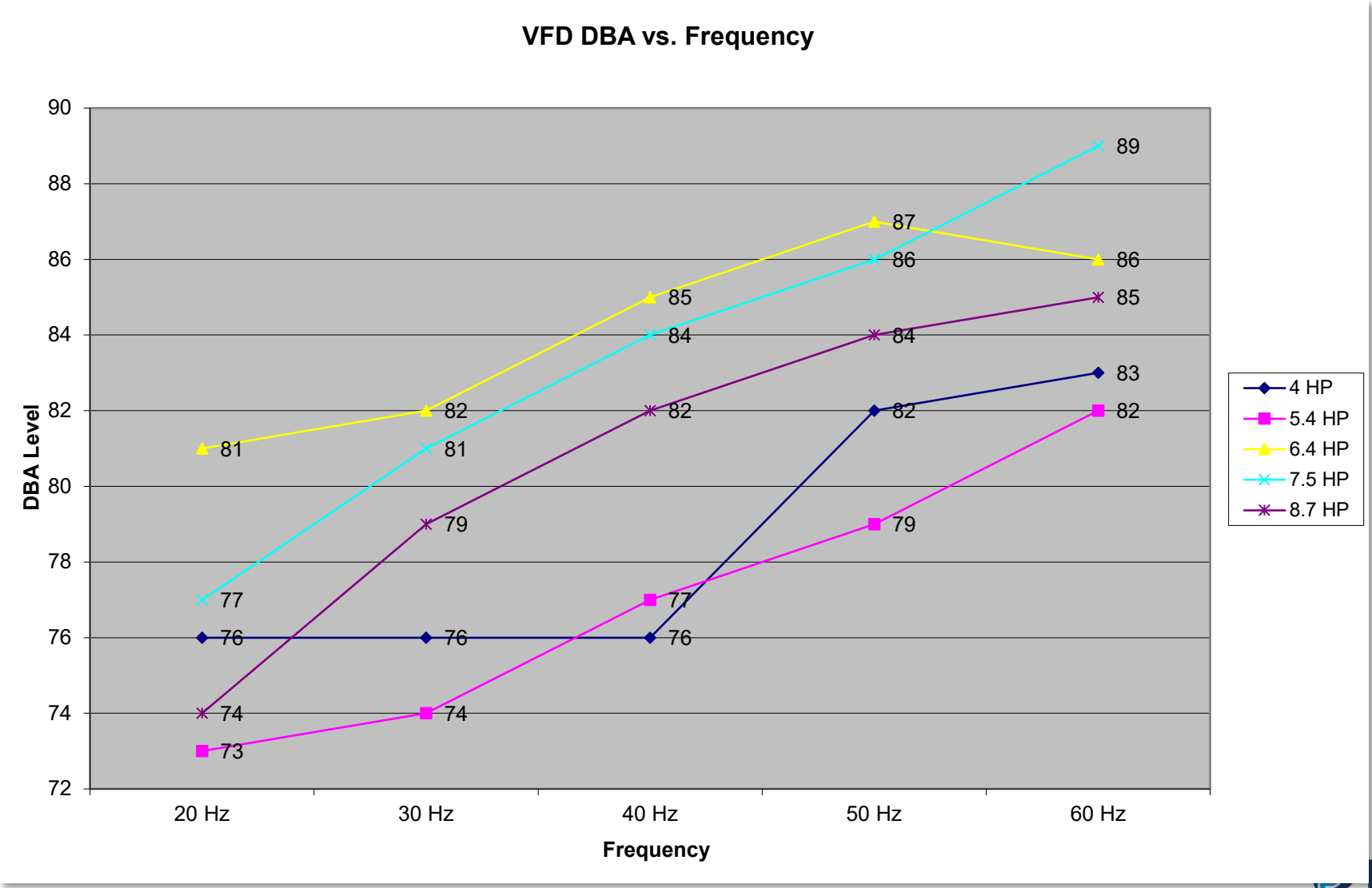
Medical Vacuum – VFD Controls (Claw)



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VFD Savings

Customer: Customer Name
AREA: Project Name

Enter the data in the Blue boxes and the rest of the sheet will calculate automatically. This chart does not reflect the additional savings from reducing the heat load caused by the motors excess energy usage.

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Patton's Medical VFD Energy Analysis

Existing System:

Existing Motor if Different than one replacing	7.5	Full nameplate Horsepower rating of the motor being used for calculation

Proposed System:

Full Horsepower	4	Full nameplate Horsepower rating of the motor being used for calculation
Full RPM	3600	Full nameplate RPM rating of the motor being used for calculation
Hertz	60	Frequency of supplied electrical power - usually 60hz
Motor Efficiency	85.00%	Motor efficiency rating
Cost of VFD	$3,275.00	Cost of the VFD
Cost of KWH	$0.095	Cost per KWH of electricity at the facility
Daily Hours of Operation	24	Hours of daily operation of the motor.

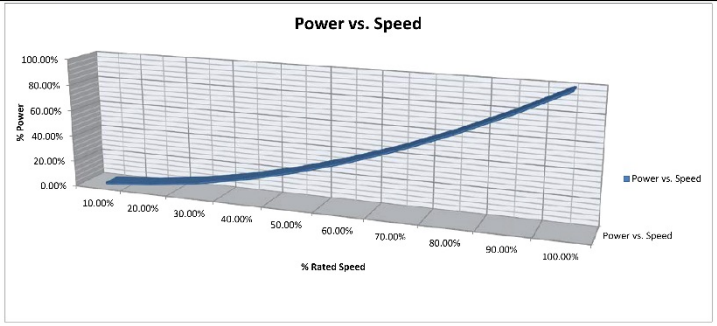
Existing System (no VFD):

Percent of Full RPM	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
HP_full	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Calculated HP	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500	7.500
Annual KWH	57661.41	57661.41	57661.41	57661.41	57661.41	57661.41	57661.41	57661.41	57661.41	57661.41
Annual Cost	$5,477.83	$5,477.83	$5,477.83	$5,477.83	$5,477.83	$5,477.83	$5,477.83	$5,477.83	$5,477.83	$5,477.83

Proposed System (with VFD):

Percent of Full RPM	10.00%	20.00%	30.00%	40.00%	50.00%	60.00%	70.00%	80.00%	90.00%	100.00%
Calculated RPM	360	720	1080	1440	1800	2160	2520	2880	3240	3600
RPM_full	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
(Calculated RPM / Full RPM)^2	0.01	0.04	0.09	0.16	0.25	0.36	0.49	0.64	0.81	1
Calculated HP	**0.040**	**0.160**	**0.360**	**0.640**	**1.000**	**1.440**	**1.960**	**2.560**	**3.240**	**4.000**
Power Usage	1.00%	4.00%	9.00%	16.00%	25.00%	36.00%	49.00%	64.00%	81.00%	100.00%
Power Savings	99.00%	96.00%	91.00%	84.00%	75.00%	64.00%	51.00%	36.00%	19.00%	0.00%
VFD Output Hz	6	12	18	24	30	36	42	48	54	60
Annual KWH with VFD	307.53	1230.11	2767.75	4920.44	7688.19	11070.99	15068.83	19681.76	24909.73	30752.75
Annual Cost with VFD	$29.22	$116.86	$262.94	$467.44	$730.38	$1,051.74	$1,431.54	$1,869.77	$2,366.42	$2,921.51
Annual Savings with VFD	**$5,448.62**	**$5,360.97**	**$5,214.90**	**$5,010.39**	**$4,747.46**	**$4,426.09**	**$4,046.29**	**$3,608.07**	**$3,111.41**	**$2,556.32**
Break-Even payback in Years	**0.60**	**0.61**	**0.63**	**0.65**	**0.69**	**0.74**	**0.81**	**0.91**	**1.05**	

Not knowing the demand profile certain assumptions are left up to the facility as to how much demand fluctuates. We control claw vacuum pump speeds from 25Hz-full speed (60Hz). You can make a number of assumptions from the highlighted area as a possible savings and potential payback for the VFD Option.



VFD Controls and Energy Savings Opportunities

Key Considerations:

- One VFD per system
- Inherent soft start/stop, easier on mechanical system
- Fail-safe backup schema
- 25Hz min run frequency for cooling reasons

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Lubricated Rotary Vane Technology

Key Considerations:

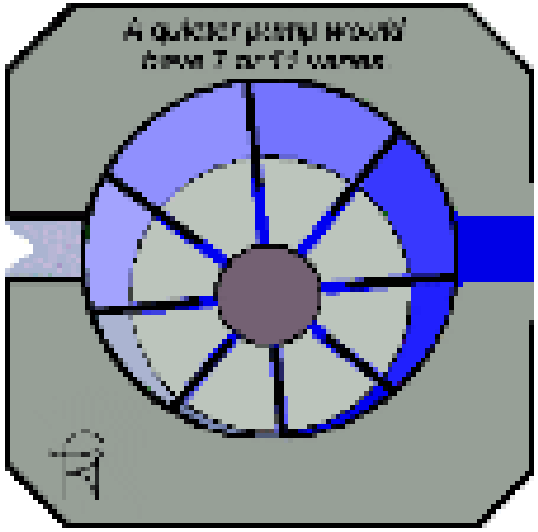
- Lower Maintenance Required on Vanes
- Deeper Vacuum Levels achieved
- Affordable Pump
- Relatively Quiet Operation
- Not allowed as WAGD evac pump by code

Replace Oil Every 1,000 hrs.

Dry Rotary Vane Technology

Key Considerations:

- Medium Maintenance Required on Vanes
- Depth of Vacuum a factor
- Quiet Operation

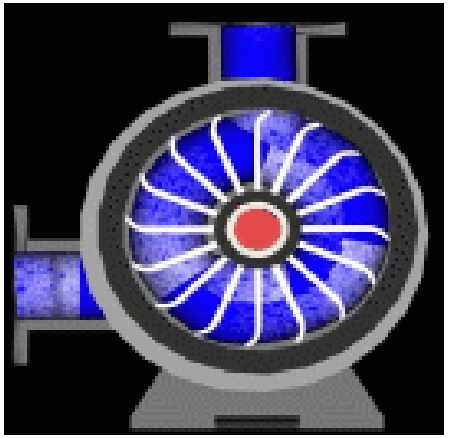


Regular check of vane width	Every 2000 hrs	Check width of vanes. Ref. vane chart for minimum width. Replace is below minimum
Coupling	5,000 hrs or 2 years	Remove motor to inspect coupling for wear. Replace as needed.

Liquid Ring Technology

Key Considerations:

- Low Maintenance
- Water Quality critical to lower maintenance
- Utility cost of water
- Quiet Operation
- Mostly seen in lab application anymore



Review of Vacuum Technologies

Technology	Cost ($/CFM)	Life Span (hours)	Noise	Maintenance Cost	Energy Consumption (CFM/HP)	Additional Considerations
Dry Vane	390	10,000+	79dB	High	4.3	Altitude considerations
Lube Vane	264	10,000+	79dB	Medium	6.9	Good choice for deeper Vacuum
Contactless Claw	330	20,000	85dB	Low	8.7	Altitude considerations
Liquid Ring	594	30,000+	76dB	Low	4.2	Good choice for deeper Vacuum

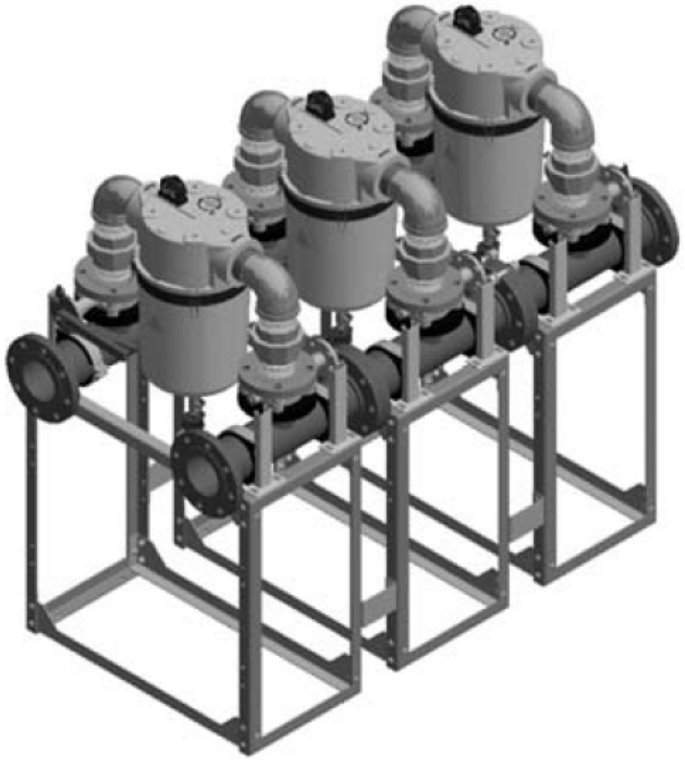
Assumptions:

- Based upon equipment costs not installed cost
- Prices ONLY for comparison of technologies
- Used 7 ½ Hp for comparison

NFPA 99 2018 Addition of HEPA Filters

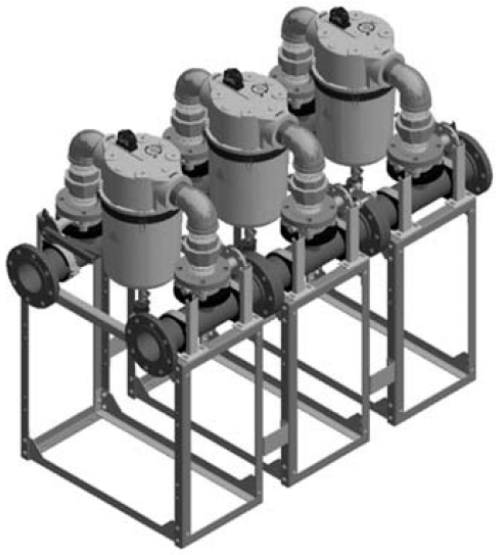
What does code say?

- Filtration must be duplexed
- Location must be patient side of Vacuum producer
- Filters shall be efficient to 99.97
- Sized for 100% peak calculated demand
- Multiple filters may be grouped to achieve scfm
- Must be redundant and have valves available for isolation for of filters for service while maintaining filtration



Pattons Medical HEPA Filters

- 99.995% efficient – exceeds code
- 2" Filter: 140 scfm/filter
- 3" Filter: 226 scfm/filter
- Combined end to end to fit flow needs
- Minimized contaminants in the oil and the environment



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Sizing Scenarios for HEPA Filters

Using a 5HP Duplex Claw with 38scfm

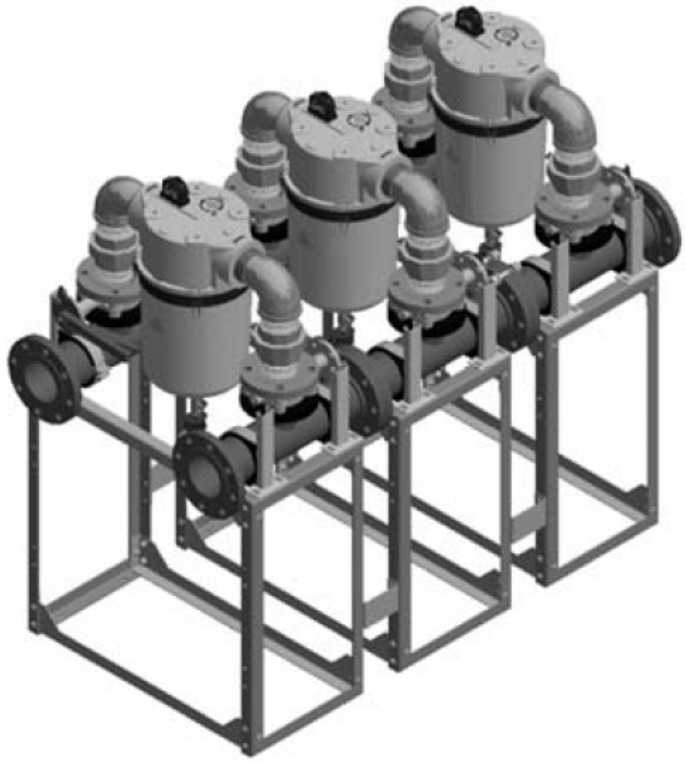
•The 2" Filter: 140 scfm/filter – duplexed

Using a 15HP Quadraplex Claw with 387 scfm

•The 3" Filter: 226 scfm/filter

•387/226 = 1.7

•Need a triplex 3" to allow for redundancy



Lab Vacuum

- Dry rotary claw, lubricated rotary vane and liquid ring vacuum technologies
- Automatic purge system on all pumps for protection and long life
- Multiple configurations in fully packaged systems
- Variable frequency drive option

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Dental Vacuum

- Oil-free Turbine type
- VFD
- Not as deep as vacuum as medical
- Code requires an amalgam separator
- Sizing Based on number of chairs, hygienists, and dentists
  - Hygienists ½ a user
  - Dentists 1 user
  - Multiply # of users for sizing chart

Meet our Medical/Lab Consultants:

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When replacing equipment or expanding, it's important to meet with a medical gas specialist to conduct a medical gas survey. Our team can confirm the outlet counts, interview respiratory therapist, ensure your equipment meets NFPA code, and answer any questions you may have.

Find your rep at https://www.pattonsmedical.com/sales-representative-search/

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Thank You

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