VitalAire®

Healthcare

DESIGN GUIDE

BUSCH

Vacuum Pumps and Systems

Medical Air & Medical Vacuum Systems

PREFACE

As part of VitalAire's dedication to the Canadian medical gas systems market, we are pleased to offer this design Guide to our customers and their consulting engineers as a resource for the design, specification, and installation of Busch Medical Vacuum and Air source systems, as sold exclusively by VitalAire Canada Inc.

To supplement this guide and provide assistance for all your medical gas systems (MGS) needs, VitalAire maintains offices across Canada staffed with MGS specialists; please do not hesitate to contact the VitalAire MGS office nearest you:

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Quebec 514.493.0721

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British Columbia 604.444.1195

GETTING STARTED

This Design Guide references many codes and standards. To compliment this document and ensure a fully compliant installation, we recommend obtaining copies of the following in addition to all other jurisdictionally relevant Building Codes and Standards:

- ✓ CAN CSA Z305.1-92 Nonflammable Medical Gas Piping Systems
- ✓ CAN CSA B51 *(latest edition)* Boiler, Pressure Vessel, and Pressure Piping Code
- ✓ CAN CCSA C22.1 *(latest edition)* Canadian Electrical Code, Part 1
- ✓ CAN CSA Z32.4 *(latest edition)* Essential Electrical Systems for Hospitals
- ✓ CAN CSA Z305.3 *(latest edition)* Pressure Regulators, Gauges, and Flow-Metering Devices for Medical Gas Systems
- ✓ Health Canada Food and Drugs Act

Prior to commencing a medical gas systems project, we also recommend researching the special permit requirements that may be applicable in your jurisdiction (ie. Medical Gas Permits are required for all medical gas systems work, including renovations, in the Province of Alberta).

Finally, to assist in determining site-specific optimal source end vacuum, O/M manuals for the suction regulators utilized are required.

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DEFINITIONS

ACFM	Actual cubic feet per minute (ACFM) is an expression of actual air volume, generally corrected for and referenced to a particular pressure.
Continuous Duty	Operational reference to pumps operating 24 hours a day, continuously.
Continuous Duty Rated	Reference to pumps capable of operating 24 hours a day, continuously, if required, but which under normal circumstances operate on demand.
Displacement	Theoretical physical volume of the air in the pump chamber based upon 100% pumping efficiency, with no allowances made for heat, friction, clearances, or other losses in the compression cycle.
Dewpoint	Temperature and pressure at which medical air will condense water vapour into liquid water within the medical air pipeline system.
Duplex System	Systems comprised of two (2) pumps, each rated for 100% Peak Calculated Load (PCL).
Intermittent Duty	Reference to pumps not capable of operating continuously (ie. pump design requires periodic shut-down for cooling or oil transfer).
Peak Calculated Load	The maximum estimated demand a facility will place on a particular medical gas/vacuum system.
NTP	NTP is a reference to "Normal Temperature and Pressure", generally accepted as 70^{o}F (20^{o} C), 14.696 psi/29.92" Hg barometric pressure, and 36% Relative Humidity.
SCFM	Standard cubic feet per minute (SCFM) is an expression of air volume at NTP.
Simultaneous Demand	Operating reference to a condition where all pumps (ie. lead pump(s) and lag pump) run simultaneously to satisfy demand in excess of lead pump(s) capability.
Source End Vacuum	The vacuum (negative pressure) level required at the vacuum system source in order to provide the vacuum level at terminal units (outlets) required by the specific suction regulators utilized in the facility.
Triplex System	Systems comprised of three (3) pumps, each rated for 50% Peak Calculated Load (PCL).
TMPD	Thermal Malfunction Protection Device. A medical air system safety feature designed to shut down an air compressor at a pre-set temperature limit.
Quadraplex System	Systems comprised of four (4) pumps, each rated for 33% Peak Calculated Load (PCL).

SYSTEM SELECTION

Selecting the best medical air and/or vacuum systems is a site-specific endeavour, requiring input from facility engineering, medical staff, and facility planning. Optimum sizing involves both quantitative and qualitative analysis.

The following steps describe an orderly process for determining Peak Calculated Load (PCL) and system selection:

1. Review building space programming (*new facilities*) or consult with facility engineering (*existing facilities*) to determine all relevant site conditions, including elevation, power availability, capacity of the emergency power generator system, pressure drop (*existing vacuum pipelines*), installation space availability, and ingress (*existing facilities*).

2. Audit room, bed, and outlet numbers and calculate a *baseline* PCL using Tables 2, 3, and 4 of the CAN CSA Z305.1 *(sample consolidated tables follow)*.

3. Through consultation with medical staff, audit site-specific usage and adjust the PCL accordingly. The CSA Z305.1 Tables are based upon average usage patterns and therefore provide a baseline PCL only. It is important to fully understand the various uses of medical air and/or medical vacuum particular to your facility, and adjust load estimates accordingly. For example, some O.R. procedures and equipment are not typical of all healthcare facilities, and consume extraordinary volumes of medical air (ie. jet insufflators), and some facilities may be designated as regional Trauma Centres, and given their typical case types and loads may require more than 85 lpm of vacuum capability per trauma room (ie. ability to operate multiple suction regulators at “Full Line” per trauma room).

4. Confirm future expansion requirements with facility planning, and adjust the PCL accordingly.

5. For medical vacuum systems it is very important to confirm Source End Vacuum. Medical air systems operate based upon storage vessel pressure fluctuations and deliver a consistent, regulated pipeline pressure. Conversely, medical vacuum systems operate based upon fluctuating vacuum levels across the entire pipeline. All regulators utilized for suction procedures are factory calibrated at a specific vacuum level, and depend on a consistent vacuum level for reliable performance. In particular, intermittent suction regulators incorporate vacuum controlled timing mechanisms. For these units to operate within specification, the vacuum level indicated in their O/M manual’s performance tables must be provided at the terminal unit. As such, to provide the optimal average vacuum level in your pipeline it is important to confirm the site-specific Source End Vacuum. See *Conversion Tables & Formulas* for a step-by-step procedure.

6. Compensate for altitude. All pump and compressor performance data is expressed at NTP; a condition that exists at sea level. As altitude increases, air density decreases, and therefore the PCL needs to be adjusted. For air compressors installed above 6,000 feet elevation, consult with VitalAire for an appropriate system selection. For medical vacuum, using Tables “A” & “B”, and the vacuum adjustment formula in *Conversion Tables & Formulas*, adjust your calculated PCL to reflect the installation altitude.

7. Reference the Busch Medical Vacuum & Air System Engineering Data, and make a system selection that satisfies your PCL and other site conditions noted in Step 1.

SAMPLE SYSTEM SELECTION – MEDICAL VACUUM

1. Site conditions. Existing facility with a triplex 10 Hp (3 phase power source) system to be replaced. Space available for new system is approximately 90" x 50" with a 10' ceiling clearance and ingress double-door open width of 60". Customer uses Allied Vacutron suction regulators, all of which are factory calibrated to 18" Hg vacuum. Measured pressure drop across existing pipeline is 2" Hg. The facility is located 3,500 feet above sea level, where the normal barometric pressure is approximately 26" Hg. Customer wishes to implement a new system designed to re-use existing power feeds, thus minimizing installation costs (ie. avoid upgrade to MCC breaker and emergency power generator).

2. Using CSA Z305.1 Table 3, a baseline PCL of 35 SCFM is determined.

3. Medical staff advises that no special suction requirements are applicable.

4. Facility planning advises that a near term renovation is planned which will result in the addition of one more trauma room. Add a future expansion allowance of 3 SCFM, bringing PCL to 38 SCFM.

5. Based upon the site-specific data, the calculated minimum acceptable Source End Vacuum (P_O) is 24.75" Hg

6. Peak calculated load adjusted to reflect altitude (PCL_A) is 76 SCFM @ 20" Hg (sea level).

7. Pump technology review. Based upon PCL_A = 76 SCFM, P_O = 24.75" Hg, and the customer's desire to maintain a triplex configuration, two systems from the Busch selection tables may be applicable:

   a. R5 series triplex 7.5 Hp (model RA-0165), capable of 76.0 SCFM @ 20" Hg (NTP), with a continuous run end vacuum of 29.9" Hg (NTP)
   b. Mink series triplex 7.5 Hp (model MM-1202), capable of 94.4 SCFM @ 20" Hg (NTP) with a continuous run end vacuum of 27" Hg (NTP).

   Final technology selection will be based upon other factors, including projected operating and maintenance costs, noise levels, and general customer preference.

SAMPLE SYSTEM SELECTION – MEDICAL AIR

1. Site conditions. New acute care facility located in Ottawa, Ontario with 425 medical air outlets programmed. Space availability will be programmed based upon system selection. Site elevation is approximately 374 feet above sea level. Power feeds and emergency generator system will be predicated upon system selection.

2. Using CSA Z305.1 Tables 2 and 4, a baseline PCL of 93.81 CFM is determined.

3. Through consultation with medical staff no adjustment is required to the baseline PCL calculated in Step 2.

4. Through consultation with Facility Planning, it is confirmed a 38 bed long-term care centre is scheduled to commence construction concurrent with the acute care facility, with both building sharing the same medical air system. Add 8.38 CFM to PCL calculated in Step 2.

5. Compensate for altitude. Given the site-specific elevation, compensation for altitude is not required.

6. Based upon a PCL of 102.19 CFM, consideration should be given to one of the following systems:
   a. Triplex OL15X15, with a system capacity of 95.8 SCFM @ 100 psi, or;
   b. Quadraplex OL15X15 with a system capacity of 143.7 SCFM @ 100 psi.

   Following additional consultation with medical staff, it is determined that the Triplex OL15X15, which is capable of satisfying 271 air flowmeters running simultaneously at 10 lpm, with one pump on stand-by, provides ample capacity.

CAN/CSA Z305.1-92 SIZING GUIDELINES

The following tables are based upon Tables 2, 3, & 4 of CAN CSA Z305.1-92. Prior to using these tables, confirm if any amendments were made through adoption of CAN CSA Z305.1 (latest edition) in your local building code (ie. medical air calculation factors are revised in Alberta's 1997 Building Code).

Medical Vacuum Load Calculation Table

	Free air allowance expressed as L/min @ 101.3 kPa								
	per bed (LPM)	# of beds	per room (LPM)	# of rooms	per outlet (LPM)	# of outlets	simultaneous usage factor (%)	Air to be transported L/min	Total LPM Required
1 Anaesthetizing Locations									
Operating Room	-	-	100		-	-	100	100	
Cystoscopy	-	-	60		-	-	100	60	
Delivery	-	-	30		-	-	100	30	
Special Proceedures (open heart, transplants, etc)	-	-	115		-	-	100	115	
Other anaesthetizing locations	-	-	30		-	-	50	15	
Anaesthetic Gas disposal	-	-	30		-	-	100	30	
Emergency rooms (major trauma)	-	-	85		-	-	100	85	
							Total for anaesthetizing locations		**0**
2 Acute Care Locations (non-anaesthetizing locations)									
Recovery Room	40		-	-	-	-	50	20	
Intensive Care Units (except cardiac)	60		-	-	-	-	75	45	
Special Proceedure (x-ray, dialysis,etc)	-	-	40		-	-	30	12	
Emergency Rooms	30		-	-	-	-	100	30	
Cardiac Intensive Care Units	30		-	-	-	-	50	15	
Catheterization Lab	-	-	30		-	-	10	3.0	
Surgical Excision Rooms	-	-	30		-	-	10	3.0	
Neonatal ICU	30		-	-	-	-	50	15	
							Total for acute care locations		**0**
3 Subacute Patient Care Areas (non-anaesthetizing locations)									
Respiratory Care Dept.	40		-	-	-	-	10	4.0	
Patient Rooms - Medical	-	-	-	-	30		10	3.0	
Examination & Treatment Rooms	-	-	30		-	-	10	3.0	
Nurseries (normal)	30		-	-	-	-	10	3.0	
Nurseries (Premature)	-	-	-	-	30		25	7.5	
Surgical	40		-	-	-	-	15	6.0	
							Total for subacute Patient Areas		**0**
4 Other Areas									
Autopsy	-	-	-	-	60		10	6.0	
Central Supply	-	-	-	-	40		10	4.0	
Equipment/Repairs/Calibration/Teaching	-	-	-	-	40		10	4.0	
							Total for other areas		**0**
Total LPM required for facility									**0**

This table is based upon Table 3 of CAN CSA Z305.1-92, and is reproduced with permission.

Medical Air Load Calculation Table

Terminal Units Range	Actual # of Terminal Units	Avg. Flow Required (lpm)	Total Required Flow (lpm)
A. 1 - 10		25.0	
B. 11 - 25		18.8	
C. 26 - 100		12.5	
D. 101 - over		6.3	

TOTAL	0	lpm
	0.00	cfm

Notes:

a. If calculated flow for Terminal Unit Range "B" is less than 250 lpm, then a minimum Total Required Flow of 250 lpm shall apply.

b. If calculated flow for Terminal Unit Range "C" is less than 470 lpm, then a minimum Total Required Flow of 470 lpm shall apply.

c. If calculated flow for Terminal Unit Range "D" is less than 1250 lpm, then a minimum Total Required Flow of 1250 lpm shall apply.

This table is based upon Tables 2 & 4 of CAN CSA Z305.1-92, and is reproduced with permission.

CONVERSION TABLES & FORMULAS

For medical vacuum systems, vendor's commonly express a system's capacity in terms of SCFM @ 20" Hg (NTP). The system selection tables offered in this guide are consistent with that practice. If you are selecting a system for installation at sea level, and your actual end vacuum requirement is 20" Hg, you are safe in making a system selection without further analysis.

If, on the other hand, your site-specific Source End Vacuum requirement is not 20" Hg and/or your installation location is above sea level, you must adjust your peak calculated demand accordingly to ensure optimal system selection.

SITE-SPECIFIC VACUUM REQUIREMENT

Not all pumps are capable of achieving the same end vacuum, and not all sites and applications require the same level of vacuum. As such, confirming a site-specific Source End Vacuum requirement is essential to selecting a suitable pump technology. For the healthcare application, as directed by CSA Z305.1 a minimum vacuum level of 16" Hg must be present at each terminal unit (outlet), and each brand of suction regulator connected to pipeline terminal units is calibrated to a specific vacuum level. Accounting for pressure drop across the pipeline and system operation characteristics, we calculate site-specific Source End Vacuum as follows:

$$\mathbf{P_O} = P_S + P_D + CF$$

$\mathbf{P_O}$	Site-specific Source End Vacuum (continuous run basis) measured at system inlet
P_S	Brand specific vacuum level required by suction regulators used in facility (*if more than one model is used, select highest vacuum level indicated in associated O/M manuals*)
P_D	Pressure drop measured across vacuum pipeline (ie. from source to farthest terminal unit*)
CF	Correction factor to accommodate sequential pump activation – use 1.5" Hg

* *We recommend selecting terminal units where intermittent suction procedures are conducted, as intermittent suction regulators exhibit the greatest variance in performance due to vacuum levels. In particular, the factory set on/off intervals for these regulators change with varied vacuum levels. If the factory calibrated vacuum level cannot be achieved at the terminal unit, adjustment to the regulator's timing mechanism may be required for safe operation.*

COMPENSATING FOR ALTITUDE (Vacuum)

As altitude increases air density decreases, and therefore larger pumps may be required to move your Peak Calculated Load (PCL). All performance data in this guide reference NTP conditions (ie. sea level), so it becomes important to compensate for altitude prior to making pump selections. After calculating your Site-specific end vacuum requirement, perform the following steps to compensate Peak Calculated Load for altitude:

1. Find the altitude applicable to your installation in Table "B", and note the corresponding Normal Barometric Pressure (P_B);
2. Calculate the altitude adjusted Source End Vacuum requirement (V_A)

$$\mathbf{V_A} = \frac{P_O}{P_B} \times 29.92$$

$\mathbf{V_A}$	Altitude adjusted Source End Vacuum requirement
P_O	Site-specific Source End Vacuum requirement
P_B	Normal barometric pressure (at installation location – Table "B")

3. Cross-reference your V_A value in Table "A" to find the appropriate SCFM:ACFM conversion ratio (M);

4. Determine your altitude compensated PCL, expressed as SCFM @ 20" Hg (sea level) using the following formula:

$$\mathbf{PCL_A} = PCL \times \frac{M}{3}$$

PCL_A	Peak calculated load, altitude compensated, expressed in SCFM @ 20" Hg (sea level)
PCL	Peak calculated load (at sea level)
M	SCFM:ACFM ratio (Table "A")

5. Using PCL_A, make an appropriate vacuum system selection from the Engineering Data Tables.

NOTE: *For altitudes greater than 3,000 feet, consult VitalAire for all MM-series Mink vacuum system selections. For the MI series Mink pumps, consult VitalAire for all installations above 1,000 feet above sea level.*

The following examples differ only in elevation, thus demonstrating the importance of compensating for the relative decrease in barometric pressure associated with higher altitudes.

Example – 1

Location:	-Ottawa, Ontario
Barometric Pressure:	-approx 29.39" Hg @ 500 feet
Suction Regulator Data:	-Allied Vacutron regulators used in facility; factory calibrated to 18" Hg
Pressure Drop:	-existing facility pipeline pressure drop confirmed at 2" Hg
PCL:	-38 SCFM (*based upon steps 1 through 4 of System Selection Process*)

P_O =18" Hg + 2" Hg, +1.5" Hg = *21.5" Hg*

V_A $= \frac{21.5\text{" Hg}}{29.39\text{" Hg}} \times 29.92 =$ *21.88" Hg*

M = 3.75 (based upon rounding 21.88 up to 22)

PCL_A $= 38 \text{ SCFM} \times \frac{3.75}{3} = 47.5$ *SCFM @ 20" Hg (sea level)*

Conclusion: To accommodate the site conditions, including pressure drop, desired system configuration, and altitude, a duplex RA-0255 system would be suitable.

Example – 2

Location:	-Calgary, Alberta
Barometric Pressure:	-approx 26" Hg @ 3500 feet
Suction Regulator Data:	-Allied Vacutron regulators used in facility; factory calibrated to 18" Hg
Pressure Drop:	-existing facility pipeline pressure drop confirmed at 2" Hg
PCL:	-38 SCFM (*based upon steps 1 through 4 of System Selection Process*)

P_O =18" Hg + 2" Hg, +1.5" Hg = *21.5" Hg*

V_A $= \frac{21.5\text{" Hg}}{26\text{" Hg}} \times 29.92 =$ *24.75" Hg*

M = 6 (based upon rounding 24.75 up to 25)

PCL_A $= 38 \text{ SCFM} \times \frac{6}{3} = 76$ *SCFM @ 20" Hg (sea level)*

Conclusion: To accommodate the site conditions, including pressure drop, desired system configuration, and altitude, a triplex RA-0165 system would be suitable.

TABLE "A"
SCFM:ACFM CONVERSION FACTORS

VACUUM LEVEL		SCFM:ACFM RATIO (M) (at sea level)
0" Hg	0 mmHg	1:1
15" Hg	381 mmHg	1:2
18" Hg	457 mmHg	1:2.5
19" H	483 mmHg	1:2.73
20" Hg	508 mmHg	1:3
21" Hg	533 mmHg	1:3.33
22" Hg	559 mmHg	1:3.75
23" Hg	584 mmHg	1:4.28
24" Hg	610 mmHg	1:5
25" Hg	635 mmHg	1:6
26" Hg	660 mmHg	1:7.5
27" Hg	686 mmHg	1:10
28" Hg	711 mmHg	1:15
29" Hg	737 mmHg	1:30
29.5" Hg	749 mmHg	1:60

TABLE "B"
ALTITUDE COMPENSATION FACTORS

ALTITUDE (feet above sea level)	NORMAL BAROMETRIC PRESSURE (P_B)	
	Inches Hg	Mm Hg
0	29.92	760
500	29.39	747
1,000	28.86	733
1,500	28.33	720
2,000	27.82	707
2,500	27.32	694
3,000	26.82	681
3,500	26.33	669
4,000	25.84	656
5,000	24.90	633
6,000	23.98	609
7,000	23.09	587
8,000	22.23	565
9,000	21.39	543
10,000	20.58	523

VitalAire – Busch R5 Medical Vacuum Systems

R5 MEDICAL VACUUM SYSTEMS – ENGINEERING DATA

R5 Duplex Medical Vacuum Systems

R5 pump model	SCFM @ 20 "Hg (Per pump)	SCFM @ 20 "Hg (Total less back-up)	Maximum vacuum "Hg	Horsepower (Per pump)	Receiver (USgal)	Standard configuration
RA-0021	4.6	4.6	29.9	1	80	Tank mounted
RA-0025	6.0	6.0	29.9	1.5	80	Tank mounted
RA-0040	8.6	8.6	29.9	2	80	Tank mounted
RA-0063	11.9	11.9	29.9	3	120	Tank mounted
RA-0100	18.5	18.5	29.9	5	120	Tank mounted
RA-0165	38	38	29.9	7.5	200	Tank mounted
RA-0205	43	43	29.9	10	200	Tank mounted
RA-0255	56	56	29.9	10	200	Tank mounted
RA-0305	68	68	29.9	10	200	Tank mounted
RA-0400	100	100	29.9	20	200	Base mounted
RA-0630	145	145	29.9	25	200	Base mounted

R5 Triplex Medical Vacuum Systems

R5 pump model	SCFM @ 20 "Hg (Per pump)	SCFM @ 20 "Hg (Total less back-up)	Maximum vacuum "Hg	Horsepower (Per pump)	Receiver (USgal)	Standard configuration
RA-0021	4.6	9.2	29.9	1	120	Tank mounted
RA-0025	6.0	12.0	29.9	1.5	120	Tank mounted
RA-0040	8.6	17.2	29.9	2	120	Tank mounted
RA-0063	11.9	24	29.9	3	120	Tank mounted
RA-0100	18.5	37	29.9	5	120	Tank mounted
RA-0165	38	76	29.9	7.5	200	Stack mounted
RA-0205	43	86	29.9	10	200	Stack mounted
RA-0255	56	112	29.9	10	200	Stack mounted
RA-0305	68	136	29.9	10	200	Stack mounted
RA-0400	100	200	29.9	20	400	Base mounted
RA-0630	145	290	29.9	25	400	Base mounted

R5 Quad medical Vacuum Systems

R5 pump model	SCFM @ 20 "Hg (Per pump)	SCFM @ 20 "Hg (Total less back-up)	Maximum vacuum "Hg	Horsepower (Per pump)	Receiver (USgal)	Standard configuration
RA-0021	4.6	13.8	29.9	1	120	Stack mounted
RA-0025	6.0	18.0	29.9	1.5	120	Stack mounted
RA-0040	8.6	26	29.9	2	120	Stack mounted
RA-0063	11.9	36	29.9	3	120	Stack mounted
RA-0100	18.5	56	29.9	5	120	Stack mounted
RA-0165	38	114	29.9	7.5	200	Stack mounted
RA-0205	43	129	29.9	10	200	Stack mounted
RA-0255	56	168	29.9	10	200	Stack mounted
RA-0305	68	204	29.9	10	200	Stack mounted
RA-0400	100	300	29.9	20	400	Base mounted
RA-0630	145	435	29.9	25	400	Base mounted

Busch R5 Series Oil Lubricated Rotary Vacuum Pumps

- ✓ 29.92” Hg end vacuum, continuous run service (at sea level)
- ✓ 99.9% oil mist elimination circuit and spin-on oil filter
- ✓ Non-metallic, non-asbestos vanes for long life and maximum heat dissipation
- ✓ Air cooled, single stage, direct driven
- ✓ Super quiet operation
- ✓ Most widely used vacuum pump in North American Healthcare

VITALAIRE/BUSCH R5 SERIES MEDICAL VACUUM SYSTEM SPECIFICATION

Supply one VitalAire/Busch (Duplex/Triplex/Quad) Medical Vacuum System consisting of (two/three/four) Busch R5 series vacuum pumps, one _____ US gallon vertical receiver and one PLC based control panel.

Each vacuum pump shall be a Busch R5 series rotary vane vacuum pump model _____, shall have a nominal capacity of _____ CFM and a capacity of _____ SCFM at a vacuum level of 20 "Hg (NTP).

Each vacuum pump shall be direct-driven through a shaft coupling by a _____ HP, NEMA C-face, foot mounted, TEFC, CSA approved electric motor wired for operation on a _____ volt, 60 hertz, 3 phase power supply. Belt drives shall not be permitted. Each pump shall be air-cooled and have absolutely no water requirements. Each pump shall have a guaranteed end (ultimate) vacuum of _____ "Hg on a continuous run basis given a barometric pressure of 29.92 "Hg.

Each vacuum pump shall include three non-metallic, non-asbestos vanes, each having a minimum service life of 30,000 hours. The vanes shall be lubricated by a fully re-circulated and filtered lubricant supply. Non-recirculating (once-through) or partial recirculating lubricant supply systems shall not be permitted. The lubricant separation system shall be integral to the pump exhaust box and shall consist of no less than four stages of internally installed lubricant and smoke eliminators through which the exhaust gas stream must pass. This system shall consist of bulk separation, lubricant mist elimination, smoke elimination, synthetic lubricant baffle, and shall be capable of removing 99.9+ percent of all lubricant and smoke particles from the exhaust gas stream. To facilitate preventative maintenance and oil changes, each pump shall be equipped with an oil drain valve and capped drainpipe.

Each pump shall be fixtured with an anti-suck-back valve mounted at the pump inlet, a 5-micron paper inlet filter, one pump isolation valve, one inlet check valve, one inlet stainless steel flex connector, and a threaded exhaust adapter to permit piping of the exhaust gases to a remote point. One exhaust check valve and drip leg assembly shall be supplied loose for each pump, requiring installation on-site to suit exhaust pipe routing. All pumps shall be mounted on vibration isolators, and supplied with an initial charge of Busch (R-530S/R-590) lubricant.

All pumps shall be (tank/stack/base) mounted. Pumps shall be connected to a common manifold and piped to an ASME coded _____ USgal (horizontal/vertical) receiver. The receiver shall include the following: Canadian Registration Number, drain valve, vent valve, solenoid actuated vacuum relief valve, sight glass assembly and receiver by-pass piping c/w three isolation valves. The system shall also include one system main isolation valve.

The (Duplex/Triplex/Quad) control panel shall be of the automatic lead/lag type and shall consist of the following: one SIEMENS programmable logic controller w/ analog expansion module and SIEMENS operator interface, one main disconnect switch, IEC rated magnetic motor starters with circuit breaker for each motor, a manual-auto-stop selector switch for each pump, one vacuum transducer (4-20 mA) and one dual set point vacuum switch, one electrical overload alarm per pump, one transformer failure alarm, individual pump overheat alarms, one lag/failure alarm with dry contacts, individual pump running lights and dry contacts, dual control transformers with primary fuses, secondary breaker, emergency power transition power loss alarm delay, and factory installed Amico Information Management Systems (AIMS) interface board and related transducer.

The entire system shall be factory assembled and tested by the vacuum pump manufacturer to insure that all performance specifications are met. All major components of the system shall comply with CSA standards. System design shall meet or exceed CAN CSA Z305.1 (latest edition) requirements, and be delivered as a CSA approved and labelled system.

MINK™ MEDICAL VACUUM SYSTEMS – ENGINEERING DATA

Mink Duplex Medical Vacuum Systems

Mink pump model	SCFM @ 20 "Hg (Per pump)	SCFM @ 20 "Hg (Total less back-up)	Maximum continuous vacuum "Hg	Horsepower (Per pump)	Receiver (USgal)	Standard configuration
MINK MI SERIES						
MI-1502	106	106	22.5	20	200	Base mounted
MINK MM SERIES						
MM-1104	12.2	12.2	28	2	120	Tank Mounted
MM-1144	16.7	16.7	28	3	120	Tank Mounted
MM-1102	21.2	21.2	28	5	120	Tank Mounted
MM-1142	34.3	34.3	28	7.5	120	Tank Mounted
MM-1202	47.0	47.0	27	7.5	200	Stack Mounted
MM-1252	58.8	58.8	27	7.5	200	Tank Mounted
MM-1322	70.6	70.6	25.5	10	200	Tank Mounted

Mink Triplex Medical Vacuum Systems

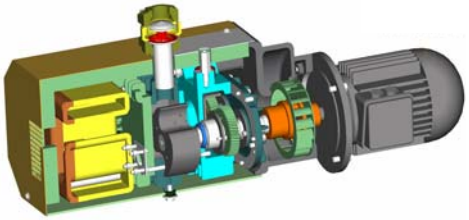
Mink pump model	SCFM @ 20 "Hg (Per pump)	SCFM @ 20 "Hg (Total less back-up)	Maximum continuous vacuum "Hg	Horsepower (Per pump)	Receiver (USgal)	Standard configuration
MINK MI SERIES						
MI-1502	106	212	22.5	20	400	Base mounted
MINK MM SERIES						
MM-1104	12.2	24.4	28	2	120	Stack Mounted
MM-1144	16.7	33.4	28	3	120	Stack Mounted
MM-1102	21.2	42.4	28	5	120	Stack Mounted
MM-1142	34.3	68.6	28	7.5	120	Stack Mounted
MM-1202	47.0	94.4	27	7.5	200	Stack Mounted
MM-1252	58.8	117.6	27	7.5	200	Stack Mounted
MM-1322	70.6	141.2	25.5	10	200	Stack Mounted

Mink Quad Medical Vacuum Systems

Mink pump model	SCFM @ 20 "Hg (Per pump)	SCFM @ 20 "Hg (Total less back-up)	Maximum continuous vacuum "Hg	Horsepower (Per pump)	Receiver (USgal)	Standard configuration
MINK MI SERIES						
MI-1502	106	318	22.5	20	400	Base mounted
MINK MM SERIES						
MM-1104	12.2	36.6	28	2	120	Stack Mounted
MM-1144	16.7	50.1	28	3	120	Stack Mounted
MM-1102	21.2	63.6	28	5	120	Stack Mounted
MM-1142	34.3	102.9	28	7.5	120	Stack Mounted
MM-1202	47.0	141.0	27	7.5	200	Stack Mounted
MM-1252	58.8	176.4	27	7.5	200	Stack Mounted
MM-1322	70.6	211.8	25.5	10	200	Stack Mounted

Busch Mink Series Oil-less Rotary Claw Pumps

- ✓ Totally oil-less compression chamber
- ✓ 100% non-contacting, non-wearing, “frictionless” rotary lobe “claw” design
- ✓ Air cooled, single stage, direct driven
- ✓ Quietest operation in its class
- ✓ Largest reference base in North American Healthcare



VACUUM SYSTEM NOTES (applicable to R5 and Mink Series)

Heat rejection: 2300 BTU/hr. per running Hp.
Required ventilation: 200 CFM per running Hp.
All capacity and maximum vacuum levels reference continuous duty service & NTP conditions.
Consult VitalAire for system FLA and dBa ratings.

VITALAIRE/BUSCH MINK SERIES MEDICAL VACUUM SYSTEM SPECIFICATION

Supply one VitalAire/Busch (Duplex/Triplex/Quad) Medical Vacuum System consisting of (two/three/four) Busch Mink vacuum pumps, one _____ US gallon vertical receiver and one PLC based control panel.

Each vacuum pump shall be a Busch Mink series dry-running rotary lobe vacuum pump model _____, shall have a nominal capacity of _____ CFM and a capacity of _____ SCFM at a vacuum level of 20 "Hg. Each pump shall have a guaranteed oil-free, non-contacting, non-wearing operation.

Each vacuum pump shall be direct-driven through a shaft coupling by a _____ HP, TEFC, CSA approved electric motor wired for operation on a _____ volt, 60 hertz, 3 phase power supply. Belt drives shall not be permitted. Each pump shall be air-cooled and have absolutely no water or oil requirement in the compression chamber. Each pump shall have a guaranteed end (ultimate) vacuum of _____ "Hg on a continuous run basis given a barometric pressure of 29.92 "Hg. All bearings inside the pumps shall be oil lubricated. Grease lubricated bearings shall not be acceptable (Except for MI 1502). All pumps shall be capable of operating continuously dead-headed without a relief valve (MM 1104/1102/1144/1142 models only).

Each pump shall be equipped with one 5-micron paper inlet filter, one pump isolation valve, one inlet check valve and one inlet stainless steel flex connector. Each pump shall be mounted on vibration isolators and supplied with a threaded exhaust adapter to permit piping of the exhaust gases to a remote point. One exhaust check valve and drip leg assembly shall be supplied loose for each pump, requiring installation on-site to suit exhaust pipe routing.

All pumps shall be (tank/stack/base) mounted. Pumps shall be connected to a common manifold and piped to an ASME coded _____ US gal (horizontal/vertical) receiver. The receiver shall include the following: Canadian Registration Number, drain valve, vent valve, solenoid actuated vacuum relief valve, sight glass assembly and receiver by-pass piping complete with three isolation valves. The system shall also include one system main isolation valve.

The (Duplex/Triplex/Quad) control panel shall be of the automatic lead/lag type and shall consist of the following: one SIEMENS programmable logic controller w/ analog expansion module and SIEMENS operator interface, one main disconnect switch, IEC rated magnetic motor starters with circuit breaker for each motor, a manual-auto-stop selector switch for each pump, one vacuum transducer (4-20 mA) and one dual set point vacuum switch, one electrical overload alarm per pump, one transformer failure alarm, individual pump overheat alarms, one lag/failure alarm with dry contacts, individual pump running lights and dry contacts, dual control transformers with primary fuses, secondary breaker, emergency power transition power loss alarm delay, and factory installed Amico Information Management Systems (AIMS) interface board and related transducer.

The entire system shall be factory assembled and tested by the vacuum pump manufacturer to insure that all performance specifications are met. All major components of the system shall comply with CSA standards. System design shall meet or exceed CAN CSA Z305.1 (latest edition) requirements, and be delivered as a CSA approved and labelled system.

BUSCH/IR MEDICAL AIR SYSTEMS – ENGINEERING DATA

BUSCH / INGERSOLL-RAND DUPLEX INTEGRATED MEDICAL AIR SYSTEMS

Compressor model	*Horsepower (per compressor)*	*SCFM @ 100 psig (per compressor)*	*Total SCFM @ 100 psig*	*Receiver USG*	*Associated Dryer Package*	*Standard configuration*
OL5X5	5	17.1	17.1	80	2-GMD5-18-MED	Tank Mounted
				120		Stack Mounted
OL5X7.5	7.5	21.2	21.2	80	2-GMD10-35-MED	Tank Mounted
				120		Stack Mounted
OL10X10	10	31.3	31.3	120	2-GMD10-35-MED	Stack Mounted
OL15X15	15	47.9	47.9	200	2-GMD20-84-MED	Stack Mounted
OL25X25	25	90.8	90.8	200	2-GMD25-106-MED	Base Mounted

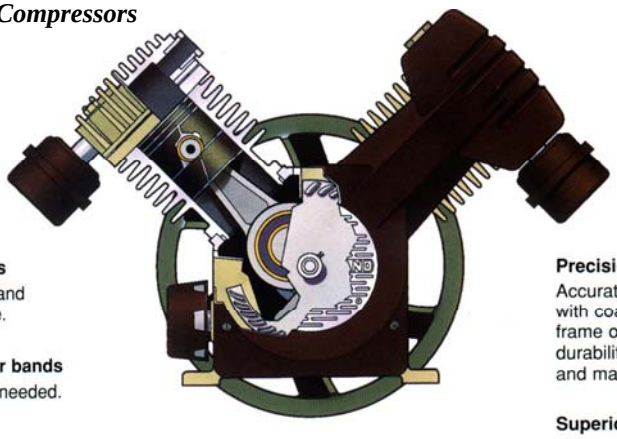
BUSCH / INGERSOLL-RAND TRIPLEX INTEGRATED MEDICAL AIR SYSTEMS

Compressor model	*Horsepower (per compressor)*	*SCFM @ 100 psig (per compressor)*	*Total SCFM @ 100 psig*	*Receiver USG*	*Associated Dryer Package*	*Standard configuration*
OL5X5	5	17.1	34.2	120	2-GMD10-35-MED	Stack Mounted
OL5X7.5	7.5	21.2	42.4	120	2-GMD20-84-MED	Stack Mounted
OL10X10	10	31.3	62.6	120	2-GMD20-84-MED	Stack Mounted
OL15X15	15	47.9	95.8	200	2-GMD25-106-MED	Stack Mounted
OL25X25	25	90.8	181.6	200	2-GMD40-170-MED	Base Mounted

BUSCH / INGERSOLL-RAND QUADRAPLEX INTEGRATED MEDICAL AIR SYSTEMS

Compressor model	*Horsepower (per compressor)*	*SCFM @ 100 psig (per compressor)*	*Total SCFM @ 100 psig*	*Receiver USG*	*Associated Dryer Package*	*Standard configuration*
OL5X5	5	17.1	51.3	120	2-GMD20-84-MED	Stack Mounted
OL5X7.5	7.5	21.2	63.6	120	2-GMD20-84-MED	Stack Mounted
OL10X10	10	31.3	93.9	120	2-GMD25-106-MED	Stack Mounted
OL15X15	15	47.9	143.7	200	2-GMD40-170-MED	Stack Mounted
OL25X25	25	90.8	272.4	200	2-GMD60-265-MED	Base Mounted

Busch IR Series Oil-less Compressors



Stainless steel valves
Designed for long life and minimum maintenance.

Teflon rings and rider bands
Self-lubricating: no oil needed.

Thermal insulator
Prevents heat of compression from transmitting to piston pin bearings.

Single-piece connecting rod
Long lasting, no-maintenance design.

Ball and needle bearings
Grease-filled and sealed to maintain optimum system performance.

Precision-fit components
Accurately machined cylinders with coated bores and cast-iron frame offers proven reliability, durability and extended ring life and maintenance intervals.

Superior cooling systems
Unique cooling design dissipates heat, enabling 24-hour a day, 125 psig, continuous duty operation.

Balanced one-piece crankshaft
Reduces noise and vibration.

SCFM ratings based upon reference pressure of 14.7 psi, temperature of 68 °F and relative humidity of 36%RH.
Heat rejection: 2300 BTU/hr. per running Hp.
Required ventilation: 200 CFM per running Hp.
Consult VitalAire for system FLA and dBa ratings.

VITALAIRE/BUSCH IR SERIES INTEGRATED MEDICAL AIR SYSTEM SPECIFICATION

Medical Air System

Supply one VitalAire/Busch IR series oil-less (tank/stack/base) mounted (Duplex/Triplex/Quad) fully integrated, skid mounted, medical air compressor package consisting of (two/three/four) Ingersoll-Rand dry running reciprocating air compressors, one _____ US gallon (horizontal/vertical) receiver, two heat-less regenerative desiccant dryers, one complete filtration system, one dual line pressure regulating assembly and one PLC based control panel complete with integrated hygrometer.

The integrated compressor/dryer system shall be factory assembled and tested. All aspects and components of the integrated skid mounted package shall meet or exceed the design requirements of CAN/CSA Z305.1 (latest edition), and the system shall be delivered as a CSA approved and labelled system.
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Compressor modules

Each compressor shall be an Ingersoll-Rand oil-less series reciprocating medical air compressor model _____ (OL5X5, OL5X7.5, OL10X10, OL15X15, OL25X25). Compressor design shall be air-cooled, reciprocating type with anodised and separately cast aluminium cylinder heads with precision bore finish (5 RMS) and non-corrosive fittings, stainless steel strip valves with stainless steel valve plates, aluminium pistons with thermally insulated piston pins, Teflon compression rings and rider bands, cast-iron internally primed frame with replaceable crankcase filter (5, 7.5, 10 HP models) or element (15 and 25 HP models), ductile iron crankshaft with internal cast-iron counterweight, oversized permanently sealed crankshaft bearings, single-piece connecting rod, sealed needle bearing on connecting rod piston pin and permanently sealed ball bearing on crankshaft end, cast-iron frame end cover, efficient air cooled cooling system providing reliable 24-hour continuous operation, cast-iron belt wheel with tapered bore designed for V-belt drive. Each compressor shall have a capacity of _____ SCFM @ 100 psig and capable of 125 psig continuous duty operation.

Each compressor shall be belt-driven by a _____ HP, ODP, CSA approved electric motor wired for operation on a _____ volt, 60 hertz, 3 phase power supply. Each compressor shall be 100% oil-free and have absolutely no water or oil requirements.

Each compressor shall be equipped with one temperature switch at the exhaust port of each cylinder head, safety relief valves, one air-cooled after-cooler, one braided stainless steel discharge flex connector, air unloading solenoid valve, one discharge check valve, one discharge isolation ball valve, one inlet inline 10 micron air filter, one inlet isolation ball valve, braided stainless steel inlet flex connectors and vibration isolation mounts.

All compressors shall be (tank/stack/base) mounted.

Air receiver

Compressors shall be connected to a common manifold and piped to a _____ US gallon (horizontal/vertical) receiver which is ASME coded, CRN approved and labelled, rated for a minimum 150 PSIG working pressure, and galvanized inside and outside. The receiver shall include the following items: one sight glass assembly, one manual drain valve, one automatic electronically timed drain valve and one safety relief valve.

Air dryer system

The air dryer system shall consist of two identical heat-less twin tower, regeneration type desiccant dryers. Each dryer shall be capable of removing the moisture content of the rated capacity of the system for an atmospheric dew point in accordance with CAN/CSA Z305.1 (latest edition) requirements.

The dryers shall be modular in design, employing aluminium flanged twin-drying chambers and cast aluminium manifolds. Dryer valves shall be non-lubricated, pilot solenoid operated, ISO mount 4-way valve for inlet, outlet and purge exhaust (HMD18 & HMD37) or non-lubricated, pneumatically operated, diaphragm type switching valves for inlet & purge exhaust, and poppet type check valves for outlet (HMD84 through HMD385). Each drying chamber shall utilise immobilised replaceable solid-core, non-corrosive activated alumina with corrosion resistant tie rods and Buna-N gaskets.

To reduce purge air consumption, a purge air control system shall be provided on each dryer. The control system shall include a dew point hygrometer controlled solenoid activated purge valve, high-surface area purge air exhaust muffler to reduce noise level within OSHA standards, high strength nylon air tubing and purge orifice in check poppet. Additionally, the dryer system shall include controls designed to automatically switch the dryer in use according to a user-adjustable time interval. In the event of a tower switching failure or low outlet pressure alarm the dryer auto control system will automatically switch to the stand-by dryer and latch the alarm condition.

Filtration system

The filtration system shall consist of two HE series pre-filter, two HE series after-filters, and two AC series activated charcoal filters.

The pre and after-filters shall be designed to remove particles down to 0.01 micron and liquids down to 0.01 mg/m^3 at 21°C. The activated charcoal filters shall be designed for removing oil vapour and odours from the compressed air flow with a maximum remaining oil carryover of less than 0.003 ppm W ar 21°C.

All compressed air filters shall be designed so that the initial dry pressure drop at rated inlet pressure and flow shall not exceed 1 psig. The housings shall be constructed of either die-cast aluminium alloy or pressure vessel quality steel. Filters shall have an element change indicator and an automatic drain valve (except for AC series charcoal filters) and “lift and twist” mechanism facilitating quick and easy element exchange. The durable stainless steel element inner and outer cores shall withstand sudden pressure surges of up to 100 psig. The element top end cap shall have an over moulded seal and taper location that ensures a perfect seal.

Line pressure regulation system

The line pressure regulation system shall be manufactured in a dual arm type assembly. Each arm of the assembly shall include, in the following order: inlet isolation ball valve, Victor forged brass body L700 series pressure regulator (up to 100 scfm) or brass body Cash Acme B series pressure regulator (more than 100 scfm), discharge pressure gauge, 1/4" needle bleed valve, cast bronze ASME Section VIII coded and CRN registered pressure relief valve, outlet isolation ball valve.

Reserve air supply connection

The integrated medical air/purification system shall include a provision for site connection of a high pressure reserve air supply complete with auto-air check assembly with three-valve by-pass designed to prevent loss of cylinder contents while the reserve air supply is in stand-by mode. The connection point shall be located between the dryer outlet manifold piping and the inlet to the line pressure regulating assembly, and shall consist of a plugged nptf “T”, one normally open solenoid actuated ball valve activated by the dryer low-outlet pressure switch, and a three-valve by-pass piping arrangement to facilitate maintenance on the auto-air check assembly.

Control System

The integrated control panel shall contain all of the necessary components to control all operating aspects of the integrated medical air compressor package. It shall consist of the following: compressors alternation PLC module, main(s) disconnect switch(es), magnetic motor starters complete with circuit breakers, manual-auto-off selector switches, dryer A manual/auto/dryer B manual three-position selector switch, continuous/controlled dryer purge selector switch, internal mechanical dual set point pressure switches for controlling the stop/start operation of compressors, visual and audible electrical overload alarms, visual and audible compressor high discharge temperature alarms with dry contacts, visual and audible primary control transformer failure alarm, visual and audible lag/failure alarm with dry contacts, compressor running lights, visual and audible dryer switching failure alarm with dry contacts, visual and audible dryer low discharge pressure alarm with dry contact, visual and audible high dew point alarm with dry contacts, two control transformers with primary fuses and secondary breaker, emergency power transition power loss alarm delay, and factory installed Amico Information Management Systems (AIMS) interface board and related transducer.

The discharge temperature sensors shall be interconnected and monitored by the controls such that the activation of any one of the sensors on a given compressor (all cylinder heads) will shut that compressor down and initiate the corresponding high discharge temperature alarm.

Hygrometer

The control panel integrated hygrometer shall be equipped with a °C/°F/ppm LCD display dew point monitoring device with high humidity alarm dry contacts. The dew point sensor (probe) shall be installed in the central control panel an connected via stainless steel tubing to point downstream of the dual line pressure regulator assembly. The probe, display and controls shall be interfaced in such a way that they provide automatic control of the desiccant tower purge cycle based on dew point and the system high humidity alarm. The hygrometer shall have the capability to auto-calibrate its sensor as required without the use of standard gas reference. Hygrometers requiring off-site recalibration or regularly replaced sensors to maintain accuracy shall not be acceptable.

Bare Exchange Program

To facilitate efficient and economical preventative maintenance integrated medical air systems shall include automatic registration in an exchange program whereby bare compressors may be returned to the factory within or before 8,000 operating hours and exchanged at a preferred price for a rebuilt compressor delivered complete with a new compressor warranty.

BUSCH/IR MEDICAL AIR DRYERS – ENGINEERING DATA

BUSCH MEDICAL AIR DRYER/PURIFICATION SYSTEMS

Dryer model	*SCFM @ 100 psig*	*Inlet/Outlet Pip size*	*Dimensions (approx)*
2-GMD5-18-MED	18		
2-GMD10-37-MED	37		
2-GMD20-84-MED	84		
2-GMD25-110-MED	110		
2-GMD30-138-MED	138		
2-GMD40-170-MED	170		
2-GMD40-230-MED	230		
2-GMD60-265-MED	265		
2-GMD75-385-MED	385		

Air dryer system

The air dryer system shall consist of two identical heat-less twin tower, regeneration type desiccant dryers. Each dryer shall be capable of removing the moisture content of the rated capacity of the system for an atmospheric dew point in accordance with CAN/CSA Z305.1 (latest edition) requirements.

The dryers shall be modular in design, employing aluminium flanged twin-drying chambers and cast aluminium manifolds. Dryer valves shall be non-lubricated, pilot solenoid operated, ISO mount 4-way valve for inlet, outlet and purge exhaust (HMD18 & HMD37) or non-lubricated, pneumatically operated, diaphragm type switching valves for inlet & purge exhaust, and poppet type check valves for outlet (HMD84 through HMD385). Each drying chamber shall utilise immobilised replaceable solid-core, non-corrosive activated alumina with corrosion resistant tie rods and Buna-N gaskets.

To reduce purge air consumption, a purge air control system shall be provided on each dryer. The control system shall include a dew point hygrometer controlled solenoid activated purge valve, high-surface area purge air exhaust muffler to reduce noise level within OSHA standards, high strength nylon air tubing and purge orifice in check poppet.

Filtration system

The filtration system shall consist of two HE series pre-filter, two HE series after-filters, and two AC series activated charcoal filters.

The pre and after-filters shall be designed to remove particles down to 0.01 micron and liquids down to 0.01 mg/m^3 at 21°C. The activated charcoal filters shall be designed for removing oil vapour and odours from the compressed air flow with a maximum remaining oil carryover of less than 0.003 ppm W ar 21°C.

All compressed air filters shall be designed so that the initial dry pressure drop at rated inlet pressure and flow shall not exceed 1 psig. The housings shall be constructed of either die-cast aluminium alloy or pressure vessel quality steel. Filters shall have an element change indicator and an automatic drain valve (except for AC series charcoal filters) and “lift and twist” mechanism facilitating quick and easy element exchange. The durable stainless steel element inner and outer cores shall withstand sudden pressure surges of up to 100 psig. The element top end cap shall have an over moulded seal and taper location that ensures a perfect seal.

Control System

The integrated control panel shall contain all of the necessary components to control all operating aspects of the medical air dryer package. It shall consist of the following:, dryer A & B manual off-on selector switches, continuous/controlled dryer purge selector switch, visual and audible dryer switching failure alarm with dry

contacts, visual and audible dryer low discharge pressure alarm with dry contact, visual and audible high dew point alarm with dry contacts,

Hygrometer

The control panel shall include an integrated hygrometer equipped with a °C/°F/ppm LCD display dew point monitoring device with high humidity alarm dry contacts. The dew point sensor (probe) shall be installed in the control panel and connected via stainless steel tubing to a point downstream of the final filters, or the optional dual line pressure regulator assembly. The probe, display and controls shall be interfaced in such a way that they provide automatic control of the desiccant tower purge cycle based on dew point and the system high humidity alarm. The hygrometer shall have the capability to auto-calibrate its sensor as required without the use of standard gas reference. Hygrometers requiring off-site recalibration or regularly replaced sensors to maintain accuracy shall not be acceptable.

Dryer Options

- Complete dual line pressure regulating assembly, consisting of two parallet pipe arms each including an inlet isolation ball valve, Victor forged brass body L700 series pressure regulator (up to 100 scfm) or brass body Cash Acme B series pressure regulator (more than 100 scfm), discharge pressure gauge, 1/4" needle bleed valve, cast bronze ASME Section VIII coded and CRN registered pressure relief valve, outlet isolation ball valve.

- Auto-dryer alternation controls and related valves

- Auto-air check assembly with inlet port for connection of high pressure cylinder reserve supply.

VitalAire – Busch Medical Vacuum & Air Systems
General Installation Requirements

*****IMPORTANT: Before starting any installation or maintenance procedures, disconnect all power to the system.**

1. Locate the medical air and vacuum systems in accordance with all applicable building codes and standards, with consideration given to noise emission relative to surrounding equipment and activities.

2. Ensure systems are installed and situated to facilitate regular scheduled preventative maintenance. A minimum clearance of 1.5 meters on all sides of each system and above each major component is recommended. A minimum distance of 1.0 meter is recommended between each base mounted module.

3. Medical air and vacuum systems must be set in place level and securely fastened to a suitable raised concrete housekeeping pad. The use of inertia bases for Vitalaire/Busch systems is not required.

4. The average temperature of the installation location should be approximately 20^{o} C (70^{o} F), with a minimum ambient temperature of 4^{o} C (40^{o} F) and a maximum ambient temperature of 30^{o} C (86^{o} F). Adequate provisions must be made to ensure cross air circulation to remove heat generated by vacuum pumps and/or air compressors; provide for a minimum of 200 CFM fresh air for every 1Hp of pump power.

5. Vacuum system control panels are tested at sea level. Adjustment of vacuum switches may be necessary to compensate for altitude.

6. Ensure medical vacuum exhaust piping is fitted with drip leg assemblies per the layout recommended on your approved shop drawing, and situated in a location easy to access for regular inspection & draining.

7. Where exhaust discharge pipes from multiple vacuum pumps are combined, each pump discharge should be equipped with a check valve (between the pump and the drip leg), having a crack pressure of <= 1/8 psi maximum.

8. Ensure medical air systems are situated near a suitable floor drain to facilitate pipe-away connection to the receiver auto-drain system.

9. Ensure flexible pipe connectors for medical air inlet and medical vacuum exhaust connections are installed horizontally to eliminate resistance to vertical vibration.

10. Prior to installation review all electrical power requirements and low voltage alarm wiring requirements, ensuring coordination and a comprehensive, safe, electrical installation.

11. **IMPORTANT:** Ensure medical air fresh air inlet piping and medical vacuum exhaust piping is of an acceptable material and sized appropriately to prevent backpressure (see Tables “C” and “D”). Make sure exterior pipe terminations are turned down and fitted with an insect screen to prevent contamination and/or flow restriction.

12. **IMPORTANT:** To ensure full warranty coverage, system start-up must be documented on the Busch System Start-Up Form shipped with the system, with one completed and signed copy returned to Busch Vacuum Technics, 1240 Lionel Bertrand, Boisbriand, QC, J7H 1N7.

VitalAire – Busch Medical Vacuum & Air Systems
Inlet & Exhaust Pipe Sizing Tables

The following tables detail the minimum recommended exhaust pipe size for medical vacuum systems and minimum recommended fresh air inlet pipe size for medical air systems based upon capacity and the total equivalent pipe length. All pipe sizes are based upon copper pipe, Type K or L, and NTP conditions. Minimum pipe sizes must be maintained for the entire length of the exhaust or fresh air piping. In the event the recommended pipe size is not available, use the next larger size pipe.

TABLE "C"
VACUUM SYSTEM EXHAUST PIPE SIZING TABLE

Capacity, SCFM @ 20 'Hg	Equivalent Pipe Length (feet) *						
	50	100	150	200	300	400	500
	Exhaust pipe size (inches)						
10	2	2	2	2	2	2	2
50	2	2.5	3	3	3	3	3
100	3	3	3	4	4	5	5
150	3	4	4	4	5	5	5
200	4	4	4	5	5	5	5
300	4	5	5	5	6	6	6
400	5	5	6	6	6	8	8
500	5	6	6	6	8	8	8
600	6	6	8	8	8	10	10

TABLE "D"
AIR SYSTEM FRESH AIR INLET PIPE SIZING TABLE

Capacity, SCFM @ 100 PSI	Equivalent Pipe Length (feet) *											
	25	50	75	100	150	200	250	300	350	400	450	500
	Inlet pipe size (inches)											
10	1.25	1.25	1.5	1.5	2	2	2	2	2	2	2	2.5
17	1.5	2	2	2	2	2.5	2.5	2.5	2.5	2.5	2.5	3
26	2	2	2	2.5	2.5	2.5	3	3	3	3	3	3
34	2	2.5	2.5	2.5	2.5	3	3	3	3	3.5	3.5	3.5
51	2.5	2.5	3	3	3.5	3.5	3.5	3.5	3.5	4	4	4
66	2.5	3	3.5	3.5	3.5	4	4	4	5	5	5	5
103	3	3	3	3	3.5	3.5	4	4	4	4	5	5
133	3	3.5	3.5	4	4	5	5	5	5	5	6	6
154	3	3	3.5	3.5	4	4	5	5	5	5	5	5
199	3.5	4	4	5	5	5	5	6	6	6	6	6

EQUIVALENT PIPE LENGTH

To determine total equivalent pipe length, add all straight lengths of pipe together plus the number of elbows multiplied by their "effective pipe length" from the table below.

	EFFECTIVE PIPE LENGTH (inches)								
Elbow Size (dia. Inches)	1.25	1.50	2.00	2.50	3.00	3.50	4.00	5.00	6.00
Effective Pipe Length (Feet)	3.7	4.3	5.5	6.50	8.0	9.40	11.0	12.0	16.0

* *To convert from feet to meters, multiply by 0.3048*

VitalAire – Busch Medical Vacuum & Air Systems
Preventative Maintenance Service Intervals

*****IMPORTANT:** **Before starting any installation or maintenance procedures, disconnect all power to the system.**

*****IMPORTANT:** **Notify hospital personnel if preventative maintenance procedure will affect medical air or vacuum supply within the facility.**

*****NOTE:** Vacuum pump and air compressor maintenance is time dependant. VitalAire recommends logging the run hours for each pump/compressor daily, and dewpoint for medical air daily, to help plan for maintenance intervals and facilitate performance trend analysis.

GENERAL SERVICE INTERVALS

The following are general service interval recommendations for VitalAire/Busch medical air and vacuum systems. Please refer to system specific Operations & Maintenance manuals for a comprehensive PM guide applicable to your system.

R5 Medical Vacuum Systems

Daily:	❑	Log pump run hours
	❑	Check condensate in receiver; drain as required
	❑	Visually check oil level & colour
	❑	Visually check exhaust filter back pressure gauge (when pump starts)
	❑	Drain condensate build-up from exhaust drip leg
	❑	Check for unusual noise/vibration
Monthly:	❑	Check all isolation valves for full travel
	❑	Check inlet air filters; clean or replace as required
Annually:	❑	Verify operation of all alarm indicators (ie. simulate lag operation, etc.)
750 Hours	❑	Change oil and oil filter; maximum recommended interval is 4 months
9 - 12 months	❑	Inspect exhaust filters; replace as necessary; max. recommended interval is yearly
4 years	❑	Lubricate (grease) motor (perform every 1.5 years under severe duty cycles)

MINK Medical Vacuum Systems

Daily:	❑	Log pump run hours
	❑	Check condensate in receiver; drain as required
	❑	Visually check gearbox lubricant level
	❑	Drain condensate build-up from exhaust drip leg
	❑	Check for unusual noise/vibration

Monthly:	❑	Check all isolation valves for full travel
	❑	Check inlet air filters; clean or replace as required
Annually:	❑	Verify operation of all alarm indicators (ie. simulate lag operation, etc.)
5000 Hours	❑	Change gearbox lubricant
6 months	❑	Grease bearings
4 years	❑	Lubricate (grease) motor (perform every 1.5 years under severe duty cycles)

Busch/IR Medical Air Compressors

Daily:	❑	Log compressor run hours
	❑	Check condensate in air receiver; drain as required
	❑	Check for unusual noise/vibration
Weekly:	❑	Check inlet air filters; clean or replace as required
Monthly:	❑	Check inlet air filters; clean or replace as required
	❑	Check inlet air filters; clean or replace as required
	❑	Clean after-coolers (externally; if applicable)
	❑	Inspect nuts, bolts, fittings; tighten where required
	❑	Inspect crankcase breather filters; clean or replace as required
	❑	Check drive belts; tighten or replace as necessary
	❑	Check isolation ball valves for full travel
Annually:	❑	Verify operation of all alarms
4,000 Hours:	❑	Inspect piston rings and rider bands
	❑	Inspect ball and needle bearings for looseness or grease leakage
8,000 Hours	❑	Replace drive set
	❑	Replace Compressor Valves
	❑	*Alternatively, Bare Compressor Exchange*

Busch/IR Medical Air Dryer/Filtration Systems (*desiccant*)

Daily:	❑	Log operating conditions (ie. pressures, temperatures, etc.)
Monthly:	❑	Observe dryer operating cycle for proper sequence
	❑	Check bleed rate across dewpoint sensor well
	❑	Check filter change indicators; change elements as required
	❑	Alternate dryer in use
Annually:	❑	Blow down relief valve
	❑	Inspect desiccant; replace if badly broken up or contaminated with oil
	❑	Check dewpoint meter for calibration; re-calibrate if necessary
	❑	Verify operation of all alarms

APPENDIX

Typical Layout Drawings

VitalAire-Busch Medical Vacuum & Air Systems

Duplex & Triplex Vacuum

Duplex, Triplex, & Quadraplex Air

For custom layouts please consult your local VitalAire representative