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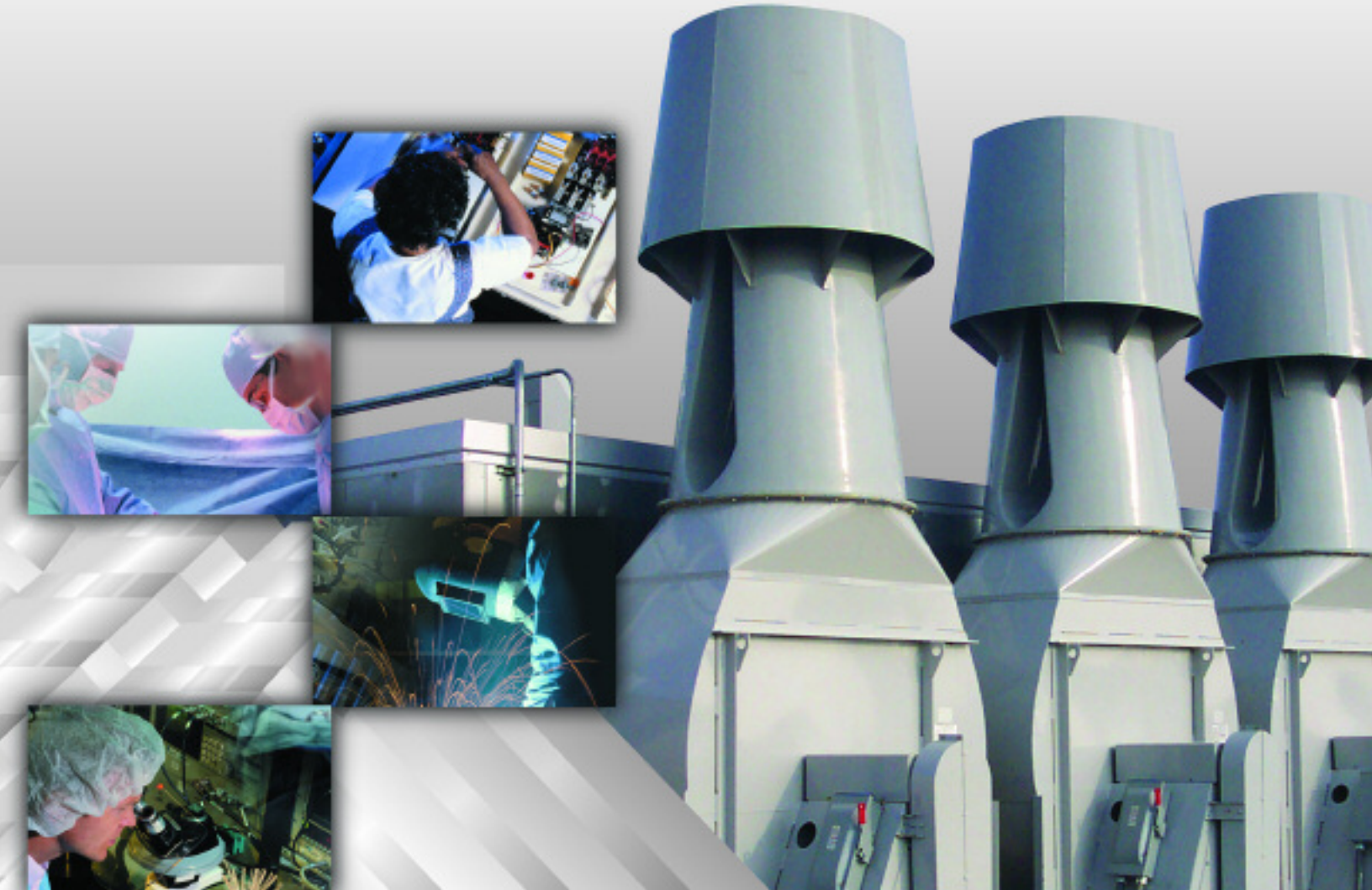
AXIJET® LEADLAG™

EXHAUST FAN CONTROL SYSTEM

(Patent Pending)



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AXIJET® LEADLAG™ EXHAUST FAN CONTROL SYSTEM

INTRODUCTION

Laboratory Exhaust Systems that utilize multiple fans in an N + 1 design must sequence the standby fan in order to prevent bearing and drive damage due to stagnancy. Since laboratory systems typically operate 24 hours per day it is impractical and unsafe to simply turn fans on and off, since this would disrupt the system static pressure of the manifold exhaust system and would jeopardize the safe exhaust of the laboratory exhaust system.

The Leadlag™ controller has an additional feature that will shut down a fan when the total system airflow has been decreased by that fan's exhaust volume. This feature would be applicable during off hours such as night mode, vacation periods or a change in system requirements.

The Leadlag™ Exhaust Fan Control System does the following…

- Reads and maintains the set static pressure in the exhaust system.
- Automatically activates the standby fan while simultaneously deactivating one of the lead running fans; preserving a constant pressure in the bypass air plenum.
- The design static pressure will be maintained within +/- 10% during any Leadlag™ sequence. Additionally, the static pressure variation will last no longer than 30 seconds.
- Opens and closes isolation dampers when fans start or stop.
- Maintains the necessary exhaust from the facility by modulating of the bypass damper which will maintain full exhaust fan design CFM. This feature ensures the design stack height. Alternatively, fans can be sequenced off in lieu of bypass air for energy saving.
- Automatically cycles the lead/lag fan(s) through all the fans in the exhaust system to eliminate premature fan failure due to inactive fan conditions, (the standby fans should be activated at least once a month).
- Stops fans from functioning whenever the exhaust volume is reduced by facility conditions.
- Provides energy savings.
- Field Modifiable Programming.

How it works…

1. The Leadlag™ controller operations are controlled by a main panel inside the building called the PLC Control Panel Unit (within a NEMA 1 enclosure). The Leadlag™ controller monitors the activated fans for hours of operation.
2. One lead fan will be deactivated after a predetermined number of operating hours and a standby fan will be activated. During this process, the Leadlag™ controller monitors the plenum pressure and adjusts the bypass damper.
3. The Leadlag™ controller also adjusts the rate at which the isolation damper opens for the activated standby fan and the deactivated lead running fan. The static pressure variation that this Leadlag™ sequences will be less than +/- 10% of the design static pressure and will last no longer than 30 seconds.
4. The Leadlag™ controller, furthermore, monitors the activated lead running fans for possible failures. If a fan does fail, an alarm light will illuminate and denote which fan experienced a failure. The power is cut to the failed fan and the next available standby fan becomes activated (as described in the steps 1. to 3. above).
5. The secondary panel is the Auxiliary Actuator Pressure Control Unit, (within a NEMA 3R enclosure) which is normally mounted on the exhaust intake plenum. The interior of the unit contains tubes for reading the static pressure and the terminals for the damper control actuator wiring. It is linked to the microprocessor in the main Leadlag™ PLC Control Panel Unit and receives input signals for static pres sure control, damper operation, and optional features such as temperature, bearing and vibration failure. Then, output signals are sent to the damper actuators and the fan motor starter.
6. Energy savings are achieved through monitoring the static pressure and design flow. The Leadlag™ PLC Control Panel Unit may be used in conjunction with the bypass damper, and it may additionally deactivate a fan when too much air is being bypassed.

Cost saving examples…

Example 1

A system design for 100,000 CFM @ 5“ SP. 5 fans in operation with 25,000 CFM of bypass air. The approximate BHP per fan is 35 for an annual cost of approximately $127,000.00 (based on 5, 40 HP motors operating 24/7/365 i.e. 8,760 hours per year @ $0.10 /kwh) The Axijet Leadlag™ controller is designed to operating in an N + 1 scenario, which would reflect 4 fans in operation and a fifth fan to be sequenced and cycle off. In the example given that would reflect an annual savings of approximately $25,400.00.

Example 2

The same design as above with an addition of night mode.

During the normal operation of the exhaust system 100,000 CFM is exhausted. The night mode has been determined that between the hours of 10:00 pm and 6:00 am the exhaust requirement is reduced to 50,000 CFM. In this scenario 2 additional fans can be cycled off for 8 hours each to provide an additional savings of approximately $8,460.00 per year per fan. The night mode hours and CFM requirements are field programmable.

The table below shows daily cost per motor and potential savings. Divide the daily rate by the hours of standby and multiply by 365 to calculate annual motor cost and potential savings.

FAN POWER		ENERGY COST PER FAN					
		PER DAY			PER YEAR		
HP	KW	$0.050	$0.075	$0.100	$0.050	$0.075	$0.100
5	3.7	$4.97	$7.45	$9.93	$1,813	$2,719	$3,626
7.5	5.6	$7.45	$11.18	$14.90	$2,719	$4,079	$5,439
10	7.5	$9.93	$14.90	$19.87	$3,626	$5,439	$7,251
15	11.2	$14.90	$22.35	$29.80	$5,439	$8,158	$10,877
20	14.9	$19.87	$29.80	$39.73	$7,251	$10,877	$14,503
30	22.4	$29.80	$44.70	$59.60	$10,877	$16,316	$21,754
40	29.8	$39.73	$59.60	$79.47	$14,503	$21,754	$29,005
50	37.3	$49.67	$74.50	$99.33	$18,128	$27,193	$36,257
75	55.9	$74.50	$111.75	$149.00	$27,193	$40,789	$54,385
100	74.5	$99.33	$149.00	$198.67	$36,257	$54,385	$72,513

Cost of operations are based on motors with minimum efficiency factor of 90%

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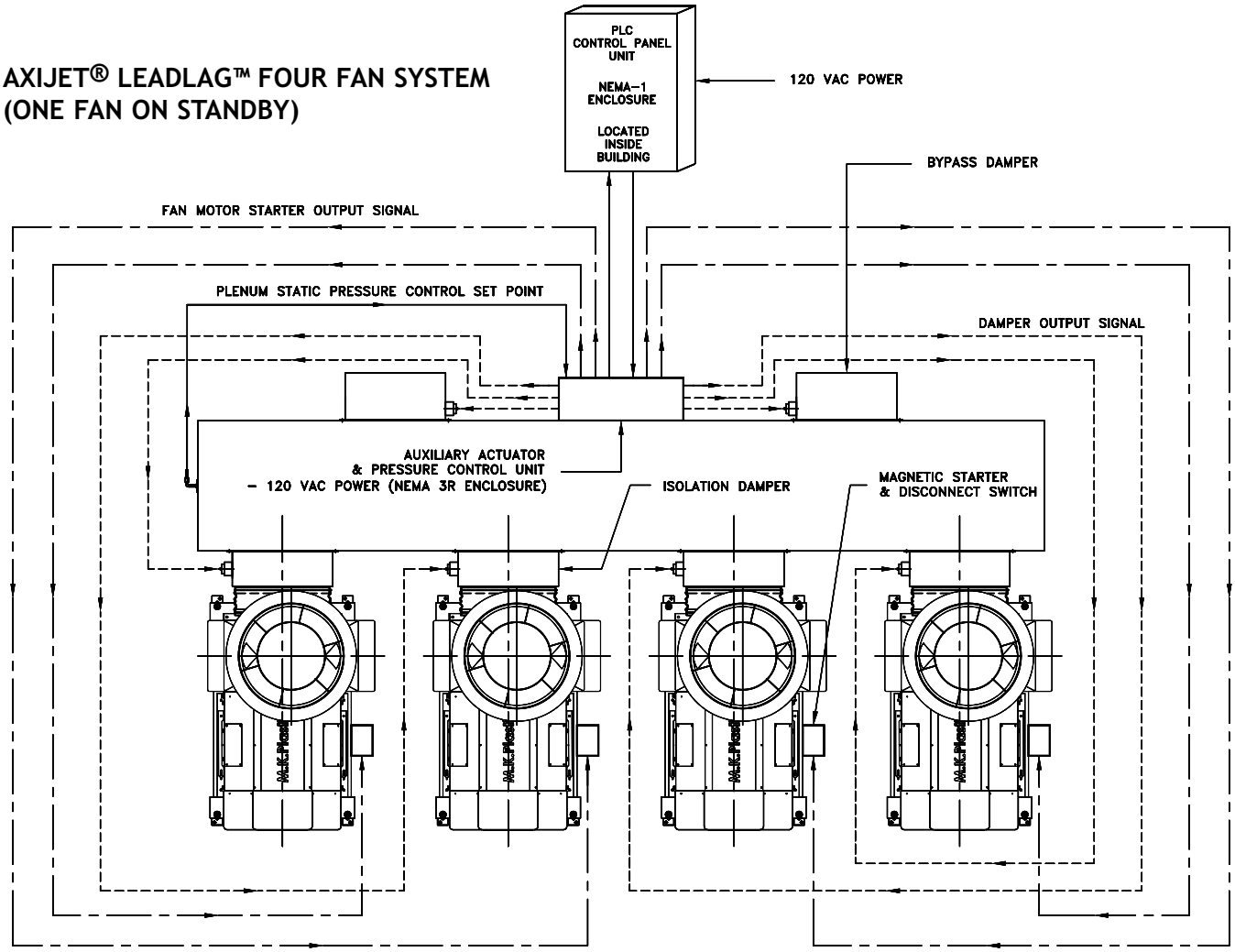
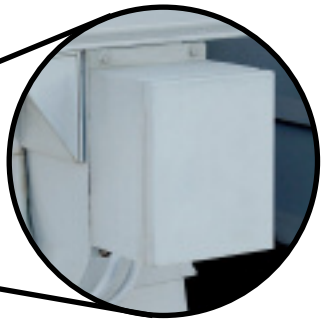
AXIJET® LEADLAG™ EXHAUST FAN CONTROL SYSTEM

AXIJET® LEADLAG™ FOUR FAN SYSTEM (ONE FAN ON STANDBY)



AUXILIARY ACTUATOR PRESSURE CONTROL UNIT

NEMA 3R enclosure, mounted outside, is linked to the PLC Control Panel Unit. The unit receives and sends signals for pressure control, damper actuator operation, fan motor starters and optional devices such as vibration failure.

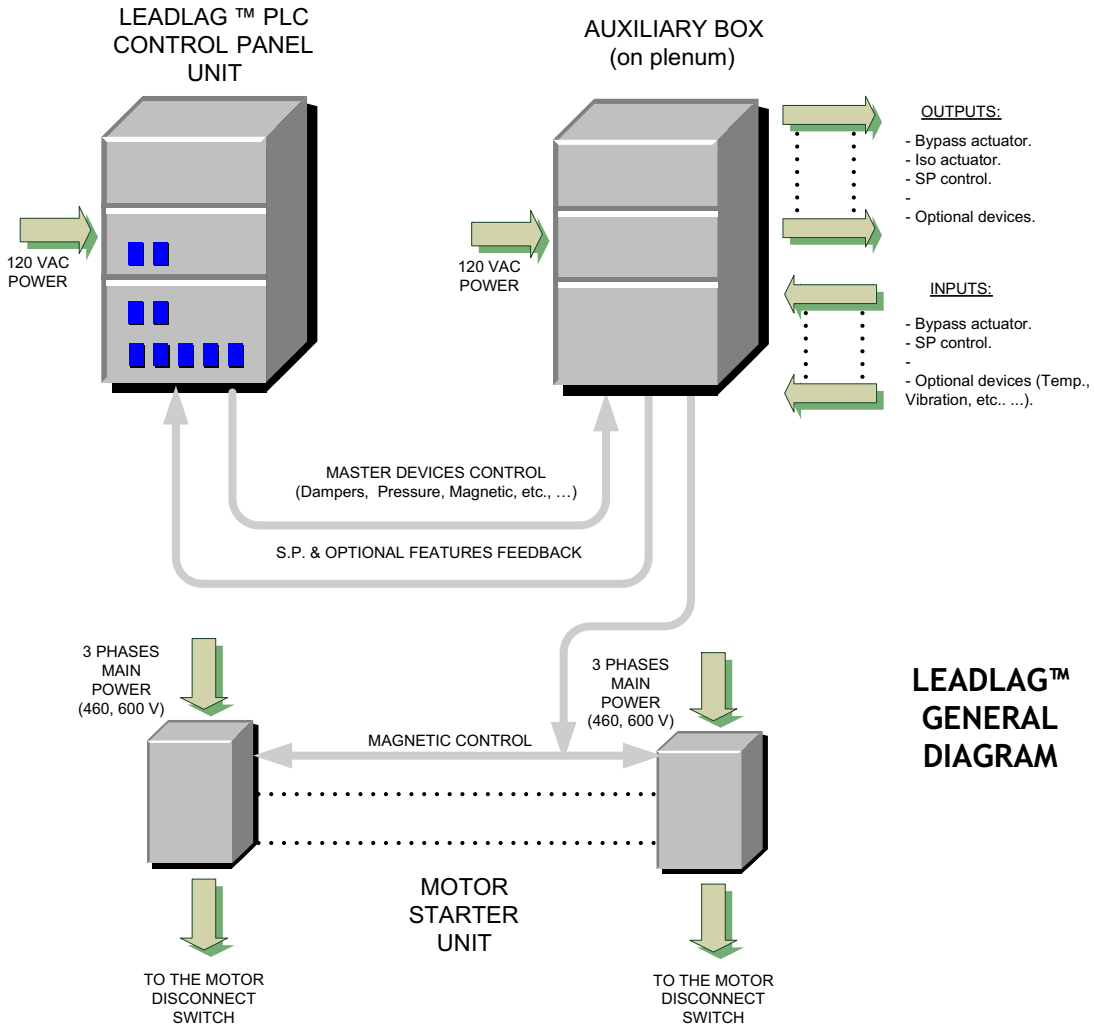


PLC CONTROL PANEL UNIT

NEMA 1 enclosure, located inside the building, that controls the functioning of the Leadlag™ operation through a microprocessor

Available Options...

- Pressure indicator; digital or analogue
- Integrated or Remote Leadlag™ Start/Stop mode
  - The Leadlag™ can be initiated or stopped at the PLC Control Panel Unit
  - The Leadlag™ can be initiated or stopped at a remote location according to the customer's needs
- Fan failure indicator (alarm), enabling to switch from Lead Fan to Lag Fan
  - Motor overload
  - Temperature limit
  - Vibration limit
  - Belt failure
  - Bearing failure
- BACnet communication Protocol compatible for Building Automation Control Networks
- Fire/smoke mode
  - Fan on or off (depending on State or Local Authority Codes)
- Compatibility with fans controlled by Variable Frequency Drives (VFD)
  (NOTE: When using VFD's, care should be taken when programming the drives to allow for minimum desired fan flow, outlet velocity and plume height of the fans)



LEADLAG™ GENERAL DIAGRAM

LEAD LAG – TYPICAL SEQUENCE OF OPERATION

Cycle Redundant Fan On/Off Sequence (N + 1 system)

1. Cycle time is pre-determined for each fan.
2. When the cycle time has passed…
    a. The Lag fan motor will start.
    b. After a delay, (pre-determined at the factory), the Lag fan isolation damper will open.
3. As soon as the Lag fans isolation damper starts to open, the Lead fan motor and its isolation damper will shut down simultaneously.
4. During the Lead/Lag cycling there could be a pressure fluctuation to within +/-10% for a short period of time, which will last no longer than 30 seconds.

Incremental Fan Off (Pressure Too High In Plenum)

1. If the pressure in the plenum is too high (detected by the PLC), the bypass damper will open to its maximum open position.
2. If the pressure is still too high in the plenum, longer than 3 minutes, (pre-set time at the factory and field adjustable), the system will disengage one of the Lead fans, as follows…
    a. The Lead fan motor and isolation damper will shut down simultaneously.
3. Once the Lead fan motor has de-energized, the bypass damper will go back to its continuous modulating zone.

Incremental Fan On (Pressure Too Low In Plenum)

1. If the pressure in the plenum is too low (detected by the PLC), the bypass damper will fully close.
2. If the pressure is still too low in the plenum, longer than 3 minutes, (pre-set time at factory and field adjustable), the system will engage one of the Lag fans, as follows…
    a. The Lag fan motor will start.
    b. After a delay, (pre-determined at the factory), the Lag fan isolation damper will open.
3. Once the Lead fan has come to full operation, the bypass damper will go back to its continuous modulating zone.

Laboratory exhaust fan control.

1. The laboratory exhaust fan manufacturer shall supply an electronic control system to monitor and control the operation of the laboratory exhaust fans.

2. The Leadlag™ laboratory exhaust fan control system shall control the sequential operation of the exhaust fans on a common plenum, and the periodic cycling of the (n + 1) standby fan while maintaining the system design static pressure to within + or - 10% for a 30 second period of time during sequencing.

3. The standby fan shall be activated on a two week cycle.

4. The system shall have the ability to be connected and monitored from a remote location inside the facility.

5. The system shall have a Network Interface Card for Internet connection to facilitate the controls manufacturer to monitor the functioning of the system remotely.

6. The system shall be configured to respond to operating parameters, and provide 4 – 20 mA output signals for monitoring and reporting status of the system components, as required by the specification.

7. The system shall include a main PLC Control Panel Unit (PCPU), in a NEMA 1 enclosure, to be located inside the building, that will contain a microprocessor to control the proper operation of the laboratory exhaust fan system.

8. The PCPU shall show fans running by lighting green LED's and show fans stopped by lighting red LED's.

9. The PCPU must have controls for Manual or Automatic operation.

10. A secondary NEMA 3R enclosure, the Auxiliary Actuator Pressure Control Unit (AAPCU), to be attached to the plenum and to contain the tubes for reading and maintaining Static Pressure and to contain terminals for damper actuators control wiring.

11. The two NEMA enclosures to be wire connected for communication of signals for static pressure control for fan isolation and plenum bypass air dampers.

12. All laboratory exhaust fan system fan isolation and plenum bypass air dampers, and associated damper actuators shall be supplied by the laboratory exhaust fan manufacturer.

13. FRP or Steel plenums shipped to the jobsite shall have the AAPCU attached to the plenum, the wiring and controls for damper actuators and the tubing for Static Pressure shall be installed by M.K. Plastics Corporation and to be tested and certified prior to shipment. Connection wiring between the PCPU and the AAPCU to be done in the field by the contractor.

14. The subcontractor doing the Leadlag™ wiring and installation of the control system on the job site, shall be under the supervision of a representative from M.K. Plastics Corporation.

15. The controls for the laboratory exhaust system shall be Leadlag™, to be supplied by the fan manufacturer, as supplied by M.K. Plastics Corporation, or equal.

LEADLAG™ - PATENT PENDING

CONDITIONS OF SALE

1.Prices quoted are current, prices prevailing at time of shipping will apply. Material in stock is offered subject to prior sale. All Sales Contracts arising out of this quotation shall be subject to our regular conditions show on this side.

2.All deliveries quoted are based on availability of material and labor at the time of quotation and subject to change. Deliveries are contingent upon strikes, accidents, fires, and other causes and we shall not be liable for any loss or damage caused by delays beyond the control of the company.

3.Goods invoiced up to and including the last day of the calendar month shall be paid for not later than the last business day of the following month. The company reserves the right to charge interest at commercial rates on any overdue account.

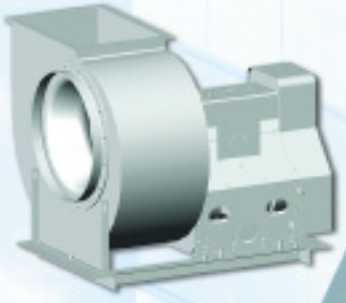
4.Any order accepted by us cannot be countermanded, revised or cancelled without our written consent and upon such terms as will indemnify us against any loss. The word “loss” as used herein shall include, but not limited to, cost of materials, special machinery, tools, jigs and fixtures built or purchased for the contract and all parts in process, fabricated in whole or in part by previous costumer authorization.

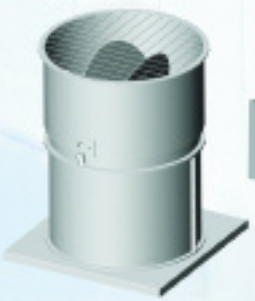
5.No contract arising from the acceptance of this quotation shall be valid and binding until approved by the company, such contract shall be governed by and interpreted in accordance with the laws of Province of Quebec.

6.All memoranda, drawings and information furnished by the company shall remain its property and shall be considered business or trade secrets received in trust and confidence for the sole purpose of assisting the buyer.

7.Orders to customer’s drawings or descriptions are filled with the understanding that the customer assumes the obligation to protect M.K. Plastics Corp. from any action for infringements of patents.

8.No modification of the above conditions of sale shall be effected by our receipt or acknowledgement of a purchase order containing additional or different conditions.





LIMITATION OF WARRANTY AND LIABILITY

We will not be responsible for the damage to equipment or materials through improper installation, storage, improper servicing, or through attempts to operate it in excess of its rated capacity or recommended use, intentional or otherwise. We will not be responsible for consequential damage.

Based on the fact that M.K. Plastics Corp. has no direct control over the actual handling and use of its products in the field, M.K. Plastics Corp. does not assume any liability for any loss of costumer or any personnel or any physical damages that claimed by anyone due to a failure or cause attributed to the use of its products. In no event shall M.K. Plastics Corp. be responsible for consequential damages of any such defective material or workmanship, including but not limited to the buyer’s loss of material or profit, increase expense of operation, downtime or reconstruction of the work and in no event shall M.K. Plastics Corp. obligation under this warranty exceed the original contract price of the defective item.

M.K. Plastics Corp. warrants its equipment, products and parts, to be free from defects in workmanship and material under normal use and service for one (1) year after delivery to the first user. Our obligation under this warranty being limited to repairing or replacing, at our option, without cost at our factory any part, or parts which shall , within such warranty period, be returned to us with transportation charged prepaid, and which our examination shall disclose to our satisfaction to have been defective.

M.K. Plastics Corp. will not be responsible for the cost of removal of a defective product or parts or the installation of a replaced product or parts, or for costs due for its removal, crating or shipping.

On account of variables including but not limited to, vibration, system noise characteristics, motor overloading or change in voltage conditions, the specifics of customer application of equipment or other system conditions, M.K. Plastics Corp. does not expressly warrant its equipment for any specific purpose.

The customer and its agents are responsible for the selection and application of M.K. Plastics Corp. products, including their fitness for the purpose and performance intended. Consequently, the customer on behalf of its agents assumes all liability related to the user/misuse, application and selection of the M.K. Plastics Corp.

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