Myth & Reality of “Basement Ventilation”

Reinventing Technology

MYTH & REALITY ABOUT PARKING AND BASEMENT VENTILATION
TEAM

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EFFECTIVE HEIGHT VIS-À-VIS TOTAL HEIGHT.
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• What does the NBC code say?
• Why should we take the slab height?
• The Centre of grille should be the criteria.

ventilation calculation:

• Each zone shall not be more than 3000 sqm.
• There shall be minimum two number of zones.
• Smoke extraction at 12 acph
• Normal ventilation at 6 acph
• Effective basement height – 10 ft
• Jet fans control using co sensors
• Sensor location – just above 1.8m & less than 25m from any corner of zone.
• Co level within 35ppm for 1hr & 25ppm for 8hr
Ducted VS Non Ducted Ventilation Systems

- Ducted ventilation systems are more effective than non ducted.
- It is the discretion of the fire officer to accept or reject ducted or non ducted systems.
- The power consumption of ducted systems is less than non ducted.
Ventilation Fans / Jet Fan

- CFD analysis is used for validation of Placement of Jet Fans
- CFD analysis is required for Fire and Smoke modeling in basement car park structure to ensure effective ventilation under normal and emergency situation
- No standard for Jet Fans in AMCA for Basement application

Benefits of Jet Fans

- Improved directional control for jet stream giving greater control of smoke in fire conditions.
  - Lower power requirement
  - Lower system losses with less jet stream contact with soffit.
  - Quiet operation.
  - Substantial savings in operating costs.
  - Substantial savings in time & cost of installation.
  - Increased safety & comfort of car park users.
  - Increased safety & efficiency for the fire service in the event of a fire.
CFD Analysis

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NO. OF CARS & ITS HEIGHT OR STACKS HAVE NO IMPACT ON CFD
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• The number of cars and stacks have an effect on the location and quantity of CO sensors.
• The height has an impact on the location of fans.

PLUMBING, ELECTRICAL SERVICES AND RAMP DETAILS HAVE NO IMPACT ON CFD ANALYSIS
PLUMBING, ELECTRICAL SERVICES AND RAMP DETAILS HAVE NO IMPACT ON CFD ANALYSIS

• Without the height of pipes electrical and HVAC services, the CFD cannot be done correctly.
• Each zone must have a fresh air (compensation air) inlet and exhaust air outlet (shafts).
• Can one ramp serve as fresh air inlet for all zones. Is it a good design?

DECIBEL LEVELS OF FANS AS MENTIONED IN THE SELECTION CHARTS ARE INDEPENDENT OF THE INSTALLATION.
Asking for 65dBA Fan

- Asking for 65dBA Fan is a lot like asking for light from a candle, you don’t know what you are going to get. The term dBA relates to sound pressure.

- How far is the Light? (Fan)
- Is the light outdoors? With no walls, all but the direct light radiates out into the “Free Field” of space. Is the fan outdoors?
- How big is the room? Light could reflect off all the walls of a small room. How big is the room?
- Are the room walls white? A room covered with black velvet would not reflect much light regardless of its size. How sound absorbent are walls?

- Have you observed a difference in noise levels dB (levels) between fans installed.
  1. Without isolators (metal to metal contact)
  2. Do vibrations lead to noise levels and vice-versa.
  3. Installation inside a room, without a door or a grille on the door, with hard surfaces.
  4. Can we create fire rated partitions that are soft surfaces from inside.
  5. Can we mount fans directly on walls?
6. Duct connections critical to control noise levels.
7. Canvass connections between ducts and fans need to be fire proof, not fire retardant.
8. Do we need canvass connections??

CO SENSORS NEED NOT TO BE CALIBERATED
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1. CO sensors and its activation.
   - 0-29 ppm - No jet fan and axial flow fan will run.
   - 39-59 ppm - Jet fan low speed and axial flow at 6 ACPH.
   - >60 ppm - Jet fan at high speed and axial fan at 12 ACPH.

2. In this scenario, will the VFD save energy?
3. Will the ducted system scenario be different?

INSTALLATION OF VFD IS A WASTE OF MONEY
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1. All controls need to be calibrated, once a year and a calibration certificate generated.
2. All VFD’s and PLC controls also need to be calibrated and tested year and year.

USE OF CO SENSORS IS MORE ECONOMICAL THAN PUTTING THESE FANS ON TIMERS
USE OF CO SENSORS VIS-À-VIS TIMERS

1. Is it a good practice to put the fan on timers based on usage of buildings.
2. Can we maintain the CO sensors in such an abusive environment?
3. Can we protect these sensors?

STATIC PRESSURE OF FANS CHOSEN ARE INDEPENDENT OF THE DUCT LENGTHS, VELOCITIES AND THE RESISTANCE IN THE SYSTEM.
STATIC PRESSURE OF FANS CHOSEN ARE INDEPENDENT OF THE DUCT LENGTHS, VELOCITIES AND THE RESISTANCE IN THE SYSTEM.

1. Correct calculation of the ESP is critical to fan performance.
2. Rule of thumb is disaster.
3. Simple methodology
   a) Evaluate the critical length.
   b) Calculate the friction as per your duct design of constant friction.
   c) No. of bends, elbows must be accounted for.
   d) Sum total the resistance, that is the static pressure.

Problems with Overdesigned & Underdesigned pressure

- Over airflow, from exhaust points leads to passive loss of energy from Air-conditioned area
- Excess consumption of Power by Fan, leads to recurring energy loss to Owner
- Make system unbalance to control, unnecessary high Noises by Fan
- Add Turbulence to system, which further adds vibration to mechanical components and may leads to early decay because of loosening of Nuts and bolts
- Under Air Flow, leads to inadequate ventilation or cooling effects to supply area &/or exhaust area.
- Electric Motor Trips or burn out, in some fans
TWO FANS, TWO DIFFERENT STATIC PRESSURES CAN BE CONNECTED IN ONE PLENUM.

1. Two fans one which is free suction and the other which is ducted cannot be connected into a common plenum.
2. Need the same strategy for correct performance i.e., ducted/non-ducted.
CROSSING OF DUCTS BETWEEN FIRE ZONES IS NOT ALLOWED.

- Ideal practice is not to cross zones with ducts.
- In case no choice can be gone with treatment and fire rating on ducts, using fire paint, fire wrap, fire dampers.
- Be involved with the architect to give adequate spaces.
FRESH AIR COLLARS NEED NOT TO BE BROUGHT DOWN TO 600mm ABOVE FLOOR LEVEL.

- Allow the fire man to crawl, to fight the fire, so oxygen is heavier, will settle down and allow the fire man to fight the fire.
- The exhaust duct needs to be at higher level by law of nature.
EXHAUST GRILLS NEED TO HAVE THE SAME NET FREE AREA AS SUPPLY AIR GRILLS.

- Use of double louvers VIS-À-VIS single louver grilles.
- Effect of pressure drop on fan power.
- Use of aerofoil blades in dampers (GI) VIS-À-VIS conventional blades (notched).
USE OF COLLAR DAMPER WITH VCD ARE ESSENTIAL FOR PROPER AIR DISTRIBUTION

- Use of collar dampers and VCD together is not recommended. Use one of them.
- If we do a correct static selection, and a correct duct design, can we avoid collar dampers.
USE OF GI POWDER COATED GRILLES IS NOT RECOMMENDED.

• GI powder coated grilles and louvers do a good job.
• Savings accrued can be invested in a good quality fans, controls etc.
NOISE LEVELS OR DB LEVELS AT BASEMENT ARE NOT IMPORTANT

• Extremely important for residential and commercial basements.
• Fire drills in hospitals and hotels a regular practice, so noise levels are critical.
USE OF NORMAL XLPE, FRLSCABLES IS ALRIGHT FOR BASEMENT VENTILATION.

• Fire rated and fire survival cables is the answer.
• Discourage the use of FRLS and XLPE cables.
PANELS INSTALLED IN THE ZONES NEED NOT BE IP-65 RATED.

• Fire rating of panels critical, and all components need to be fire rated, so that they can last through the entire evacuation process.
ENERGY EFFICIENCY OF THE NORMAL VENTILATION FANS IS NOT IMPORTANT. (IE-2)

- Energy efficiency is the key to any design, and use of efficient fans and motors critical.
- Can we use IE-3, IE-4 or IE-5 motors.
- Do they have a payback?
- Will volumes bring economy of scale?
- Can we use direct driven axial fans with EC motors?
- Can we tweak the blade and impeller design to bring in efficiencies?
- Can we change materials of construction?
THE STATIC OF THE FAN IS INDEPENDENT OF THE FAN SPEED.

Static and fan speeds generally follow the fan laws.
Fan Laws

- Air Quantity vs Static Pressure
- Air Quantity vs Total Pressure
- Based on Duty Point
- BKW
- Fan Total Efficiency
- Fan Static Efficiency
- Noise Level

Fan Performance Curve

- Fan absorbed Shaft Power
- Fan Total Efficiency
- Noise Level at Source
Fan Performance Curve

NOISE LEVELS DECIBELS ARE INDEPENDENT OF FAN SPEEDS.
• Noise is not proportional to Fan outlet velocity

• Not necessary as in HVAC all flow are turbulent flow

• Noise $\propto$ Fan rpm, but in same Fan diameter

• Noise $\propto$ Fan diameter, but at same RPM

• Too much stringent on Low rpm & Low outlet velocity may lead to selection of Higher Diameter at Low RPM leads to Noisy Fan unknowingly.

PROVIDING ADEQUATE CUT OUTS IS NOT IMPORTANT FOR PROPER EXTRACTION.
• Be involved with architects for adequate openings and cut outs.
• Improper cut outs lead to
  i) Higher resistance.
  ii) Higher noise levels.
  iii) Incorrect extraction.

Fan act as a Pump “Not Air Generator”

**What is Fan / Blower**: A fan is a machine used to create flow within a fluid, typically a gas such as air.

The fan consists of a rotating arrangement of vanes or blades which act on the fluid, which creates Pressure difference across sides and Fluid bounds to move.

It requires appropriate Passage for suction & Delivery of air.
• Smoke extraction to be activated using flow switch activation of sprinklers
• In addition local or remote manual start stop required
• Smoke outlet & fresh air inlet shall be 5 m apart
• Fresh air intake common shaft can be used for different basements
• Exhaust shafts to be separate for all basements

A HVAC ENGINEER DOES NOT NEED TO UNDERSTAND FIRE ZONING AND WATER CURTAINS, AS THIS IS THE PERVIEW OF FIRE FIGHTING CONSULTANT.
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• Need to understand the fire zoning, the relevant NBC codes etc.

ZONING:

• ZONE TO BE ISOLATED USING FIRE BARRIER
• IF PHYSICAL BARRIER IS NOT FEASABLE THAN WATER CURTAIN CAN BE USED
• ADDITIONAL WATER REQUIREMENT FOR WATER CURTAIN TO BE CONSIDERED IN FIRE TANKS FOR 60 MIN OF OPERATION FOR SIZE OF MAXIMUM ZONE.
• Water curtain pumps shall be separate from other fire fighting pumps.
DUCT DESIGN AND INSTALLATION ARE CRITICAL TO FAN PERFORMANCE SYSTEM.

- Duct shall be designed considering both normal & emergency operation
- Control dampers & gasket to be provided
- Fresh air from bottom & exhaust from top
- Though not mandatory ducts should be fire rated
Good Installation Practice / System Effect

The diagram below shows some more common causes of system effect.

USE OF CERTIFIED VIS-À-VIS NON CERTIFIED.
Fan selection

- Each zone to have multiple exhaust & ventilation fans
- Each fan to be amca certified
- Exhaust fans to be ul/ce certified
- Fans to be with backdraft damper
- fans to be located in fan rooms
- Jet fans to be located as per cfd analysis
- Cfd to include actual site constraint like beams & other services

Fan curve:

- Low electricity consumption vs commercial viability
- Low noise level
- Point of selection considering both normal & emergency modes
- Tube axial upto 1” – 1.5” sp
- Vane axial above 1” sp
AMCA CERTIFICATION IS ONLY ESSENTIAL FOR AIR PERFORMANCE.

3rd Party Certification & Validation

- Every Laboratory has its core competency in interest subject. They develop their facility for testing of product for performance, e.g. AMCA developed their standard for Air Performance, UL for safety concern like Electrical, Mechanical, Fire, Exova warrington Fire for Fire safety.
- Certificates assure designers and users that products have been tested, rated, and in accordance with established testing standards.
- Testing on up to date test standards, based on feedback from Testing & Industry.
- Certified products are even subject to continuing check tests.
Benefits of Fans in accordance with BSEN 12101-3:2002

- Fire Rated certification ascertains that the building occupant in case of Fire with Smoke, Fans would efficiently and continuously extract 250°C/ 300°C of heat and smoke for at least 2 hours.

- Fire Rated Fans would reduce damage caused by decomposition of thermal products and hot gases.

Benefits of AMCA Certified Fans in accordance with AMCA 210 & AMCA 300 for Air & Sound Performance

- The Certified Ratings Seal assures you that a product has been tested using the appropriate test standard. Each licensed product is subject to continuing check tests.

- AMCA International’s Certified Ratings Program assures specifiers, engineers, and users that the products being provided are tested, rated, and certified in accordance to
Benefits of AMCA Certified Fans

• Performance seal on equipment have been tested and its catalogue ratings have been submitted too and approved by AMCA international Staff.

• Our Certified Axial Flow Fan will insure proper Air Changes which further helps in renewal of oxygen level and removal of gases like Carbon Monoxide, Carbon Dioxide, Sulfur Dioxide or Hydro Carbons generated by the Cars / Vehicles.

Benefits of AMCA Certified Fans

• Product is subjected to continuing check test in AMCA international laboratories. All certified products are open to challenge testing which competing manufactures, or third party may initiate.
AXIAL FLOW FAN CURVES FOR NOISE AND AIR PERFORMANCE ARE NOT REQUIRED AT THE TIME OF DETAILED DESIGN. RULE OF THUMB CAN BE APPLIED.

Difference in "Air Performance" and "Air & Sound Performance" Certified Product

- **Products**
  - Agricultural fans
  - Axial fans
  - Axial impellers
  - Axial ventilators
  - Centrifugal fans
  - Centrifugal ventilators
  - Energy-recovery ventilators
  - Exhauster fans
  - Jet tunnel fans
  - Mixed-flow fans
  - Power unit
  - Propeller fans
  - Single-room air handlers

- **CRIP Publications**
  - ASHRAE Standard 311, Certification and Rating Manual for Industrial Ventilation
  - ASHRAE Standard 311, Certification and Rating Manual for Industrial Ventilation
  - ASHRAE Standard 311, Industrial Ventilation—Design of Systems and Equipment for Modern Industrial Facilities

- **Test/Rating Standards**
  - ASHRAE Standard 255, Energy Efficiency Classification for Fans
  - ASHRAE Standard 255, Laboratory Methods of Testing Fan for Certified Aerodynamic Performance Rating
  - ASHRAE Standard 255, Laboratory Methods of Testing Fan for Certified Aerodynamic Performance Rating
  - ANSI/ASME A31.5, Laboratory Method for Sound Testing of Fans
  - ANSI/ASME A31.5, Laboratory Method for Sound Testing of Fans
  - ISO 5801, Fans—Performance Testing Using Standardized Airflows
Fan curve:

- Low electricity consumption vs commercial viability
- Low noise level
- Point of selection considering both normal & emergency modes
- Tube axial upto 1” – 1.5” sp
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Fan Performance Curve

- Air Quantity vs Static Pressure
- Air Quantity vs Total Pressure
- Based on Duty Point
- BKW
- Fan Total Efficiency
- Fan Static Efficiency
- Noise Level
Fan Performance Curve

USE OF SOUND ATTENUATORS.
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- Pressure drops lead to higher fan power.
- Many times spaces are not available to get attenuation.
- Solving a problem after creating it?
- Increasing cost unnecessarily.

Testing and commissioning is not mandatory at site.
1. Third party testing and commissioning at site.
2. Appoint a commissioning agency at the start of the project reporting to owners directly.
3. Calibrated instruments to be made available at site within 15 days from the start of the project.
4. Documentation.

Installation & Operational Manual

- Should read and maintain product manual, installation to longer life of product.
- Electrical Connection shall be primarily done as per OEM manufacturer, however manufacturer should be consult
- For troubleshooting can refer Manual too
Introduction:

- The establishment of a pressure difference across a barrier to protect exit is pressurization
- Staircase 50 pa
- Lift well 50 pa
- Lift lobby 25-30 pa
- Building Height
### Calculation:

\[ Q = 2610.4 \sqrt{\Delta p} \]

- **Q** = Volumetric air flow rate, cfm
- **p** = pressure difference across flow path, in. of water

### Table 1: Typical Leakage Areas for Walls and Floors on Commercial Buildings

<table>
<thead>
<tr>
<th>Construction Element</th>
<th>Wall Tightness</th>
<th>Area Ratio ( A/A_{w} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior building walls*</td>
<td>Tight</td>
<td>0.50 ( \times 10^{-4} )</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>0.17 ( \times 10^{-4} )</td>
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<tr>
<td></td>
<td>Loose</td>
<td>0.35 ( \times 10^{-5} )</td>
</tr>
<tr>
<td></td>
<td>Very Loose</td>
<td>0.12 ( \times 10^{-2} )</td>
</tr>
<tr>
<td>Stairwell walls*</td>
<td>Tight</td>
<td>0.14 ( \times 10^{-4} )</td>
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<tr>
<td></td>
<td>Average</td>
<td>0.11 ( \times 10^{-5} )</td>
</tr>
<tr>
<td></td>
<td>Loose</td>
<td>0.35 ( \times 10^{-5} )</td>
</tr>
<tr>
<td>Elevator shaft walls*</td>
<td>Tight</td>
<td>0.18 ( \times 10^{-3} )</td>
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<tr>
<td></td>
<td>Average</td>
<td>0.14 ( \times 10^{-3} )</td>
</tr>
<tr>
<td></td>
<td>Loose</td>
<td>0.18 ( \times 10^{-2} )</td>
</tr>
<tr>
<td>Floors*</td>
<td>Tight</td>
<td>0.65 ( \times 10^{-5} )</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>0.52 ( \times 10^{-4} )</td>
</tr>
<tr>
<td></td>
<td>Loose</td>
<td>0.17 ( \times 10^{-5} )</td>
</tr>
</tbody>
</table>

*Firewalls and stairwells are part of a fireproof shaft. Fire lobby necessary to be pressurized in such case, unless naturally ventilated.
### Stairwell:

#### FIRE STAIRCASE 1 (STILT + 28 + TERRACE)

<table>
<thead>
<tr>
<th></th>
<th>WALL</th>
<th>AREA</th>
<th>WALL TYPE</th>
<th>NO. OF DOORS</th>
<th>LEAKAGE AREA</th>
<th>PRESSURE MAINTAINED</th>
<th>VELOCITY MAINTAINED</th>
<th>CFM REQUIRED</th>
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<tbody>
<tr>
<td>1</td>
<td>WALL 1</td>
<td>238.5</td>
<td>0.00017</td>
<td>20</td>
<td>0.049665</td>
<td>60</td>
<td>1708</td>
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<tr>
<td>2</td>
<td>WALL 2</td>
<td>238.5</td>
<td>0.00017</td>
<td>20</td>
<td>0.049665</td>
<td>60</td>
<td>1708</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>WALL 3</td>
<td>238.5</td>
<td>0.00017</td>
<td>20</td>
<td>0.049665</td>
<td>60</td>
<td>1708</td>
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</tr>
<tr>
<td>4</td>
<td>WALL 4</td>
<td>238.5</td>
<td>0.00017</td>
<td>20</td>
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<td>60</td>
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<tr>
<td>5</td>
<td>DOORS</td>
<td>0.033</td>
<td>29</td>
<td>0.057</td>
<td>50</td>
<td>12015</td>
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<td>6</td>
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<td>0.033</td>
<td>29</td>
<td>0.057</td>
<td>50</td>
<td>12015</td>
<td></td>
<td></td>
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<td><strong>TOTAL</strong></td>
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<td><strong>25903</strong></td>
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</table>

Total (Considering 5% Safety factor): 27093

### Lift well:

#### FIRST LIFT(STILT+28)

<table>
<thead>
<tr>
<th></th>
<th>WALL</th>
<th>SQM</th>
<th>SQM/SQM</th>
<th>DOORS</th>
<th>SQM</th>
<th>(Pa)</th>
<th>CFM REQUIRED</th>
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<tbody>
<tr>
<td>1</td>
<td>WALL 1</td>
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<td>0.03132</td>
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<td>294</td>
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<tr>
<td>3</td>
<td>WALL 3</td>
<td>174</td>
<td>0.00018</td>
<td>0.03132</td>
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<td>0.019575</td>
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<tr>
<td>5</td>
<td>DOORS</td>
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<td>28</td>
<td>1.12</td>
<td>60</td>
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<td></td>
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<tr>
<td>6</td>
<td>FAN OPENING ON LIFT(300mm DIA)</td>
<td>0.07</td>
<td>28</td>
<td>0.07</td>
<td>60</td>
<td>890</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>GAP BETWEEN LIFT &amp; WALL(50mm)</td>
<td>0.3</td>
<td>1</td>
<td>0.3</td>
<td>60</td>
<td>3770</td>
<td></td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
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<td></td>
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<td><strong>20176</strong></td>
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</table>

Total (Considering 5% Safety factor): 21187
Lift lobby:

**General requirement:**

- Pressurization shaft shall be with pressure relief damper.
- Pressurization intake shall be at least 4m from any exhaust outlet.
- Pressurization fan selection will be same as basement ventilation fresh air fan.
- Pressurization shafts can be masonry or ducted
- End terminals shall be with dampers
- Leakage area across doors – 5mm
OPPORTUNITIES

1. Direct driven SISW/DIDW fans.
2. Use of EC fans.
3. Use of high efficiency motors.
4. Use of ducts with inbuilt sealant and fire rated gaskets.
5. Use of duct sealants which are fire rated.
6. User of certified products only.
7. To be a third party testing and commissioning agency.
QUESTIONS??

THANK YOU

A BIG THANK YOU TO ALL CONTRIBUTORS!