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# DES



# DUST EXTRACTION STANDARD

## WHAT

*This standard includes requirements, recommendations and best practice when installing new filter equipment, based on experience from numerous installations. It is a supporting document for designing dust extraction systems for IKEA Industry.*

## WHY

*Focus is on low energy consumption, simple installations and high performance equipment, that ensures 24/7 running systems without break down of filters and avoiding any periodic manual cleaning of the filter. Additionally ensuring a well-designed system to be built that is suited for the production intended in the units, reduces the cost of investment. At the same time the productivity will be enhanced by less down time and less time spent on machine cleaning and reducing damages to the products caused by chip marks and impressions*

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| | | | |
| | | | |

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# 1. BACKGROUND

The content in the Dust Extraction Standard (DES) is to provide a solid starting point when designing new filter installations and when retrofit of equipment shall be adhered. The standard covers recommendations and demands for Flat Line and Solid Wood divisions.

To meet the ambition, the DES is constructed in order to create evaluation parameters in interest of both parties, and having a guideline of information exchange that allows IKEA Industry to understand the equipment performance and capacity, ensuring safety demands.

DES, is developed with the objective to create a base ground, ensuring that intentions from supplier and IKEA Industry meets the same goal with main focus on below topics when dust extraction system is discussed;

***✓ Safety !***

***✓ Energy !***

***✓ Performance !***

# 2. INTRODUCTION

Extraction systems represent typically 25-35% of the total energy consumption in IKEA Industry factories. It is vital that the extraction systems installed meet demands stated by IKEA Industry in order to ensure best option whenever possible, and for that the supporting documents used.

It is therefore crucial from the very first beginning of a project to spend time considering the optimum design of the system. By doing so the system will meet regulations and ensure best possible performance.

Valid European directives and referred norms shall always be used as a base together with this document when designing, and highest request shall always be used. In case of higher demands in the country of the installation outside Europe these shall be fulfilled.

# 3. STANDARDS AND NORMS

In general the equipment shall be designed, manufactured and declared in conformity with the machine directive 2006/42/EG, if applicable the directive 1999/92/EG (ATEX) and 2014/34/EU (ATEX equipment directive). This would be accomplished by meeting the demands in applicable harmonized standards addressing these directives.

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The equipment shall be designed according additional requirements in this IKEA Industry manual according to the following list.

| | |
|---|---|
| EN 60079-10-1 | Explosive atmospheres. Classification of areas. Explosive gas atmospheres |
| EN 60079-10-2 | Explosive atmospheres. Classification of areas. Combustible dust atmospheres |
| EN 14491:2012 | Dust explosion venting protective systems |
| EN 14460:2006 | Explosion resistant equipment |
| EN 60204-1 | Safety of machinery - Electrical equipment of machines - Part 1: General requirements |
| EN ISO 14122:2 | Safety of machinery. Permanent means of access to machinery. Working platforms and walkways |
| EN ISO 14122:3 | Safety of machinery - Permanent means of access to machinery - Part 3: Stairs, stepladders and guard-rails |
| EN 60034-30-1:2014 | Classification of three phase asynchronous motors by IEC |
| EN 12779 | Safety of woodworking machines – Chip and dust extraction systems with fixed installation – Safety requirements |

*IKEA Industry applicable manuals and standards:*

IKEA Industry Fire Prevention Manual

Electrical machine installation standard

Construction Standard

Health Manual 2014-04-15

Electrical Standard 2015-08-28

*Note: Latest valid standard and norms mentioned above must be used!*

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# 4. ATEX

All related ATEX issues is to be found in the Fire Prevention Manual **FPM**. DES does in general not describe content related to ATEX, but is referring to the chapter enclosed in the FPM. In some cases text from the FPM is included to highlight the technical importance.

**Note! All installations/installation types and extraction equipment shall comply with FPM, and it is strictly forbidden for both buyer and supplier to compromise the content and demands stated. Risk assessment shall be performed prior signing contract of any installation or rebuilding work for dust and chip handling systems. The assessment shall be approved by IKEA Industry chosen Inspection Company before any take-over or SAT test**

# 5. EQUIPMENT

Dust extraction systems in general consist of the main common equipment listed below;

- **Filter**
  - Under pressure (air volume extracted through the filter) equipped with either,
    - Inbuilt fans
    - Standalone fans
  - Over pressure (extracted air volume blown into filter), equipped with,
    - Standalone fans
- **Fans**
  - Clean air (Clean Air Fans)
  - Dust inside fans (Transport Fans)
- **Duct system**
  - Main duct (Duct into filter)
  - Main duct Machine (Drop line to machine)
  - Duct branch Machine (Duct branch connection on machine)
  - Duct system filter/fan (Duct between filter/fan)
  - Duct system Return air (Duct from filter/fan to atmosphere or return air)
- **Transport system**
  - Pneumatic (Waste transported with fan or pump)
  - Conveyor (E.g. Chain or Screw)
- **Silo**
  - Steel construction
  - Concrete construction
- **Cyclone**
  - Pre-separation before filter
  - Separation for Silo, container etc.

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- **Electrical Cabinet**
  - Main cabinet for extraction equipment

# 5.1. Installation type

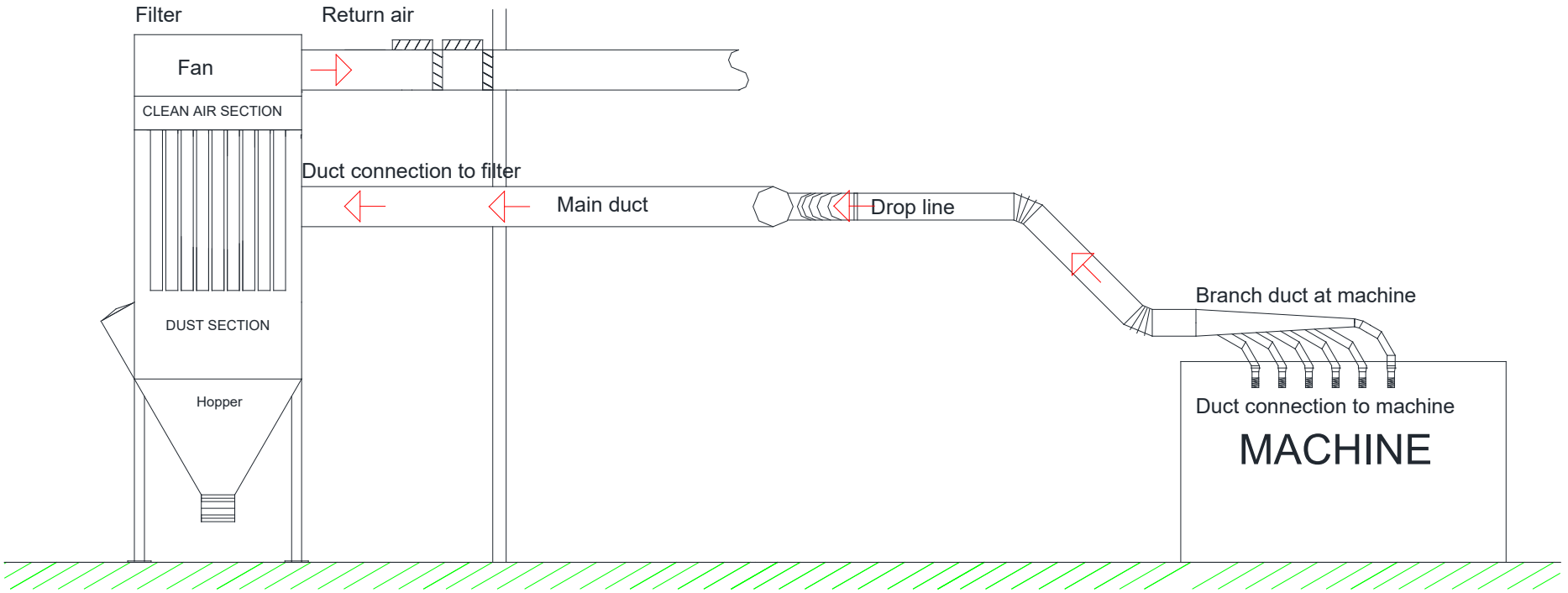
Following describes and illustrates the concept of installation types used in IKEA Industry, and further recommendable location of additional equipment implemented in the complete extraction installation.

Prior starting up projects, the best principal option of installation type to discussed.

Equipment must be designed to meet the ATEX classification stated by IKEA Industry, following the illustrated specifications below

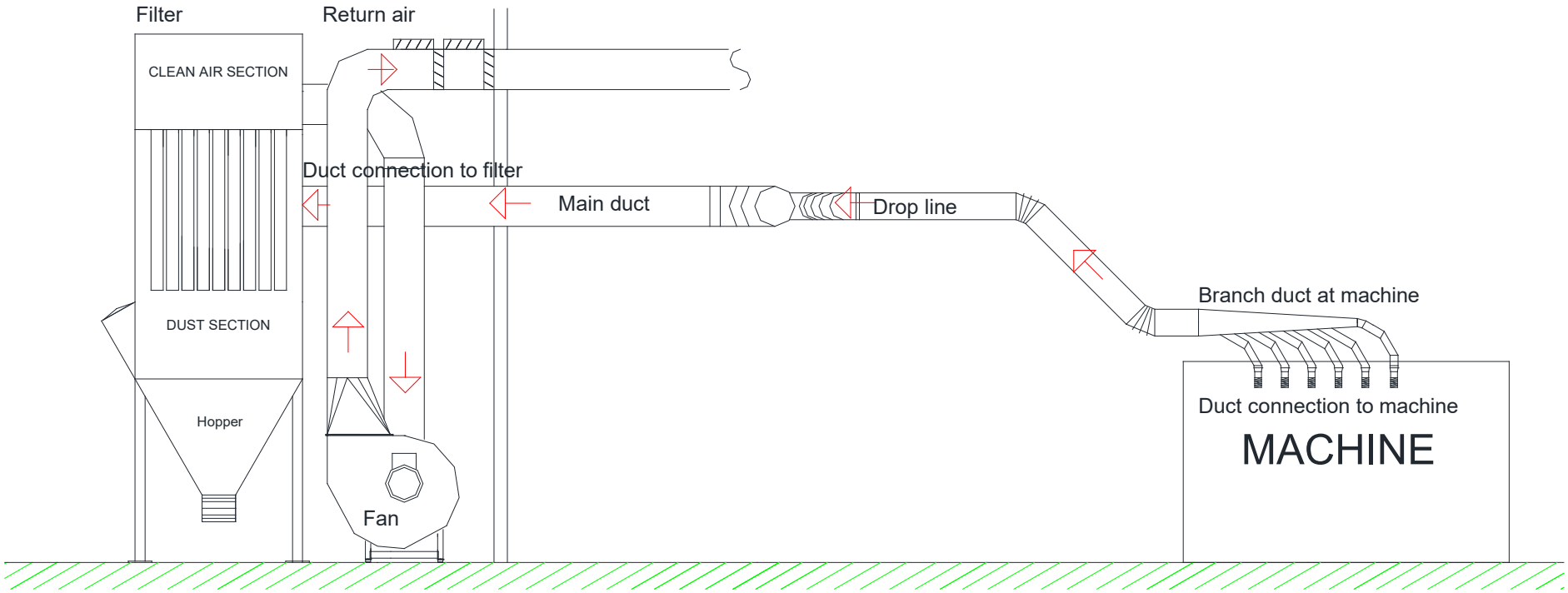
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## 5.1.1. Under pressure FILTER system (inbuilt fans)



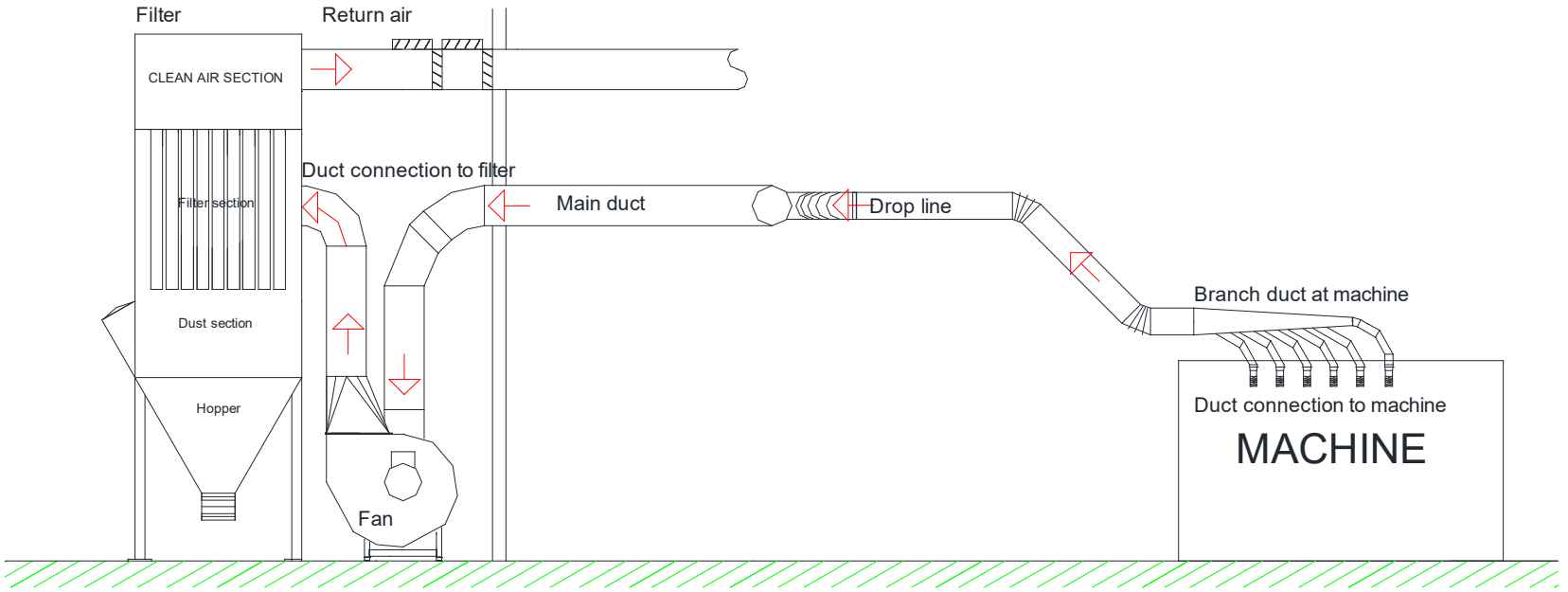
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## 5.1.2. Under pressure FILTER system (standalone fans)



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## 5.1.3. Over pressure filter standalone fans



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**Note!** *ATEX classification must follow the demands described in FPM "Ex-verification of equipment for dust"*

The location of a filter is determined by the machinery layout, building architecture or logistic infrastructure of the unit. It means that the distance from extraction points to filter will due the complexity of the ducting be subject for decision of the preferred filter system. To meet the best possible compliable solution, it is important to evaluate the duct design and by that, pressure drop calculation. New equipment to be installed must in general be supported with a well-documented pressure drop calculation of the system installed, handling the worst case scenario.

General features of the equipment is evaluated, based on the requirements of IKEA Industry.

# 5.2. Filter

## 5.2.1. General Requirement

Regardless the installation or filter type to be installed, all equipment shall follow below conditions

### 5.2.1.1. Location

The minimum distance between filters/cyclones and buildings are 3 meters.

If the building is constructed with fire wall, which means that it has a rating of REI60, the distance can be reduced to min 1m - allowing personal passage between filter and building.

Whenever location of filter must be chosen, it is important that the installation will not interfere with facility interior such as escape routes, drive passages, technical equipment, transformer stations, compressor rooms etc.

### 5.2.1.2. ATEX

All filters must comply with ATEX min Kst 100 and $P_{max}$ 8 bar, as technical insurance in terms of future changes, no matter the application for the filter at its prior design and dust specification.

Dust specifications according FPM.

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When the filter has to be extended in the height and deviates from its original design the recoil forces from an explosion shall be calculated according to EN14491:2012 and included in the design of support structures as well as enclosure strength. If the foundation or base steel structure for the equipment is supplied by the buyer, the recoils force shall be specified together with all other necessary loads given to the buyer for the calculations

### 5.2.1.3. Sprinkler

All Filters shall be equipped with fixed dry riser sprinkler system, in order to extinguish any possible fire inside a filter. Location of the sprinkler system inside the filter must ensure water rinsing in the full height and cross section of the filter housing.

Connection point outside of the filter should be in a height from ground level of 0,5m – 0,8m. Distance from the connection point from the filter to connection for fire brigade – minimum 3 meters and located in a free accessible area for the fire brigade.

Design of the sprinkler shall follow the recommendations described in EN12779

It can be recommended to have the sprinkler system connected to inside water supply with additional fire alarm.

**Note! - In case of fire in filter – it is strictly forbidden to open any doors or hatches to the filter**

### 5.2.1.4. Hopper section

Discharge using screw, rotary valve or chain conveyor system in hopper of filter by evaluating the application requirement with main consideration

- Quantity of dust ($m^3/h$)
- Dust type and density ($kg/m^3$)
- Properties of the waste material (threaded, coarse, humidity e.g.)

*Worst case should always be covered, e.g. evaluating high momentarily waste amount – typically when filter is running cleaning cycle after shut down of the filter.*

### 5.2.1.5. Noise

Noise level for the air returned to the production area shall be less than 80 dBA. Noise level outside production area shall follow the local rules and requirements for the unit.

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#### 5.2.1.6. Emission

Maximum allowed amount of particles in the return air 0,1 mg/m3. Emission to the outlet must follow local demands and requirements stated by the local authorities.

#### 5.2.1.7. Monitoring

In order to receive information and controlling the filter system, it is with highly importance that the extraction system is equipped with following devices

1. Filter drop ΔP (Pa) with Output (4-20 mA)
2. Broken Bag Detector (Activation shall interlock the filter)
3. Smoke sensor (located in the return air ducting close to filter, alternative inside the clean air section of the filter - see illustration chapter 5.4.9) Activation interlock the extraction system
4. Level sensor in the waste discharge area for the rotary valve of the filter

#### 5.2.1.8. Dust types

It is not allowed to mix lacquer dust with wood waste in one filter – extraction from lacquer lines must be isolated into a separate filter.

In general, waste from filters should be separated into silos or container, avoiding mixture of waste types, such as wood, ABS, etc.

### 5.2.2. Filter type recommendation

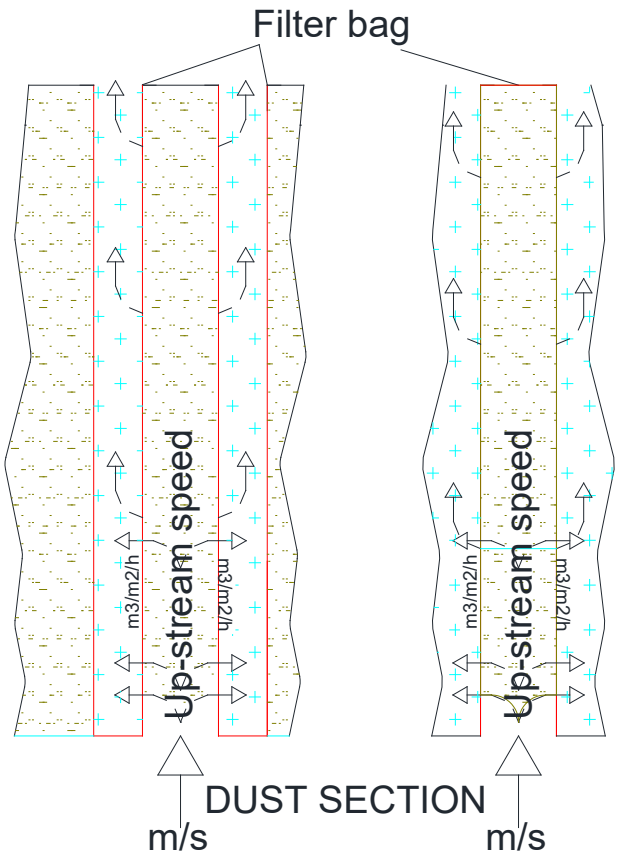
The optimum filter specifications that will be of highest value for IKEA Industry, are listed below with additional ref. to – Design Criteria

- Individual filter housing that can operate both as over and under pressure system is recommended for future flexibility.
- Modular build filter housing offers flexibility in terms of extension options for the future
- It is in general recommended to aim for under pressure system as it provides higher safety and further the pressure drop in the extraction system is lower – evaluation must be supported with proper pressure drop calculation.
- Filter house construction with inlet sections for extracted air for both pre-separation and avoiding turbulence in the hopper part of the filter.
- Explosion vents directed to non-hazardous area
    - It is highly important that complete installation will not include hazardous area around the filter where personal on daily basis will be present during operation. Installations that include hazardous area around the filter during operation must be avoided
- Filter should be designed with cleaning system including "off-line filter section" during cleaning. It is important that the pressure drop over the filter bags is kept low as possible

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  - Filter systems that provide pressure drop in the filter bags life time between 0-500 Pa is highly recommendable, combined with long life time of the filter bags
  - Reversed air cleaning will be considered as the optimum requirement to IKEA Industry Flat line and Solid wood divisions as it will stress the filter media textile structure to a minimum
  - The cleaning process should be able to provide a full cleaning of the filter bags > 5 times per hour, and further ensure full cleaning of the filter < 10 minutes after shut down of the filter
  - Cleaning system with compressed air should only be chosen as the installation is the only option for proper cleaning.
    - *Quality of the compressed air should comply with a dew point corresponding to the worst case scenario of local minimum temperatures, in order to avoid freezing problems and water/oil contamination on the filter bags. It is supplier responsibility to inform IKEA Industry*
- Dust filtration following the principle of outside dust contamination on the filter bags is highly recommended, as it gives best possible elimination of filter clogging and further allows peak loads outside the nominal design load.
  - Illustration below
  - ***Note!*** *The pressure drop through filter bags will increase whenever the filter load or up-stream speed increases, and the combination;*
    - *Low filter load, but high upstream speed, should be considered very carefully and motivated after risk assessment only*

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*Dust load **outside** filter bags*

*Dust load **inside** filter bags*

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# 5.3. Fans

Fans are divided into Clean Air and Transport fans.

Fans with clean air normally has a higher efficiency as the impeller construction is only to transport clean air – where the impeller construction for the transport fan has to be designed for material flow.

In both cases it is important to ensure the quality of the technology as the fans provides both the extraction and in the extraction system consumes 95% of the total power consumption.

Fans for extraction systems shall always have well documented readable performance rates. Whenever the fans are designed the performance must be according to the installation purpose with a pressure loss coefficient to be included in the design calculation.

## 5.3.1. General requirement

### 5.3.1.1. Direct driven

Fan types where the motor is either flanged to the fan housing (motor type B2) or the motor is bolted to the frame for the fan housing (motor type B3). In both cases the impeller is mounted directly to the shaft of the motor.

Motor shall have thermistor installed.

### 5.3.1.2. Belt driven

Fan types where the motor is connected to the impeller via pulleys and belt. In general belt driven fans shall be avoided in order to ensure high efficiency.

Motor shall have thermistor installed.

### 5.3.1.3. Sound booth

In cases where the noise level from the fan must be reduced, the fan can be located in a sound booth. Transport fans located in sound both needs to have additional maintenance due to the risk of dust accumulation inside the booth caused by leakages. Additional it is mandatory that the booth is equipped with fire detection equipment including interlocking of the complete extraction system.

### 5.3.1.4. Spark detection

Clean air fans; do not need to have spark detection system connected in the duct system for the fan.

Transport fan; Transport fans must have spark detection installed after the fan.

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### 5.3.1.5. Efficiency

Efficiency of the fans must be high as possible to ensure performance with lowest possible power consumption.

*Motors connected to the fan must follow classification of three phase asynchronous motors by IEC (EN 60034-30-1:2014)*

**Note! – If an IE2 motor will be driven by an inverter complying with IEC standard, it must be marked with following label:**




*Efficiency of IE3 motors does not automatically correspond to the best efficiency compared with IE2 therefor efficiency must be informed and accompanied by documentation for the motor*

Efficiency of fan stated in technical specification must comply with ISO 12759 or similar method.

**Note! – Above efficiency classification is valid only for optimal conditions, i.e. laboratory test.**

The real efficiency for the fan ***installed in the system*** **is calculated by following equation, and shall be informed before any prior installation. Below indicates both the power consumption in the installation and ensures the performance of the extraction.**

$$\mu_{fan\ in\ system}(\%) = \frac{Q \times \Delta Pt \times 100}{3600 \times 1000 \times P_{power\ consumed}}$$

*Where:*

| | | | |
|---|---|---|---|
| *Q* | = | Air volume (design) | ($m^3$/h) |
| *ΔPt* | = | Total static Pressure drop in system | (Pa) |
| *P* | = | Power consumption (fan included motor) | (kWh) |

Where;

$$P_{power\ consumed\ [kWh]} = \frac{Power\ shaft}{\mu motor}$$

*Whereas:*

| | | | |
|---|---|---|---|
| $\mu_{motor}$ | = | Efficiency motor | According specification of the motor |

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### 5.3.2. Fan recommendation

In order to meet the ambition of IKEA Industry to secure low running cost and further having best possible safety included in the extraction systems, evaluation of fans includes following considerations to be preferred;

Fan reaction time: Fast acceleration and deceleration time in different drive points for the fan(s) is important – this to ensure best possible reaction time when the demand of air volume is changing. For under pressure system it is recommended to have few fans installed in order to meet variable air volume demands within short reaction time.

Extraction fans must be equipped with frequency inverter in general, allowing compensation of both air volume and pressure demands in the complete system (PID-regulation). Evaluation of the number of inverters to be integrated should be evaluated in order to comply with fast acceleration and deceleration of the system. Flexible connection between fan and ducting must be avoided whenever possible avoiding leakages.

## 5.4. Duct System

Duct design and quality has a high influence when pressure drop (ΔPs), noise and safety is evaluated. Following chapter describes requirements and recommendation.

### 5.4.1. Duct quality and specification

Spiro ducting is not allowed whenever dust is extracted, and can only be used in the return air system complying with FPM.

All ducting used for extraction must in general have a proved strength to withstand minimum under pressure -5000 Pa. If systems includes higher pressure demand the duct strength must comply with the pressure demand including a 20% safety margin.

Ducts outer surface treatment to follow the demands for the actual situation. In general galvanized surface treatment is preferred.

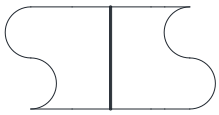
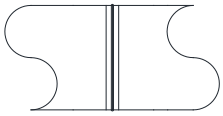
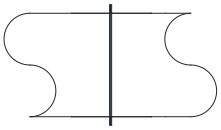
Documentation of duct strength must be available for both under pressure and over pressure following the recommendation and demands in FPM (Fire Prevention Manual)

If ducts penetrates walls going from one fire cell to another the ducting shall be equipped with fire damper – corresponding to the demands in the Fire prevention Manual and the Construction Manual.

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## 5.4.2. Clamps

Clamps used for connection of the duct segments must ensure proper strength and should correspond to below recommendation.

| | | |
|---|---|---|
|  |  |  |
|  |  |  |
| *Slim clamps can be used <u>only</u> with dimension < 300 mm* | *Wide clamps or flanges in full range of dimensions. Dimensions > 600 mm will normally be assembled with flanges.* | |

## 5.4.3. Support

Support of the ducting must comply with IKEA **Construction Standard** whereas:

- **6.5.1 Loads**
  - Load of 30 kg/m2 for employer's installations in the factory and storage areas shall be allowed over and above building installations such as sprinkler, lighting, ventilation etc.

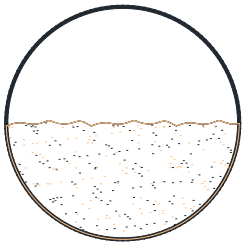
To meet the conditions stated in the **Construction Standard** and **Fire Prevention Manual,** general dimension of the support material and amount of support points must meet design criteria with below illustrated (example) loads;

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| Duct dim (mm) | volume (m3) | density (kg/m3) ex duct weight EXAMPLE | Estimated weight duct segment 1 m ex dust "EXAMPLE" (wall thikness 1 mm) (kg/m) | 1 m Duct segment 50 % filled up (kg) | 1 m Duct segment 100 % filled up (kg) |
|---|---|---|---|---|---|
| 800,0 | 0,50 | 120,0 | 25,1 | 55,3 | 85,4 |
| 700,0 | 0,38 | 120,0 | 22,0 | 52,0 | 68,1 |
| 600,0 | 0,28 | 120,0 | 18,8 | 48,8 | 52,8 |
| 500,0 | 0,20 | 120,0 | 15,7 | 45,7 | 39,3 |
| 400,0 | 0,13 | 120,0 | 12,6 | 42,6 | 27,6 |

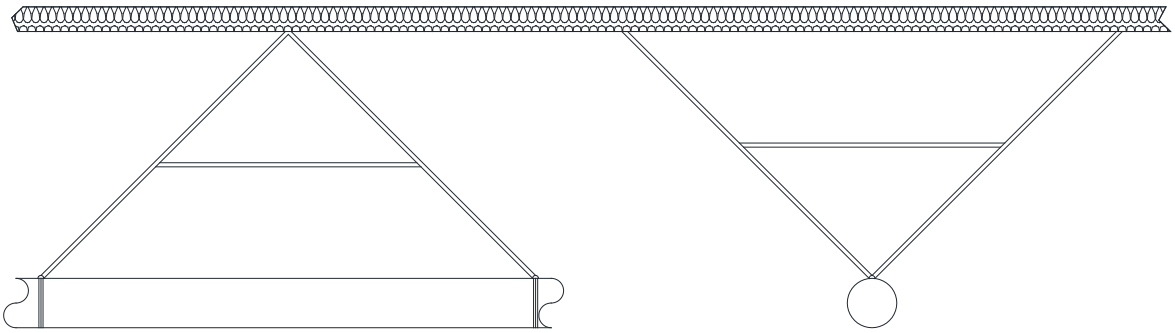
*Above **EXAMPLE** indicates the load of selected duct dimensions (total weight of duct segments depending on the wall thickness of the duct and density of the dust type)*

As extraction provides pneumatic transport of dust, it can in worst case scenario happen that air speed inside the ducting will not be sufficient enough to transport the dust/waste, often 50% of the cross section area will be filled causing accumulation of the dust inside the ducting,



– equivalent to 50% of the duct volume. Even with installed security equipment it will not give enough insurance that scenario of dust contamination will not happen. This can lead to ducts falling down, if support material does not meet the design criteria of above scenario.

*The fasteners for the support material should be designed for a worst case scenario, 100% full duct. The proper dimension shall be determined by using the European construction norm Eurocode, where safety margins are added according to the specific situations and possibility of material flows. Further compliance to the conditions of the ceiling construction ensuring loads at the fixing points.*



*Example of duct support, ensuring that ducting is fixed with steel profile in a way that the ducting will not create movement forward/backwards or side way. The*

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*support illustrated is an example only, but in generally in the full length of the complete duct installation, there should be fixing points eliminating the scenario described.*

Before the installation start, the supplier shall present documentation with calculations and technical solutions for the duct support systems

Duct supports shall preferably be attached to roof structure. In case this is not possible, the roof steel plate can be considered. However, an evaluation shall be carried out prior start of installation, by a construction specialist or a design company.

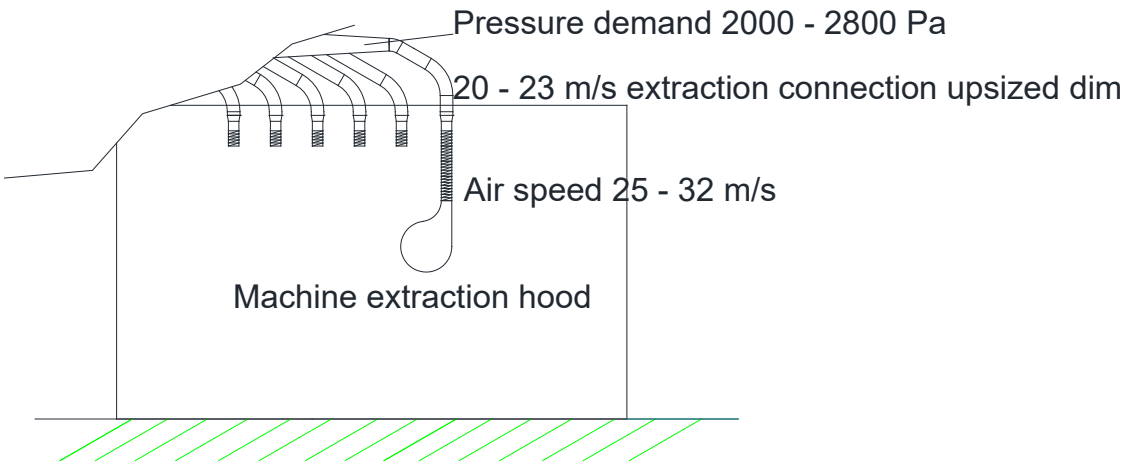
*If there will be any questions or doubts regarding strength of the building parts, the central engineering department will support.*

### 5.4.4. Machine connection (connection to hoods)

The duct connection to the extraction hoods are mostly prepared by the machine supplier. Duct connections at the machine automatically influence the total pressure drop in the complete extraction system. Below is listed topics and guide lines that must be followed to ensure lowest possible pressure drop.

- Ensure shortest possible flexible hose connections
- Flexible hoses should be installed with a straight position as possible
- Ducts to the machine should be upsized in diameter allowing lowest possible air speed

<u>Recommendable design figures:</u>




*Example of recommendable design figures – depending on the individual machine and duct installation*

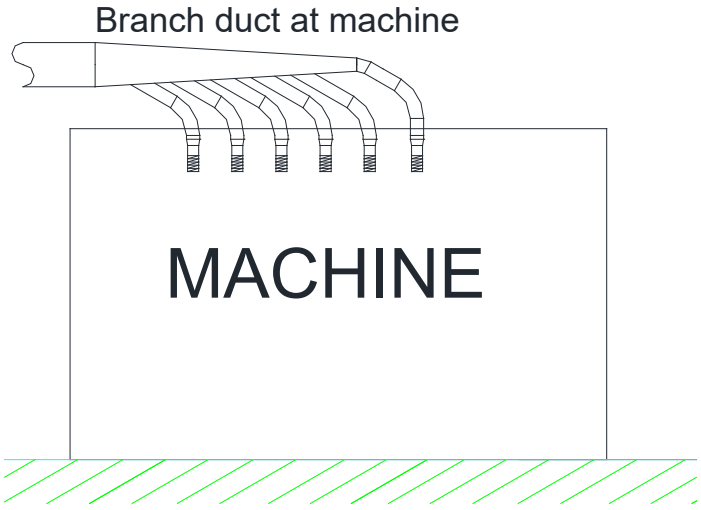
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When air volumes and general design values must be stated, the worst case scenario should be chosen ref. "Design Criteria"

Justifying the air speed (m/s) and Pressure demand (Pa) at the machine must be done by

- evaluating information and recommendation from the machine supplier
- and/or benchmarking existing installation(s) in IKEA Industry units

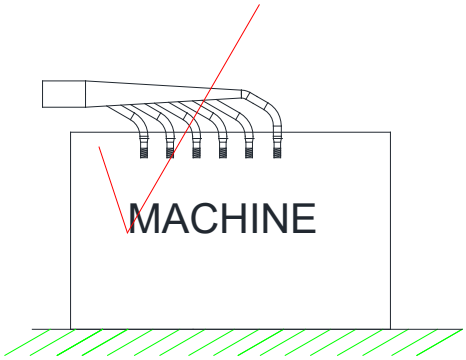
### 5.4.5. Machine connection (branch connection)



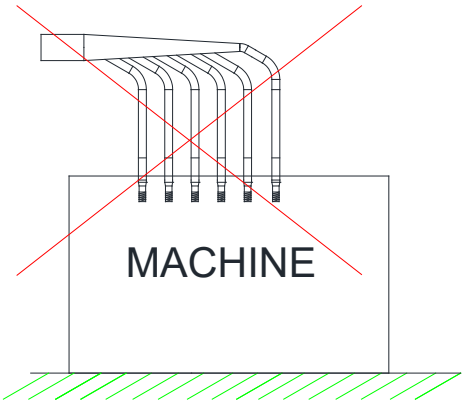

Branch connections follows the same principle as the general duct connection to the machine, as they often cause increased pressure drop demand for the complete extraction system and can create substantial noise source – if the duct branch isn't designed properly. It is for that reason recommendable to follow the basic design:

- Shortest distance possible to the machine for the duct connection (below illustration)
- Dimension of the branch to ensure proper air speed minimum 18 m/s – but at the same time is highly recommended to ensure air speed 20 – 23 m/s

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*Example of preferred installation design*



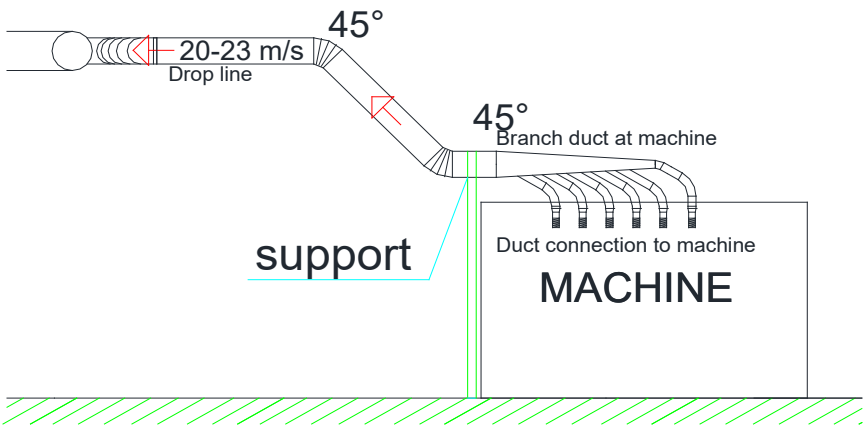

*Example - non preferred installation design*

## 5.4.6. Main duct to machine connection (drop lines)

Drop lines to the machines collects the total amount of dust extracted from the machine, and represents the total air volume extracted at the machine.

The minimum required air speed in the ducting is 18 m/s. As the machine can produce high amount of dust waste, it is for security matter necessary to evaluate the air speed needed to ensure transport of the dust. It is recommended that the air speed design should aim for 20-23 m/s

Below illustrates the basic principle to aim for;



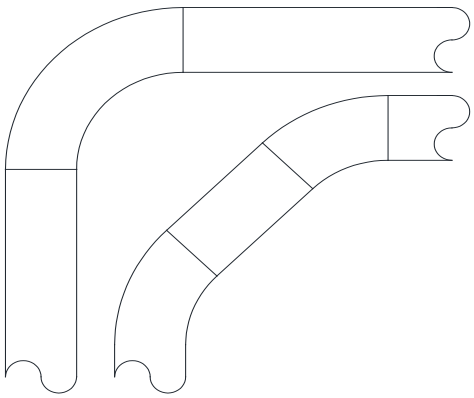
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*Example! - duct connection from main duct to machine. In order to decrease noise level and minimize the pressure demand in the system - ducts with 45 $^0$ bends. Duct connection at the machine is supported with a column fixed to the floor (can if possible be fixed to the machine) – creating stabilization of the branch duct located on top of the machine and ensuring safety.*

## 5.4.7. Main duct (ducts to filter/fan)

The duct to the filter must be designed in a way that it will provide lowest possible pressure drop and further meet design criteria providing lowest possible noise level.

- Reducing amount of bends and ensuring bends with high radius ($90^0$ bends should whenever possible be performed with $2x45^0$ segment bends with middle piece straight ducting – aiming for a total radius factor r/D = 2 – 4)
- Air speed 18 – 25 m/s is recommended complying to the criteria for proper transport speed in the ducting



*Whenever basic design criteria cannot be full filled, it should be stated.*

## 5.4.8. Duct system filter (duct connection to filter)

Duct connections to the filter/fans must obtain the elements described in above design criteria, as it has big impact on

- Noise level
    - Often transported waste in the ducting is cause of the highest noise source at and around the filter installation
- Energy consumption
    - Complexity of ducting will create higher pressure drop
- Performance of equipment

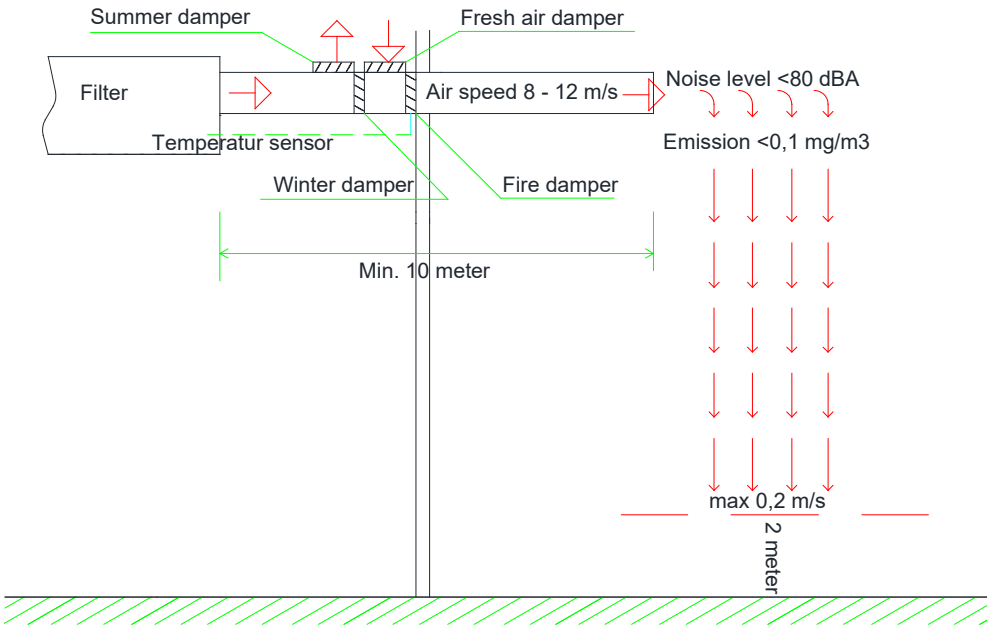
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- Duct connections to equipment must include considerations meeting the optimum performance requirement for the equipment

It is essential to have the duct work and installation design included when filter installation will be established.

*It is of high priority during evaluation of projects, as the duct work and design will have huge impact on above topics.*

## 5.4.9. Return air (duct system from filter to building)




*Principal illustration of return air system equipped with motorized louvres/dampers (summer / winter/ fresh air intake), location according IKEA Industry FPM.*

### 5.4.9.1. Fire damper

According **FPM 3.4.6 Fire dampers;** shall be installed whenever comfort- or process ventilation ducts penetrate fire separations and serve the spaces on both sides of the fire separating wall (different fire areas). If the ventilation duct only serves one fire cell area, it might be sufficient to provide the ventilation duct with fire insulation within the non-served fire area. Fire dampers shall close on signal from the general fire alarm, or by separate smoke detectors in the ducts, while fusible link activation is not allowed. Proper closing of fire dampers **shall** be tested at least twice yearly – in addition;

- Fire resistance complying to a rating of EI60 if nothing else is stated

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    - Fire resistance of the damper shall be the same as the wall, as minimum the requirement is EI60
- Temperature sensor located and installed in clean air section of the filter, or in the return air close to filter
- The activation of the fire dampers by power supply 24VDC with spring/return motor
- Recommendable to have the fire damper tested automatically provided by the control system in between the half year test – functionality where the automatic test is performed when filter is shut down mode with feedback signal for both open and closed position
- Any fault on the fire damper **shall** interlock the extraction system, and when the temperature sensor becomes activated due to temperature above its nominal set point (72°C)

### 5.4.9.2. Summer damper

Damper for summer function should be motorized, as the location often is without reach from the ground – following the motor supply specification of 24 V/DC

Position of the summer damper shall comply with FPM, ensuring that flame or pressure will not endanger people

### 5.4.9.3. Winter damper

Damper for winter function should be motorized, as the location in the ducting and preferably as close as possible to the summer damper – following the motor supply specification of 24 V/DC

### 5.4.9.4. Fresh Air intake damper

Damper for fresh air intake function should be motorized, as the location in the ducting and preferable closets possible to the summer/winter damper – following the motor specification supply 24 V/DC

The fresh air intake will minimize draft situation during summer period. It can be advisable to connect a pre-filtration filter media in order to avoid dust to enter the production area – it has to be evaluated for the actual installation

### 5.4.9.5. Noise level and emission

To ensure environmental conditions in production area, the recommendation illustrated must be followed, where

- Noise level in production area < 80 dBA
- Emission level in production area max 0,1 g/m$^3$
    - It is not allowed to return air from filters extracting from lacquer machines
- Air speed at the ground level max 0,2 m/s
- Noise level around the filter complying with local demands and rules

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*In some units depending on the location, the amount of returned air from the filter is determined by the local authorities. To ensure air balance in the factory, it is necessary to submit the system with a separate fresh air intake in order to supply fresh air (Supplementary fresh air must be equipped with a heating coil)*

## 5.5. Transport system

Pneumatic transport of dust waste collected from filters can contain high volumes of dust and chips, and by that the nominal air density is increased. It is important that fans connected to the transport system is dimensioned correctly and as minimum be installed with 20% spare capacity. This to ensure that the system can handle eventual peak loads.

Air speed 28 – 30 m/s must be obtained in the duct system.

Duct bends for transport system should be designed with wall thickness min. 2 mm, which is also recommended for the straight duct system. To minimize noise level the design principal should follow the general design criteria, ensuring duct bends with large radius.

As the transport system has a vital function in the total layout of the filter installation, and often serve several filters, the system should be equipped with a proper monitoring system to avoid break downs.

Ducting itself should be equipped with inspection hatches located in strategic places, in order to trouble shoot in case of blockage – actual location defined and decided for the individual installation.

Dust waste shall be separated where needed - in general,

- wood
- lacquer
- plastic (e.g. edge band trimming and profiling should always be separated)

*Deviations from the above demands shall be addressed to IKEA Industry central office*

## 5.6. Cyclone

Whenever cyclones will be installed it should be considered (if possible) to have the fan connected downstream of the outlet. This to minimize noise and maximize the efficiency of the fan.

Duct system and design must follow the same criteria described in chapter 5.4.8, especially as location of cyclones are located on the top of silos and for that can cause noise pollution at border lines to neighbors.

If the installation allows the use of a closed loop duct system it should be considered, as it will avoid the demand of extra filter connected to the outlet of the cyclone. Filters connected to cyclones must follow the same recommendation and demands stated in the chapter for "Filter"

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*In general cyclones must follow the recommendations stated in FPM*

## 5.7. Silo

Silos shall have openings for manual discharge of material in case of fire or other reason for emptying.

For safety requirements the points below should be followed:

- The silo shall be free standing and positioned outdoors
- The bottom of the silo, on which the chips and dust are stored shall be above ground level
- The cross-section of the silo shall either remain constant or decrease with height. The interior walls of silo shall be smooth and free from ledges, corners and parts where chips and dust could be accumulated.
- The silo filling system and the opening for feeding the silo shall be designed so that the chips and dust are distributed evenly in the silo
- If the filling height exceeds 6 m, inspection openings are required in the silo. The inspection openings shall be placed directly above the discharge openings.
- The silo shall have openings for the manual discharge of chip and dust. Minimum size for openings shall be 1,2 m wide X 2 m high. The openings shall be on the same level as the bottom of the silo. If the silo bottom is elevated from the ground the openings can be smaller but distributed so that an effective emptying can be carried out.
- The discharge openings shall be lockable.
- To eliminate pressure on doors and protect personnel, blinds shall be installed inside of the doors. These blinds shall ensure that no considerable volumes will come out when the door is opened. The blinds shall be designed as elements that can be lifted out one by one even under pressure to achieve a controlled discharge of material.
- The number of openings required in the silo is as shown below in Table 1:

**Table with required number of openings**

| Silo cross section | Inside width/inside diameter | Openings required |
|---|---|---|
| Square/rectangular | ≤ 4,0 m | 1 |
| | 4,0 m - 6,5 m | 2 |
| | 6,5 m - 8,5 m | 3 |

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| Silo cross section | Inside width/inside diameter | Openings required |
|---|---|---|
| | > 8,5 m | 4 |
| Round | < 5,0 m | 1 |
| | 5,0 m - 7,5 m | 2 |
| | >7,5 m | 4 |

- Where the silo is equipped with an automatic discharge system (e.g a rotating screw conveyor) the access door(s) shall be interlocked with the automatic discharge system and the run-down time shall be less than 10 sec.
- Discharge systems shall always be wind protected and IKEA Industry fire prevention manual shall always be acted upon designing

***Before any installation of a silo, it is mandatory that IKEA Industry AB central office shall approve the technical installation***.

## 5.8. Control board

Control board for extraction equipment must follow the Electrical Standard.

It is important that during the project phase, that the size of the main switch for the power supply is informed as well as the dimensions of the electrical cabinet

Electrical boards for filters/fans must be prepared with interface connection for IKEA Industry control and monitoring system - DEEM.

*For further information IKEA Industry central office should be contacted before any roll out of a project ensuring interface connection to DEEM.*

# 6. DESIGN CRITERIA

Whenever an extraction system has to be evaluated or installed, it is important to have data included that covers Air Volume, Pressure, and Power Consumption

The technical documentation at hand for the extraction equipment need to be supported by design criteria for the installation to be served. It is well proven that equipment installed does not meet the performance stated in laboratory conditions and for that reason the basic demands need to be followed. To secure filter performance and lowest possible running cost the following templates are provided (available in BMS):

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- Machine Data
- Performance Data
- SAT
- RFQ

# 6.1. Purchase

Whenever new extraction equipment is to be purchased, the RFQ shall include information of the performance to be expected. RFQ document shall be accompanied with documents listed and described in chapter

- Machine Extraction Data
  - Template including
    - Air Volumes
    - Air Speed
    - Pressure demand

**Note! When IKEA Industry is purchasing extraction equipment the air volume at the individual machines is set as reference – Total air volume is considered as overall design criteria for the filter capacity to be installed. Capacity of fans shall always secure worst case scenario.**

- Performance Data
  - Template includes information
    - Air volumes worst case scenario
    - Performance in different scenarios – Scenarios stated by IKEA Industry
    - Power consumption in the different scenarios
    - Filter characteristic

**Note! It is important that the installed equipment complies with the stated information above, as running cost for the system is vital for IKEA Industry and further having guarantee that the equipment can obtain required extraction performance in the full life time of the filter bags. The stated values *must be accompanied and supported with diagrams or other readable documentation, as it will be part of the evaluation as described in "Take Over"* by using measuring methods described in "Measuring"**

- SAT-template
  - Includes evaluation description of data stated in the Machine Extraction Data and Performance Data templates

All extraction installations offered shall as minimum include 2D drawing indicating

- Atex Zones
- Indication of Ex-vent blast zones
- Noise level
- Foot Print with Weight indication

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- Air speed in the ducting to inlet and outlet of filter/fan

## 6.2. Machine Extraction data

Machine Extraction Data, containing;

- Air volume at individual machines ($m^3/h$)
- Total air volume for installed equipment
- Pressure @ machine
- Air speeds in the duct lines form machine to the connected filter/fan
- Reference point for pressure demand in the whole system – Worst case scenario to be taken into consideration and stated.

*Machine Extraction Data template will be included in RFQ as appendix when purchase is intended. For trouble shooting and installation evaluation in general the template should be used as supportive tool. This template will secure proper extraction at every machine – where it is actually needed.*

| MACHINE EXTRACTION DATA ref.: UNIT - PRODUCTION AREA - DWG - DATE | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Identification | | | | Machine data | | | | | | | | Main ducts | | |
| Machine Id No: | FILTER connected | FAN ID No: | Main duct Id | Duct connections No | Dimension mm | Design Air Speed m/s | Air volume | Branch diameter (mm) | Air volume m3/h | Air Speed m/s | Static Pressure at machine Pa | Main duct diameter mm | Air speed Main duct mm | Air Volume m3/h |
| a | a-1 | | 1 | 1 | 0 | 0 | - | 0 | - | | 0 | 0 | | |
| | | | | 2 | 0 | 0 | - | | | | | | | |
| | | | | 3 | 0 | 0 | - | | | | | | | |
| | | | | 4 | 0 | 0 | - | | | | | | | |
| | | | | 5 | 0 | 0 | - | | | | | | | |
| | | | | 6 | 0 | 0 | - | | | | | | | |
| | | | | 7 | 0 | 0 | - | | | | | | | |
| | | | | 8 | 0 | 0 | - | | | | | | | |
| | | | | 9 | 0 | 0 | - | | | | | | | |
| | | | | 10 | 0 | 0 | - | | | | | | | |
| Machine Id | | | Main duct Id | Duct connections No | Dimension mm | Design Air Speed m/s | Air volume | Branch diameter | Air volume m3/h | Air Speed m/s | Static Pressure at machine Pa | | | |
| b | a-1 | | 1 | 1 | 0 | 0 | - | 0 | - | | 0 | 0 | | |
| | | | | 2 | 0 | 0 | - | | | | | | | |
| | | | | 3 | 0 | 0 | - | | | | | | | |
| | | | | 4 | 0 | 0 | - | | | | | | | |
| | | | | 5 | 0 | 0 | - | | | | | | | |
| | | | | 6 | 0 | 0 | - | | | | | | | |
| | | | | 7 | 0 | 0 | - | | | | | | | |
| | | | | 8 | 0 | 0 | - | | | | | | | |
| | | | | 9 | 0 | 0 | - | | | | | | | |
| | | | | 10 | 0 | 0 | - | | | | | | | |
| Machine Id | | | Main duct Id | Duct connections No | Dimension mm | Design Air Speed m/s | Air volume | Branch diameter | Air volume m3/h | Air Speed m/s | Static Pressure at machine Pa | | | |
| c | a-1 | | 1 | 1 | 0 | 0 | - | 0 | - | | 0 | | | |
| | | | | 2 | 0 | 0 | - | | | | | | | |
| | | | | 3 | 0 | 0 | - | | | | | | | |
| | | | | 4 | 0 | 0 | - | | | | | | | |
| | | | | 5 | 0 | 0 | - | | | | | | | |
| | | | | 6 | 0 | 0 | - | | | | | | | |
| | | | | 7 | 0 | 0 | - | | | | | | | |
| | | | | 8 | 0 | 0 | - | | | | | | | |
| | | | | 9 | 0 | 0 | - | | | | | | | |
| | | | | 10 | 0 | 0 | - | | | | | | | |
| TOTAL AIR VOLUME (m3/h) | | | | | | | | | | | | | | |

*Above example illustrates the basic content of the extraction data related to air volume demands with reference to the project description.*

## 6.3. Performance data

In order to understand the capacity and performance of equipment installed with reference to the "Machine Extraction Data". It is well proven that equipment installed does not meet the performance based on laboratory conditions. The basic specification of the filter equipment must include the below information following conditions to the actual installation.

System data, including;

- Pressure drop in the system

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  - (*Important! – total system pressure drop ΔPa for worst case scenario to be chosen*)
- Total air volume ($m^3$/h)
- Power consumption (kWh) – with reference to worst case scenario
- Pressure drop in filter – IKEA Industry will inform scenarios
- Filter load ($m^3/m^2$/h) accompanied with flow speed inside/between filter bags
- Load and upstream flow speed complying with dust specification
- Air speed in the return air to the production area (m/s)
- Air speed returned must comply with the condition in the architecture of the building

| **Total air volume** | **Pressure @machine** | **Pressure drop filter** | **Static pressure drop in system** | **Power consumption** | **Efficiency System** | **Upstream speed in - / between filter bags** | **Filter load** |
|---|---|---|---|---|---|---|---|
| ***$m^3/h$*** | ***Pa*** | ***Pa*** | ***Pa*** | ***kW*** | ***%*** | ***m/s*** | ***$m^3/m^2/h$*** |
| **SCENARIO 1 – capacity according machine list** | | | | | | | |
| **A** | **B** | **0** | **C** | **D** | **E** | **F** | **G** |
| **A** | **B** | **250** | **C1** | **D1** | **E1** | | |
| **A** | **B** | **500** | **C2** | **D2** | **E2** | | |
| **SCENARIO 2 – filter capacity according design** | | | | | | | |
| **A1** | **B** | **0** | **C3** | **D3** | **E3** | **F1** | **G1** |
| **A1** | **B** | **250** | **C4** | **D4** | **E4** | | |
| **A1** | **B** | **500** | **C5** | **D5** | **E5** | | |
| **SCENARIO 3 – max capacity** | | | | | | | |
| **A2** | **B** | **500** | **C5** | **D6** | **E6** | **F1** | **G2** |
| **A1** | **B** | **500** | **C6** | **D7** | **E7** | **F2** | **G1** |

Scenario 1:

- Filter installed with required air volume; stated "A" in Template "Machine Extraction Data"

Scenario 2:

- Filter installed with air volume as designed "A1" $m^3$/h at supplier stated pressure drop$\Delta$ $Pt_{system,}$ (Pa)

Scenario 3:

- If filter equipment proposed *can* have additional spare capacity compared with the project design requirements; understood as additional capacity of the system stated and specified as follows,
  - When minimum required pressure is fixed "C5",: max air volume stated
  - When design air volume is fixed "A1",,,,,,,,,,,,,,,,,: max pressure achievable stated

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Upstream speed and filter load shall correspond to filter in operational condition – meaning that off-line filter section is present during extraction.

*Performance Data document will be an appendix to RFQ document and further in the Take Over procedure*

## 6.4. Take over

In order to ensure the capacity and performance of equipment installed the basic technical specification informed in "Machine Extraction Data" and "Performance Data" must comply to the commissioning report and to be verified during Take Over and used as an appendix with the SAT document as part of the final documentation.

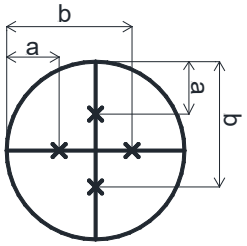
# 7. MEASURING

Measuring methods of IKEA Industry shall always be used, in order have aligned definitions agreed.

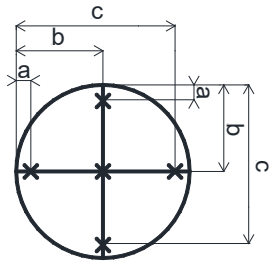
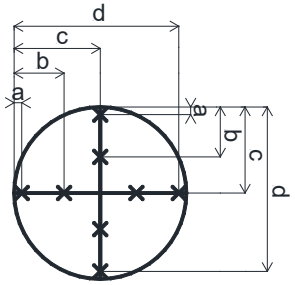
## 7.1. Air volume

Air volume measured must follow below table to ensure the most accurate values. The probe position points are determined in order to have equal cross section areas with respect to the boundary layer in the ducting. Each measuring point must be performed in 5 sec duration, and the average value used.

Table with measuring points

| Nominal diameter, $d_n$ (mm) | Probe position point indication (illustration) | Probe position points location (mm) **a** | **b** | **c** | **d** |
|---|---|---|---|---|---|
| 100 |  | 29 | 71 | | |
| 125 | | 36 | 89 | | |
| 160 | | 46 | 114 | | |
| 200 | | 20 | 100 | 180 | |

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| | | | | | |
|---|---|---|---|---|---|
| 250 | | 25 | 125 | 225 | |
| 315 | | 32 | 160 | 283 | |
| 400 |  | 40 | 200 | 360 | |
| 500 | | 22 | 145 | 355 | 478 |
| 630 | | 27 | 185 | 445 | 603 |
| 800 |  | 34 | 230 | 570 | 766 |
| 1000 | | 43 | 290 | 710 | 957 |
| 1250 | | 54 | 360 | 890 | 1196 |

Measured speed values (m/s) used for determination of the air volume, using below equation;

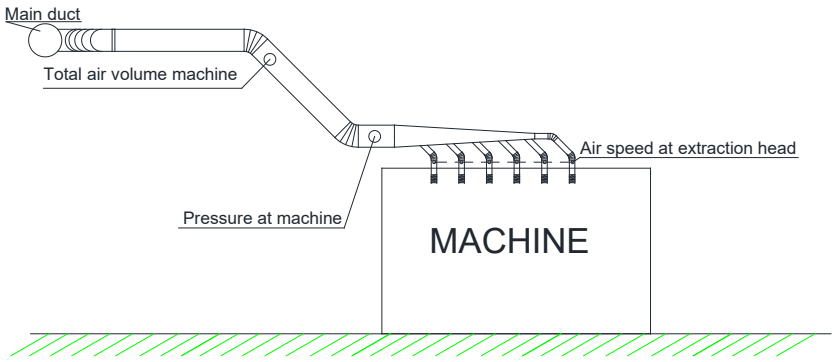
**Air volume *Q* (m³/h) round duct**

$$Q = A * 3600 * v_{average} * K \quad [m^3/h]$$

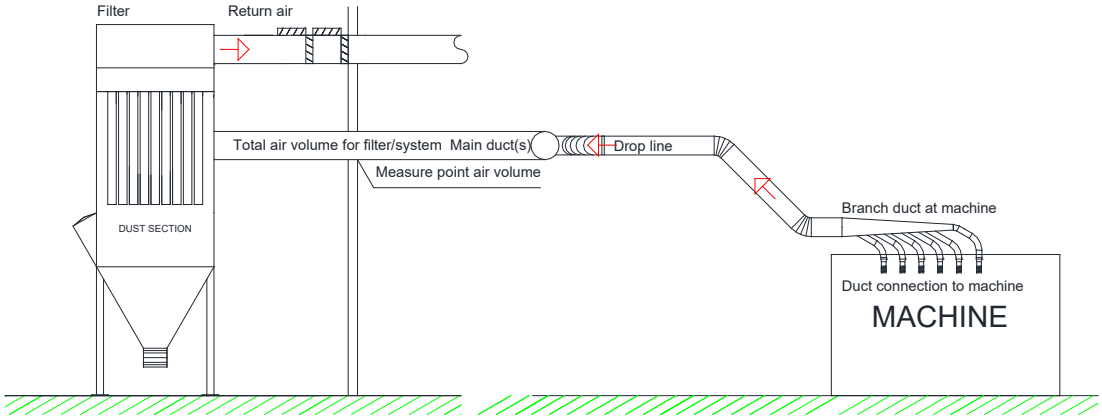
*Where,*

| | | | | |
|---|---|---|---|---|
| $v_{average}$ | = | *Average air speed* | *(m/s)* | *Average speed from the measures* |
| *A* | = | *Cross section area* | *($m^2$)* | *Of the represented ducting* |
| *K* | = | *Correction factor* | | *0,95* |

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*Example of points for measuring air volume and pressure close to the machine*

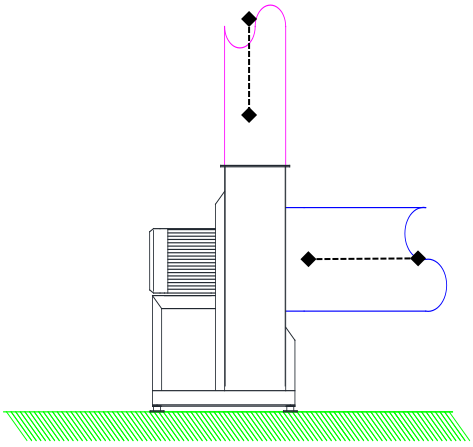



*Example of points for measuring total air volume for the extraction system for one filter*

# 7.2. Pressure

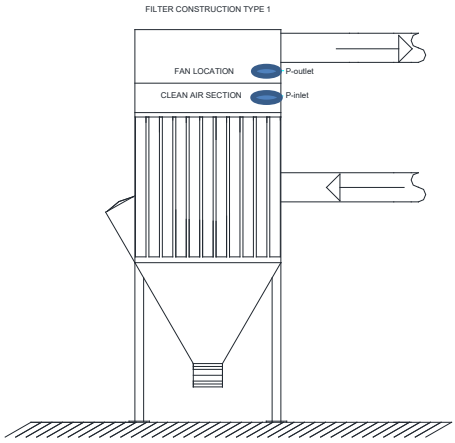
| | |
|---|---|
| | |

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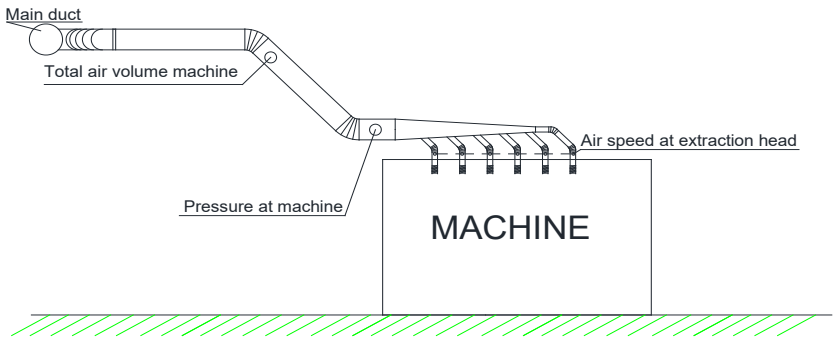
**Standalone fans**

- The measure point before the fan should be closest to the inlet of the fan
- Pressure from the outlet should be measured within a distance from the fan outlet where the pressure value is considered stable




**Filter system with inbuilt fans**

- The measure point before the fan should be closest to the inlet of the fan
- Pressure from the outlet should be measured in the section for the fan(s). If fans are connected with ducts into the return air, the pressure can be measured in the ducting




**Machines**

The pressure reference at the machines according IKEA Industry DES is defined as closest main duct collecting point at machine illustrated above. In case machine supplier is confronted, it is important to line out the definition of the pressure measuring point.

# 7.3. Power consumption and efficiency

## Absorbed power

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If the current for the fan(s) must be measured to determine the power absorption (kW), below equation will be used

$$P = U * I * \sqrt{3} * Cos\phi$$

Where,

| | | | |
|---|---|---|---|
| ***P*** | = | Power absorbed | (kW) |
| ***I*** | = | Voltage | (Amp) |
| ***U*** | = | Current | (V) |

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## Efficiency of systems and fans installed

Efficiency of system is measured and calculated by following equation:

$$\mu_{fan\,/\,system}(\%) = \frac{Q\ x\ \Delta Pt(system\ measured) x\ 100}{3600 \times 1000\ \times\ P_{measured}}$$

*Where,*

| | | | | |
|---|---|---|---|---|
| ***Q*** | = | Air volume | ($m^3$/h) | *In main duct line(s) to filter equipment* ***"measuring method - Measuring air volume -/ speed"*** |
| ***$\Delta P_t$*** | = | Total System Pressure drop ($P_{inlet}$+ $P_{outlet}$) | (Pa) | *In systems with inbuilt fans in filter* "**Measuring pressure in filter system–with inbuilt fans"**<br>*Standalone fans (under pressure and positive pressure filter systems) –* "**Measuring pressure in filter systems – with standalone fans"** |
| ***$P_{measured}$*** | = | Power absorbed (measured) | (kW) | *For the fan(s) only – if inverter is installed, the absorbed power read on display is considered valid, or other measuring device connected, else***Calculation method –** "**Absorbed power"** |