DurkeeSox®
Air Dispersion System

The experts in the air dispersion industry world wide

DURKEESOX DESIGN MANUAL

This design manual is an instruction to engineers or customers for the purpose of designing DurkeeSox air dispersion system. It is necessary to point out that there is no essential difference of design between DurkeeSox air dispersion system and traditional duct system especially spiral duct design. The designer could design the system in accordance with this guide or by DurkeeSox owned specialized software iSox, or turns to DurkeeSox engineering & technology center for a whole solution.

Any two acutally applied DurkeeSox systems are different, DurkeeSox will provide a whole system solution based on the individual application parameters which are supplied by customer and the system design is by our professional design software that can simulate the real application.

2014 English

D U R K E E S O X D E S I G N M A N U A L

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PREFACE

DESIGN CONSIDERATIONS

For any design, the starting is to consider all the factors which contribute to the air-conditioning and airflow distribution.

- The air-conditioning requirements on specified engineering design include cooling and heating load, air volume, end air velocity, uniformity and more.

—— Cooling and heating load: it mainly aims at the calculation method and basis the designer adopts. It is necessary to understand design intent in detail so as to estimate the relation of the load and air supplying model, airflow distribution, and suspension height.

—— Airflow volume: it is mainly to understand the relation of different air supplying height and airflow volume per unit area, to make sure supplying air volume in the whole air-conditioned room and air dispersion effect in different seasons to meet the application requirements.

——End air velocity: it mainly aims at different functional areas of every project. Requirements of end air velocity vary with different functional areas. It is necessary to know the intention of the project application and the end user's actual demand, on the basis of which to design the orifice size and fabric permeability to ensure the ultimate application effect.

——Uniformity: it is similar to end air velocity. The emphasis is to understand the functional areas and actual usage requirements of each area and provide the different design layout.

- Space design: it includes height, structural barrier, machinery room location, air return layout, ductwork aesthetics etc.

——Design on height is to know the elevation of all the equipments and structures in the whole space, which include , roof, floor, ceiling, equipment, ductwork, lamp area, operation space etc, to design the duct diameter and height layout.

—— Structural barrier is which potentially affects the layout but could not be reflected in the drawing. It includes beam, half partition, grid ceiling, decorative column etc. It is necessary to avoid structural barriers when design in order to prevent any modification to Durkeesox system during installation at site.

——Machinery room location and air return outlets layout indicate the whole air circulation orientation, which help better layout ducts and orifices direction, thus improve air distribution in air-conditioned room.

——For layout aesthetics of ductwork, it aims at places with certain aesthetic requirement to the building like public places. Some of such places have closed ceiling, some not. To investigate the whole decoration style can takes better matching with architectural design scheme and increase the integral aesthetics.

In actual application, the engineering drawing is normally supplied by designer, HVAC design layout preferred (including installation position of AHUs and equipment parameters).

DESIGN PARAMETER RECOMMENDATION

Item	Application	Normal height(ft)	Applied condition	Air exchange rate (times)	Cooling capacity per ft^2	Airflow per meter (CFM)	Gemeral and velocity(FPM)	Special area and velocity(FPM)
1	Commercial places (supermarkets, shopping centers, leisure etc)	16-26 (5~8m)	heating, ventilation, cooling	4~6	19~23W/ft^2 200~250W/m^2	60-180(1 in w.g.) 100-300(m^3/h)	60~100 (0.3-0.5m/s)	Supermarket frozen area 20~40 (0.1~0.2m/s)
2	public places (exhibition center, theatre)	26~33 (8~10m)	heating, cooling	5~8	19~23W/ft^2 200~250W/m^2	120-300(1 in w.g) 200-500(m^3/h)	60~100 (0.3-0.5m/s)	
3	Gymnasium, Sporting venues	≧33 ≧10m	heating, cooling	6~10	19~18W/ft^2 200~300W/m^2	180-360(1.4 in w.g) 300-600(m^3/h)	60~100 (0.3-0.5m/s)	Small ball gymnasium 20~50 (0.1~0.25m/s)
4	industrial facilities (chemical, mechanical, printing, etc)	20~33 (6~10m)	directional air dispersion , cooling	8~15	Depends on productin process requirements	120-240(1 in w.g) 200-400(m^3/h)	60~100 (0.3-0.5m/s)	Post air supply 100~200 (0.5~1.0m/s)
5	food processing, medicine, refrigeratory & electric places	16~33 (5~5m)	Refrigeration/ cleanroom ventilation/ heating	Depends on clean and anti -microbial rates	Depends on productin process requirements	60-300(0.8 in w.g) 100-500(m^3/h)	20~60 (0.1-0.3m/s)	
6	Offices	13~20 (4~6m)	heating, cooling	4~6	14~17W/ft^2 150~180W/m^2	30-120(0.6 in w.g) 50-200(m^3/h)	40~100 (0.2-0.5m/s)	

Above data is only for reference in the general occasion. Virtually any engineering parameter is subject to real application.

1 DURKEESOX® SYSTEM LAYOUT

DurkeeSox system layout is mainly applied to air supplying ductwork. Air return system doesn't need to make any modification and should be designed traditionally.

The layout is based on site situation or requirements in HVAC design drawing including AHU location, floor height, aesthetic requirements etc.

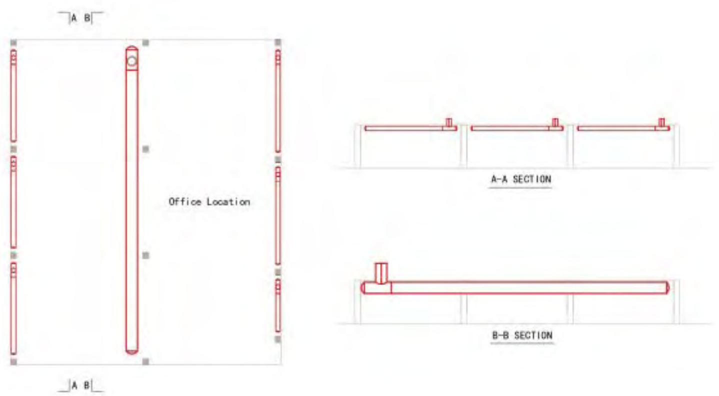
When design the Durkeesox system, the system layout and the location of air supplying equipment (Fan unit) must be considered at the same time. The location of air supplying equipment directly affects the system investment and air distribution performance. The quantity of duct is preliminarily determinate by air volume and single duct length requirements of the room, and then arrange the system evenly in the whole indoor space.

1.1 General Application Layout

1.1.1 Low Ceiling Design

A Offices

The offices' space is low and small. It is recommended to lay out along the wall, beam and column to save the space and increase the aesthetics. For the offices with ceiling there are two options, one is to choose half round series mounted against ceiling in the middle (evenly), the other is to choose quarter round series mounted against the wall along every wall corner (or one side).

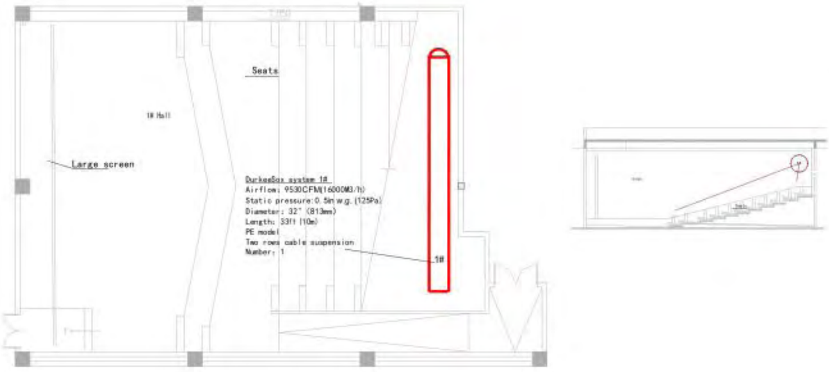


North china power grid HQ dining hall

Low and small space with ceiling, Durkeesox system mounted along the wall corner, inconspicuous and space saving

B Cinema, hall and auditorium

The cinema and hall are mostly sector or rectangle theatre with complicated decoration, where floor height is different. In order not to damage the integral decoration effect and application effect, the DurkeeSox system is mostly mounted along the back row or side wall.

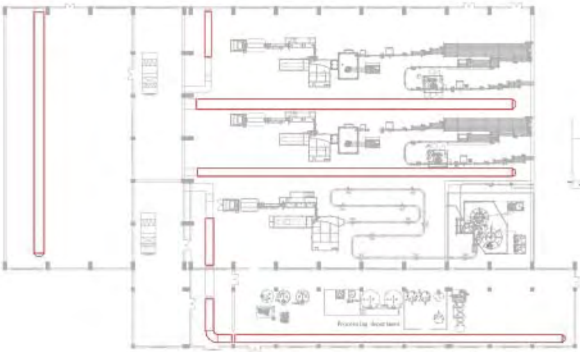


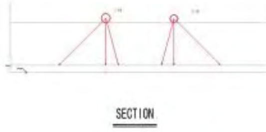
Optics valley cinema

The DurkeeSox air duct is mounted along the back row, by which lifts the ceiling, increases interior space and reduces the construction cost, compared with the traditional duct mounted on the top of the ceiling

C Factory

The floor height is low but w orkshop area is big. There are a lot of equipments and workers distributed unevenly on the ground. The DurkeeSox® system should be mounted along the assembly line or densely occupied area, to meet the air supply requirements of both the production process and the working post.



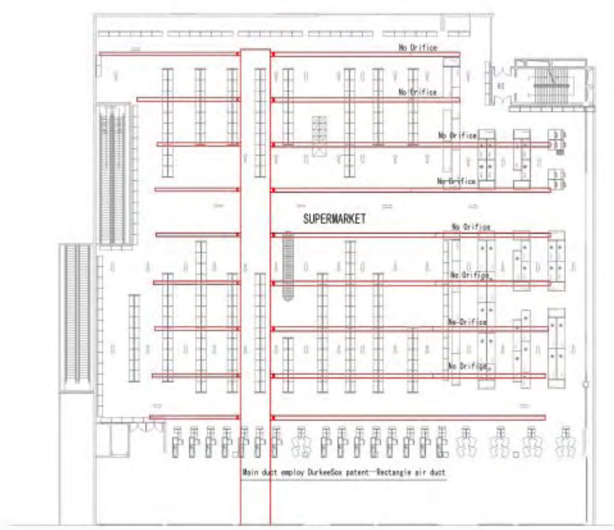


Kraft Foods Factory

The Durkeesox system was mounted just above the worker's head along assembly line to achieve the most comfort at minimum energy cost

D Supermarket

For the supermarket with low and limited space, due to various pipes mounted on the top and shelves on the ground, storey height is very limited which causes strict requirement on the duct diameter. It is required to equally disperse the air flow by area, evenly arrange pieces of small ducts in the whole area and make sure the Durkeesox system perpendicular to shelves and parallel to the lamp area. For main air duct, Durkeesox patented rectangle duct is recommended.



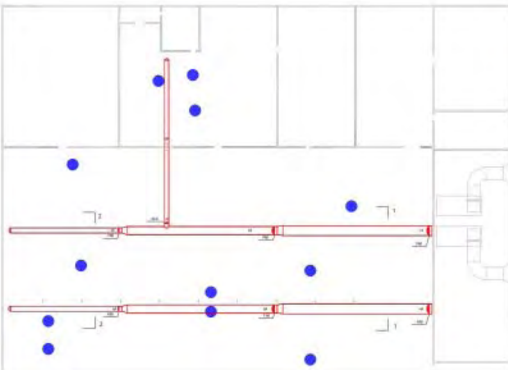
Carrefour Store

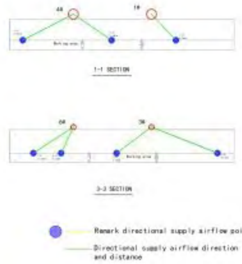
Carrefour is the representative of low space supermarket in china. Branch duct is round profile and its diameter should be controlled below 24" main duct is rectangle profile and its diameter is also controlled below 24". The system design fully met Carrefour's requirements and solved some problems.

1.1.2 Large Space, High Ceiling Design

A Large space factory

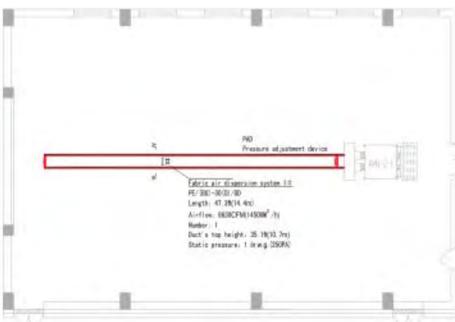
For large space factory, it is necessary to consider the match of air return system and air duct layout use straight duct as possible to improve indoor airflow distribution. Moreover the air duct should be mounted along the assembly line to avoid the equipment and travelling crane. Due to multi-row orifices and sector dispersion of system which cover more air dispersion area, it is possible to properly reduce the quantity of main duct needed as long as tall equipment has little effect on the airflow distribution and large diameter doesn't influence the aesthetics.

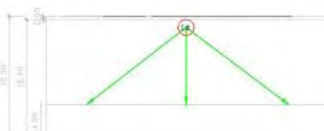




Yili dairy factory

The Durkeesox air duct is mounted along the second-floor aisle and just above the assembly line





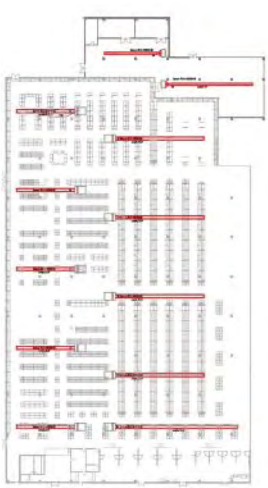
A-A SECTION

Haiwang Pharmaceutical

The Durkeesox air duct was mounted along the centerline at the same lifting height as ventilated case. It is aesthetical and economical to replace the traditional multiple metal ducts by single Durkeesox duct.

B Large space design in supermarket

For large space storage as Metro, the DurkeeSox system should be perpendicular to the shelves or above the main aisle, and arranged evenly considering the economy and airflow distribution.

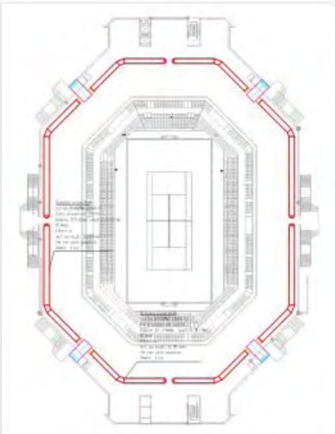


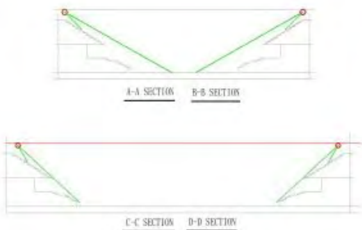
Metro

The representative of high space supermarket-Metro, nearly all the DurkeeSox air ducts are perpendicular to the shelves and as close to main aisle as possible

C Gymnasium

For gymnasium with auditorium, mostly air supply duct is specially designed surrounding the auditorium, with multi-row orifices to make sure the uniform end air velocity in whole auditorium area.





Olympics Tennis Stadium

DurkeeSox system is mounted behind and surrounding auditorium, so as to make sure the audience's comfort and match the integral decoration style.

For gymnasium with flat grid structure, Durkeesox system is distributed inside the grid structure as long as there is space.

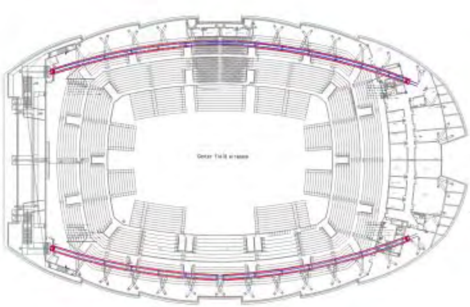
Gymnasium HVAC Layout Drawing 1:150
$S=8400ft^2$

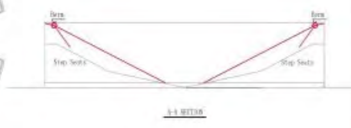
Gymnasium 2-11# Supply Airflow Sketch

Gymnasium

Blue DurkeeSox ducts, light in weight, are mounted parallel to each others in the grid structure which is convenient and quick to install for overall project cost saving.

For roof of gymnasium especially with large space, is normally grid structure and there is the bridle path. DurkeeSox system can be mounted along the either side of the bridle path or inside the grid structure. In this way there are a lot of benefits, such as the space saving, more aesthetic, easy disassembly and maintenance.





Sports Center

DurkeeSox system is mounted along the underside of the bridle path, which is under the canopy and on the top of the auditorium.

1.2 General Design Guideline for Aesthetic Consideration

1.2.1 Diameter Selection At Different Installation Height And Aesthetic Requirement

For system design, Aesthetic would be different in different diameter and installation height. Generally the diameter of air duct increases with increase in installation height. Of course there will be some exceptions depending on real application. Below table gives diameter range typically fit with different height range.

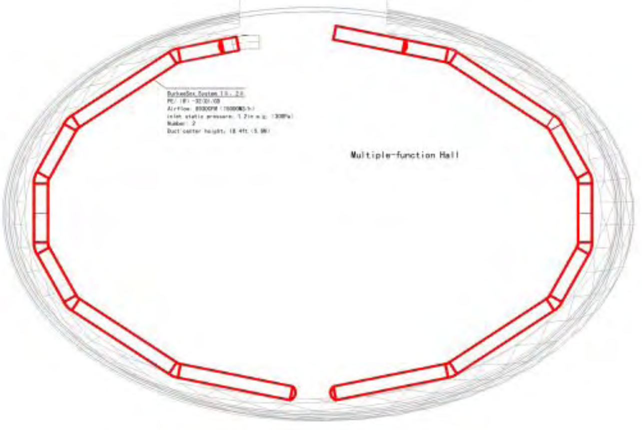
Height		Diameter Range	
Inch	m	Inch	mm
10~13	3~4	12" ~18"	305~457
13~16	4~5	18" ~30"	457~762
16~26	5~8	30" ~44"	762~1118
26–39	8~12	44" ~54"	1118~1372
>39	>12	57" ~72"	1372~1829

Tennis Center

The design is just right regardless of height, styling and color, the perfect combination of aesthetics and effect

1.2.2 Arc Layout Design

Large-span structure is used more and more in modern architectures. There is grid structure inside with arc, dome or ellipsoid coping. DurkeeSox system can be mounted closed in arc or circular, oval to match the architecture style. In this way the layout is aesthetic and air dispersion effect is more uniform.



Leqing Administrative Center

Durkeesox® system is mounted along the vault in arc shaped layout which is just in harmony with glass&steel frame structured roof,presenting extraordinary aesthetics.

1.2.3 Closed Loop Layout Design

In the occasion with large air volume and high aesthetics requirements, it is considered to use closed design, mounted along the closed corner, steal beam to form closed DurkeeSox ductwork. The shape of closure can be consistent with the cross-sectional shape of architecture. The closed design is not only more aesthetic but also to make air dispersion more uniform and stable.

Swimming Training Center

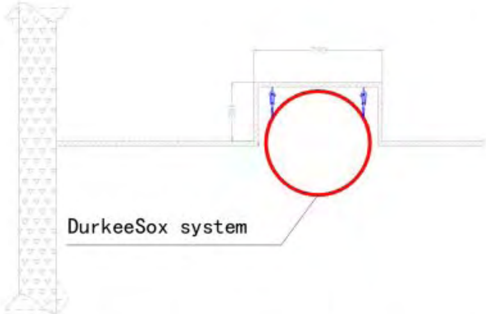
The Durkeesox® system extend simultaneously from the outlets of the air handling unit to two edges of one wall, and then close the loop on the opposite wall after running along the corners respectively, thus contributing to the stableness and uniformity of air supply.

1.2.4 Match Design with Interior Decor

The indoor decoration of architecture is more and more individuation. DurkeeSox® system layout can match the decoration and lighting to increase the integral aesthetics.

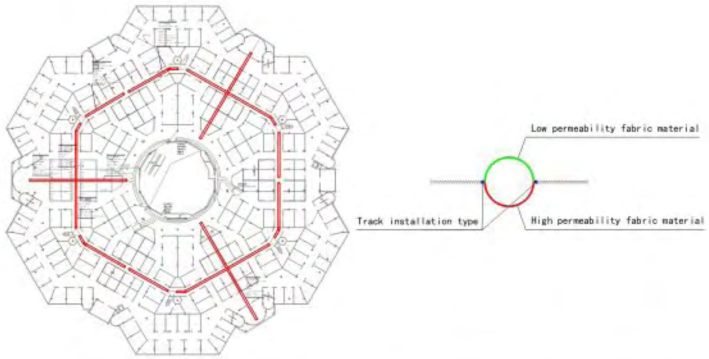
a、The ducts of half-round or quarter-round could not be installed against plaster board ceiling, especially for suspended ceiling with various sculpts, we recommend cutting groove in parallel with the structure trend orientation of sculpt on the ceiling and installing the Durkeesox® duct inside the groove, and then identifying deciding the size of exposed part of the duct to the open ceiling space according to the site circumstance, in this way, it could not only add beauty to the appearance but also produce better lighting effect (install cold light lamp inside the groove) .


Hunan Mengjie Textile



Cut a groove with a width of 31" width on above the ceiling and embed DurkeeSox duct of 30" dia. inside, thus contributing to the elegant appearance and space efficiency of this application.

b、While matching with cladding panel ceiling, we recommend cutting continuous groove with width equal to duct diameter when making ceiling support and installing half- round duct with aluminium alloy track, as a result, it could not only save space but also add beauty to the appearance.



Due to the limitation of storey height, we cut a groove with a width of 300mm on the ceiling situated above the corridor and embed DurkeeSox duct inside the groove, contributing to the space efficiency and its elegancy in appearance.

C、We recommend differentiating the application by method in accordance with different mesh size when matching with gridding ceiling. As for gridding ceiling with small sized mesh , please refer to the installation method for plaster board ceiling. As for gridding ceiling with large sized mesh, the duct should be installed above the ceiling and laid out in line with the direction of the orifices of DurkeeSox system so that it could totally meet the demand of air supply.

Ventilation Air duct is installed above the gridding to match with the ceiling so that air could be supplied downward evenly through gridding mesh, as a result, it will not affect finishing and decoration.

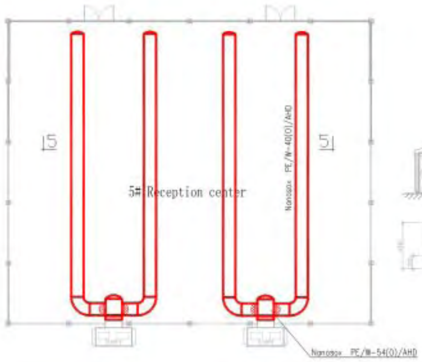

Suppermarket

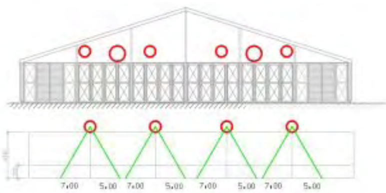
Special Large Gridding Ceiling

1.3 Special Case Design

1.3.1 Special Fittings

Due to speciality of use, make the product install and disassembly more easily and economical. The designer needs to merely consider the effect of DurkeeSox system and the distance between adjacent air ducts, to reduce the number of air ducts as possible.



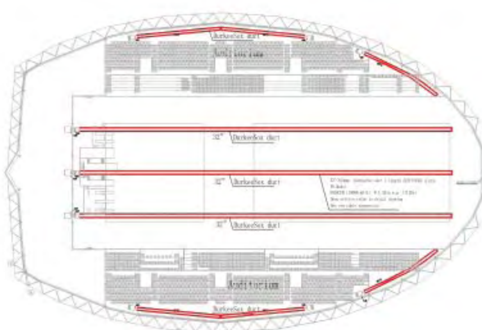


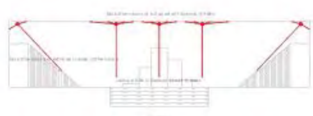
BOCOG Reception Center

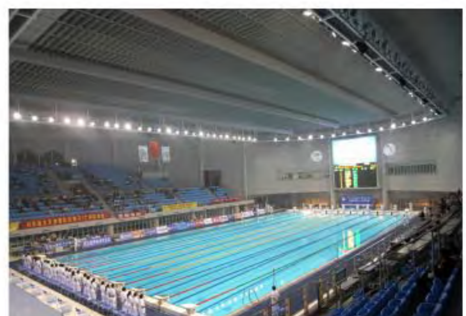
BOCOG reception center does display nobleness though the place is temporary, besides, so do other nineteen reception centers including Adidas,CocaCola,etc Olympics sponsors reception center

1.3.2 The anti-condensation design of architecture

The anti-condensation design mentioned here aim at the architecture structure. Nowadays plenty of glass curtain walls and roofs are used, which bring a lot of problems though increase the aesthetics, among which is the condensation of inner surface of the glass curtain in winter. The DurkeeSox system increases the orifice blowing to the glass curtain wall to solve the problem. When design it is considered to mount DurkeeSox system along glass curtain or mount one or more ducts especially for glass curtain.







Sports Center Swimming Pool

Condensation prevention is achieved by installing 3 Durkeesox duct above the swimming pool.

Swimming pool

A-A SECTION

One Durkeesox air duct is installed on the two sidewalls respectively to realize uniform air supply and it's appearance bleed perfectly with the decoration style and to prevent condensation effectively on sidewall glass curtain

2 SHAPE AND DIMENSION DESIGN OF DURKEESOX SYSTEM

2.1 Shape Design

Shape of DurkeeSox System is selected based on the customer needs and real application requirements.

Generally speaking, round shape is mainly applied to the architecture with open and high space ; Half Round (D Surface) and quarter round are mainly applied to the architecture with low and short space and suspended ceiling; Oblate round is mainly applied to the limited low space to solve the layout issue of main duct with larger airflow, fully embodies the superior performance of DurkeeSox air duct.

Round shape

This series is the most common one, mainly applied on the suspension system with galvanized cable and aluminum track. It is applicable to various fabric and air supply mode, the applied diameter range from 6 " to 72 ". The inlet diameter of round shape is selected based on the inlet air velocity, air volume and system design requirements. The series is also equipped with standard elbow, T-connector, transition and other standard fittings. Besides this series also can be installed perpendicularly.

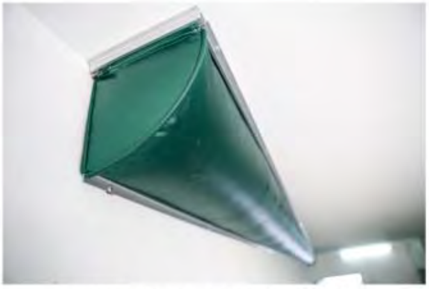
Round shape (O)

Flush Mount series

It is mainly applied to the occasions where the air duct is mounted under the ceiling or along the wall. There are three kinds of shapes, large half round, half-round (D surface) and quarter round. The overall airflow is delivered to the indoor through the duct inlet or the plane at the top along wall or ceiling. When design, it is necessary to fully consider other factors which contribute to the system diameter selection, are shape, dimension and position and number of the inlet. The inlet dimension becomes smaller if more than one inlet used.

Half- round (D)

Large half–round (HD)

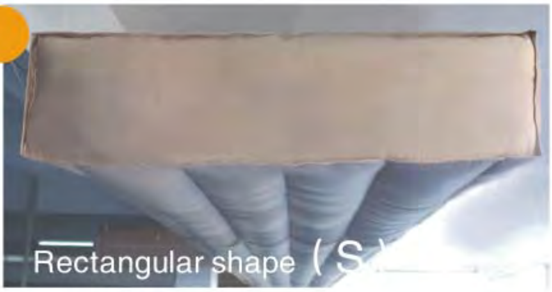


Quarter–round (Q)

Rectangle air duct series

Patent protection product

It is mainly applied to limited storey space to help solve the space management issue of main duct, full play of superiority of DurkeeSox systemt. According to field conditions, there are various dimensions to satisfy the customer requirements thus achieve the most optimized design.



Rectangular shape (S)

2.2 Diameter Selection

Diameter selection is related to the air velocity and pressure in duct. When air velocity and pressure don't match, air duct is possible to turbulence, accordingly influence the actual air dispersion effect. Below is the schematic of the relation among pressure, turbulence and air velocity we got through experiment.

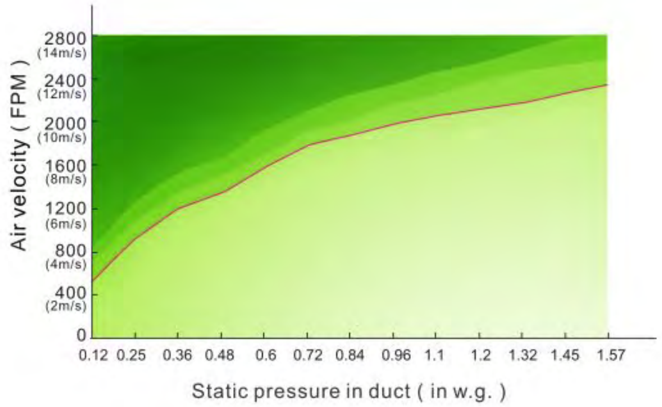


Figure 1: with the higher velocity and the lower pressure the bigger turbulence is, namely turbulence is related to the ratio of air velocity to pressure, the bigger ratio , the bigger turbulence . Moreover higher air velocity would increase the system noise. The air velocity in the DurkeeSox system can be selected based on the curve.

Hereby we can calculate specific diameter according to air volume.

Diameter range: : 6"(152mm) - 72"(1829mm) , The diameter is related to air volume and system inlet air velocity

Formula: $$g = v \cdot \pi \cdot D^2/4$$

Where : g——air volume of single duct v——inlet velocity D——diameter

In order to ensure the intersection point of air velocity and pressure in the duct within the safety zone of the turbulence risk schematic, considering the noise caused by higher air velocity and negative pressure and other factors, inlet air velocity of DurkeeSox system is:

Generally straight duct suggested to be less than 9m/s

elbow suggested to be less than 8m/s

T-connector suggested to be less than 8m/s

half round duct suggested to be controlled in the range from 6 to 7 m/s

large half round duct suggested to be less than 8m/s

rectangle duct suggested to be less than 8m/s

If diameter is excessively big and installation room is not enough, it is suggested to use rectangle duct or divide the system into a few small ducts.

It is necessary to point out that if use isox software DurkeeSox owned, after you input inlet air volume and air velocity, the software directly draws the duct with corresponding diameter .

"isox"design software

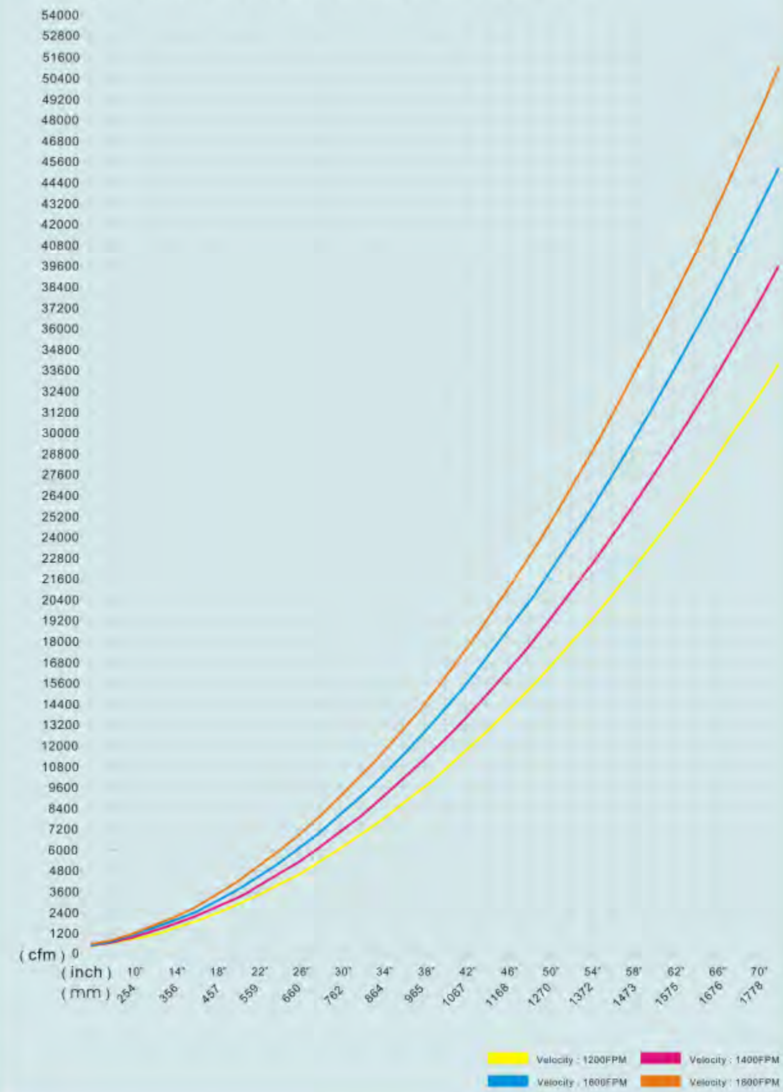
2.2.1 Round

Given the system air volume, select appropriate inlet air velocity according to application requirements, then determine the diameter based on below table.

Dia		Inlet velocity (FPM)		
in	mm	1400	1600	1800
6	152	274	313	352
8	203	486	556	625
10	254	760	869	977
12	305	1094	1251	1407
14	356	1490	1703	1915
16	406	1946	2224	2502
18	457	2463	2814	3166
20	508	3040	3475	3909
22	559	3679	4204	4730
24	610	4378	5003	5629
26	660	5138	5872	6606
28	711	5959	6810	7661
30	762	6841	7818	8795
32	813	7783	8895	10007
34	864	8786	10041	11297
36	914	9850	11258	12665
38	965	10975	12543	14111
40	1016	12161	13898	15636
42	1067	13407	15323	17238
44	1118	14715	16817	18919
46	1168	16083	18380	20678
48	1219	17512	20013	22515
50	1270	19002	21716	24431
52	1321	20552	23488	26424
54	1372	22163	25330	28496
56	1422	23836	27241	30646
58	1473	25568	29221	32874
60	1524	27362	31271	35180
62	1575	29217	33391	37564
64	1626	31132	35580	40027
66	1676	33108	37838	42568
68	1727	35145	40166	45187
70	1778	37243	42563	47884
72	1829	39402	45030	50659

inlet airflow volume in specified duct diameter and airflow velocity (cfm)

Graph of round duct diameter seletction



2.2.2 Large Half–Round

Large Half-round shape DurkeeSox air duct system is applied in closed ceiling places with large airflow volumes; there is small difference in diameter selection between large half-round and round DurkeeSox system, Firstly, we must select inlet position on the top or at the end.(as figure 1, figure 2 shown). Secondly determine inlet air volume, if more than one inlet is chosen on the top position. Every inlet airflow volume is defined as total air volume divided by number of total inlets. And then as shown on the table below, To determine the inlet diameter according to the required inlet air velocity and inlet air volume.

Figure 1

End inlet velocity1200-1600FPM

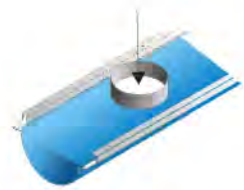


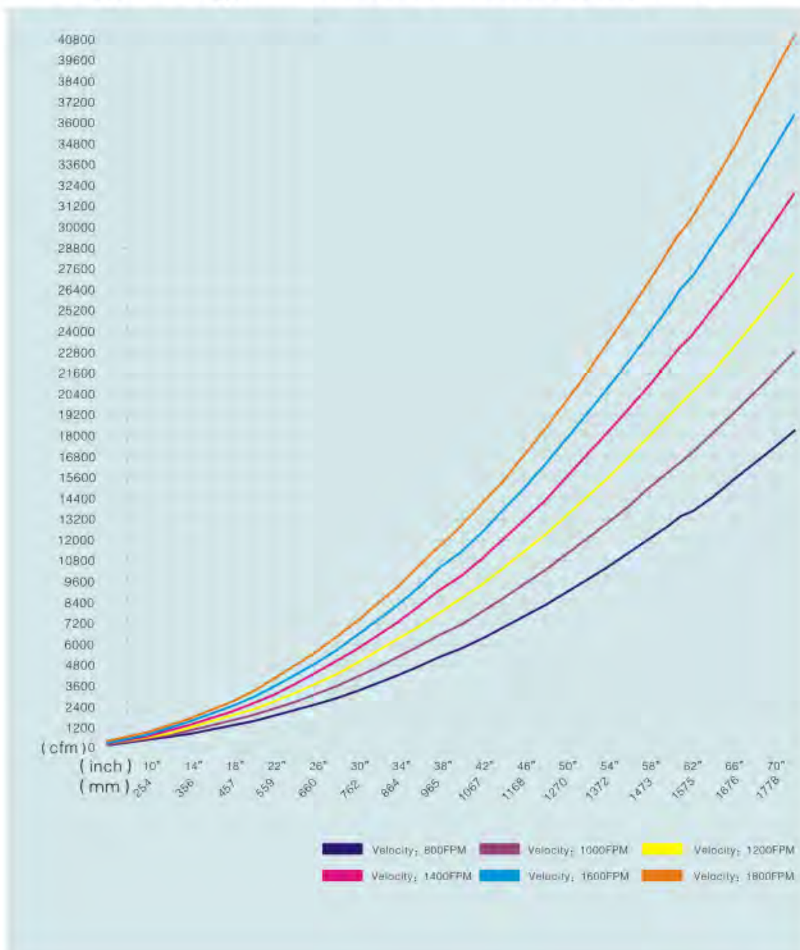
Figure 2

Top inlet velocity 1200-1400FPM

Dia		Inlet velocity(FPM)		
in	mm	1200	1400	1600
6	152	185	216	247
8	203	331	386	441
10	254	518	604	690
12	305	746	871	995
14	356	1017	1186	1356
16	406	1322	1543	1764
18	457	1676	1955	2234
20	508	2071	2416	2761
22	559	2507	2925	3343
24	610	2986	3484	3981
26	660	3495	4078	4660
28	711	4056	4732	5408
30	762	4659	5435	6212
32	813	5304	6188	7071
34	864	5990	6988	7986
36	914	6703	7820	8938
38	965	7472	8717	9962
40	1016	8282	9663	11044
42	1067	9135	10658	12180
44	1118	10029	11701	13372
46	1168	10946	12771	14595
48	1219	11923	13910	15897
50	1270	12942	15098	17255
52	1321	14002	16335	18669
54	1372	15104	17621	20138
56	1422	16225	18929	21633
58	1473	17409	20311	23212
60	1524	18636	21742	24848

inlet airflow volume in specified duct diameter and airflow velocity (cfm)

Graph of large half round duct diameter seletction



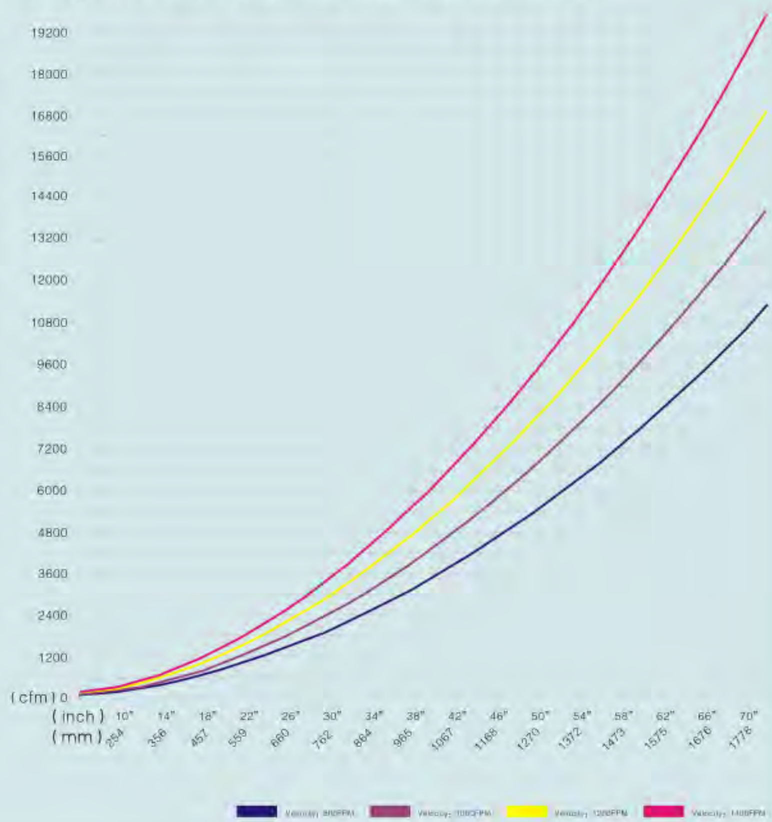
2.2.3 Half Round

Half-round shape DurkeeSox system is applied in closed ceiling with lower space installed against a wall or ceiling. there is small difference in diameter selection between half-round and round DurkeeSox system, Firstly, we must select inlet position on the top or at the end. Secondly determine inlet air volume, if more than one inlet is chosen on the top position. Every inlet airflow volume is defined as total air volume divided by number of total inlets. And then as shown on the table below, To determine the inlet diameter according to the required inlet air velocity and inlet air volume.

Dia		Inlet velocity(FPM)		
in	mm	1000	1200	1400
8	203	171	206	240
10	254	268	322	375
12	305	387	464	541
14	356	527	632	737
16	406	685	822	959
18	457	868	1042	1215
20	508	1072	1287	1501
22	559	1299	1558	1818
24	610	1546	1856	2165
26	660	1810	2172	2534
28	711	2101	2521	2941
30	762	2413	2896	3378
32	813	2747	3296	3846
34	864	3102	3723	4343
36	914	3472	4166	4861
38	965	3870	4644	5418
40	1016	4290	5148	6006
42	1067	4731	5678	6624
44	1118	5195	6233	7272
46	1168	5670	6803	7937
48	1219	6175	7411	8646
50	1270	6703	8044	9384
52	1321	7252	8703	10153
54	1372	7823	9388	10952
56	1422	8404	10084	11765
58	1473	9017	10821	12624
60	1524	9652	11583	13513

inlet airflow volume in specified duct diameter and airflow velocity (cfm)

Graph of half round duct diameter seletction

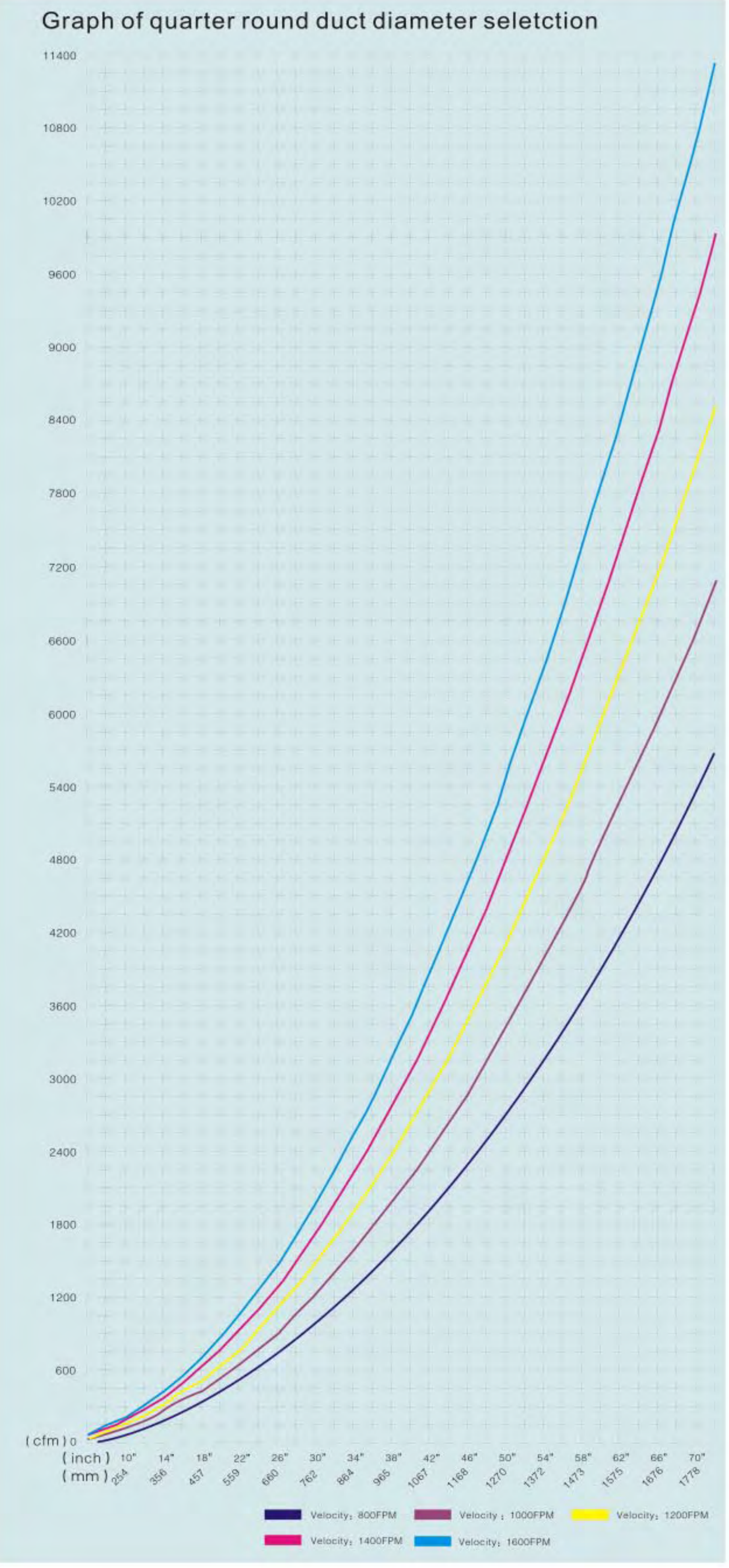


2.2.4 Quarter Round

There is hardly any difference in Diameter selection between half round and quarter round system. Determine the inlet diameter according to required inlet air velocity and inlet air volume. After determine the inlet dimension, you can determine the diameter of quarter round system according to below table.

Dia		Inlet velocity(FPM)		
in	mm	1200	1400	1600
6	152	58	68	77
8	203	103	120	137
10	254	161	188	214
12	305	232	271	309
14	356	316	369	421
16	406	411	480	548
18	457	521	608	694
20	508	643	751	858
22	559	779	909	1039
24	610	928	1082	1237
26	660	1086	1267	1448
28	711	1261	1471	1681
30	762	1448	1689	1930
32	813	1648	1923	2198
34	864	1861	2172	2482
36	914	2083	2430	2777
38	965	2322	2709	3096
40	1016	2574	3003	3432
42	1067	2839	3312	3785
44	1118	3117	3636	4156
46	1168	3402	3969	4536
48	1219	3705	4323	4940
50	1270	4022	4692	5362
52	1321	4351	5077	5802
54	1372	4694	5476	6258
56	1422	5042	5882	6723
58	1473	5410	6312	7214
60	1524	5791	6757	7722

inlet airflow volume in specified duct diameter and airflow velocity (cfm)



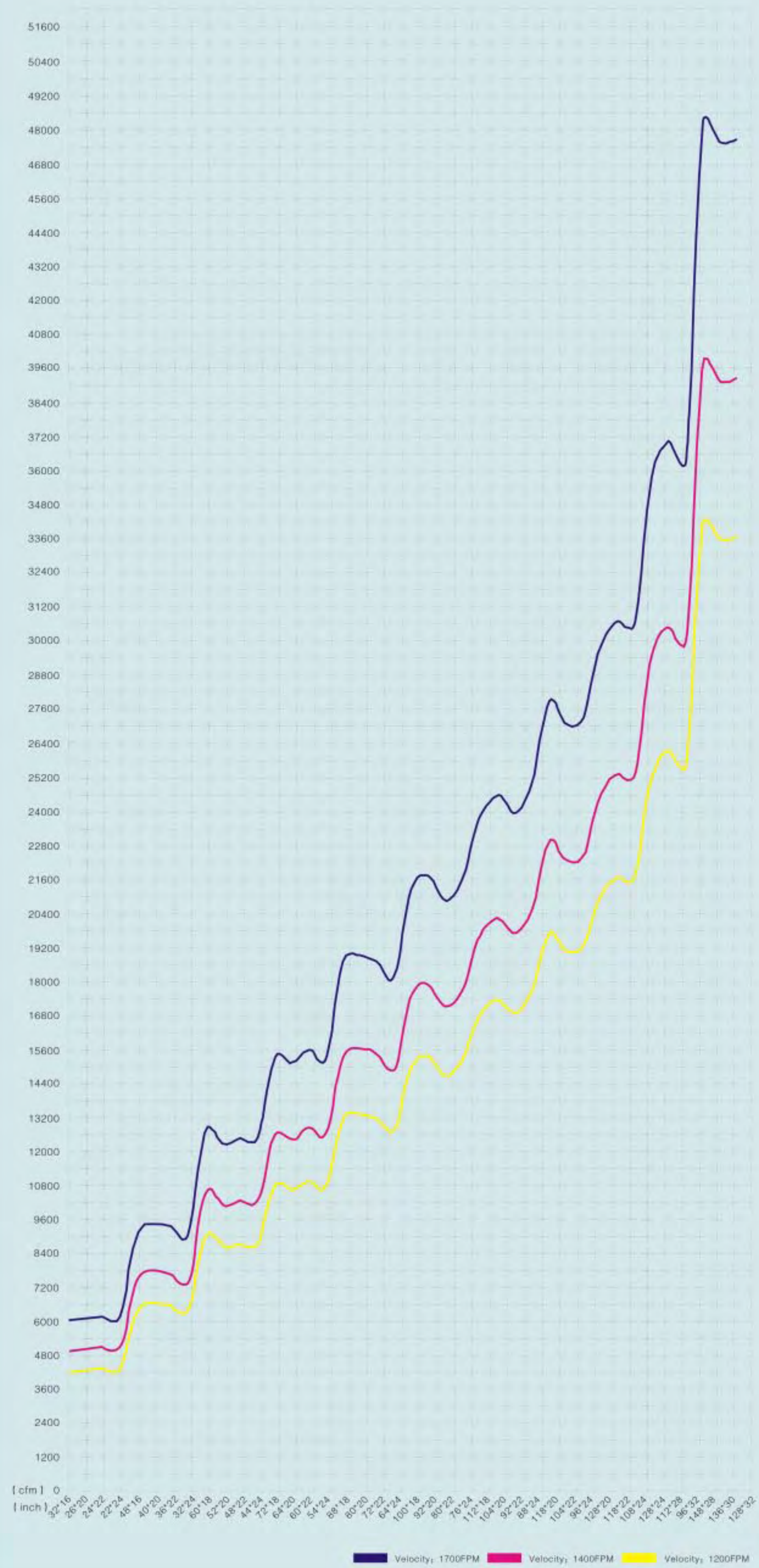
2.2.5 Rectangle Duct

Air volume of rectangle duct is proportional to cross-sectional area. When cross-sectional area is unchanged, there are different aspect ratios to be selected. In principle the bigger aspects ratio is,the lower air velocity is.

Dimension(in)		Inlet velocity(FPM)		
Lengh	Width	1200	1400	1700
32	16	4194	4893	5941
26	20	4260	4970	6035
24	22	4332	5055	6138
22	24	4332	5055	6138
48	16	6288	7336	8908
40	20	6558	7651	9291
36	22	6492	7574	9196
32	24	6301	7351	8926
60	18	8849	10324	12536
52	20	8526	9948	12079
48	22	8658	10101	12265
44	24	8665	10109	12276
72	18	10620	12390	15045
64	20	10495	12244	14868
60	22	10824	12628	15335
54	24	10634	12406	15065
88	18	12978	15141	18385
80	20	13116	15302	18581
72	22	12991	15156	18404
64	24	12602	14703	17854
100	18	14749	17207	20894
92	20	15084	17598	21369
80	22	14432	16838	20446
76	24	14959	17452	21191
112	18	16520	19273	23403
104	20	17053	19895	24158
92	22	16599	19365	23515
88	24	17322	20209	24541
118	20	19344	22568	27405
104	22	18765	21892	26584
96	24	18896	22045	26769
128	20	20655	24097	29261
118	22	21286	24834	30156
108	24	21260	24803	30118
128	24	24802	28935	35136
112	28	25701	29985	36411
96	32	25184	29382	35678
148	28	33498	39081	47455
136	30	32957	38450	46689
128	32	33056	38565	46829

inlet airflow volume in specified duct diameter and airflow velocity (cfm)

Graph of rectangle duct dimension selection



3 SYSTEM STANDARD FITTINGS DESIGN

Considering the multiplicity of DurkeeSox system layout, we offer various fittings and components by special materials made. These fittings can be connected and installed easily and simply, moreover, and all these fittings can be automatically generated on design drawing by DurkeeSox latest developed patented software ISOX-design. Greatly reduce the design drawing procedures.

3.1 General Fittings

Inlet Connection


Double Layer Inlet

Generally, use single layer or double layer inlet to cover on outlet of metal duct fixed with belt, rivetted. For double layer inlet, only fixes the inside layer, the outer layer is used to cover up and remove to for washing.

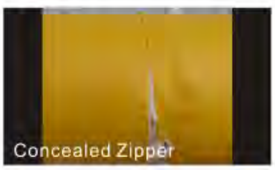
End


End Cap

Use end cap, join with duct by zipper, easier to change for washing or extend.

Employ fixed end, to seam at end becoming a part of duct.

Zipper Connection

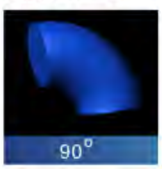

Concealed Zipper

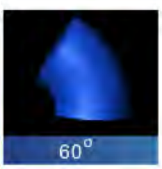
Join among straight duct, fittings, and components, similar to conventional used flange.

Nanosox®uses concealed zipper, covered by a sleeve from outside.

Dia		Zip spacing	
in	mm	ft	m
6-32	152-813	33	10
34-52	864-1321	26	8
54-72	1372-1829	20	6

Elbow–E


90°


60°

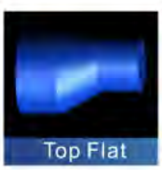

30°

Elbow's standard centerline radius is 1.5 x Dia.
The elbow consists of multiple gores, different angle meets different application requirements.

Transition–V


Bottom Flat


Concentrate


Top Flat

Connect ducts with different diameter.
Bottom flat: more aesthetic
Concentrate: better airflow
Top flat: easier to install

T–connector–T


Top Flat


Concentrate

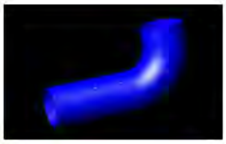

Bottom Flat

Deliver the airflow to branch ducts which are , perpendicular to main duct. Connected by zipper with main ducts.

3.2 Special Fittings

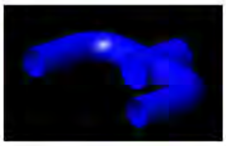
Y inlet-Y

Connect two outlets of AHU to one duct.



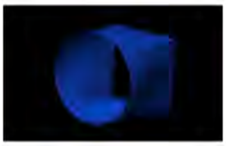
Elbow inlet-IE

Connect fabric duct inlet with elbows.



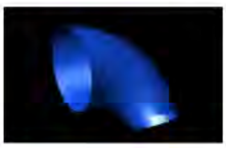
T-connector inlet-IT

Connect fabric duct inlet with T-connector.



Square to round inlet-SR

Connect conventional square metal duct to round fabric duct



Transition lbow-EV

Connect elbows in different diameter.

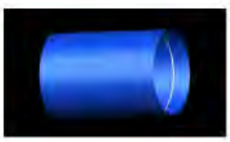
Bevel transition-BV

connect uneven ducts with different diameters.

Bevel end-BC

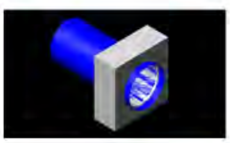
Disperse air in the bevel end of duct toward all directions, Specialized design for practical case

3.3 Functional Fittings



Tension ring-TW

For supporting use, fixed inside duct to produce aesthetic appearance. applied to upright elbows, etc special occasions.



Wall pass through-TR

A component to resolve through wall problem, employs tension ring and certain length of duct to fix in the hole of wall and seal the gap between, then connect both ends with duct by zippers.

Expansion segment-ES

Connected between two sections, Fold one end in airflow direction, fixed by hasp from outside, contributing to certain flexibility in length.

4 AIR SUPPLY PRESSURE CALCULATION

The factors which influence the pressure of DurkeeSox system include inlet static pressure, velocity pressure and frictional pressure loss. In DurkeeSox system velocity pressure converts to static pressure along length direction, called static pressure regain. Frictional pressure loss and local resistance loss caused by fittings are called pressure loss for short. So average static pressure in the duct can be considered to be composed of three portions: inlet static pressure, static pressure regain and pressure loss.

Inlet Static Pressure

Inlet static pressure is generally determined by AHU. If AHU is not directly connected to air duct system, inlet static pressure is static pressure of the direct connector of DurkeeSox air duct. If AHU is directly connected to air duct system, inlet static pressure is the static pressure of AHU. Generally speaking, end static pressure should be more than 70 pa, but it depends on engineering conditions. Based on a great deal of engineering experiences, we recommend optimized pressure gradient reference of air duct in different heights to fulfill appropriate air velocity in the applied area, as below

High(ft)	8	11.5	13	14.5	16.5	19.5	26	33	49	65.5
Inlet static pressure(in w.g.)	0.28	0.48	0.6	0.72	0.8	1	1.2	1.4	1.6	2

Above data is only for reference in the general occasion. Virtually any engineering parameter is subject to real application.

Static pressure regain

Due to sealed end of DurkeeSox system, air velocity becomes lower and lower along the length direction of DurkeeSox system, that is velocity pressure becomes lower and lower, velocity pressure converts to static pressure, namely static pressure regain becomes bigger and bigger.

The total static pressure regain converted from inlet velocity pressure is:

$$\text{Static pressure regain} = \text{Inlet velocity pressure} = \frac{1.29 \times \text{Inlet velocity}^2}{2}$$

Since air velocity in duct is generally only 1400-1800FPM, static pressure regain which converts from velocity pressure is only in 0.13~0.14 w.g.

For DurkeeSox system, there is pressure loss caused by friction and local resistance along the length direction. Since pressure loss is proportional to air velocity when airflow is becoming smaller and smaller, resistance loss decreases continuously. At the same time there is local resistance loss in every standard part and outlet of air duct. In DurkeeSox system there is mainly straight duct, few T-connector, elbow and transition, so generally the loss is mainly friction loss. Friction loss of air flow in constant cross-section duct is calculated by following formula.

$$\Delta p_m = \frac{\lambda}{d} \cdot \frac{v^2 \rho}{2} l$$

l ——Friction factor ; n ——Average air velocity in duct ; r ——Density of air ;

l ——Length of air duct ; d ——Diameter of round duct ;

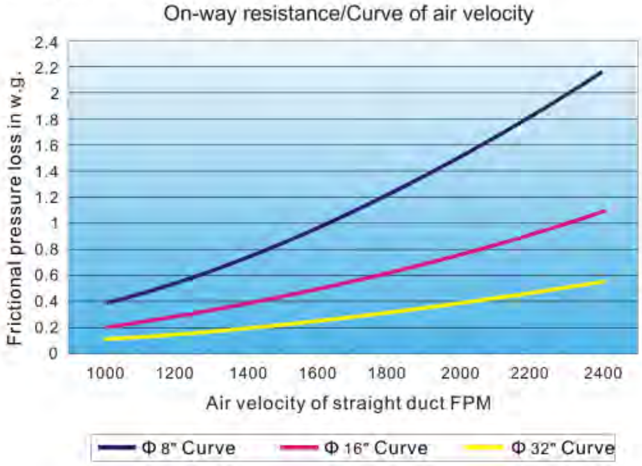
Friction factor is not constant, and it is related to flow conditions in duct and roughness of air duct wall.

$$\frac{1}{\sqrt{\lambda}} = -2\lg\left(\frac{K}{3.7d} + \frac{2.51}{Re\sqrt{\lambda}}\right)$$

According to comprehensive research on fabric material and DurkeeSox system, friction factor is not more than 0.024 (about 0.019 for metal duct). Because round series of DurkeeSox systemt is mostly applied and there are orifices along the length direction, average air velocity in duct is 1/2 of inlet velocity. Thus friction loss is much less than metal duct.

According to engineering experience, we summarize the friction loss value for different inlet velocity and different duct length in straight duct, as follows:

On-way resistance/Curve of air velocity



4.1 Pressure calculation in duct

4.1.1 Pressure calculation for straight duct

Since there is no local resistance loss in straight duct, pressure of the DurkeeSox system is composed of three portions, static pressure, velocity pressure and frictional pressure loss. Of which relation between static pressure regain and frictional pressure loss plays a major role. In most cases in DurkeeSox system, static pressure value from static pressure regain is larger than frictional pressure loss value.

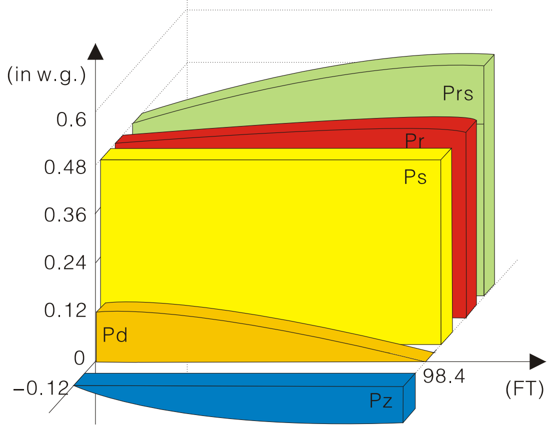
As mentioned above, calculated pressure in straight duct can overcome frictional pressure loss to achieve ideal airflow distribution. Theoretically straight duct can be regarded as static plenum box, but static pressure is impossible to be consistent everywhere in straight duct. At the entrance velocity pressure is no change, static pressure is inlet static pressure. Gradually velocity pressure converts to static pressure, and reaches its maximum at the end, this value is vector sum of inlet static pressure, static pressure regain and resistance caused pressure loss.

End static pressure = inlet static pressure + static pressure regain−pressure loss （Pr=Ps+Prs−Pz）

Average pressure of duct is namely average value of inlet static pressure and end static pressure

Its principle is shown in the following chart:

Ps−Inlet static pressure
Pr – End static pressure
Prs – Static pressure regain
Pd – Inlet velocity pressure
Pz – Frictional pressure loss



As calculation method of static pressure regain mentioned above, when inlet air velocity in straight duct is 1800FPM, static pressure regain is in 0.21 w.g.. When inlet air velocity in straight duct is 1400FPM, static pressure regain is in 0.13 w.g.. Hereby we can think, a minimum of static pressure regain in straight duct of DurkeeSox system is around in 0.12 w.g. and frictional pressure loss is very small.

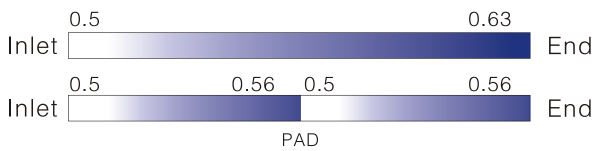
Example：
A factory's warehouse, area is 3400ft2, a LWHA 150 lifting type indoor AHU used, air volume is 8530CFM, inlet pressure is 1 w.g., DurkeeSox system used, diameter 30", length 47.2 ft, elevation on the top of duct is 35.1ft.

For DurkeeSox system, actual inlet air velocity is $V=L/S=8530/\pi(30/2/12)^2 \approx 1738FPM$

Average air velocity in the duct is regarded as：$V' = V/2 \approx 869FPM$
static pressure regain：$Prs=1.29V'^2/2=0.202$(in w.g.)=Pd
Frictional pressure loss：$Pz=0.024(\bar{V})^2 \rho l/2d=0.023$(in w.g.)
Inlet static pressure：$Ps=1-Pd=0.798$(in w.g.)
End static pressure：$Pr=(1-Pd)+Prs-Pz=0.977$(in w.g.)
Then pressure difference between end and inlet static pressure is：$P'=Pr-Ps=0.179$(in w.g.)

Pressure difference accounts for 18.3% of inlet static pressure.

According to the summary to a great deal of engineering experience, when the proportion of pressure difference to inlet static pressure is less than 10%, we can approximately consider air dispersion uniform along the length direction of DurkeeSox system. So for this warehouse project, the proportion of pressure difference to inlet static pressures is more than 10%, PAD (PAD introduction see Page 25), a pressure balance device, should be installed in the duct to balance static pressure in whole duct. As shown in the following illustration, after balance, the maximum pressure difference is in 0.1 w.g. in the whole DurkeeSox system, the proportion of pressure difference to inlet static pressure is less than 10%.



4.1.2 Complicated System Pressure Calculation

A set of complicated DurkeeSox system generally includes a main duct and some branch ducts, elbows, transitions, T-connectors, static pressure plenum box and more. Except frictional pressure loss, there is local resistance caused pressure loss. When calculating the complicated DurkeeSox system, select the most disadvantaged loop, calculate the frictional pressure loss and local resistance caused pressure loss respectively and then sum both, namely overall resistance caused pressure loss. Hereby minimum inlet static pressure can be calculated..

According to the formula introduced before we can conclude the calculation method for frictional pressure loss. So in following part we will mainly introduce local pressure loss calculation of fittings. When airflow goes through elbows, transitions, T-connectors and other fittings, cross section or flow direction changes which causes corresponding local pressure loss as traditional air duct.

$$Z = \xi \frac{\rho v^2}{2}$$

Z ：Local pressure loss；ξ：Local resistance factor(mainly from experiment, similar with traditional ducts)；
ρ：Density of air；v ：air velocity

In order to reduce local pressure loss of DurkeeSox system, we generally optimize the design:

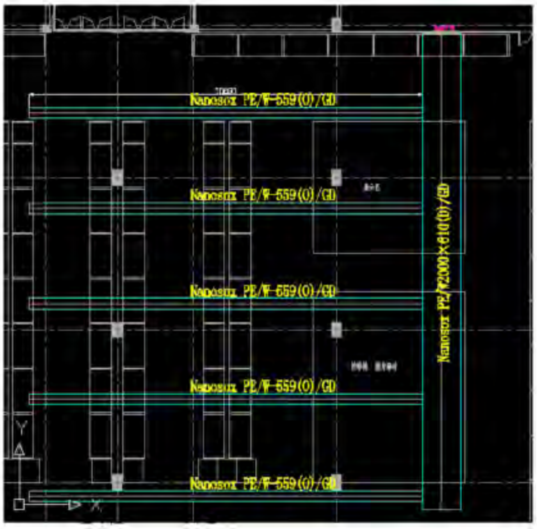
1. Synthesize various factors to select diameter, reduce air velocity in the duct as possible.
2. Optimize the special-shaped fittings design; avoid airflow direction from changing too abruptly and section from changing too fast.

According to engineering experience, we summarize local resistance value of fittings and components of DurkeeSox system as below table (when air velocity is 1600FPM):

Elbow（curvature＝1）	Constant T－connector	Transition（reducing angle30°）	Plenum box
In 0.04 w.g.	in 0.05 w.g.	In 0.012 w.g.	in 0.18 w.g.

Take a supermarket as an example：

The supermarket, air volume of AHU is 21200cmh, select number AHU-14 air handing unit system, main duct's dimension is 79"*24", five branch ducts, diameter of each branch duct is 22". Select the longest and most disadvantaged loop as calculation basis, 82fts main duct and 67.6 fts branch duct, frictional pressure loss calculation is as below:



Main duct: 82fts, 79"*24", equivalent diameter is，

$$D = 4\frac{A}{C} = 4\frac{2*24''}{2*(2+24'')} = 37''$$

$$\Delta p_m = \frac{\lambda}{d} ? \frac{v^2\rho}{2} l = \frac{0.024*4^2*1.2}{37''*2} *82 = 0.024 \text{ in w.g.}$$

Branch duct:67.6fts, diameter 22"

$$\Delta p_m = \frac{\lambda}{d} ? \frac{v^2\rho}{2} l = \frac{0.024*4^2*1.2}{22''*2} *67.6 = 0.034 \text{ in w.g.}$$

Local resistance caused pressure loss calculation: ：

Through T-junction, pressure loss for main duct is Z_L = 0.45（Q'/Q）*ρV^2/2
Through T-connection, pressure loss for branch duct caused by flow direction change isZ = ξ*ρV^2/2
For farthest branch duct required static pressure = 0.8 in w.g.（outlet air pressure at 11.5fts height) + 0.024 in w.g.（frictional pressure loss of main duct) + 0.034 in w.g. (frictional pressure loss of branch duct) + 0.02 in w.g.*5（pressure loss of main duct section by T-connection）+ 0.06 in w.g. (pressure loss of branch duct section by T-junction）
Pressure required for the most disadvantaged lope is 1.02 in w.g., so ,AHU pressure shall be at least more than 1.2 in w.g.（total pressure)

When the system is running，pressure in each branch duct equals to pressure in main duct before T-connection minus local pressure loss by T-connection.
Pressure in main duct Pcn=P_p(total pressure)-P_{dn}H (pressure loss of main duct by T-connection)-Pz(on-way resistance caused pressure loss)
Likewise, static pressure regain also exists in the complicated system.
End static pressure in main duct section = 1.02 in w.g.(inlet pressure)-P_{dn}H(pressure loss of main duct by T-connection)-Pz(frictional pressure loss)+Prs(static pressure regain)=1.02 - 0.02×5 - 0.024 + 0.2 = 1.096 in w.g.
End static pressure in proximal branch duct=1.02 - 0.06（T-connection caused pressure loss）= 0.96 in w.g.

Thus for complicated system, calculate the inlet pressure based on resistance calculation of most disadvantaged loop, at the same time consider outlet air pressure, frictional pressure loss of main duct and branch duct, various local pressure loss. Accurately calculate the work pressure of each branch duct referring to main duct pressure at T-connection, similar as pressure distribution of long straight duct, but need to minus local pressure loss caused by airflow direction change. In order to balance the air volume and air pressure of each branch duct, use the ACD and consider the ratio of inlet static pressure to velocity pressure, the bigger the ratio is, more uniform pressure distribution of branch duct will be.

5 AIRFLOW DISPERSION DESIGN

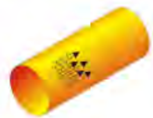
Before designing air dispersion of DurkeeSox system, it is necessary to understand the airflow distribution principle.

5.1 Air Dispersion Model Selection

According to engineering requirements, space, height and heating/cooling mode and more, there are different air dispersion models to be selected for DurkeeSox system to meet customers' requirements; its principles are as follows:

PM–100% Permeation Model

The system is made from fabric with 100% large permeability only. Airflow is dispersed to occupied area through fabric permeation with very low velocity (to 20 FPM), draught free and no condensation.

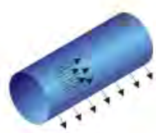



EJ–100% Injection Model

The system is made from nor-porous fabric without permeability. There are orifices on the surface of fabric duct, through which airflow is dispersed towards specific direction with high speed, far throw and even airflow.


PS–Permeation With Slots Model

The system is made from lower permeable fabrics with specific air dispersion slots along the length direction. It integrates two advantages, permeation and directional air dispersion.

PE–Permeation With Injection Model

The system is made from the lowest permeable fabric with designed orifices on the duct. It integrates two advantages, permeation and directional air supplying.


5.2 Air Dispersion Design

Design the details by professional design software DurkeeSox owned and patented especially for fabric air dispersion system, which includes designing permeable volume, type, dimension, number and direction of slots or orifices, DurkeeSox engineering technology center is responsible for this part.

5.2.1 Even Air Dispersion Principle

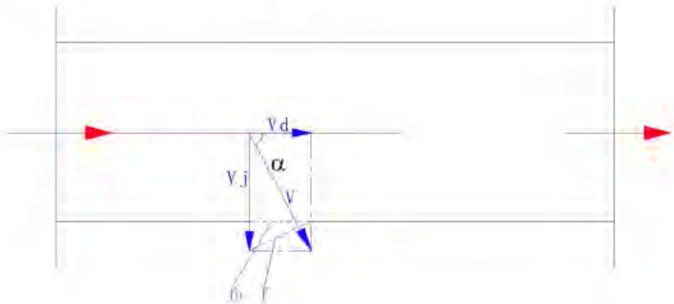
5.2.1.1 Even Air Dispersion Duct Design Principle

When air flows in the air duct, static pressure perpendicularly acts on the duct wall. If the orifice is opened on the sidewall, air will be dispersed perpendicularly to the duct wall due to internal and external pressure difference of the orifice.

Airflow Velocity caused by static pressure difference: $V_j = \sqrt{\frac{2P_j}{\rho}} m/s$ Air velocity in air duct is $V_d = \sqrt{\frac{2P_d}{\rho}} m/s$

P_j ——static air pressure in duct;

P_d ——velocity air pressure in duct;

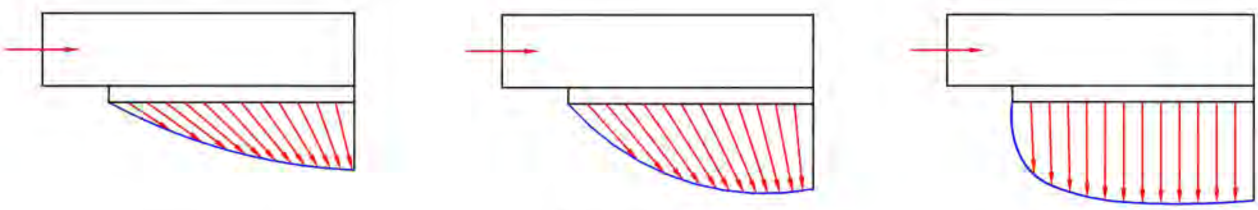


airflow direction out of orifices:

angle between airflow and axes of duct $tg\alpha = \frac{V_j}{V_d} = \sqrt{P_j/P_d}$

Therefore, when air discharges through the orifice, its actual velocity and direction not only depend on velocity caused by static pressure, but also are affected by airflow velocity in the duct, as shown in the following chart. Under the influence of airflow velocity in the duct, orifices dispersion direction will deflect, actual velocity is resultant speed. For rectangle duct with constant section and slots model, velocity distribution at the orifice is as follows. In air supplying duct, airflow decreases continually from start to end, velocity pressure decreases correspondingly, static pressure increases, which makes slots/orifices outlet velocity increase continually;

As the following chart, when air velocity in the duct is all the same



Pressure in 0.2 w.g. Pressure in 0.4 w.g. Pressure in 0.8 w.g.

5.2.1.2 Basis Conditions for Even Air Dispersion

$$L_0 = 3600\mu \cdot f_0 \sin\alpha \cdot v = 3600\mu \cdot f_0 \sqrt{\frac{2P_j}{\rho}}$$

P_j: Static pressure μ: flow coefficient α : outflow angle

From the formula we know, for uniform air duct with constant side-hole area, in order to keep the same supplying airflow rate for each side hole, it is necessary to ensure the same static pressure and flow coefficient for each side hole. And make the outflow perpendicular to the hole as possible, meaning of outflow angle is close to 90 degree. Those requirements can be met by below methods:

——Keep the same static pressure for each side hole, namely velocity pressure drop between two adjacent side holes equals to resistance caused pressure drop between two side holes ;

——Keep the same flow coefficient for each side hole, flow coefficient is related to hole shape, outflow angle and ratio of air volume after andbefore the hole($L_0/L = \overline{L_0}$). When $\alpha \geqslant 60^0$ 、$\overline{L_0}$ = 0.1 - 0.5, it is approximately μ = 0.6 is constant.

——Increase outflow angle α

In air duct, the bigger the ratio of static pressure to velocity pressure is, the bigger outflow angle is, the more the outflow direction is close to perpendicular; when the ratio is smaller, outflow direction will deflect to one direction, at this time even if air volume is the same for each side hole, it still fails to realize uniform air supplying.To maintain ($\alpha \geqslant 60^0$) , we shall ensure $P_j/P_d \geqslant 3.0$ ($v_j/v_d \geq 1.73$) ,namely, the pressure value is larger than 0.48 in w.g.(120Pa) better.

5.2.1.3. Even Air Dispersion Model

Air dispersion models can be divided into two parts, permeation model and Ejection model. With these two kinds of air dispersion models DurkeeSox air dispersion system covers two kinds of ventilation mode, displacement ventilation and compound ventilation. How do these two kinds of air dispersion models ensure DurkeeSox air dispersion system realizing even air supplying? It will be analyzed respectively in the following.

A : Permeable air dispersion model

Uniform air supply is long-time stability and consistency of supply air velocity and air volume in the whole air supply area. For permeable air dispersion model of DurkeeSox system, it is no doubt that both air velocity and air volume are stable and the consistency is to ensure uniform and stable permeability of air duct material. It can be guaranteed by high quality imported material of DurkeeSox system to achieve even air permeable supplying.

B : Ejection model

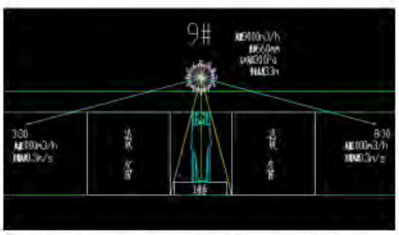
Ejection model is the orifices which are linearly, evenly and densely covered on the surface of DurkeeSox system. Its effect and principle is similar to diffusers of traditional air duct. To realize uniform air supplying is to require static pressure to be uniform along the length direction. In fact due to static pressure regain, end static pressure is normally large than inlet static pressure, which causes air flow unevenly distributes along the length direction, inlet air flow is less than end air flow. Aim at this condition DurkeeSox develops patented component PAD, Pressure adjustment device, which is used to balance static pressure in the duct and makes static pressure uniform along the length direction, so as to realize the uniform air supplying. PAD is introduced on DurkeeSox components part, page 25 in detail.

PAD Pressure adjustment device

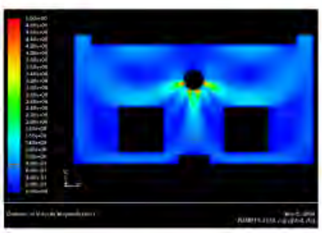
When two air dispersion models act together or separately, the most ideal and uniform surface air supply in current technical conditions can be realized which effectively solves two problems: uneven air supply of traditional point to point air supply and expensive cost of surface air supply. In order to prove that DurkeeSox design supplies uniform air supply for every project, we can provide professional CFD computer-aided design and simulation.

Through CFD application, the software can display and analyze the airflow in closed space, predict the effect in a short time and through changing various parameters to achieve the best air supply effect. CFD numerical simulation makes us understand the mechanism of the problem more intuitively. Here we will introduce a case about CFD numerical simulation of air flow field in a work shop, the details are as following:

This workshop produces precision components, with high requirements on air velocity and temperature in the working area, at the same time it requires to form air curtain outside the working area which effectively isolates the odor and oil equipments produce on both sides of workbench. The elevation diagram of the location is:

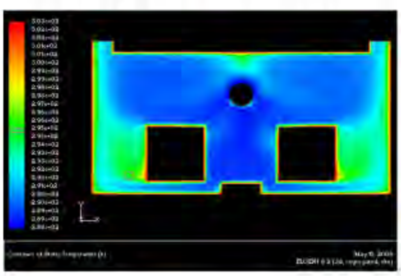


Build mathematic model,input all the parameters,get the calculated result



Curve of velocity field in section plane

This figure shows air supply condition of jet holes in four directions. Though air velocity is very high at ejection holes, more than 32.8fts (red area), airflow begins settlement and entrainment rapidly under air duct. Air velocity of whole space drops to about 100 FPM, thus creates a comfortable work environment. Just below air duct there is obvious higher speed airflow on workbench, as selected point in the figure, 140FPM (light blue), and form air curtain to effectively isolate heat and odor from the equipment. Jet holes in the direction of 3:30 and 8:30 disperse the air to lateral of equipments and the air arrives upper return air intake following the return air.

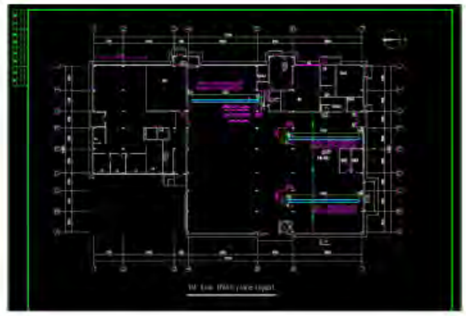


Curve of temperature field in section plane

The figure obviously shows low-temperature zone, the work area below the air duct, 68 F(20 C) (blue); temperature of equipments and walls is above 77 F(25 C)due to heat transfer with outside (orange and red), temperature of lateral of equipment is quite high due to far away from air outlet, as selected point in the figure, 73.5 F(23 C) (green); because there is maintenance channel outside the equipment which workers occasionally go through, there is unnecessary to revise the design to supply air to the area alone. Therefore, DurkeeSox system design totally satisfies application requirement, air dispersion effect is guaranteed.

5.2.2 Air Dispersion System Design Processure

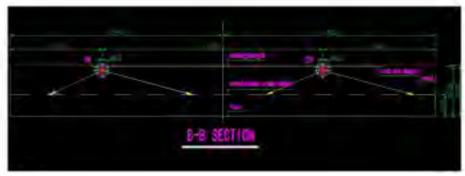
Take an actual motor engine plant as an example, after finishing layout design and height design, air dispersion design procedure is as follows:



A Determine the range and area needed to control according to the profile of height design

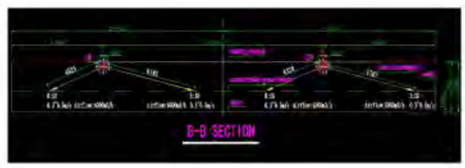
Generally according to uniform layout principle, midline of two adjacent DurkeeSox air ducts is regarded as boundary. Based on engineering conditions, divide the area by airflow of every duct and plane layout to make airflow distribution even as possible. Height of comfort area namely air supply height is selected based on application requirements (refer to design code), generally 5~6 fts for comfort air conditioning.

B Determine opening direction



According to divided area, draw orifices direction and select rows of required opening. Since there is diffraction for orifices, orifices direction can not directly point to boundary but 5~10 fts set aside for diffraction distance. The direction of throw can be determined according to the location of orifices direction line in drawn clock scales.

C Determine air volume distribute



After the orifices direction, rows and throw range of every duct are determined, the proportion of airflow volume dispersed from orifices can be determined according to the proportion of area every row of orifices cover, and marked on the drawing.

D Determine air volume by permeation and orifices

According to actual situation and special requirements of application, DurkeeSox system selects the fabric with proper permeability to get proper permeated air volume, and then according to total air volume calculates air volume by orifices(detailed calculation method see below)

E Determine orifice sizes and rows

ISOX-manufactory, patented by DurkeeSox Company, is air dispersion design software especially for fabric air distribution system. At this time all required input data for the software have been determined. The following is the final design phase before production: determine orifice sizes and rows. This step is directly completed by the software and input to automatic product line for production. A set of completed DurkeeSox system design has been finished.

5.2.3 Permeated Airflow Calculation

There is a wide range of permeability for fabric of DurkeeSox system. When static pressure is in 0.5 w.g., permeability of DurkeeSox system ranges from 0-32cfm/ft^2 (0 - 579m^3/m^2/h) , to meet the requirements of various types of engineering projects in fabric permeability.One of the features of fabric air distribution system is that air volume of the system is supplied to the working area through two ways: one is permeation of fabric material, the other is evenly distributed orifices around air duct (main channel). Generally air volume through permeation is just used to prevent condensation, accounts for 5% - 10% of total system air volume or less (except 100% permeation model). If permeated air volume has excessive energy exchanged with surrounding environment, it would cause certain waste in high space. Generally according to requirements of different environments and air supplying temperature, we will select proper permeability (the ratio of permeated air volume to total system air volume)

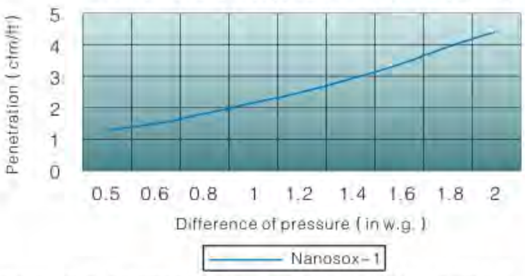
When 100% permeation model is used in the system, air volume Qfabricdispersed through fabric permeation, is basically system air volume. Air is all dispersed to indoor space through fabric permeation.

Airflow through fabric:

Q_{fabric}=FP X SA X (AP/0.5)
Fp——Fabric permeation , Q_{fabric}——Airflow through fabric , Sa——Supply area, Ap——Average Pressure

About fabric permeability, we analyze and test material with different permeation under different system pressure, details are as follows:
When pressure in the standard condition increases from in 0.5-1.4 w.g.,
Permeability changes to 2.3~2.8 times of the original.

Fabric permeability / Curve of pressure change



For example: A gymnasium

Equipment parameters:
Air volume is 8820CFM, inlet static pressure is 1.4 in w.g., installation height is 46ft, diameter of selected DurkeeSox air duct is 32", length is 121.7fts, only one duct.
Permeability---pressure increases from standard 0.5w.g. to 1.4w.g. , permeability increases to 2.3 to 2.8 times of original.

Option 1
Fabric permeability is 0.4cfm/ft^2 when static pressure in 0.5 w.g.,
Q = 0.4 x 2.8 x1019.52m^2 = 1142CFM,
Permeated air volume accounts for 12.7% of total system air volume.

Option 2
Fabric permeability is 2cfm/ft^2 when static pressure in 0.5 w.g.,
Q = 2 x 2.8 x1019.52m^2 = 5709CFM,
Permeated air volume accounts for 64.7% of total system air volume.

The gymnasium is large space, of which air supply pressure is high and air throw is far, so permeation ratio is controlled within 20%. Namely select the fabric permeability 0.4-0.6cfm/ft^2 when static pressure is in 0.5 w.g.. Otherwise, if select option 2, high permeability will cause a great deal of cooling air consumed in upper space and couldn't be supplied to working area, temperature gradient couldn't meet design requirements. At the same time when material permeability is out of control and orifices stay the same, it directly causes air duct pressure released and pressure in the duct is far less than designed value, in 1.4 w.g., thus air throw would be greatly shortened, air duct could not be inflated sufficiently.

To sum up, for large space project it is better to select DurkeeSox air duct made from fabric of which permeability is less than 0.5cfm/ft^2, only in this way we can assure the air dispersion effect and meet actual engineering needs. So we suggest marking selected fabric's maximum or minimum permeability in equipment parameters table when releasing the design drawing.

5.2.4 Orifice Airflow Calculation

Air volume supplied to indoor space through openings of every segment

$$Q_{vent} = Q_t - Q_{fabric}$$

Q_{vent} ——air vulume by orifices, Qt ——total air volume

For permeation with slots model or ejection model, designed air volume dispersed through fabric permeation is relatively small. It is possible to select different permeability finally when further design. Airflow is supplied to indoor space mainly through orifices or slots.

6 SYSTEM COMPONENT DESIGN

6.1 Air Dispersion Components

A: Orifice

Make holes by laser on the surface of DurkeeSox air duct.

B: Nozzle

Make Nozzle from special material, fixed on DurkeeSox air duct to replace normal air outlets

C: Ring

Make ring shape from flexible rubber material, to strengthen the orifice

6.2 Functional Components

A: PAD pressure adjustment device design

PAD (Pressure adjustment device) is pressure balance device specially applied for fabric air dispersion system, of which material is a kind of special permeable grid material and shape is conical. One end is connected to fabric air duct through concealed heavy-duty zipper and in the other end adjust the cord to change end vent area, so as to adjust pressure distribution in the system. DurkeeSox patented this structure. In straight duct of fabric air dispersion system, end static pressure is higher than inlet static pressure due to static regain. Thus pressure is uneven and air supply is uneven no matter at the beginning or at the end. That is why pressure balance device, PAD is required to install in air duct. PAD change airflow resistance through changing vent area, thus adjust pressure balance between front and back end. The smaller opening of PAD is, the bigger resistance is, and the bigger change in pressure difference is. It has an obvious effect on adjusting pressure balance in air duct.

PAD pressure adjustment device

Full open

Half open

Close

Location of Installation:

——**Inside duct**

For all systems which are more than 39fts and extend by zipper or with a more than 1400FPM air velocity.

Function: decrease air velocity in duct, reduce velocity pressure; balance air pressure through the duct.

Relationship between opening of PAD and air pressure

Opening	1	3/4	1/2	1/4	0
Inlet Pressure	0.5	0.5	0.5	0.5	0.5
End cap Pressure	0.64	0.6	0.57	0.54	0.51

* Under other pressure value the situation will be different

PAD is preset according to design before deliver to the customer. Adjust end vent area only when air dispersion is uneven between front and back end during real application, so in field installation, PAD setting is not needed to adjust unless otherwise stated.

B: ACD airflow control device design

ACD (airflow control device)is air volume adjustment device specially applied for fabric air dispersion system. In order to balance the flow of branch duct, ACD, air volume adjustment device, is installed to the system, similar to traditional air valve. Likewise ACD is subject to patent protection and DurkeeSox owned the patent.

Different from PAD, ACD is made from denser grid material or fabric directly, more capable of controlling air volume. The important function of ACD is to balance air volume of each branch duct. When more than one branch duct are connected to the same main duct, air velocity of each branch duct at the connection to main duct is inconsistent, which causes static pressure of each branch duct is inconsistent. So both pressure and air volume of each branch duct is possibly much different. Branch duct of which air volume is too large is possible to turbulence, at this time reduce the opening of ACD to change the wind resistance of the branch duct, stabilize air velocity and stop turbulence.

ACD airflow control device

Full open

Open 3/4

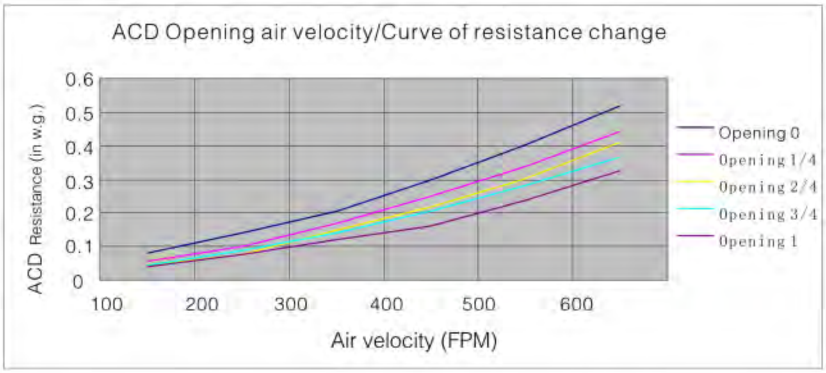
Close

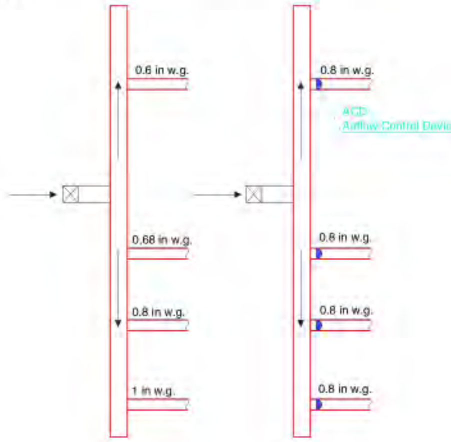
Function: Balance air volume before entering branch ducts.

Location of installation :

——Air supply main duct and branch duct

When air velocity in main duct behind outlet (or within 10 ft of outlet) is more than 1200FPM,



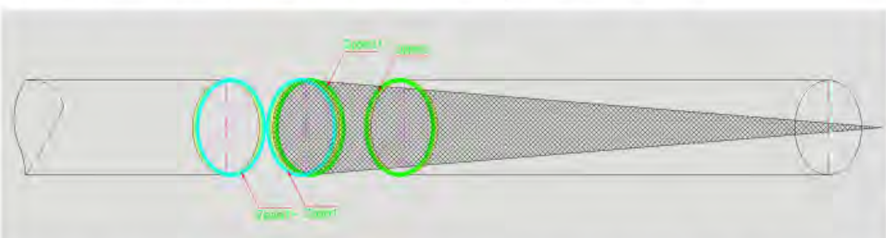


If ACD is not installed, air volume of each branch duct is obviously inconsistent; if ACD is installed, adjust the opening till air volume of each branch duct tend to the same, at this time static pressure of each branch duct is same, see right figure.

C: FAF fabric air filter design

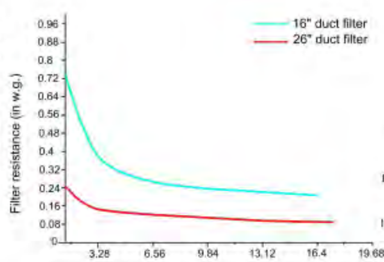
FAF(fabric air filter) is unique component of DurkeeSox air duct system and used to increase cleanliness of indoor air and effectively extend time interval of system cleaning and maintenance.

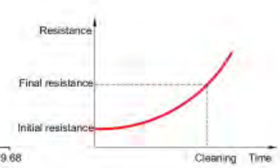
ACD air valve is preset according to design before deliver to the customer, which is also adjustable by unzipping according to actual needs when application (but air velocity is relatively high).



Fabric in filter material make airflow bypass and cause small resistance. When filter is not installed, air supply pressure reaches maximum; when length of filter increased, pressure in air duct gradually decreases. Below chart is resistance schematic with and without filter. As can be seen from figure, when length of filter is four times of diameter, the decreasing trend of resistance is already very gentle.

Filter generates resistance to airflow, resistance caused by new filter called "initial resistance" correspondingly resistance caused by obsolete filter called "final resistance" When filter is covered by dust, resistance increases; the dirtier filter is, the quicker resistance increases. When resistance increases to a specified value, it will make air volume of air-conditioning systems sharply decrease. Moreover due to big gap among the fabric, too big resistance is possible to blow the dust away in the filter. At this time resistance no longer increases but filtration efficiency decreases to zero. Therefore when "final resistance" reaches in 0.4-0.8 w.g., filter should be cleaned. Cleaning cycle depends on supply air quality.





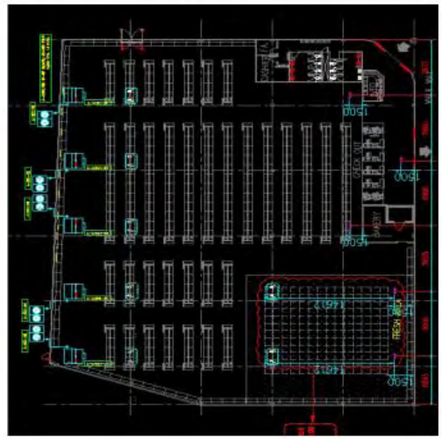
7 CASE STUDY

After finishing whole design, besides layout, design description and equipment parameters table, DurkeeSox engineering technology center will issue system calculation sheet, namely calculation data by ISOX-design, DurkeeSOX patented design software, according to all parameters, which is also basis of production of DurkeeSox system and guarantee of application effect. Following take local area of a engineering project as an example to describe design process of the system.

A supermarket, building area is 22000 ft^2, five hanging style ventilated cases are used, each air volume is 10000CFM (16800CMH), every unit is corresponding to a DurkeeSox air duct, all are straight ducts and distributed evenly.

Step 1: Planning and layout

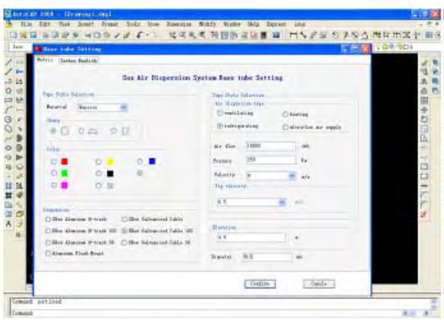
According to characteristics of the supermarket, DurkeeSox system is mounted perpendicular to shelf and is parallel to lamp lane. In accordance with this scheme five DurkeeSox system in all are evenly mounted.



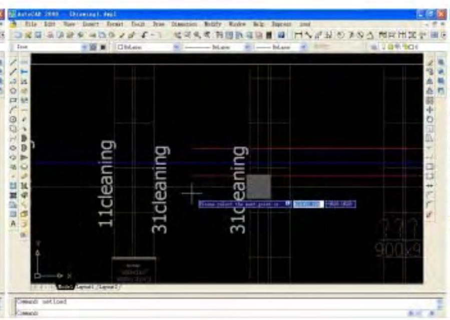
Supermarket shelf plan layout drawing

Step 2: Shape, dimension design

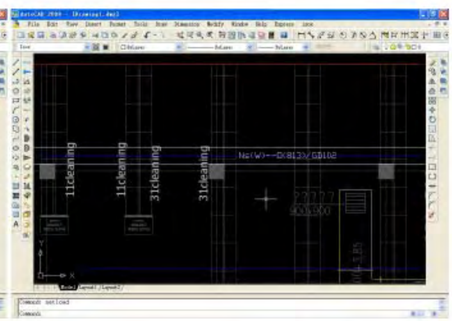
Input design parameters to ISOX-design, proprietary software by DurkeeSox, including fabric material series, color, shape, input air volume, inlet air pressure, inlet air velocity and more. System will automatically recommend duct dimension (diameter is 32") and draw air duct, automatically mark " 1# duct" On the analogy of this draw other four DurkeeSox air ducts.



Input all design parameters



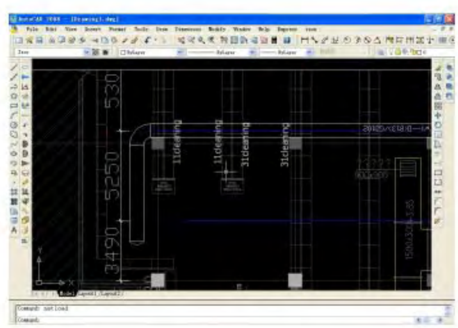
Determine start point of duct drawing



Generate plan drawing for1 # duct

Step 3: : Fittings design

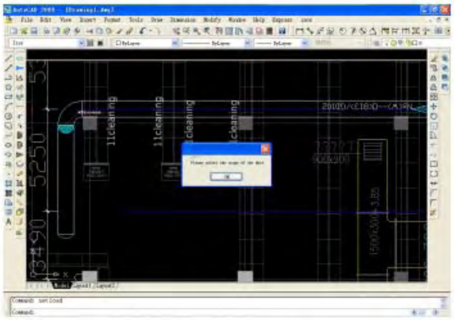
Because ducts are all straight, isox software automatically generates inlet and end of general parts. In the process of air duct layout, if there is direction change, system will automatically generate various general parts, such as elbow, transition, T-connection and more.



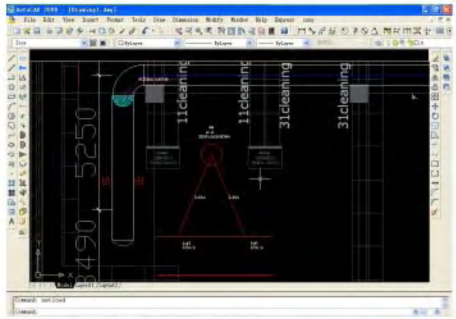
Automatically generate elbows

Step 4: Air dispersion design

Mark air dispersion area (designated air supply range) in plane diagram, isox design software automatically generates air dispersion profile of DurkeeSox air duct system.



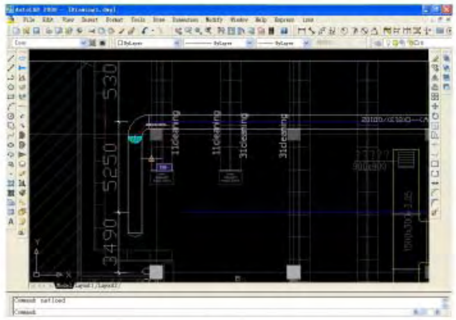
Mark air dispersion area



Automatically generate air dispersion section drawing

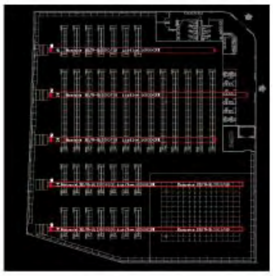
Step 5: Component design

By isox, insert various components which system needs, such as PAD pressure adjustment device, ACD airflow control device, FAF fabric air filter and more, and automatically complete drawing.

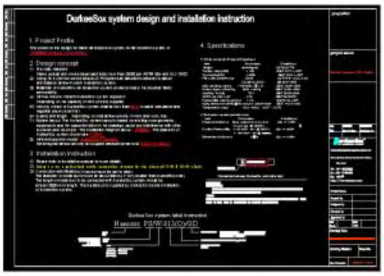


Insert component

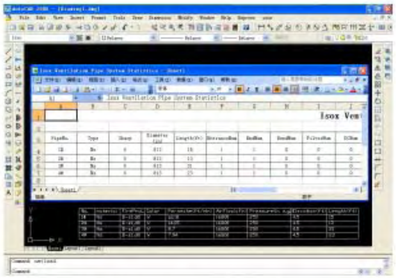
After these designs are finished, make design manual by template according to various parameters of the project. Complete design drawings should include equipment parameters table, which can be automatically generated by isox design software after finishing plane layout design. Finally DurkeeSox engineering technology center will issue system calculation book to verify design feasibility and guarantee air supply effect of DurkeeSox air duct system. By isox design software plane layout, design description and equipment parameter table are as follows:



Plan drawing



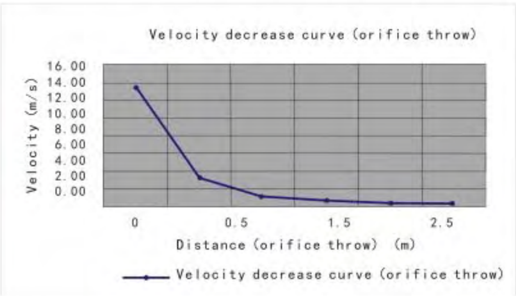
Design manual

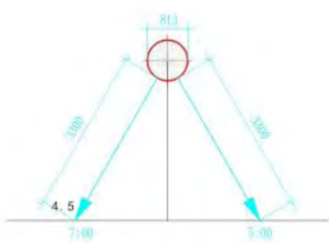


Automatically list all parameters

Issue the calculation book of DurkeeSox system as follows:

DurkeeSoxsystem calculation			
system number	air volume	Q(m³/h)	16800
1#	diameter	D(mm)/(")	813
	indoor installation height	H(m)	5
	working air pressure	P(pa)	300
	fabric permeability	Q(m³/h)	18
	permeated air volume	Q(m³/h)	2800
	system length	L(mm)	29000
	Jet airflow angle per orifice	°	5:00
	quantity of orifice	N(个)	757
	spacing between orifices	L(mm)	35
	Dia. of orifice	d(mm)/(")	15.24
	air volume per orifice	q(m3/h)	9.12
	air throw per orifice	x₀(m)	3.3
	air velocity in working area	v(m/s)	0.5
	jet airflow angle per orifice	°	7:00
	quantity of orifice	N(个)	757
	spacing between orifices	L(mm)	35
	dia. of orifice	d(mm)/(")	15.24
	air volume per orifice	q(m3/h)	9.12
	air throw per orifice	x₀(m)	3.3
	air velocity in working area	v(m/s)	0.5





Thus we get complete calculation table of 1# DurkeeSox system for the supermarket, which contains complete data such as opening dimension and direction and more. Now DurkeeSox system design has been all completed.

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