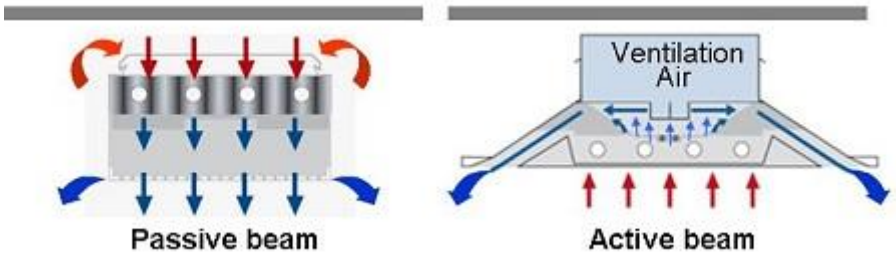
Nom: **Date:**

HVAC Learning.com

Exercise Booklet

Print this exercise booklet before studying the lesson on-line. It will enable you to write your answers to the HVAC learning exercises. You will thus be able to switch between reading or listening to the file on-line and writing in the booklet.



SELECTING INDUCTION UNITS AND ACTIVE CHILLED BEAMS

English lesson
https://hvac-learning.com/air-conditioning-cooling/fan-coils-units-cooling-floor-and-ceiling-chill-beam-training/selecting-induction-units-and-active-chilled-beams/

French version:
https://formation.xpair.com/cours/selection-ejecto-convecteurs-poutres-froides-actives.htm

For each exercise, you will write your answer, then you will study its correction on-line before going to the next exercise.
If you cannot do an exercise, you will be able to study its correction directly, but ***force yourself to write your answer*** *as often as possible.*

Note that between 2 exercises, you will find it necessary to study the course. As a warning, in the booklet, you will sometimes find the following indication:

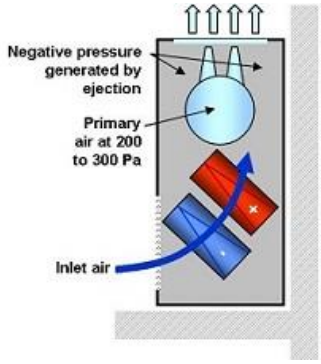
- *"* ***Study the course on-line before doing the next exercise****" or*
- *"* ***Study the course on-line before going to the next paragraph****"*

Only study the paragraphs or the exercises which have an equal or a lower level than the one your training requires.
NVQ Level = Vocational Certificate
A Level = High school Diploma
HND Level = Associate's Degree
MSC Level = Engineering Schools

Then, when you have completed a file, you will be able to assess your level on-line through a Multiple Choice Questionnaire in which you will only answer the questions related to the themes you have studied.
So now off you go and work well!
Good luck!
The Authors.

N°1 – Induction unit outputs – HND to Master's level

Study the course on-line.



Model Length (mm)	Air flow (l/s)	Noise Level (dB A)	Primary air cooling power (W)				Water cooling power (W) (cased unit)							
			Δt_l 6	8	10	12	Δt_{mk} 5	6	7	8	9	10	11	12
600	8	<25	58	77	96	115	195	241	269	303	351	383	424	459
600	11	<25	79	106	132	158	210	256	291	330	378	416	459	500
600	14	<25	101	134	168	202	222	268	307	348	395	436	478	521
600	17	<25	122	163	204	245	231	275	318	360	405	446	488	530
600	20	25	144	192	240	288	235	280	323	366	409	451	492	534
600	21	25	151	202	252	302	236	280	324	367	409	452	494	535

Table2 : Data – Cooling. chilling & dimension specification guide at 250 Pa pressure ; Source Swegon
With :
– Air-flow : primary air-flow in [l/s]
– Δt_l = temperature difference between air of the premises and primary air temperature
– Δt_{mk} = temperature difference between the air of the premises and the chilled water average temperature

Question 1

What is the « chilled primary air power » quoted by the manufacturer above, for a beam fed with a primary air-flow of 20 [l/s] at 17 [°C] (63°F) in premises at 25 [°C] (77°F)?
Check by calculation the accuracy of this.

N°2 – Selecting Induction units – HND to Master's level

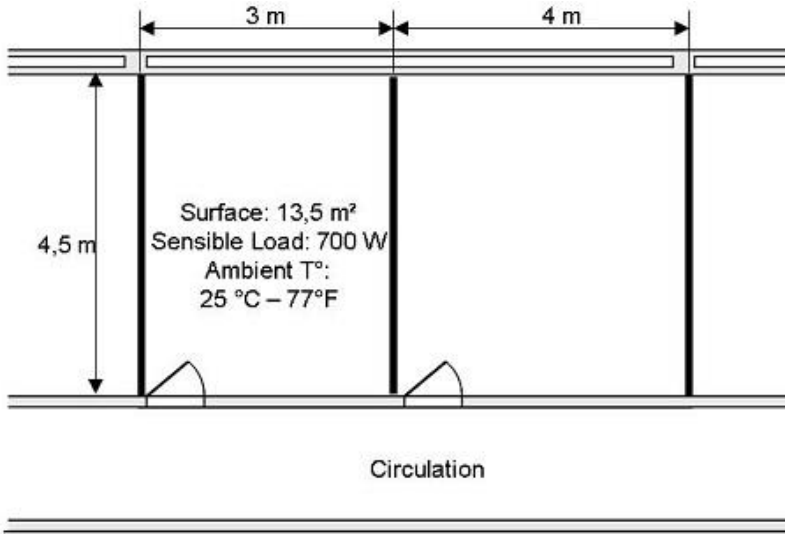
Induction unit selection means identifying a model looking at: ***Cooling power*** *(primary air & water) ≥* ***Sensible load of premises***

Unit's Length (mm)	Air flow (l/s	Sound Level (dB A)	Primary air cooling power (W)				Water cooling power (W) (cased unit)							
			Δt_l 6	8	10	12	Δt_{mk} 5	6	7	8	9	10	11	12
600	8	<25	58	77	96	115	195	241	269	303	351	383	424	459
600	11	<25	79	106	132	158	210	256	291	330	378	416	459	500
600	14	<25	101	134	168	202	222	268	307	348	395	436	478	521
600	17	<25	122	163	204	245	231	275	318	360	405	446	488	530
600	20	25	144	192	240	288	235	280	323	366	409	451	492	534
800	11	<25	79	106	132	158	272	337	375	423	489	533	590	637
800	14	<25	101	134	168	202	288	353	398	450	518	569	628	684
800	17	<25	122	163	204	245	302	366	417	473	540	595	655	714
800	20	25	144	192	240	288	313	377	432	490	556	613	673	733
800	23	26	166	221	276	331	322	385	443	503	567	625	683	743
1000	14	<25	101	134	168	202	359	402	483	525	605	681	725	800
1000	17	<25	122	163	204	245	374	426	507	557	638	714	766	842
1000	20	25	144	192	240	288	388	447	528	586	667	744	802	879
1000	23	26	166	221	276	331	400	465	547	611	691	769	834	911

Table 2 : Data – Cooling. chilling & dimension specification guide at 250 [Pa] pressure ; Source Swegon

Question 1

Using the table above, choose a single model capable of handling the premises.
Data :
– Minimum fresh air-flow : 50 [m³/h]
– Primary air temperature: 17 [°C] (63°F)
– Chilled water range: 14/18 [°C] (57/64°F)



Question 2

Using the table above, complete the table below with temperature differences of ΔtI and Δtmk of 8 [K].

Model (mm)	Min primary air flow (m^3/h)	Cooling power (air & water) for Δt_i and Δt_{mk} 8 K	Primary air flow (m^3/h)	Cooling power (air & water) for Δt_i and Δt_{mk} 8 K
600				
800				
1000				

Question 3

Explain why the power output of induction units diminishes with primary air-flow.

Note below the minimum fresh air flow per occupant (french rule).

Use of premises	Minimum fresh air flow [m^3/h] per occupant
Offices, non-physical work space	25
Restaurant, shop, meeting premises	30
Workshops & light physical work	45
Other workshops & premises	60

Unit's Length (mm)	Air flow (l/s	Sound Level (dB A)	Primary air cooling power (W)				Water cooling power (W) (cased unit)							
			Δt_l 6	8	10	12	Δt_{mk} 5	6	7	8	9	10	11	12
600	8	<25	58	77	96	115	195	241	269	303	351	383	424	459
600	11	<25	79	106	132	158	210	256	291	330	378	416	459	500
600	14	<25	101	134	168	202	222	268	307	348	395	436	478	521
600	17	<25	122	163	204	245	231	275	318	360	405	446	488	530
600	20	25	144	192	240	288	235	280	323	366	409	451	492	534
800	11	<25	79	106	132	158	272	337	375	423	489	533	590	637
800	14	<25	101	134	168	202	288	353	398	450	518	569	628	684
800	17	<25	122	163	204	245	302	366	417	473	540	595	655	714
800	20	25	144	192	240	288	313	377	432	490	556	613	673	733
800	23	26	166	221	276	331	322	385	443	503	567	625	683	743
1000	14	<25	101	134	168	202	359	402	483	525	605	681	725	800
1000	17	<25	122	163	204	245	374	426	507	557	638	714	766	842
1000	20	25	144	192	240	288	388	447	528	586	667	744	802	879
1000	23	26	166	221	276	331	400	465	547	611	691	769	834	911

Table 2 : Data – Cooling. chilling & dimension specification guide at 250 [Pa] pressure

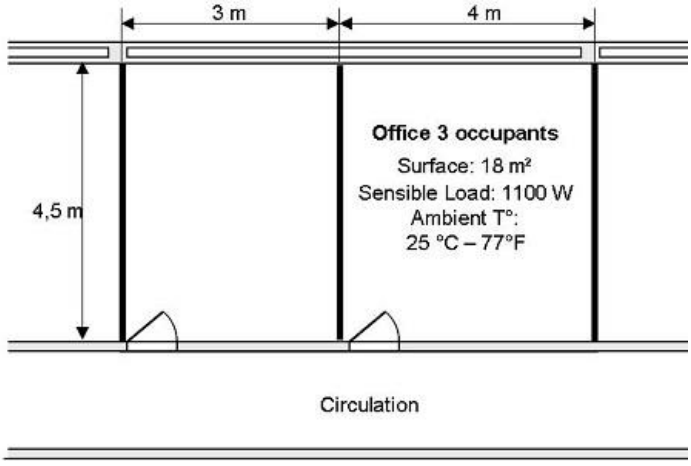
Question 4

While limiting the primary air-flow to statutory fresh air-flow (according to the French Labour Code above), select in the documentation above two identical induction convectors to handle the premises.

Data :

– Primary air temperature : 17[°C] (63°F)

– Chilled water range : 14/18 [°C] (57/65°F)

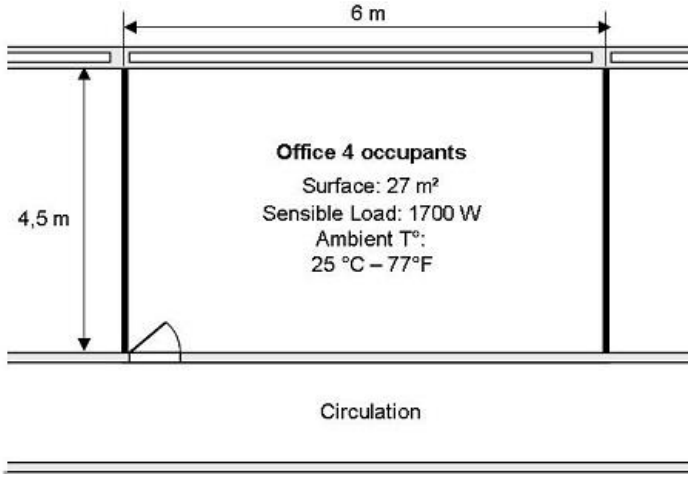


Note below the minimum fresh air flow per occupant (french rule).

Use of premises	Minimum fresh air flow [m³/h] per occupant
Offices, non-physical work space	25
Restaurant, shop, meeting premises	30
Workshops & light physical work	45
Other workshops & premises	60

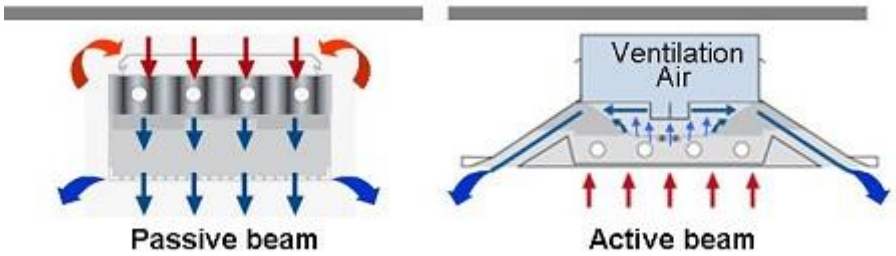
Question 5

While respecting french Labour Code stipulations, select in the documentation a maximum of 2 identical induction units able to handle the premises shown below, while requiring a minimum of recycling.
Calculate in [m³/h] the recycling flow required.
Data :
– Primary air temperature : 17 [°C] (63°F)
– Chilled water range : 14/18 [°C] (57/65°F)



N°3 – Active chilled beam output – HND to Master's level

Study the course on-line.



Vents all open

Unit's length:	Air flow (l/s)	Sound level dB(A)*	p_i (Pa)	Cooling capacity Primary air (W)					Cooling capacity water (W)							
				ΔT_l	6	8	10	12	ΔT_{mk}	6	7	8	9	10	11	12
1,2 m	8,5	<25	18		61	82	102	122		187	213	244	270	301	327	358
1,2 m	11,5	<25	31		83	110	138	166		231	269	302	341	374	412	445
1,2 m	14,5	<25	50		104	139	174	209		265	310	354	398	442	487	530
1,2 m	17	<25	70		122	163	204	245		304	350	401	453	499	550	602
Vents 50% open																
1,2 m	3,5	<25	11		25	34	42	50		109	130	145	161	176	192	231
1,2 m	5,5	<25	31		40	53	66	79		156	182	208	234	260	285	311
1,2 m	8,5	<25	70		61	82	102	122		206	244	275	307	344	375	413

*Room attenuation = 4 dB, open damper

Table 2 : Data – Cooling. Selection guide for several vent blocking levels

Question 1

With a similar primary air feed pressure, when blocking vents, what is the change of:
– Primary air-flow
– Cooling power

Question 2

What specification modification would allow the manufacturer to quote a flow of 8.5 [l/s] with all vents blocked as well as with 50% of vents blocked?

Vents all open

Unit's length:	Air flow (l/s)	Sound level dB(A)*	p_i (Pa)	Cooling capacity Primary air (W)					Cooling capacity water (W)							
				ΔT_l	6	8	10	12	ΔT_{mk}	6	7	8	9	10	11	12
1,2 m	8,5	<25	18		61	82	102	122		187	213	244	270	301	327	358
1,2 m	11,5	<25	31		83	110	138	166		231	269	302	341	374	412	445
1,2 m	14,5	<25	50		104	139	174	209		265	310	354	398	442	487	530
1,2 m	17	<25	70		122	163	204	245		304	350	401	453	499	550	602
Vents 50% open																
1,2 m	3,5	<25	11		25	34	42	50		109	130	145	161	176	192	231
1,2 m	5,5	<25	31		40	53	66	79		156	182	208	234	260	285	311
1,2 m	8,5	<25	70		61	82	102	122		206	244	275	307	344	375	413

*Room attenuation = 4 dB, open damper

Question 3

Complete the table below using the documentation above.
Data:
– Premises at 25 [°C] (77°F)
– Primary air temperature: 17 [°C] (63°F)
– Chilled water range: 14/18 [°C] (57/64°F)

Number of vents	Primary air-flow (l/s)	Primary air cooling power (W)	Beam power (primary air + water)
100 %	8.5		
50 %	8.5		

Question 4

For a primary air feed flow maintained by increasing feed pressure, explain why the chilled beam power increases when blocking vents.

Study the course on-line before treating the next paragraph.

N°4 – Selecting active chilled beams – HND to Master's

Active chilled beam selection consists of choosing one or more models such as: ***Cooling power*** *(primary air & water)* ≥ ***sensible load of premises***

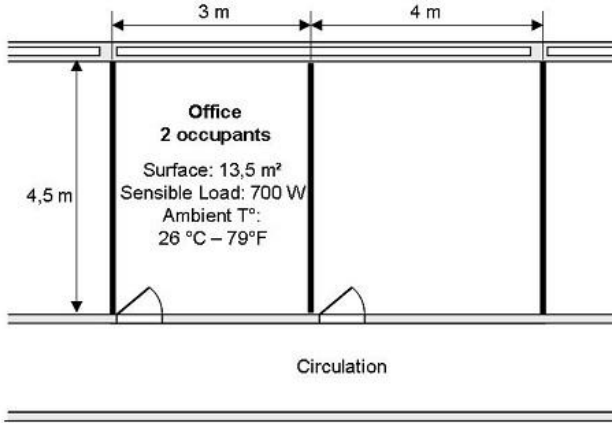
Unit Length (mm)	Air flow (l/s)	Noise Level (dB A)			Cooling capacity Primary air (W)					Cooling capacity Water (W)							
		open	close		ΔT_l	6	8	10	12	ΔT_{mk}	6	7	8	9	10	11	12
1,8 m	13,5	<25	<25	18		97	130	162	194		295	336	385	426	475	516	565
1,8 m	17,5	<25	29	31		126	168	210	252		365	425	477	538	590	651	703
1,8 m	23	<25	35	50		158	211	264	317		419	489	558	628	698	768	837
1,8 m	27	<25	40	70		194	259	324	389		480	553	633	715	788	869	950
2,1 m	15,5	<25	26	18		112	149	186	223		349	397	455	504	562	610	669
2,1 m	21	<25	34	31		151	202	252	302		431	504	565	637	699	771	832
2,1 m	26	<25	40	50		187	250	312	374		495	578	660	743	825	908	990
2,1 m	31	26	44	70		223	298	372	446		568	653	749	846	932	1028	1124
2,4 m	18	<25	30	18		130	173	216	259		403	459	526	582	649	705	772
2,4 m	24	<25	37	31		173	230	288	346		498	581	652	736	807	889	960
2,4 m	30	26	43	50		216	288	360	432		572	668	763	858	953	1049	1144
2,4 m	36	29	48	70		259	346	432	518		665	755	865	977	1076	1187	1298
2,7 m	21	<25	33	18		151	202	252	307		457	520	596	660	736	799	876
2,7 m	27	<25	40	31		194	259	324	389		565	659	740	834	915	1009	1090
2,7 m	34	29	46	50		245	326	408	490		649	757	865	973	1081	1190	1297
2,7 m	41	33	51	70		295	394	492	590		744	855	981	1108	1220	1346	1472

Premises subject to French Labour Code (article 232-5-3:

Use of premises	Minimum fresh air flow [m³/h] per occupant
Offices, non-physical work space	25
Restaurant, shop, meeting premises	30
Workshops & light physical work	45
Other workshops & premises	60

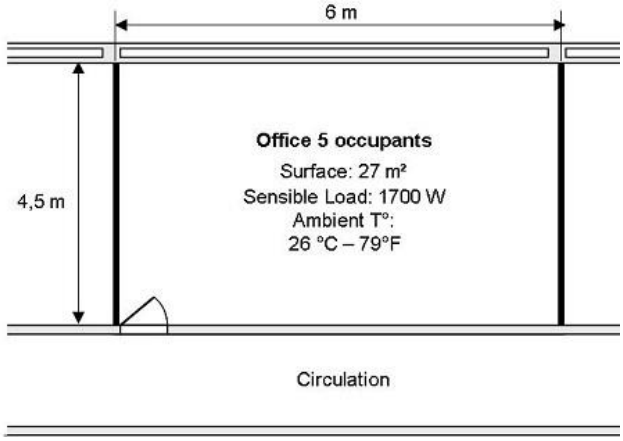
Question 1

In the above documentation, ensuring the quoted minimum fresh air flow according to the french Labor Code, choose a chilled beam able to handle the premises below. Indicate the feed pressure of the vents.
Data :
– Premises at 26 [°C] (79°F)
– Primary air temperature : 18 [°C] (64°F)
– Chilled water range : 14/18 [°C] (57/64°F)



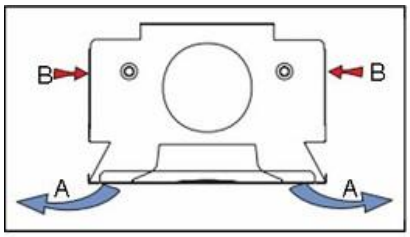
Question 2

In the above documentation, select two identical chilled beams able to handle the premises below with a minimum of recycling according to the french Labor Code.
Indicate the feed pressure and recycling flow required.
Data:
– Premises at 26 [°C] (79°F)
– Primary air temperature: 18 [°C] (64°F)
– Chilled water range: 14,5/17,5 [°C] (58/63°F)

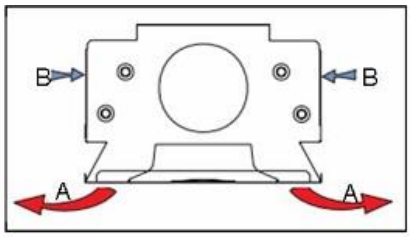


N°5 – Active beams in heating mode – HND to Master's level

Study the course on-line.

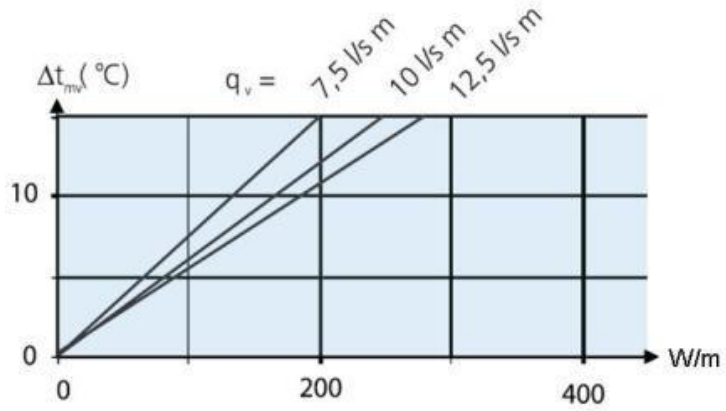


Cooling, ventilation.
A = primary air and chilled room air
B = warm room air



Heating, ventilation.
A = primary air and heated room air
B = cold room airroom air

Swegon specifies in the conditions below, the power output of its heating coil to which we can add the power brought by primary air (as long as this is introduced at a higher temperature than ambient air).



With:
– P : heating coil power in [W] per [ml] (*)
– q_v: primary air flow in [l/s] per [ml] of beam (part of primary flow over a metre of length) (*)
– Δt_{mv} : temperature difference between the average water and the ambient temperature.
(*) Furthermore the manufacturer shows a length to take into account equal to the nominal length of the beam less 160 [mm].

Question 1

Calculate the calorific power which can be supplied by a beam of 1,800 [mm] nominal length in premises at 20 [°C] (68°F) for:
– Beam primary air feed flow: 60 [m^3/h] introduced at 30 [°C] (86°F)
– Water temperature range 31/27 [°C] (88/81°F)

Note : seeing as we fit chilled beams with heating coils, it is preferable that these ensure the heating on their own, so that we don't need to heat primary air hotter than ambient air. We can thus avoid allowing for a blown air temperature adjustment on the AHU depending on exterior temperature offset point line type (always difficult to adjust).
In addition, it is preferable that the blown primary air temperature stays lower than ambient air temperature in winter; thus giving us a free cooling option in mid-season.

Question 2

Calculate the calorific power which can be supplied by a beam of 2700 [mm] nominal length in premises at 19 [°C] (66°F) for:
– Beam primary air feed flow: 70 [m³/h] introduced at 15 [°C] (59°F)
– Water temperature range 32/28 [°C] (90/82°F)

English lesson
https://hvac-learning.com/air-conditioning-cooling/fan-coils-units-cooling-floor-and-ceiling-chill-beam-training/selecting-induction-units-and-active-chilled-beams/

French version:
https://formation.xpair.com/cours/selection-ejecto-convecteurs-poutres-froides-actives.htm