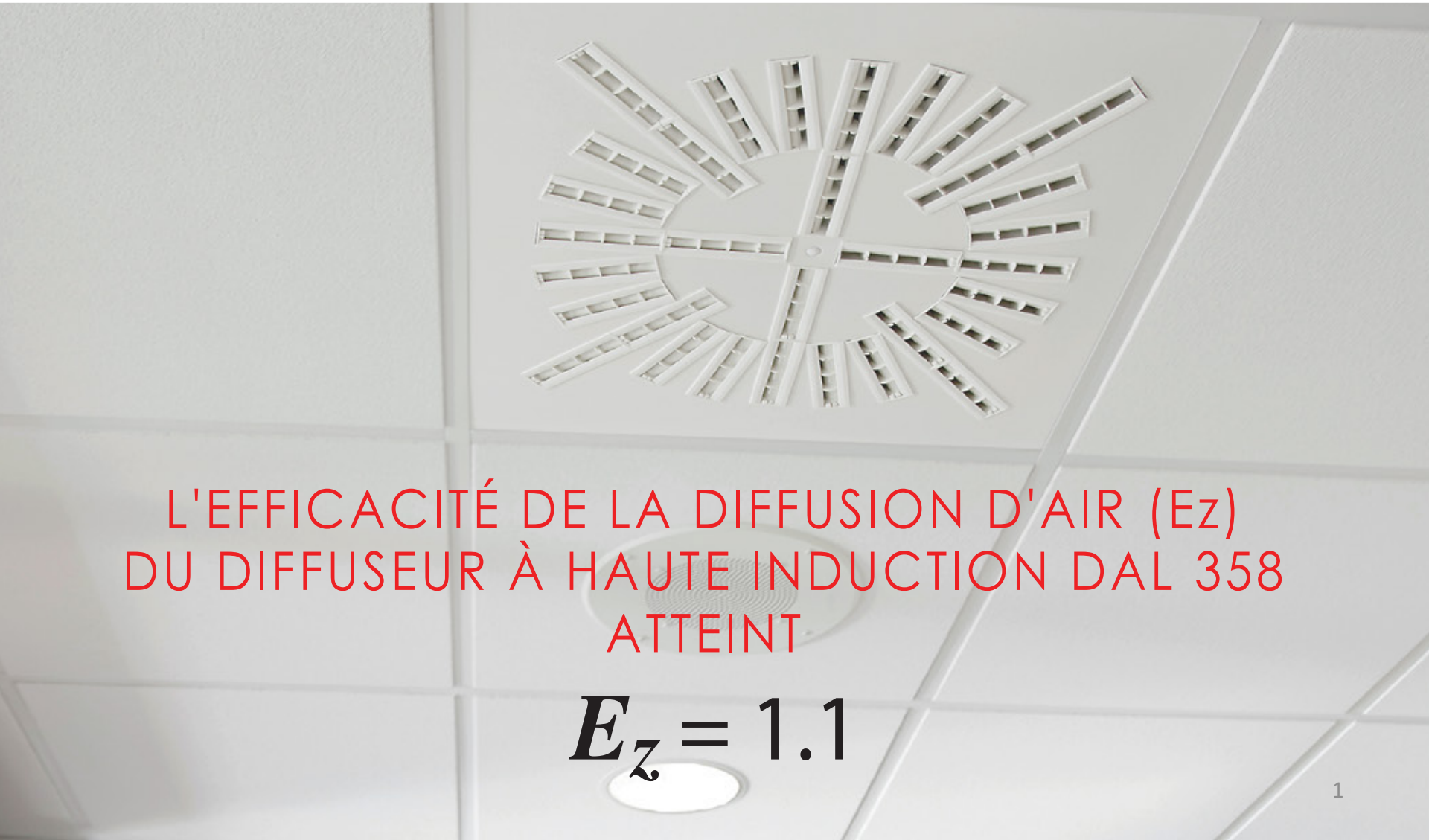


L'EFFICACITÉ DE LA DIFFUSION D'AIR (Ez) DU DIFFUSEUR À HAUTE INDUCTION DAL 358 ATTEINT

$$E_z = 1.1$$

Exigences du Code national du bâtiment - Canada 2010 (CNB)

Section 6.2.2.1. Ventilation exigée

2) À l'exception des *garages de stationnement* visés par l'article 6.2.2.3., les débits auxquels de l'air extérieur est fourni dans les *bâtiments* par les installations de ventilation ne doivent pas être inférieurs aux débits exigés par la norme ANSI/ASHRAE 62, « Ventilation for Acceptable Indoor Air Quality ».

ASHRAE 62.1 - Calcul de l'air neuf

Le standard ANSI/ASHRAE 62.1-2016 recommande un apport d'air extérieur calculé en fonction du nombre d'occupants et de la surface desservie en utilisant les valeurs fournies dans le tableau **6.2.2.1.**

Pour déterminer le débit d'air extérieur total, il faut:

1. Calculer la quantité de l'apport d'air neuf comme suit :

$$Vbz = Rp \cdot Pz + Ra \cdot Az$$

Avec :
Rp : débit d'air extérieur par personne
Pz : nombre de personne dans la zone
Ra : débit d'air extérieur par zone
Az : superficie de la zone.

2. Sélectionner l'efficacité de la diffusion d'air *Ez*, selon le tableau 6.2.2.2 **ou selon le test ASHRAE 129** (*Measuring Air-Change Effectiveness*)

3. Calculer le débit d'air extérieur total : ***Voz = Vbz / Ez***

ASHRAE 62.1 - Calcul de l'air neuf

TABLE 6.2.2.2 Zone Air Distribution Effectiveness

Air Distribution Configuration	E_z
Ceiling supply of cool air	1.0
Ceiling supply of warm air and floor return	1.0
Ceiling supply of warm air 15°F (8°C) or more above space temperature and ceiling return	0.8
Ceiling supply of warm air less than 15°F (8°C) above space temperature and ceiling return provided that the 150 fpm (0.8 m/s) supply air jet reaches to within 4.5 ft (1.4 m) of floor level (See Note 6)	1.0
Floor supply of cool air and ceiling return, provided that the vertical throw is greater than 50 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) or more above the floor	1.0
Floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification, or underfloor air distribution systems where the vertical throw is less than or equal to 50 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) above the floor	1.2
Floor supply of warm air and floor return	1.0
Floor supply of warm air and ceiling return	0.7
Makeup supply drawn in on the opposite side of the room from the exhaust, return, or both.	0.8
Makeup supply drawn in near to the exhaust, return, or both locations.	0.5

NOTES:
1. "Cool air" is air cooler than space temperature.
2. "Warm air" is air warmer than space temperature.
3. "Ceiling supply" includes any point above the breathing zone.
4. "Floor supply" includes any point below the breathing zone.

5. As an alternative to using the above values, E_z may be regarded as equal to air-change effectiveness determined in accordance with ASHRAE Standard 129 [6] for air distribution configurations except unidirectional flow.

Test diffuseurs DAL 358 et DAL 359 selon ASHRAE 129

Conditions tests
Configuration typique

2.1 Indoor Environment Research facility (IERF)

This state-of-the-art research facility was designed to allow full-scale testing and physical modeling of office space lighting, thermal comfort, indoor air quality, airflow, contaminant-flow patterns, ventilation, acoustical characteristics, and occupants' reactions to these parameters. A plan of the facility is shown in Figure 1 and Figure 2, and the dimensions in Table 1.

Figure 1: IERF office environment, with a window on the exterior wall.

Conditions test : Plan de la zone testée

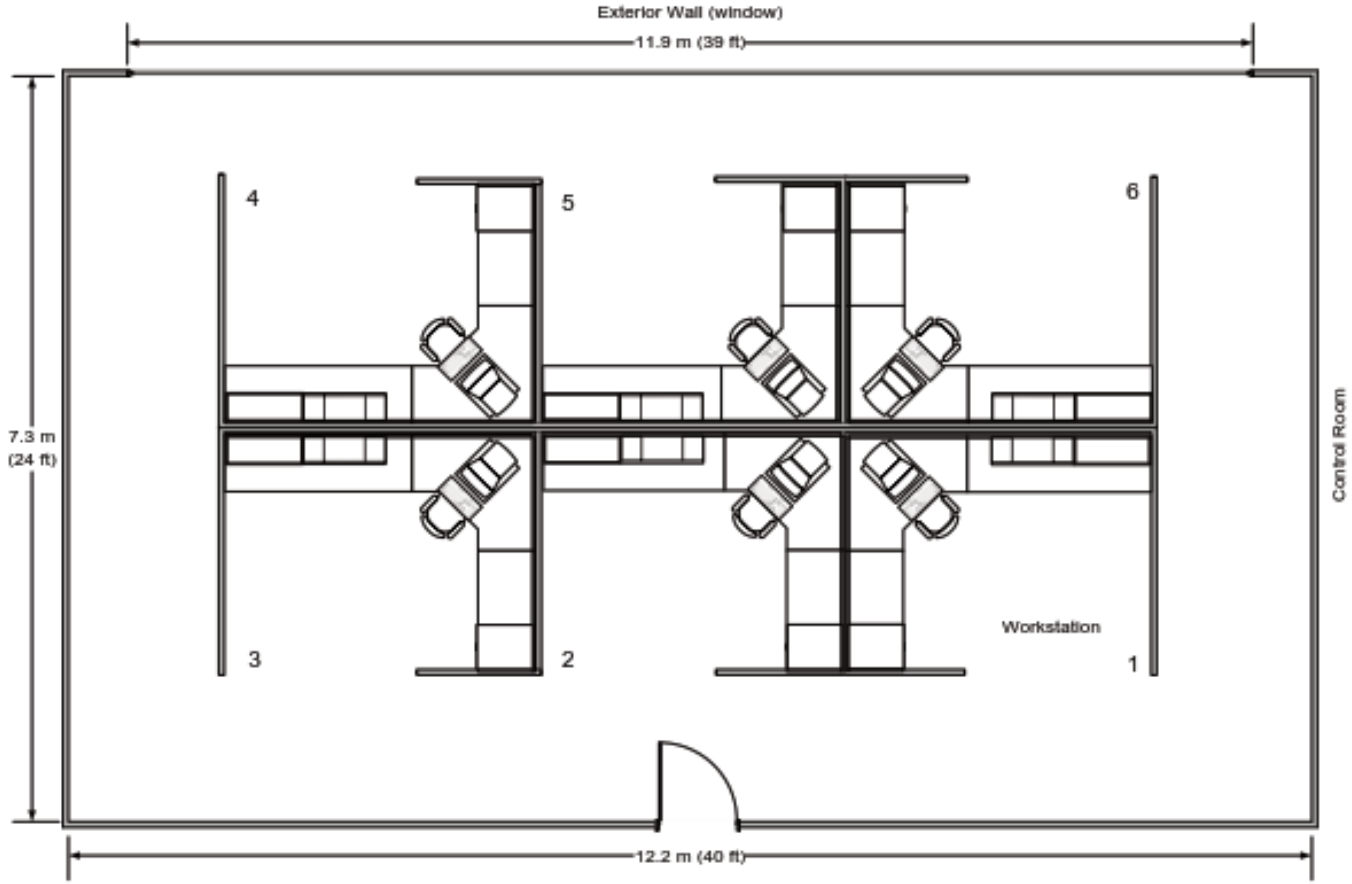
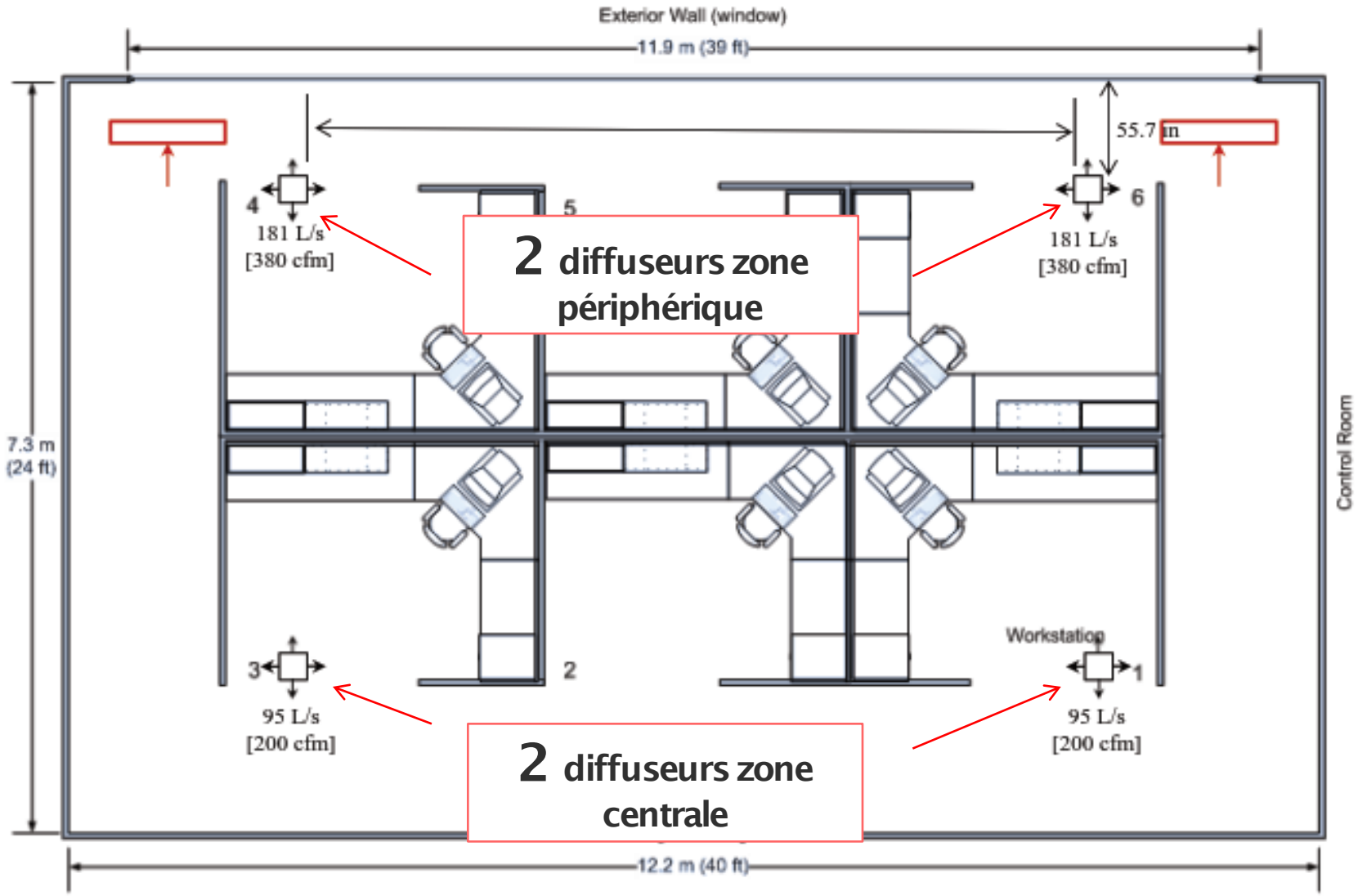


Figure 2: Plan view of the IERF test area.

Conditions test : Emplacement des diffuseurs



Conditions test : Système HVAC utilisé

The facility has a dedicated air handling unit (AHU). The system is zoned (into the five zones) and has supply and return ducts in both the floor and ceiling plenums allowing air delivery/return from either high or low level. Each zone is equipped with re-heat. The system can be operated in variable air volume (VAV) or constant air volume (CAV) mode.

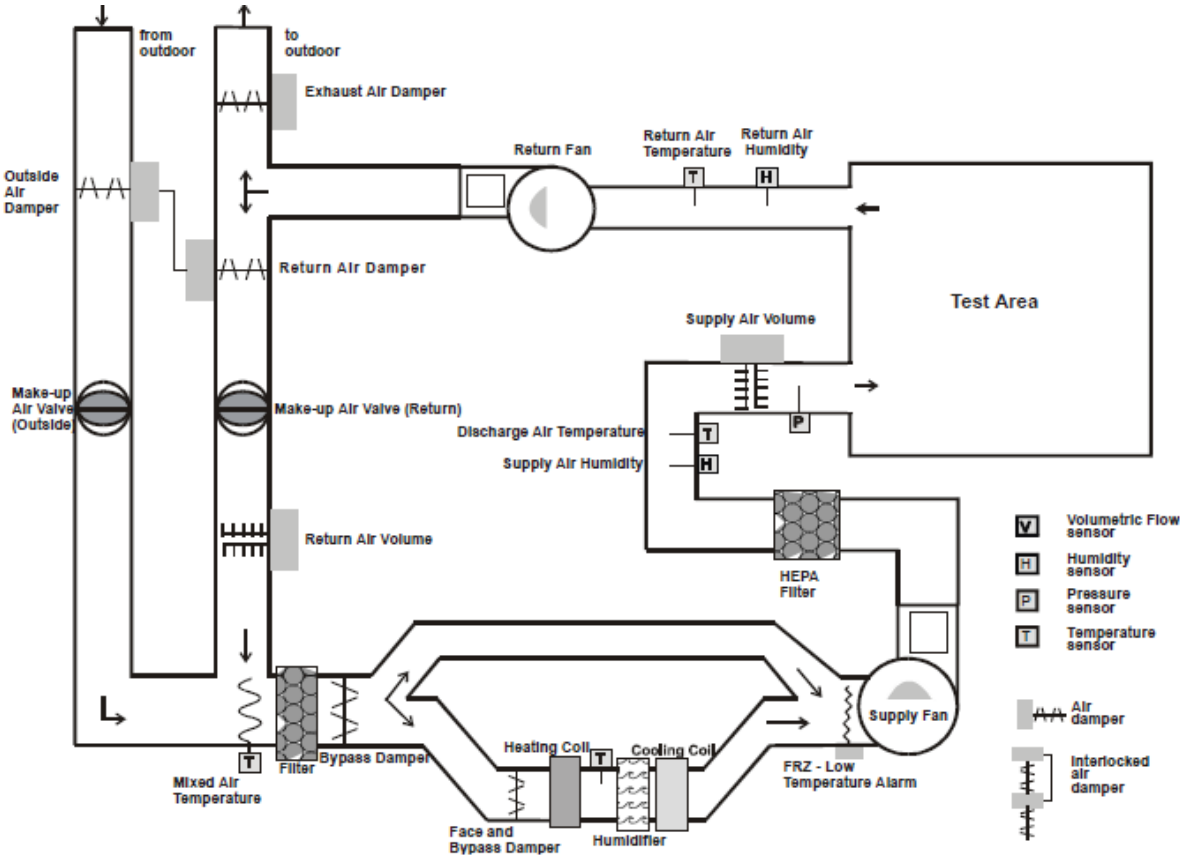


Figure 3: IERF HVAC system.

Conditions test : Automated tracer gas system

Le CNRC est **le seul laboratoire au Canada** qui possède ce système de gaz traceur

Conditions test : Appareils de mesures

The measurements of air velocity, air temperature, relative humidity and SF_6 concentration were conducted in cubicles 1, 3, 4 and 6. Instruments were supported by poles with sensors attached to a sensor holder (cluster) as shown in Figure 14 and sensor holder was located on the pole at different heights above the floor.

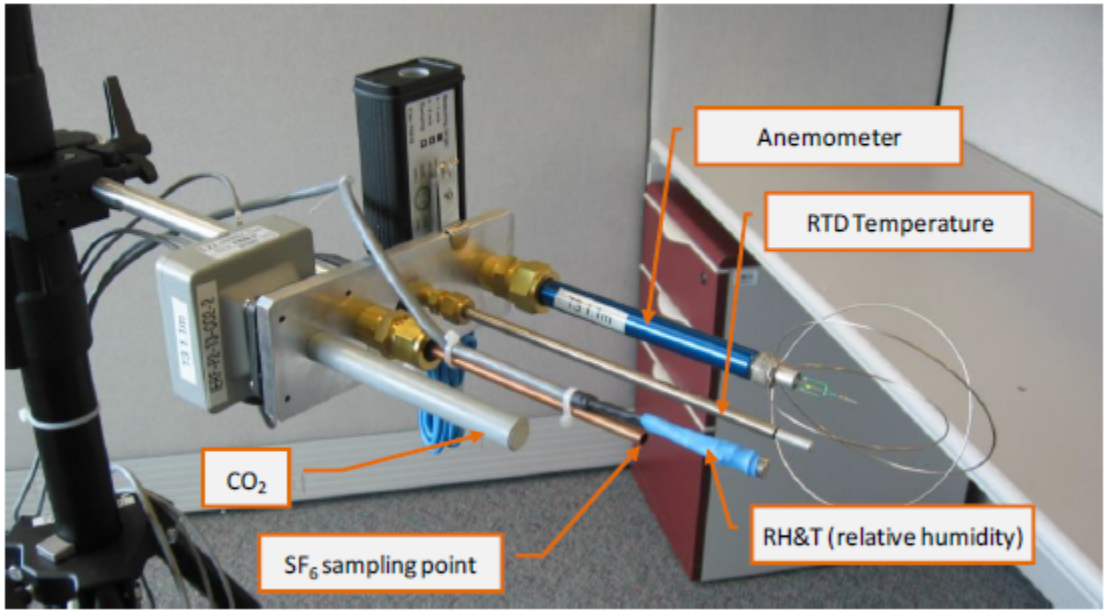


Figure 14: Sensor holder with sensors attached. A PVC pipe was attached to the back end of the copper pipe for SF_6 sampling.

Conditions test
Emplacement des appareils de mesures

Measurement poles were placed in selected workstations. The instruments were held vertically by a pole 0.6 m from the desk (measurement normal to the desk). Each pole supports anemometers, RTDs, RH sensors, anemometers and tracer gas sampling tubes. Measurement poles have been placed in workstations number 1, 3, 4 and 6 and close to exterior wall/window (cubicle 4 and 6 locations) as shown in Figure 12.

Figure 12: Measurement poles installed in a workstation (left) and at the exterior wall (window)

Diffuseurs testés

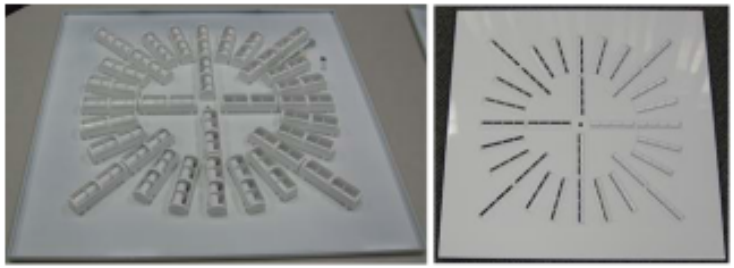


Figure 7: Diffuser DAL 358 DN500

Figure 8: Diffuser DAL 358 DN600

Figure 9: Diffuser DAL 359 DN500

Figure 10: Diffuser DAL 359 DN600

Figure 11: Conventional 6" square diffuser

Exemple de résultats de test

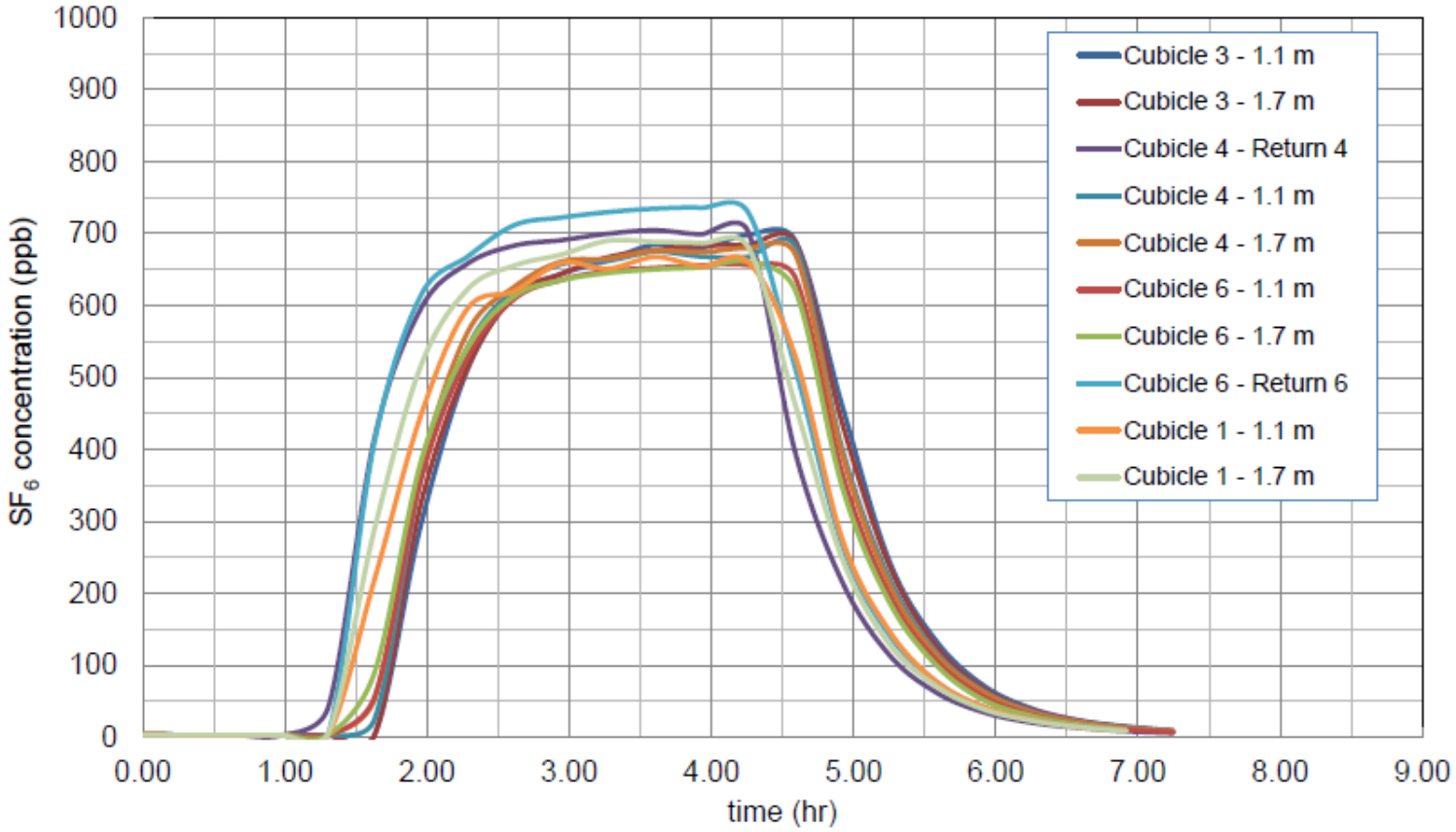
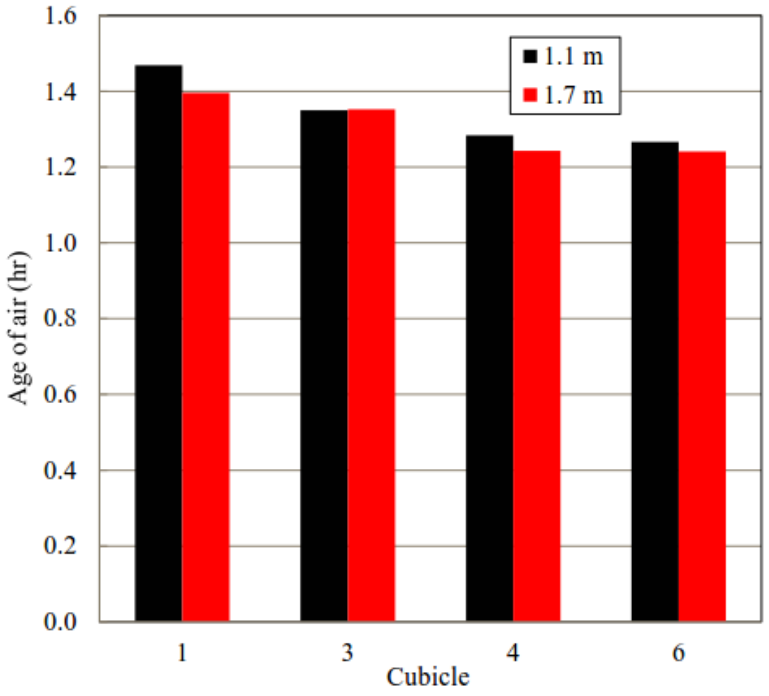


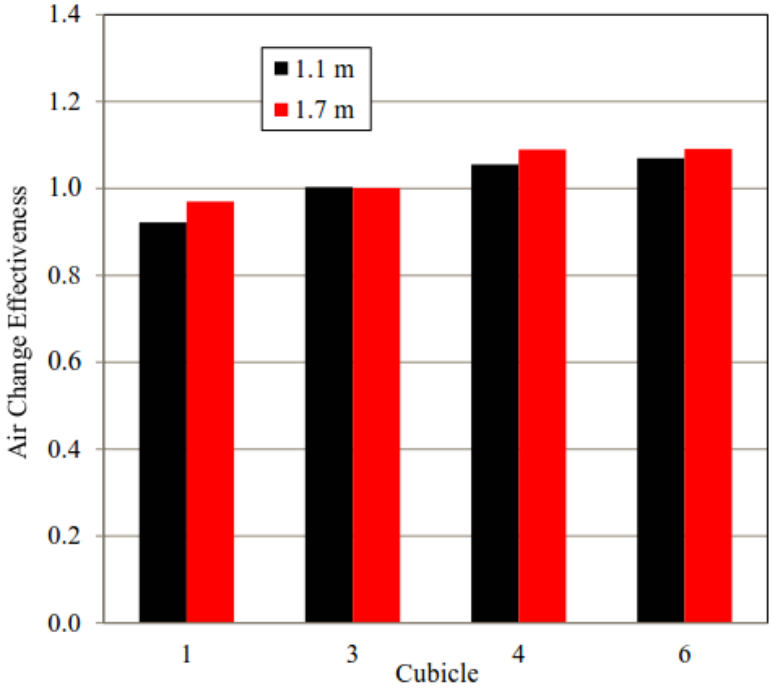
Figure 24: Example of tracer gas test results

Exemple de résultats de test

NRC·CNRC

Age of Air & Air Change Effectiveness – DAL 358 March 29 (Night Time)





Résultats finaux

Table 12: Summary of measured ACE in the simulated office space

Case	1	2	3	4	5	6
Diffuser	DAL 359	DAL 359	DAL 359	DAL. 358	Square Conv.	DAL 358
Number (type)	2 (DN600)	2 (DN500)	2 (DN500) 2 (DN 600)	2 (DN500) 2 (DN600)	4	2 (DN600)
Workstation	4 & 6	1 & 3	1 & 3 / 4 & 6	1 & 3 / 4 & 6	1 & 3 / 4 & 6	4 & 6
Minimum	0.92	0.88	0.91	0.92	0.68	0.97
Maximum	1.11	1.12	1.16	1.18	0.87	1.16
Mean	1.01	0.96	1.03	1.10	0.77	1.06
STDV	0.05	0.06	0.07	0.05	0.04	0.06

Conclusion

Executive Summary

This report details the experiments that were undertaken as part of the project A1-008251 on the air distribution effectiveness of overhead systems using high induction diffusers compared to a system using conventional square diffusers.

NAD Klima manufactures a new model of swirl diffuser DAL359 and DAL 358 equipped with off-centre drums (rollers). This technology is able at the same time, to diffuse air with high flow rate and with a low acoustic power, to produce any form of flow of air even after assembly, to vary the outlet velocity of the air and especially allows a better mixture between the primary air and the air of the room realized by a high induction immediately at exit of the slits.

Experiments were undertaken at the NRC Construction Indoor Environment Research Facility (IERF). The study investigated the ventilation effectiveness of overhead distributions systems using two types of high induction diffusers as indicated by the air distribution effectiveness. The assessment of the ventilation effectiveness required the use of tracer gas techniques.

This investigation evaluated the performance of two overhead systems using two swirl high induction diffusers; DAL 358 Swirl diffusers which is a high induction swirl airflow diffuser with square front plate and eccentric ABS cylinders and profiles controlling air stream, and DAL 359 which is a highly inductive swirl diffuser with a square front plate and fitted air control blades of ABS. The performance of the swirl diffusers was also compared to the air distribution performance of conventional square diffusers.

The study measured several aspects of the performance of overhead systems with the focus on the air change effectiveness. The measured air change effectiveness for the baseline (conventional square ceiling diffusers) was an average value of 0.77 (nominalized to 0.8), value reported in ASHRAE 62.1-2016 for overhead system in heating mode with ceiling supply of warm air (8°C or more above space temperature) and ceiling return. The measured ACE for overhead system using high induction diffusers DAL 359 was an average value of 1.03 (nominalized to 1.0), showing no need to increase of 25% the required rate of outdoor air supply. The measured ACE for overhead system with high induction diffusers DAL 358 was higher with an average value of 1.1 (nominalized to 1.1), showing not only that the increase of rate of outdoor air supply by 25% is not required but could be reduced by 9%. This means that when using DAL 358 diffusers, the rate of outdoor air supply could be reduced by 27%. Results obtained in this study provide evidence of improved air distribution effectiveness of overhead ventilation systems using swirl high induction diffusers.

The predicted thermal comfort, in terms of vertical air temperature difference and limit to air speed obtained for overhead systems using high induction diffusers under test conditions (in heating mode) were not different from those obtained for an overhead system using conventional square diffusers and were within the limit set by ASHRA 55-2013.

Exemple d'application
1 Place Ville-Marie à Montréal

Nombre d'étages de bureaux
43

Superficie locative par étage
36 000 pi. Ca.

Superficie locative totale
1 548 000 pi. Ca.

Nombre d'occupation de personnes
12 600

$$Vbz = Rp \cdot Pz + Ra \cdot Az$$

$$= 5 \text{ cfm /pers x } 12\,600 \text{ pers.} + 0{,}06 \text{ cfm/pi}^2 \text{ x } 1\,548\,000 \text{ pi}^2$$

$$= 155\,880 \text{ cfm}$$

Exemple d'application
1 Place Ville-Marie à Montréal

Vbz = 155 880 cfm

$V_{oz} = V_{bz} / E_z$	Diffuseur à cône	Diffuseur à haute induction DAL358
E_z (efficacité de la diffusion d'air)	0,8	1,1
V_{oz} (débit d'air extérieur total)	192 150 cfm	139 745 cfm
Coûts chauffage/climatisation	$2,8 / cfm	$2,8 / cfm
Coûts d'humidification	$2,4 / cfm	$2,4 / cfm
Coûts de déshumidification	$0,8 / cfm	$0,8 / cfm
Frais annuels (6$ x V_{oz})	$1 152 900	$838 470
Économie d'énergie (%)	-	**27%**
Économies ($) / année	-	**$314 430**
Économies ($) / 5 ans	-	**$1 572 150**

Économie générée par le DAL 358 selon ASHREA 62.1

Simulation

Pièce	Grandeur (≈120 pi² /pers)	pcm/pers.	pcm/pi²	Diffuseur Standard E_z=0.8 Coût ≈ 30$	Diffuseur DAL 358 E_z=1.1 Coût ≈ DN 600 : 219$ DN 500 : 164$	Économie générée/année/diffuseurs	Payback Du NAD
Bureau (2 personnes)	15x16 240 pi²	5 pcm/pers= 10 pcm	0.06 240x0.06= 14.4 pcm	24.4 pcm ÷ 0.8 = 30.5 pcm A/F	24.4 pcm ÷ 1.1 = 22.2 pcm A/F	8.3 pcm x *6$ = Économie de 50$/diffuseur	219$ ÷ 50$ = **4.4 ans**
Pharmacie (20 personnes)	100 x 100 10 000 pi²	5 pcm/pers= 100 pcm	0.18 10000x0.18= 1 800 pcm	1 900 pcm ÷ 0.8 = 2 375 pcm A/F	1 900 pcm ÷ 1.1 = 1 727 pcm A/F	648.6 pcm x *6$ = Économie de 3 888$/an DAL358 DN 600=400 pcm 10 000pi²÷400 pcm= 25 3 888 $/an÷25 diffuseurs= 155.52$ / diffuseurs	219$ ÷ 155.5$ = **1.4 ans**
Bibliothèque Université Sherbrooke Faculté de Droit (88 personnes)	34 000 pi²	1 pers/400 pi² = 88 pers. 5 pcm/pers= 440 pcm	0.12 34000x0.12= 4 080 pcm	4 520 pcm ÷ 0.8 = 5 650 pcm A/F	4 520 pcm ÷ 1.1 = 4 109 pcm A/F	1 541 pcm x *6$ = Économie de 9 246$/an DAL358 DN 500=280 pcm 34 000 pi²÷280 pcm= 121 9 246$/an÷121 diffuseurs= 76 $ / diffuseurs	164$ ÷ 76$ = **2.2 ans**
Magasin Ex : Bouclair (20 personnes)	6 000 pi²	7.5 pcm/pers= 150 pcm	0.12 6 000x0.12= 720 pcm	870 pcm ÷ 0.8 = 1 087.5 pcm A/F	870 pcm ÷ 1.1 = 790.9 pcm A/F	296.6 pcm x *6$ = Économie de 1 779.6$/an DAL358 DN 600=400 pcm 6 000 pi²÷400 pcm= 15 1779.6$/an÷15 diffuseurs= 118.6 $ / diffuseurs	219$ ÷ 118.6$ = **1.8 ans**
Centre d'ongle et de beauté (10 personnes)	2 000 pi²	20 pcm/pers= 200 pcm	0.12 2 000x0.12= 240 pcm	440 pcm ÷ 0.8 = 550 pcm A/F	440 pcm ÷ 1.1 = 400 pcm A/F	150 pcm x *6$ = Économie de 900$/an DAL358 DN 500=280 pcm 2 000 pi²÷280 pcm= 7 900$/an÷7 diffuseurs= 128.6 $ / diffuseurs	164$ ÷ 128.6$ **=1.3 ans**
Animalerie (10 personnes)	5 000 pi²	7.5 pcm/pers= 75 pcm	0.18 5 000x0.12= 600 pcm	675 pcm ÷ 0.8 = 843.7 pcm A/F	675 pcm ÷ 1.1 = 613.7 pcm A/F	230 pcm x *6$ = Économie de 1 380$/an DAL358 DN 500=280 pcm 5 000 pi²÷280 pcm= 18 1 380$/an÷18 diffuseurs= 76.7 $ / diffuseurs	164$ ÷ 76.7$ = **2.1 ans**
Gym Ex : Aréna Thibault (40'x100') (20 personnes)	4 000 pi²	20 pcm/pers = 400 pcm	0.06 4 000x0.06= 240 pcm	640 pcm ÷ 0.8 = 800 pcm A/F	640 pcm ÷ 1.1 = 582 pcm A/F	218 pcm x *6$ = Économie de 1 308$/an DAL358 DN 600=400 pcm	219$ ÷ 131$ = **1.8 ans**