

Test report n° SC-STP-2021-068

concerning the ECHOSHAPE Linear Feltline ceiling

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REQUESTED BY :

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Test report n° SC-STP-2021-068

SCOPE

The purpose of this test is to characterize VOC and formaldehyde emissions from a felt suspended ceiling according to ISO 16000 standards and to check the compliance of emissions with requirements of the mandatory requirements in France : VOC emission class according to French labelling system (Decree n° 2011-321 of March 23, 2011 and Order of April 19, 2011 modified by Order of February 20, 2012) and absence of release of CMR compounds (Orders of April 30, 2009 and May 28, 2009).

According to CSTB quotation n° Pa20INTEGX-01835

REFERENCES TEXTS

- EN ISO 16000-9 : Indoor air – Part 9 : Determination of the emission of volatile organic compounds from building products and furnishing – Emission test chamber method (ISO, 2006).
- EN ISO 16000-11 : Indoor air – Part 11 : Determination of the emission of volatile organic compounds from building products and furnishing – Sampling, storage of samples and preparation of test specimen (ISO, 2006).
- ISO 16000-6 : Indoor air – Part 6 : Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS or MS-FID (ISO, 2011).
- ISO 16000-3 : Indoor air – Part 3 : Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air – Active sampling method (ISO, 2011).

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Test report n° SC-STP-2021-068

OBJECT SUBMITTED FOR TESTING

This test report is concerning the ECHOSHAPE Linear Feltline suspended ceiling from INTEGRA METAL CEILING SYSTEMS BV (batch number: L40/55 – 100121, production date: January 10, 2021)

Test sample	Laboratory reference	Reception date	Start of the test		End of the test
			Test specimen preparation	Introduction in test chamber	
ECHOSHAPE Linear, Feltline	POL-21-05	19/01/2021	22/01/2021 12:30	22/01/2021 12:44	19/02/2021 10:33

Table 1: Description of test samples

PRÉPARATION OF TEST SPECIMEN

For the emission test, INTEGRA provided CSTB with several elements of the ECHOSHAPE Linear Feltline ceiling (Length: 1.20 m; width: 0.04 m). The test specimen has been prepared by cutting a 0.6 m long element of ECHOSHAPE, to be representative of the quantity of product used in ceiling panels (12 m of felt per m² of ceiling). As the ECHOSHAPE Linear Feltline is installed as suspended ceiling panels, it has been tested with all emitting surfaces (Figure 1). The apparent emitting surface is 0.048 m². Just after preparation, the test sample has been directly introduced in an emission test chamber.



Figure 1 : Test specimen of the ECHOSHAPE Linear Feltline ceiling

Test report n° SC-STP-2021-068

EMISSION TEST CHAMBER CONDITIONS

Just after preparation, test specimens were introduced in a glass emission test chamber according to requirements of EN ISO 16000-9 standard. Testing parameters are presented in Table 2.

Test parameters	Test chamber conditions
Emission test chamber type	CLIMPAQ (glass)
Emission test chamber volume	0.0509 m ³
Temperature	22.9 ± 1.1 °C
Relative humidity	50.1 ± 2.3 %
Test specimen surface	0.048 m ²
Air flow rate	0.062 m ³ /h
Air exchange rate	1.23 h ⁻¹
Product loading factor	0.94 m ² /m ³
Area specific air flow rate (q _{test})	1.30 m ³ /m ² .h
Test duration	28 days

Table 2: Testing conditions

VOC AND FORMALDEHYDE SAMPLING CONDITIONS

VOC and aldehyde (ALD) active sampling were performed in duplicate by pumping air through respective sorbents just before beginning of the test (day 0) and 28 ± 2 days (day 28) after introduction of the test specimen in the emission test chamber.

Sampling conditions are presented in Table 3.

Sampling conditions	COV	COV	ALD
Number of sampled tubes	1	1	1
Sorbent type	Tenax TA	Tenax TA	DNPH
Sampling duration	60 min.	60 min.	60 min.
Sampling air flow rate	100 mL/min	75 mL/min	600 mL/min
Sampled air volume	6.0 L	4.5 L	36.0 L

Table 3 : Sampling conditions

Test report n° SC-STP-2021-068

METHODES DE MESURE DES COV ET ALDEHYDES

Sampling and measurements of VOC are performed according to ISO 16000-6. Parameters selected for VOC analyses at CSTB are presented in Table 4.

Analytical equipments used for VOC analyses are :

- Perkin Elmer Turbomatrix 350 automatic thermo desorption (ATD) unit coupled to a Perkin Elmer Autosystem XL gas chromatograph (GC), with a flame ionization detector (FID) Perkin Elmer TurboMass mass spectrometer (MS).
- Perkin Elmer Turbomatrix 650 automatic thermo desorption (ATD) unit coupled to a Perkin Elmer Clarus 580 gas chromatograph (GC), with a flame ionization detector (FID) Perkin Elmer Clarus SQ8S mass spectrometer (MS).

Parameters	Analytical conditions
Desorption temperature	280 °C
Nitrogen flow rate	50 mL/min
Desorption duration	20 min
Secondary trap temperature	280 °C
Temperature cycle	40 °C during 5 min. 2,5 °C/min. up to 170 °C 7,5 °C/min. up to 300 °C 300 °C during 26 min.
Capillary column	Capillary column (Elite ou VF 5 ms) length : 60 m, internal diameter : 0,25 mm, phase thickness : 1 µm
FID temperature	270 °C
Mass spectrometer parameters	70 eV 33-450 amu

Table 4 : Analytical conditions for VOC analyses

VOC are identified by mass spectrometry (MS) and quantified by flame ionization detector (FID) using their specific response factor when available (specific calibration) or using the toluene response factor (concentrations expressed in toluene equivalent).

The total VOC concentration (TVOC) is calculated as the sum of concentrations of all volatile organic compounds eluting between n-hexane and n-hexadecane (included) quantified using the toluene response factor. The TVOC concentration is expressed in toluene equivalent.

Test report n° SC-STP-2021-068

Sampling and measurements of formaldehyde and other carbonyl compounds (ALD) are performed according to ISO 16000-3. Parameters for their analysis at CSTB are presented in Table 5.

Sampling is performed by pumping on cartridges filled with silica gel coated with 2,4-dinitrophenylhydrazine (DNPH). After sampling, cartridges are eluted in 5 ml acetonitrile. Two 20 µl injections of this elution solution are analyzed by high performance liquid chromatography (HPLC) on a WATERS Alliance system.

Aldehydes are identified and quantified using specific calibration.

Parameters	Analytical conditions
Detector	UV or Photodiode (wave length : 360 nm)
Capillary column	WATERS Novapack C18 length : 150 mm internal diameter : 3,9 mm phase thickness : 4 µm pore diameter : 60 Å
Elution flow rate	1,5 mL/min
Column temperature	35 °C

Table 5 : Analytical conditions for formaldehyde and other carbonyl compounds analyses

Test report n° SC-STP-2021-068

TEST RESULTS

Test results presented in this report are the arithmetic means of the 2 sampled and analysed samples. Results are corrected from the chamber blank value measured before introduction of the test specimen in the emission test chamber.

Test results are expressed as area specific emission rates (SER_a , in $\mu\text{g}/\text{m}^2\cdot\text{h}$), calculated according to EN ISO 16000-9 as:

$$SER_a = C_{\text{mes}} \cdot q_{\text{test}}$$

where C_{meas} are the measured concentrations ($\mu\text{g}/\text{m}^3$) and q_{test} the area specific air flow rate during testing (Table 2).

SER_a = Area specific emission rates ($\mu\text{g}/\text{m}^2\cdot\text{h}$)			
Compounds	N° CAS	28 days	Calibration
VOC (NF ISO 16000-6)			
benzène	71-43-2	LD	specific
trichloroéthylène	79-01-6	ND	specific
phtalate de dibutyle	84-74-2	LD	specific
phtalate de bis(2-éthylhexyle)	117-81-7	LD	specific
toluène	108-88-3	LD	specific
tétrachloroéthylène	127-18-4	ND	specific
éthylbenzène	100-41-4	LD	specific
m-xylène	108-38-3	LD	specific
p-xylène	106-42-3	LD	specific
styrène	100-42-5	ND	specific
o-xylène	95-47-6	LD	specific
2-butoxyéthanol	111-76-2	ND	specific
1,2,4-triméthylbenzène	95-63-6	ND	specific
1,4-dichlorobenzène	106-46-7	ND	specific
TVOC	-	7,4	toluene equivalent
ALD (NF ISO 16000-3)			
formaldéhyde	50-00-0	LD	specific
acétaldéhyde	75-07-0	LD	specific

Table 6 : VOC and ALD area specific emission rates ($\mu\text{g}/\text{m}^2\cdot\text{h}$)
from the ECHOSHAPE Linear Feltline ceiling (LD : detection limit, LQ : quantification limit)

Test report n° SC-STP-2021-068

EVALUATION OF VOC AND ALD EMISSIONS

For the evaluation of VOC and formaldehyde emissions from building products, exposure concentrations are calculated from area specific emission rates as:

$$C_{exp} = SER_a / q_{scenario}$$

Where C_{exp} are the calculated exposure concentrations ($\mu\text{g}/\text{m}^3$) in the reference room defined in the Order of April 19, 2011, SER_a are the area specific emission rates ($\mu\text{g}/\text{m}^2.\text{h}$) and $q_{scenario}$ the area specific air flow rate for the selected emission scenario (for this test, "ceiling" scenario: $q_{scenario} = 1.25 \text{ m}^3/\text{m}^2.\text{h}$).

C_{exp} = Exposure concentrations ($\mu\text{g}/\text{m}^3$)			
Compounds	N° CAS	28 days	Calibration
VOC (NF ISO 16000-6)			
benzène	71-43-2	LD	specific
trichloroéthylène	79-01-6	ND	specific
phtalate de dibutyle	84-74-2	LD	specific
phtalate de bis(2-éthylhexyle)	117-81-7	LD	specific
toluène	108-88-3	LD	specific
tétrachloroéthylène	127-18-4	ND	specific
éthylbenzène	100-41-4	LD	specific
m-xylène	108-38-3	LD	specific
p-xylène	106-42-3	LD	specific
styrène	100-42-5	ND	specific
o-xylène	95-47-6	LD	specific
2-butoxyéthanol	111-76-2	ND	specific
1,2,4-triméthylbenzène	95-63-6	ND	specific
1,4-dichlorobenzène	106-46-7	ND	specific
TVOC	-	5,9	toluene equivalent
ALD (NF ISO 16000-3)			
formaldéhyde	50-00-0	LD	specific
acétaldéhyde	75-07-0	LD	specific

Table 7 : COV and ALD exposure concentrations ($\mu\text{g}/\text{m}^3$)
from the ECHOSHAPE Linear Feltline ceiling (LD : detection limit, LQ : quantification limit)

Test report n° SC-STP-2021-068

VOC EMISSION CLASS ACCORDING TO THE FRENCH LABELLING SYSTEM

Compounds	CAS number	emission classes			
		C	B	A	A+
formaldehyde	50-00-0	> 120	< 120	< 60	< 10
acetaldehyde	75-07-0	> 400	< 400	< 300	< 200
toluene	108-88-3	> 600	< 600	< 450	< 300
tetrachlorethylene	127-18-4	> 500	< 500	< 350	< 250
xylene	1330-20-7	> 400	< 400	< 300	< 200
1,2,4-trimethylbenzene	95-63-6	> 2000	< 2000	< 1500	< 1000
1,4-dichlorobenzene	106-46-7	> 120	< 120	< 90	< 60
ethylbenzene	100-41-4	> 1500	< 1500	< 1000	< 750
2-butoxyethanol	111-76-2	> 2000	< 2000	< 1500	< 1000
styrene	100-42-5	> 500	< 500	< 350	< 250
TVOC		> 2000	< 2000	< 1500	< 1000

Table 8 : VOC emission classes according to Order of April 19, 2011
(units: exposure concentrations at 28 days in $\mu\text{g}/\text{m}^3$)

Compounds	N° CAS	Cexp at 28 days	Emission class
formaldéhyde	50-00-0	LD	A+
acétaldéhyde	75-07-0	LD	A+
toluène	108-88-3	LD	A+
tétrachloroéthylène	127-18-4	ND	A+
xylène	108-38-3	ND	A+
1,2,4-triméthylbenzène	95-63-6	ND	A+
1,4-dichlorobenzène	106-46-7	ND	A+
éthylbenzène	100-41-4	LD	A+
2-butoxyéthanol	111-76-2	ND	A+
styrène	100-42-5	ND	A+
TVOC	-	6	A+
Resulting emission class			A+

Table 9 : Exposure concentrations at 28 days ($\mu\text{g}/\text{m}^3$) and resulting emission class
from the ECHOSHAPE Linear Feltline ceiling (LD : detection limit, LQ : quantification limit)

VOC and ALD emissions from the ECHOSHAPE Linear Feltline ceiling from INTEGRA METAL CEILING SYSTEMS BV fulfill requirements of emission class A+ of the French mandatory labelling system (according to Decree n° 2011-321 of March 23, 2011 and Order of April 19, 2011 modified by Order of February 20, 2012).

Test report n° SC-STP-2021-068

ABSENCE OF RELEASE OF CMR COMPOUNDS

Compounds	N° CAS	Cexp at 28 days
trichloréthylène	79-01-6	ND
benzène	71-43-2	LD
phtalate de bis(2-éthylhexyle)*	117-81-7	LD
phtalate de dibutyle*	84-74-2	LD
Compliance with Orders		YES

Table 10 : Emission of CMR compounds according to Order of April 30, 2009 and May 28, 2009 from the ECHOSHAPE Linear Feltline ceiling (LD : detection limit, LQ : quantification limit) (* : not under accreditation)

Emissions of CMR compounds from the ECHOSHAPE Linear Feltline ceiling from INTEGRA METAL CEILING SYSTEMS BV comply with requirements of April 30, 2009 and May 28, 2009 Orders (exposure concentrations at 28 days < 1 µg/m³).

Test report n° SC-STP-2021-068

ANNEX

Compounds	N° CAS	Detection limit LD ($\mu\text{g}/\text{m}^3$)	Quantification limit LQ ($\mu\text{g}/\text{m}^3$)	Measured concentrations sample 1 ($\mu\text{g}/\text{m}^3$)	Measured concentrations sample 2 ($\mu\text{g}/\text{m}^3$)	Calibration
VOC (NF ISO 16000-6)						
benzène	71-43-2	0,3	0,9	LD	LD	specific
trichloroéthylène	79-01-6	0,3	0,9	ND	ND	specific
phtalate de dibutyle	84-74-2	0,5	1,5	LD	LD	specific
phtalate de bis(2-éthylhexyle)	117-81-7	0,3	0,9	LD	LD	specific
toluène	108-88-3	0,3	0,9	LD	LD	specific
tétrachloroéthylène	127-18-4	0,5	1,5	ND	ND	specific
éthylbenzène	100-41-4	0,3	0,9	LD	LD	specific
m-xylène	108-38-3	0,3	0,9	LD	LD	specific
p-xylène	106-42-3	0,3	0,9	LD	LD	specific
styrène	100-42-5	0,3	0,9	ND	ND	specific
o-xylène	95-47-6	0,3	0,9	LD	LD	specific
2-butoxyéthanol	111-76-2	0,3	0,9	ND	ND	specific
1,2,4-triméthylbenzène	95-63-6	0,3	0,9	ND	ND	specific
1,4-dichlorobenzène	106-46-7	0,3	0,9	ND	ND	specific
TVOC	-			6,7	4,6	toluene equivalent
ALD (NF ISO 16000-3)						
formaldéhyde	50-00-0	0,1	0,3	LD	LD	specific
acétaldéhyde	75-07-0	0,1	0,3	LD	LD	specific

Table 11 : Detection limits (LD), quantification limits (LQ) and measured concentrations for both air samples ($\mu\text{g}/\text{m}^3$) from the ECHOSHAPE Linear Feltline ceiling

End of test report