FRANCE

M & F RANKING ACCORDING TO NF F 16-101

The actual classification used by French regulations for the classification of fire behaviour of materials/component is described in:

- NF F 16-101: ñRolling stock ï Fire behaviour ï Materials selectionò
- NF F 16-102: ñ Rolling stock ï Fire behaviour ï Materials selection ï Application for electrical equipmentò

This classification regards substantially three vehicles categories:

- √ A1: all rolling rock, including their driversôcabins, which travel ferequently though tunnels
- √ A2: urban and suburban rolling rocks which travel infrequently through tunnels,
- √ B: mainline rolling rock, including locomotives, which travel infrequently through tunnels.

Theses standards provide the classification of the material by ñreaction to fireò and ñsmokeò (combination of smoke opacity and toxicity). The product of the above parameters gives the ñrisk index».

1.1 Reaction to fire test

-For wide specimens, the ñreaction to fireò tests classify the material/product into one of six categories: from M0 to M5 and are obtained from combination of the parameters measured. Theses reaction to fire tests comes form the buildings standards

The principal test used in this standard is the ñEpiradiateurò According to NF P 92501 both for rigid and flexible materials more than 5 mm thickness are evaluated. NF P 92503 is used for flexible materials with thickness up to 5 mm. If dripping is noted in the above tests, NF P 92504 and NF P 92505 test s (rate of flame speed) are used.

A complementary test for floor covering is the radiant panel test NF P 92506 which is used only if in the primary test (NF P 92501 and NFP 92503) the material does not obtain the M1 or M2 classification. The NF P 92510 test (calorific potential l) is used to give materials classified in M1 class (below NF P 92501) the M0 class (if the heat of combustion is less than 2500 kJ/kg).

-For small specimens which are not able to be assessed with the M rating,, two tests are used: Oxygen index (NF EN ISO 4589-2) and glow wire test (NF EN 60695-2-10). These tests classify the materials into five classes: from I0 to NC (I5). The same tests are used for the electrical materials as described in NF F 16 102.

Table 1: small specimens reaction classes

• Class	Result of test	
	LOI	**Glow wire**
I0	>= 70	No ignition at 960° C
I1	>= 45	No ignition at 960° C
I2	>= 32	No ignition at 850° C
I3	>= 28	Ignition does not persist at 850° C after glow wire is withdrawn
I4	>= 20	
NC	< 20	Non classified

-For wires

The wires are assessed according to the NF C 32-070 standard testy method based on the horizontal flame spread along a wire.

1.2 Smoke parameters

Concerning ñsmokeò parameter, as described in the standard, this is obtained from the combination of ñsmoke emissionòand ñtoxicity indexò

The first one is evaluated by the NF X 10 702 (Smoke Density Chamber) and the second one with NF X 70-100. The Assessment of smoke toxicity is focused on CO, CO_2, HCl, HBr, HF, HCN, and SO_2. The NO_x,, acrolein and formaldehyde derivatives will be probably integrated in the requirements in a near future. The toxic analysis can be realised with the ionic chromatography (Figure 2).

Each of the gas concentrations is divided by an ï acceptable- value and then summed to determine the toxicity index called ITC according to the below formula

$$\mathbf{ITC : 100 \times \Sigma (ti/Cci)} \qquad (3)$$

Table 2: reference value of gaseous species

Gaseous species	CCi mg/m^3
CO	1750
CO_2	90 000
HCl	150
HBr	170
HCN	55
HF	17
SO_2	260
CCi : reference value	

The smoke emission index is a combination of the maximum optical density (Dm) and the summation of optical density up to 4 min VOF4. These two parameters Dm and VOF4 are assessed during the smoke chamber test.

The toxicity results are combined with the smoke emission results. And, at least, these three indices are added to form a smoke index: according to the formula 4:

$$\mathbf{IF = Dm/100 + VOF/30 + ITC/2} \qquad (4)$$

According to NF 16101, the combination of these two parameters gives the ñsmoke valueòwith classes from F0 to F5.

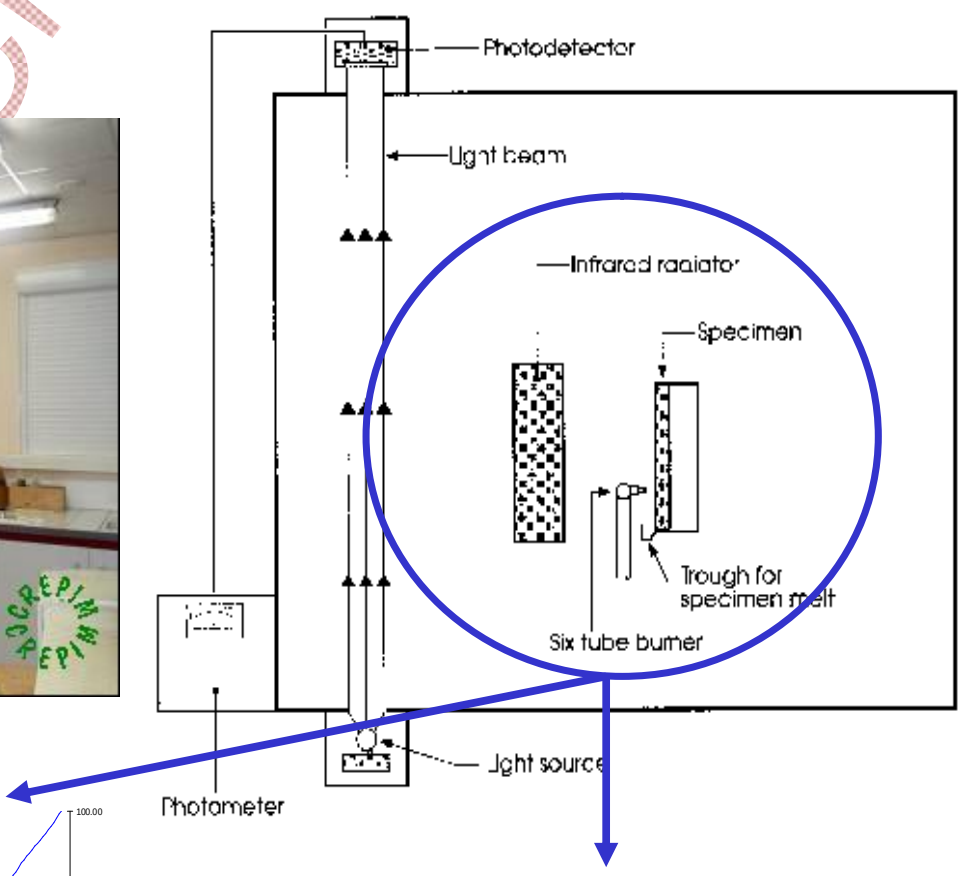
Table 3: F rating according IF values

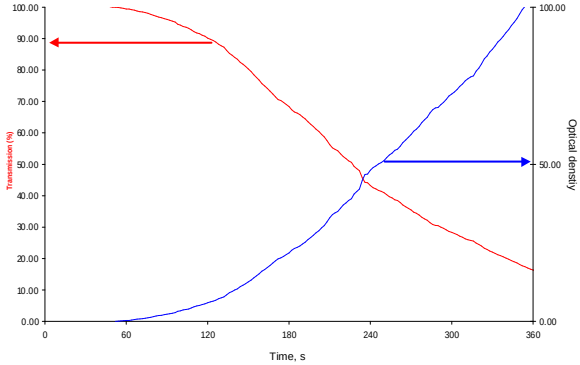
IF value	F rating
<5	F0
< 20	F1
< 40	F2
< 80	F3
< 120	F4
>120	F5

The Smoke Density Chamber (ASTM E 662 in USA) illustrated in is used widely in testing of transportation.

This apparatus measures smoke generation from small, solid specimens exposed to a radiant flux level of 25 kW/m^2 in a flaming (piloted ignition) or non-flaming mode. The smoke produced by the burning specimen in the chamber is measured by a light source ï photometer combination. The attenuation of the light beam by the smoke is a measure of the optical density or quantity of smokeôthat a material will generate under the given conditions of the test.

Figure 1: the NF X 10-702 smoke box apparatus (USA : ASTM E 662)





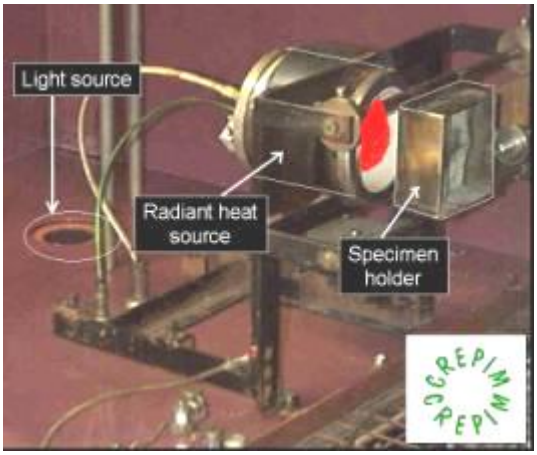
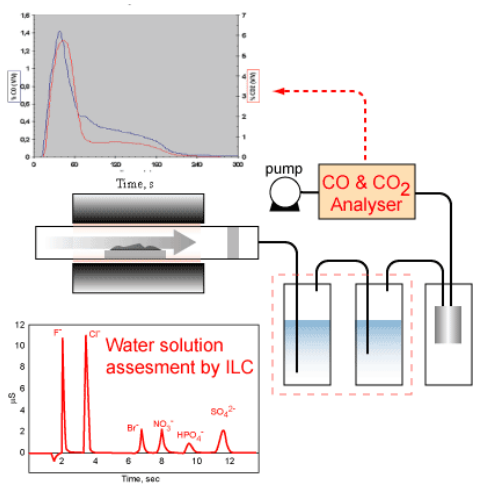
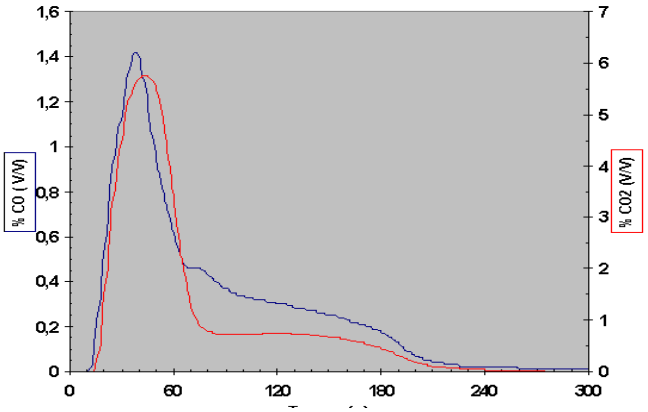
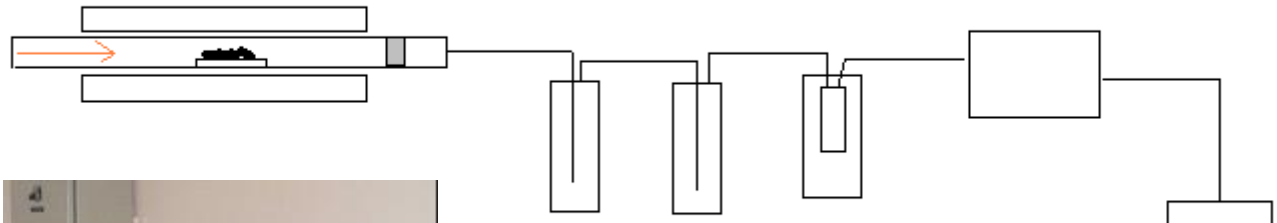


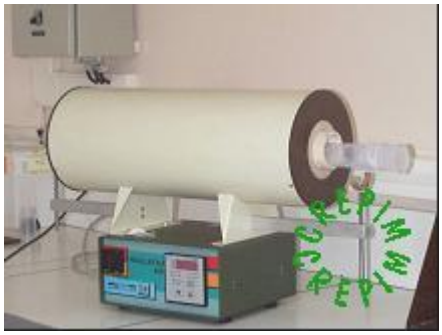
Figure 2: the NF X 70-100 tubular furnace test method





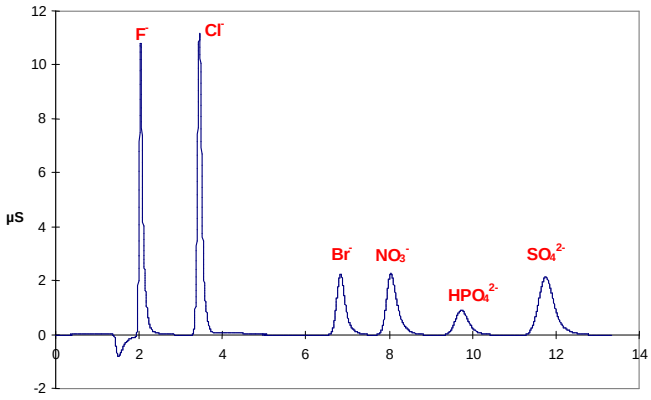
CO and CO_2 analyser





Water solutions assessment by ILC

pump



Time. s

The French standard gives a complete set of allowable pass criteria by using 18 matrices. Each grid is available for a specific material/component with three classes:

- ✓ Acceptable,
- ✓ Acceptable with agreement of user,
- ✓ Not acceptable.

In general, the higher the F category, the lower the limit on flammability which is allowed.

Figure 3: M and F requirements versus category

	A1	A2	B
Ceiling	M0F0	M0F0	M1F1
Wall	M1F1	M1F1	M2F1
Curtain	M1F1	M1F1	M1F1
Light	M1F1	M1F1	M1F2
Seat (each component)	M1F1	M1F1	M1F2
Flooring	M1F1	M2F1	M2F1
Interior Wires	AF1	AF1	BF2
Exterior Wires	BF1	BF2	CF3
Exterior material	M2F1	M2F2	M3F3
Bed furniture	M1F1	M1F1	M1F1

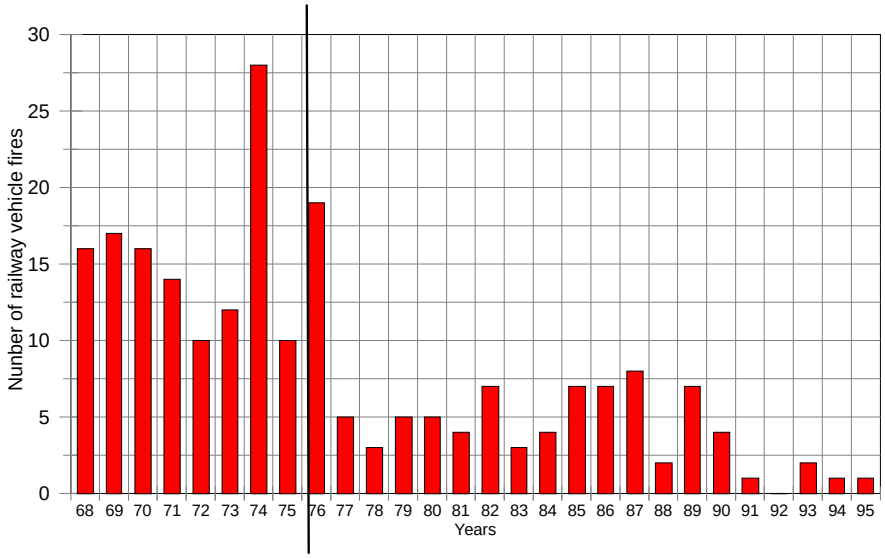
Figure 4: light diffusers requirement for A1 category, matrice n°4

	I 0	I 1	I 2	I 3	I 4	NC
	M 0	M 1	M 2	M 3	M 4	NC
F 0	A	A	**AA**	**AA**	**NA**	**NA**
F 1	A	A	**AA**	**AA**	**NA**	**NA**
F 2	A	A	**AA**	**AA**	**NA**	**NA**
F 3	A	A	**AA**	**NA**	**NA**	**NA**
F 4	A	A	**NA**	**NA**	**NA**	**NA**
F 5	A	**NA**	**NA**	**NA**	**NA**	**NA**

A: acceptable, **NA: non acceptable**, **AA : Acceptable with agreement of user**

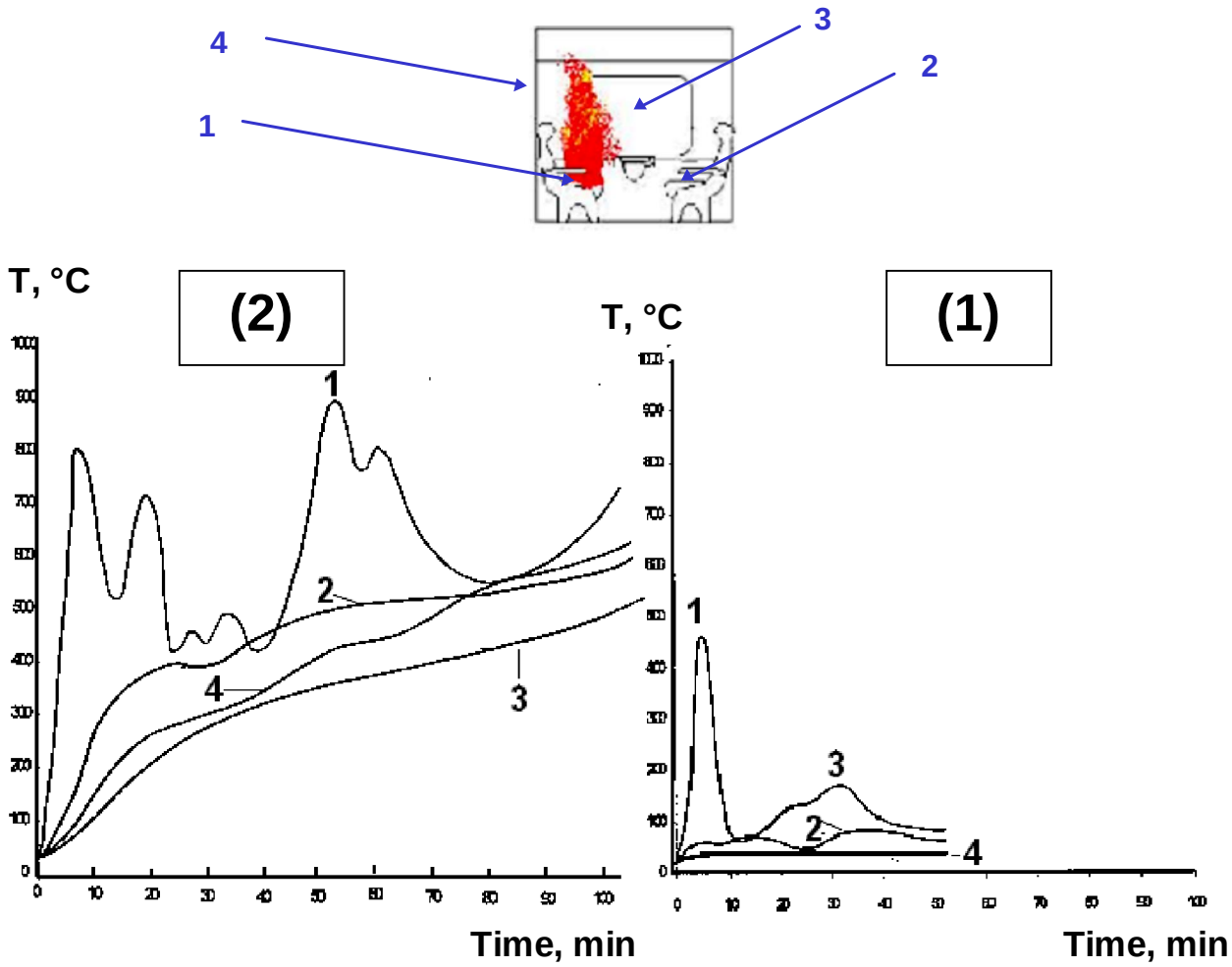
The NF F 16-101 regulation is effective since 76 end its achievement clearly shows a decrease of railways vehicle fires.

Figure 5: railway vehicle fires evolution



Also note that real scale state has pointed out the strong decrease of fire temperature and so fire spread using material in compliance with the NF F 16-101 requirements

Figure 6: real scale test temperature evolution with (1) and without (2) material complying with the NF F 16-101 requirements



Please feel free to contact CREPIM for further information :

CREPIM

Contact :
Mr. Franck POUTCH, Director
Parc de la Porte Nord
Rue Christophe Colomb
62700 Bruay La Buissière
France
Tel : +00 33 3 21 61 64 00
Fax : +00 33 3 21 61 64 01
Email : franck.poutch@crepim.fr
http://www.crepim.com