



# SINTEF

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# TEST REPORT

TITLE / TEST METHOD

**Fire testing of FIRAX  
according to ISO 5660-1:1993**

PRODUCT NAME

**FIRAX**

CLIENT(S)

Spanolux S.A.  
Zoning Ind. Burtonville  
6690 Vielsalm  
BELGIUM

CLIENT'S REF.

Mr. Damien Bourgueil

PROJECT NO.

102010.90/05.237 B

TASK MANAGER (NAME, POSITION, SIGN.)

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REPORT DATE

2005-11-18

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2005-10-25 and 2005-11-11

TOTAL NO. OF PAGES

14

**ABSTRACT:**

The product **FIRAX** was tested horizontally according to ISO 5660-1:1993.

The product was tested in three thicknesses: 12 mm, 18 mm and 22 mm. Three single tests were conducted on each thickness.

The tested specimens were exposed to a heat flux density level of 50 kW/m<sup>2</sup>.

**TEST RESULTS:**

Test results are given in Appendix I.

The test results show that **the 22 mm FIRAX** satisfies the criteria for materials used in furniture and other components onboard high speed crafts according to IMO Res. MSC.90(71), and can be regarded as a fire-restricting material.

Notice should be taken regarding the fact that the amount of fire retardant varies with the thicknesses of the tested products. This fact must be taken into consideration when making an eventual approval of the tested product. See "Test specimens" on page 2.

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Excerpts may be quoted only with the written permission of SINTEF NBL.  
The test results referred to in this report relate only to the items tested.  
Test reports from SINTEF NBL, form the basis of fire technical classifications, certifications and approvals.

**PRODUCT DESCRIPTION:**

*Type of product:* Fire retardant fibre board (MDF)

*Manufacturer:* Spanolux

*Place of production:* Vielsalm, Belgium

*Sampling:* The tested material was selected by the client. The material subjected for testing arrived at SINTEF NBL 2005-10-07. It is not known to SINTEF NBL if the fire characteristics of the product received are representative of the fire characteristics of the average product.

*Test specimens:* Test specimens of fire retardant fibre board with dimensions 100 x 100 mm. The product was tested in three thicknesses: 12 mm, 18 mm and 22 mm.

Measured parameters as thickness, square density and density for the tested products: see Table 1 and Table 2 in Appendix I.

Colour: pink/red.

On request from the client, the amount of fire retardant is not included in this test report. This information is archived at SINTEF NBL.

Notice should be taken regarding the fact that the amount of fire retardant varies with the thicknesses of the tested products. This fact must be taken into consideration when making an eventual approval of the tested product.

**TESTING:**

*Operator:* Erling Stenhaug, engineer

*Conditioning of the test material:* The test specimens were stored in air with a relative humidity of 50 % and a temperature of 23 °C until constant mass was obtained.

*Number of single tests:* 3 single tests on three thicknesses – all conducted at heat flux level 50 kW/m<sup>2</sup>.

**REMARKS / DEVIATIONS:**

The uncertainty of measurement of reaction to fire tests is an item under discussion within TC4 of EGOLF. Pending the outcome of this process, SINTEF NBL will not give an expression of the uncertainty of measurement of the results presented in this report.

Notice should be taken regarding the fact that the amount of fire retardant varies with the thicknesses of the tested products. This fact must be taken into consideration when making an eventual approval of the tested product.

**APPENDICES**

Appendix I:	Test Results
Appendix II:	Terms used for materials' reaction to fire
Appendix III:	Classification Criteria

**Appendix I - Test results**
**Table 1** Results from testing of **12 mm FIRAX** according to ISO 5660-1, heat flux density 50 kW/m<sup>2</sup>.

Specimen no		1	2	3	Average
Irradiance level from cone	[kW/m <sup>2</sup> ]	50	50	50	50
Specimen orientation	[H/V]	H	H	H	
Exhaust system flow rate	[m <sup>3</sup> /s]	0,024	0,024	0,024	0,024
Specimen thickness	[mm]	12,1	12,1	12,1	12,1
Specimen surface area	[m <sup>2</sup> ]	0,0088	0,0088	0,0088	0,0088
Specimen mass	[g]	90,4	92,4	93,1	92,0
Specimen density	[kg/m <sup>3</sup> ]	747,1	763,6	769,4	760,1
Specimen square density	[kg/m <sup>2</sup> ]	9,0	9,2	9,3	9,2
Specimen colour		Red/pink	Red/pink	Red/pink	
Time to ignition	[s]	655	856	850	787
Time to extinction	[s]	Still flames at termination of tests			-
Duration of test	[s]	1210	1210	1225	1215
Mass remaining after test	[g]	29,2	29,1	30,0	29,4
Total mass loss	[g]	61,2	63,3	63,1	62,6
Total mass loss	[%]	67,7	68,5	67,8	68,0
Mass loss per square meter	[g/m <sup>2</sup> ]	6952,7	7197,4	7175,2	7108,5
Mass loss rate per square meter	[g/m <sup>2</sup> s]	5,7	5,9	5,9	5,9
Total heat released	[MJ/m <sup>2</sup> ]	33,2	27,2	35,1	31,8
Maximum heat release rate	[kW/m <sup>2</sup> ]	74	47	50	57
Av. heat release rate 180 s after ignition	[kW/m <sup>2</sup> ]	54	43	44	47
Av. heat release rate 300 s after ignition	[kW/m <sup>2</sup> ]	49	42	47	46
Total heat released 300 s after ignition	[MJ/m <sup>2</sup> ]	15	13	14	14
Max heat release rate, 30s sliding average	[kW/m <sup>2</sup> ]	71	45	49	55
Effective net heat of combustion	[MJ/kg]	4,8	3,8	4,9	4,5
Total smoke production	[m <sup>2</sup> ]	6,1	7,7	8,1	7,3
Average smoke production	[m <sup>2</sup> /s]	0,005	0,006	0,007	0,006
Average specific smoke production	[m <sup>2</sup> /kg]	99,2	120,8	127,9	116,0
Total CO-production	[g]	3,37	5,13	6,37	4,96
CO produced per mass unit burnt	[g/g]	0,055	0,081	0,101	0,079
FIGRA <sub>ISO5660</sub>	[W/s]	0,9	0,4	0,4	0,6
FIGRA <sub>ISO5660,30s</sub>	[W/s]	0,9	0,4	0,4	0,6
SMOGRA <sub>ISO5660</sub>	[m <sup>2</sup> /s]	0,162	0,086	0,099	0,12
SMOGRA <sub>ISO5660,30s</sub>	[m <sup>2</sup> /s]	0,112	0,068	0,074	0,08
Filename ("raw data")		<b>t0523701</b>	<b>t0523707</b>	<b>t0523717</b>	

- = Average value not possible to calculate

Calculation of FIGRA<sub>ISO5660</sub>: (HRR<sub>max</sub> x surface area x 1000) / t<sub>HRRmax</sub> [W/s]

Calculation of SMOGRA<sub>ISO5660</sub>: (SPR<sub>max</sub> x surface area x 1000) / t<sub>SPRmax</sub> [m<sup>2</sup>/s<sup>2</sup>]

FIGRA<sub>ISO5660,30</sub> and SMOGRA<sub>ISO5660,30</sub> is calculated the same way, but uses the maximum HRR and SPR values from a 30 seconds sliding average.

**Table 2** Results from testing of **18 mm FIRAX** according to ISO 5660-1, heat flux density 50 kW/m<sup>2</sup>.

Specimen no		1	2	3	Average
Irradiance level from cone	[kW/m <sup>2</sup> ]	50	50	50	50
Specimen orientation	[H/V]	H	H	H	
Exhaust system flow rate	[m <sup>3</sup> /s]	0,024	0,024	0,024	0,024
Specimen thickness	[mm]	18,3	18,3	18,3	18,3
Specimen surface area	[m <sup>2</sup> ]	0,0088	0,0088	0,0088	0,0088
Specimen mass	[g]	140,9	138,9	132,9	137,6
Specimen density	[kg/m <sup>3</sup> ]	769,9	759,0	726,2	751,73
Specimen square density	[kg/m <sup>2</sup> ]	14,1	13,9	13,3	13,8
Specimen colour		Red/pink	Red/pink	Red/pink	
Time to ignition	[s]	N.I	N.I	N.I	-
Time to extinction	[s]	N.I	N.I	N.I	-
Duration of test	[s]	1205	1210	1210	1208
Mass remaining after test	[g]	69,7	65,7	71,3	68,9
Total mass loss	[g]	71,2	73,2	61,6	68,7
Total mass loss	[%]	50,5	52,7	46,4	49,9
Mass loss per square meter	[g/m <sup>2</sup> ]	8093,7	8322,6	7001,3	7805,9
Mass loss rate per square meter	[g/m <sup>2</sup> s]	6,7	6,9	5,8	6,5
Total heat released	[MJ/m <sup>2</sup> ]	22,8	22,9	29,5	25,1
Maximum heat release rate	[kW/m <sup>2</sup> ]	25	32	38	32
Av. heat release rate 180 s after ignition	[kW/m <sup>2</sup> ]	N.I	N.I	N.I	-
Av. heat release rate 300 s after ignition	[kW/m <sup>2</sup> ]	N.I	N.I	N.I	-
Total heat released 300 s after ignition	[MJ/m <sup>2</sup> ]	N.I	N.I	N.I	-
Max heat release rate, 30s sliding average	[kW/m <sup>2</sup> ]	24	30	36	30
Effective net heat of combustion	[MJ/kg]	2,8	2,8	4,2	3,3
Total smoke production	[m <sup>2</sup> ]	7,4	8,3	9,1	8,3
Average smoke production	[m <sup>2</sup> /s]	0,006	0,007	0,008	0,007
Average specific smoke production	[m <sup>2</sup> /kg]	127,8	138,4	111,2	125,8
Total CO-production	[g]	6,4	6,2	6,4	6,3
CO produced per mass unit burnt	[g/g]	0,09	0,09	0,10	0,09
FIGRA <sub>ISO5660</sub>	[W/s]	0,2	0,2	0,3	0,2
FIGRA <sub>ISO5660,30s</sub>	[W/s]	0,2	0,2	0,3	0,3
SMOGRA <sub>ISO5660</sub>	[m <sup>2</sup> /s]	0,051	0,076	0,094	0,07
SMOGRA <sub>ISO5660,30s</sub>	[m <sup>2</sup> /s]	0,053	0,060	0,071	0,06
Filename ("raw data")		<b>t0523708</b>	<b>t0523713</b>	<b>t0523718</b>	

N.I = No Ignition

- = Average value not possible to calculate

Calculation of FIGRA<sub>ISO5660</sub>: (HRR<sub>max</sub> x surface area x 1000) / t<sub>HRRmax</sub> [W/s]

Calculation of SMOGRA<sub>ISO5660</sub>: (SPR<sub>max</sub> x surface area x 1000) / t<sub>SPRmax</sub> [m<sup>2</sup>/s<sup>2</sup>]

FIGRA<sub>ISO5660,30</sub> and SMOGRA<sub>ISO5660,30</sub> is calculated the same way, but uses the maximum HRR and SPR values from a 30 seconds sliding average.

**Table 3** Results from testing of **22 mm FIRAX** according to ISO 5660-1, heat flux density 50 kW/m<sup>2</sup>.

Specimen no		1	2	3	Average
Irradiance level from cone	[kW/m <sup>2</sup> ]	50	50	50	50
Specimen orientation	[H/V]	H	H	H	
Exhaust system flow rate	[m <sup>3</sup> /s]	0,024	0,024	0,024	0,024
Specimen thickness	[mm]	22,1	22,1	22,1	22,1
Specimen surface area	[m <sup>2</sup> ]	0,0088	0,0088	0,0088	0,0088
Specimen mass	[g]	162,9	157,9	163,3	161,4
Specimen density	[kg/m <sup>3</sup> ]	737,1	714,5	738,9	730,2
Specimen square density	[kg/m <sup>2</sup> ]	16,3	15,8	16,3	16,1
Specimen colour		Red/pink	Red/pink	Red/pink	
Time to ignition	[s]	N.I	N.I	N.I	-
Time to extinction	[s]	N.I	N.I	N.I	-
Duration of test	[s]	1215	1385	1210	1270
Mass remaining after test	[g]	89,6	95,2	95,6	93,4
Total mass loss	[g]	73,3	62,7	67,7	67,9
Total mass loss	[%]	45,0	39,7	41,5	42,1
Mass loss per square meter	[g/m <sup>2</sup> ]	8329,5	7127,6	7698,1	7718,4
Mass loss rate per square meter	[g/m <sup>2</sup> s]	6,9	5,1	6,4	6,1
Total heat released	[MJ/m <sup>2</sup> ]	25,1	26,2	15,0	22,1
Maximum heat release rate	[kW/m <sup>2</sup> ]	31	29	19	27
Av. heat release rate 180 s after ignition	[kW/m <sup>2</sup> ]	N.I	N.I	N.I	-
Av. heat release rate 300 s after ignition	[kW/m <sup>2</sup> ]	N.I	N.I	N.I	-
Total heat released 300 s after ignition	[MJ/m <sup>2</sup> ]	N.I	N.I	N.I	-
Max heat release rate, 30s sliding average	[kW/m <sup>2</sup> ]	30	28	18	25
Effective net heat of combustion	[MJ/kg]	3,0	3,7	1,9	2,9
Total smoke production	[m <sup>2</sup> ]	4,9	3,9	3,9	4,3
Average smoke production	[m <sup>2</sup> /s]	0,004	0,003	0,003	0,003
Average specific smoke production	[m <sup>2</sup> /kg]	66,5	59,1	64,8	63,5
Total CO-production	[g]	5,25	5,02	4,04	4,77
CO produced per mass unit burnt	[g/g]	0,07	0,08	0,06	0,07
FIGRA <sub>ISO5660</sub>	[W/s]	0,2	0,2	0,2	0,2
FIGRA <sub>ISO5660,30s</sub>	[W/s]	0,2	0,2	0,2	0,2
SMOGR <sub>ISO5660</sub>		0,12	0,08	0,07	0,09
SMOGR <sub>ISO5660,60s</sub>		0,01	0,05	0,05	0,04
Filename ("raw data")		t0523704	t0523706	t0523709	

N.I = No Ignition

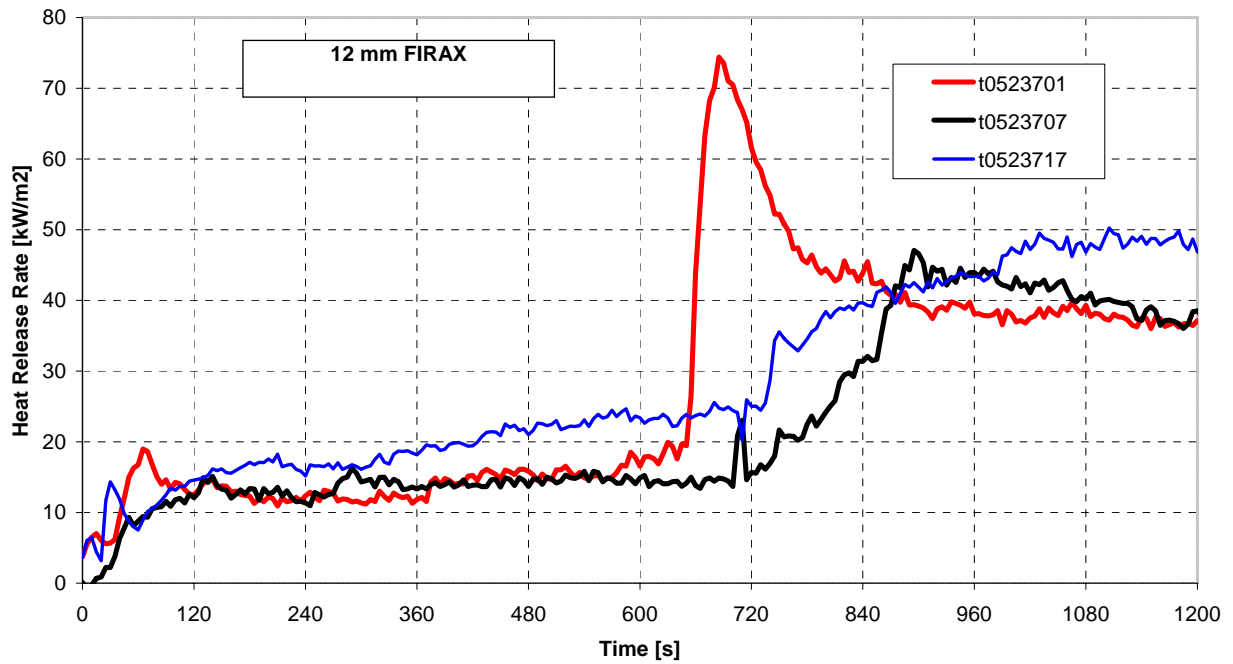
- = Average value not possible to calculate

 Calculation of FIGRA<sub>ISO5660</sub>: (HRR<sub>max</sub> x surface area x 1000) / t<sub>HRRmax</sub> [W/s]

 Calculation of SMOGR<sub>ISO5660</sub>: (SPR<sub>max</sub> x surface area x 1000) / t<sub>SPRmax</sub> [m<sup>2</sup>/s<sup>2</sup>]

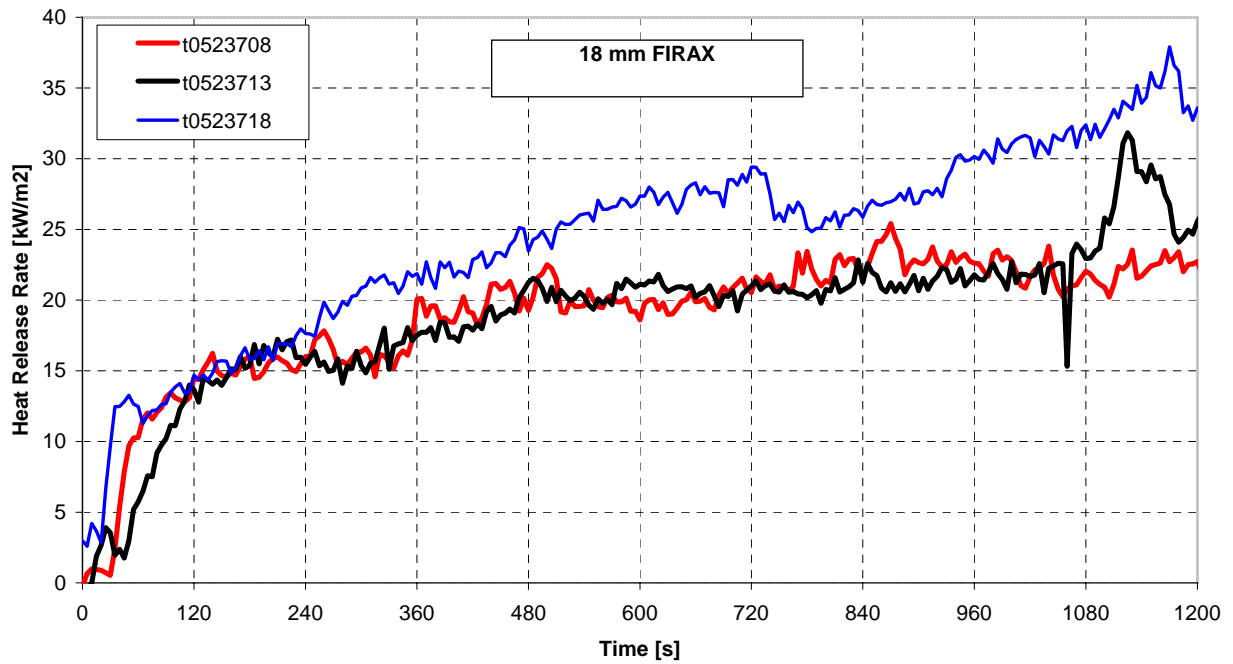
 FIGRA<sub>ISO5660,30</sub> and SMOGR<sub>ISO5660,30</sub> is calculated the same way, but uses the maximum HRR and SPR values from a 30 seconds sliding average.

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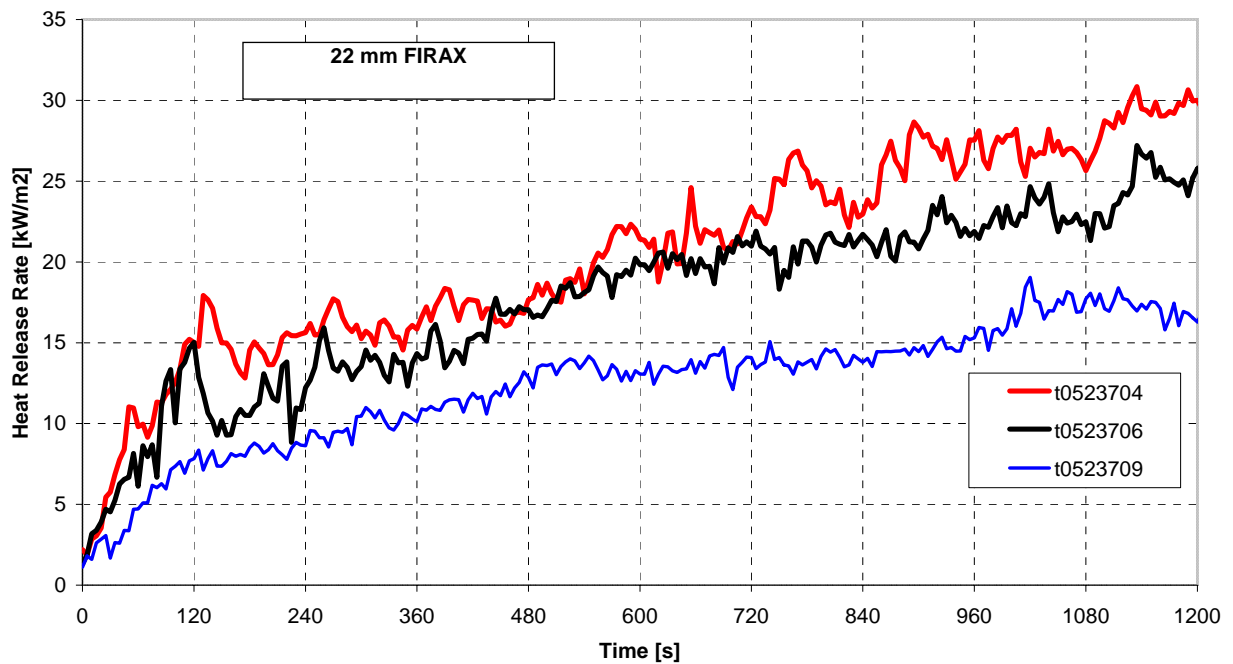
**Figure 1** Heat release rate [ $\text{kW/m}^2$ ] during testing of **12 mm FIRAX** at irradiance level  $50 \text{ kW/m}^2$

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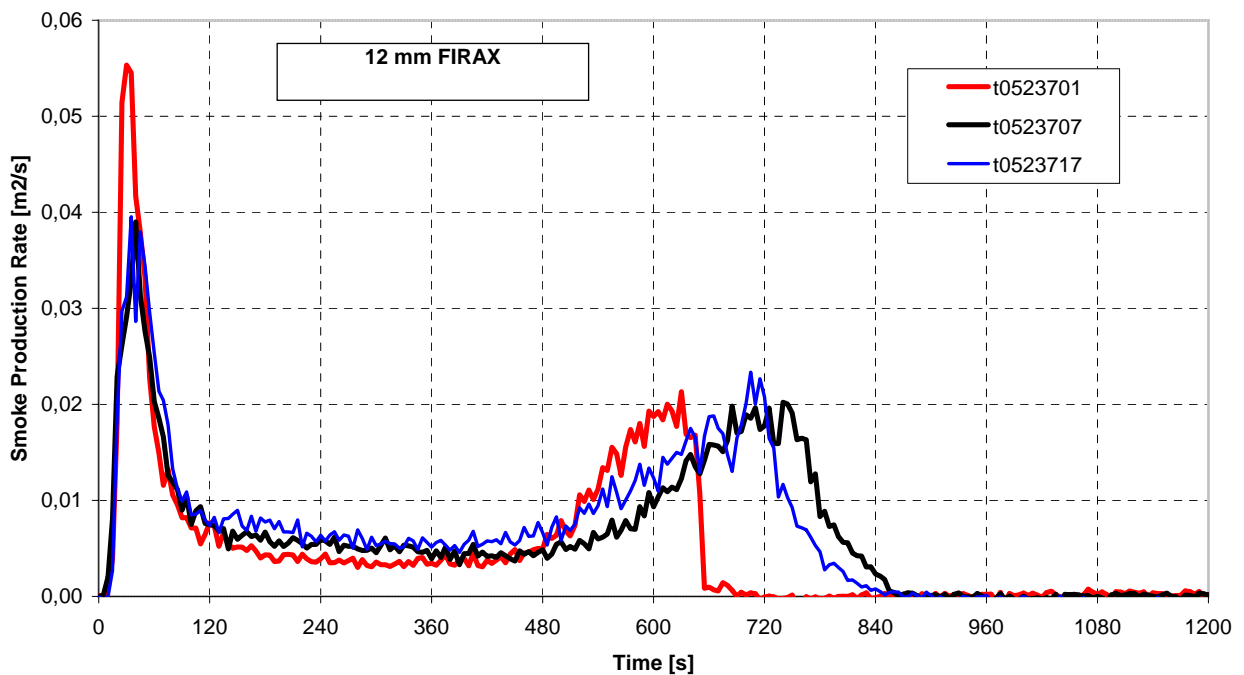
**Figure 2** Heat release rate [ $\text{kW/m}^2$ ] during testing of **18 mm FIRAX** at irradiance level  $50 \text{ kW/m}^2$

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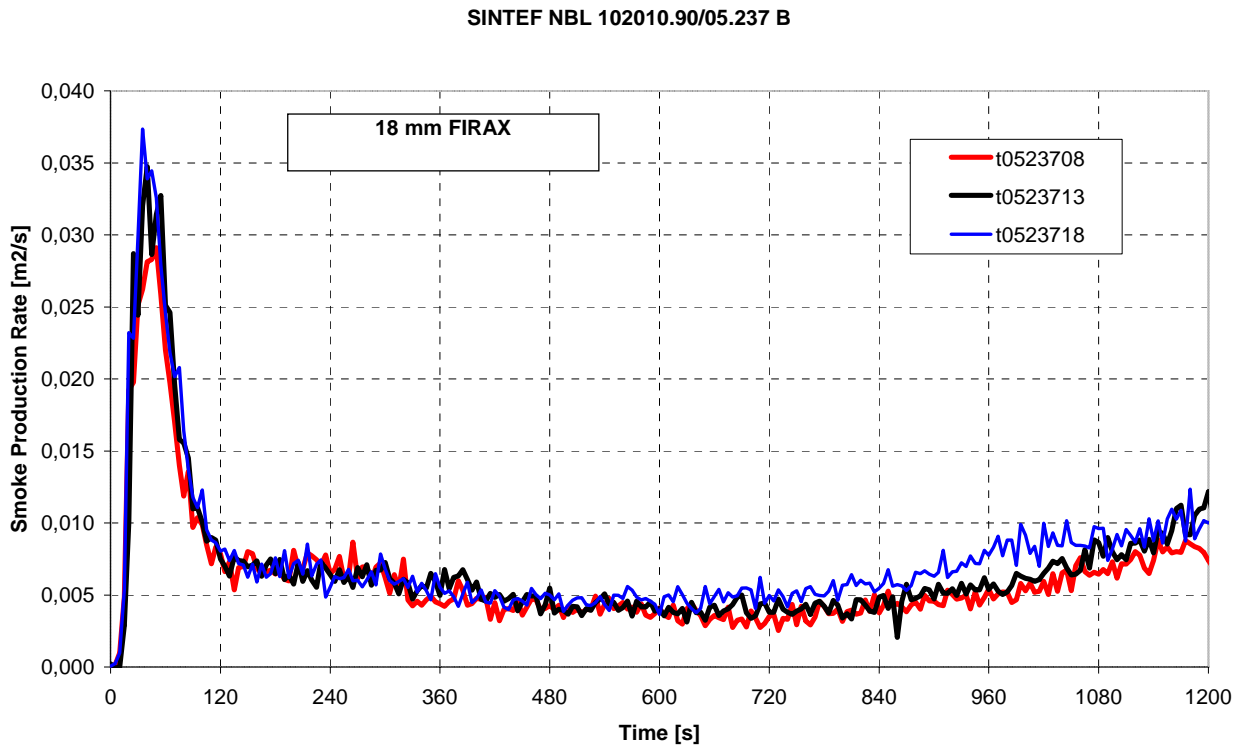


**Figure 3** Heat release rate [kW/m<sup>2</sup>] during testing of **22 mm FIRAX** at irradiance level 50 kW/m<sup>2</sup>

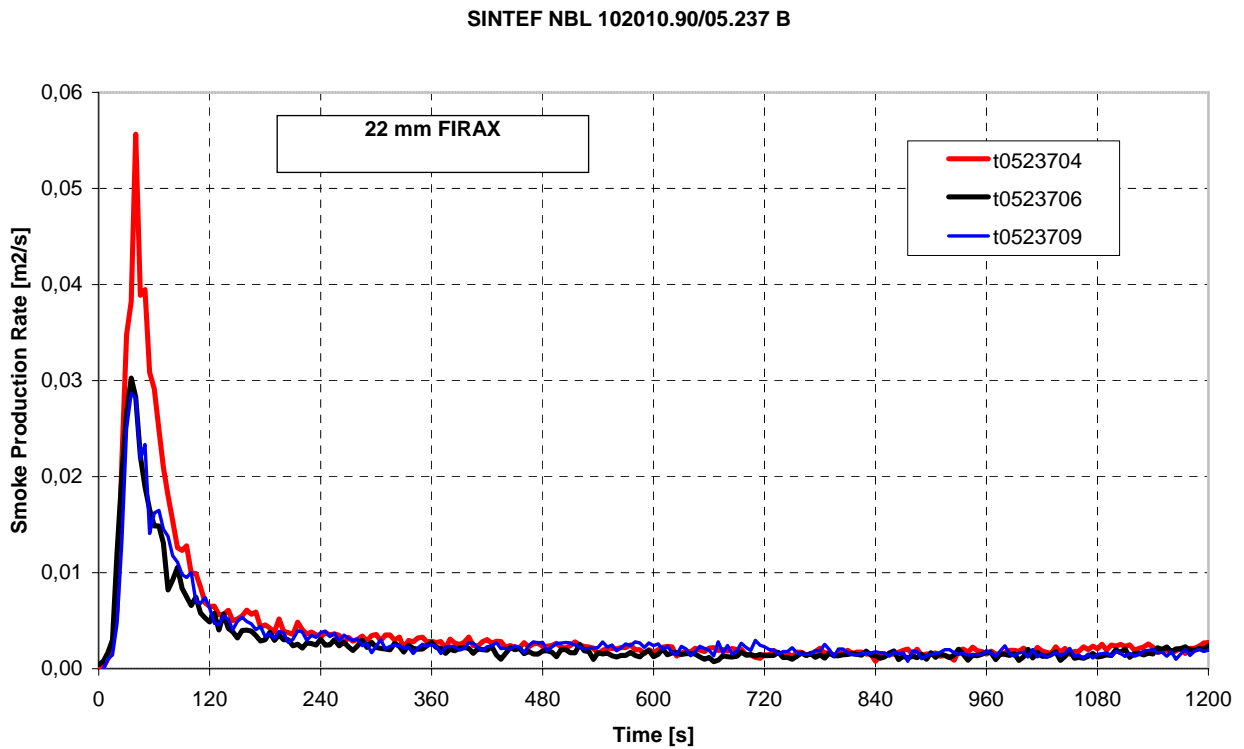
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**Figure 4** Smoke production rate [m<sup>2</sup>/s] during testing of **12 mm FIRAX** at irradiance level 50 kW/m<sup>2</sup>

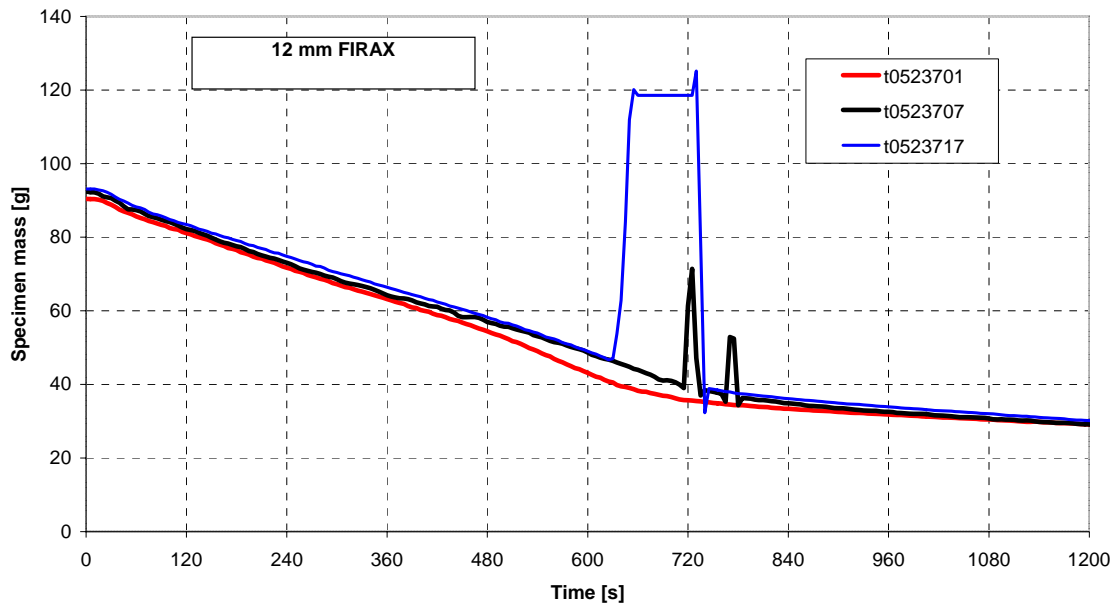


**Figure 5** Smoke production rate [ $\text{m}^2/\text{s}$ ] during testing of **18 mm FIRAX** at irradiance level  $50 \text{ kW}/\text{m}^2$



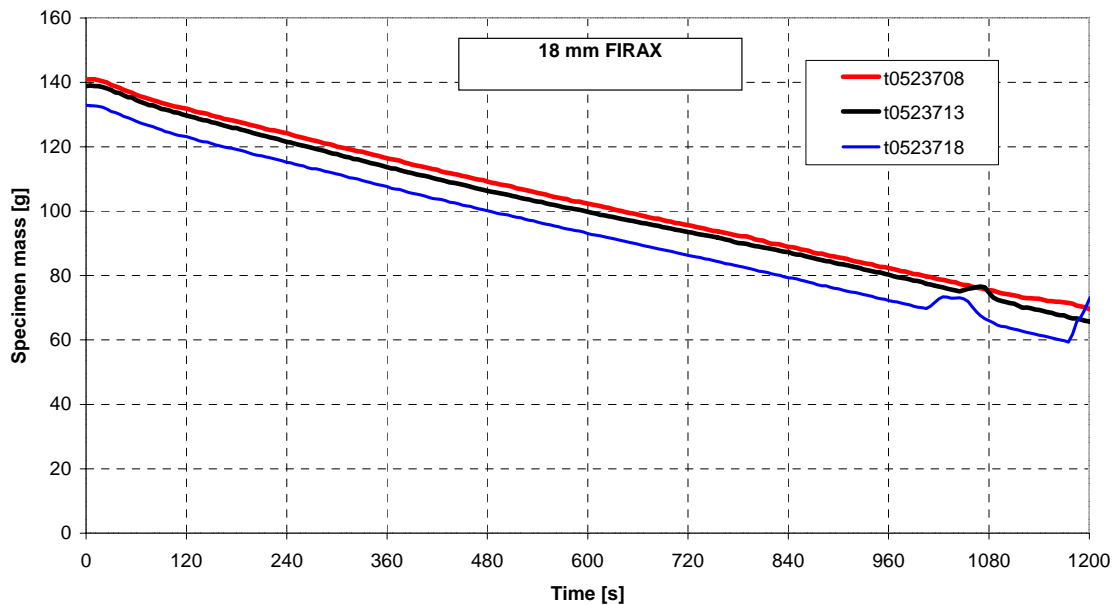
**Figure 6** Smoke production rate [ $\text{m}^2/\text{s}$ ] during testing of **22 mm FIRAX** at irradiance level  $50 \text{ kW}/\text{m}^2$

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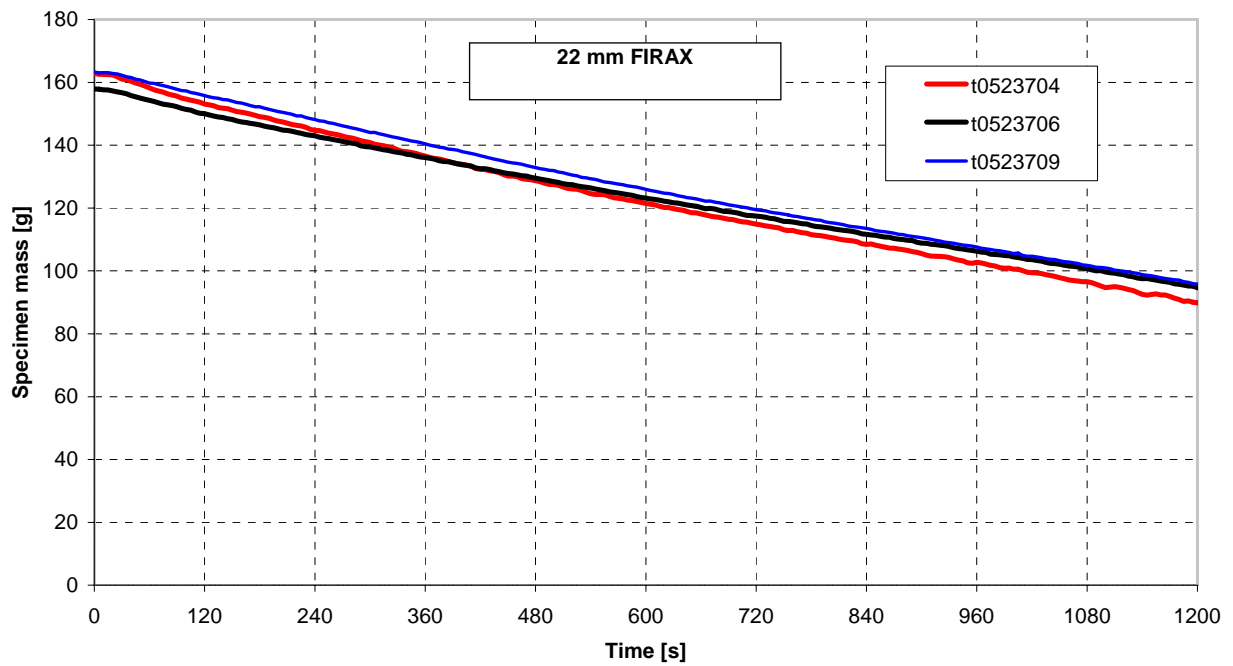
**Figure 7** Specimen mass [g] during testing of **12 mm FIRAX** at irradiance level  $50 \text{ kW/m}^2$ . During parts of tests 2 and 3, the surface cracked so that parts of the specimens touched the igniter and protection screen. This caused an increase of mass as shown in the figure.

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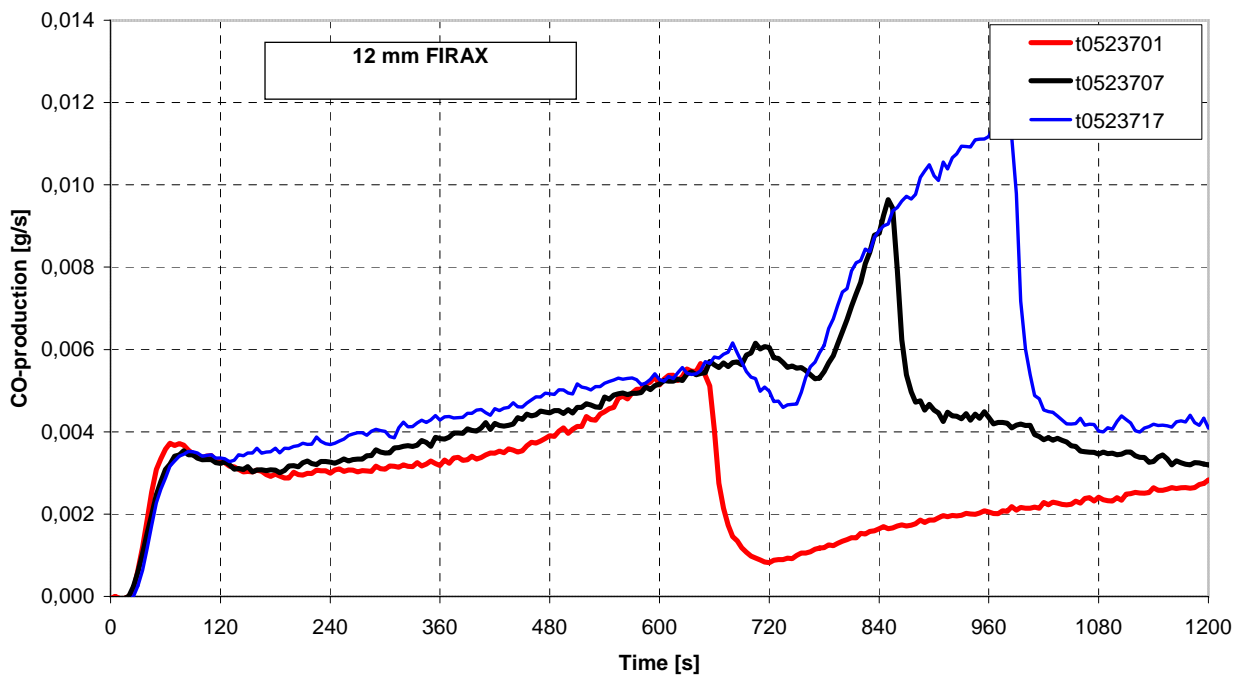
**Figure 8** Specimen mass [g] during testing of **18 mm FIRAX** at irradiance level  $50 \text{ kW/m}^2$ . During parts of tests 2 and 3, the surface cracked so that parts of the specimens touched the igniter and protection screen. This caused an increase of mass as shown in the figure.

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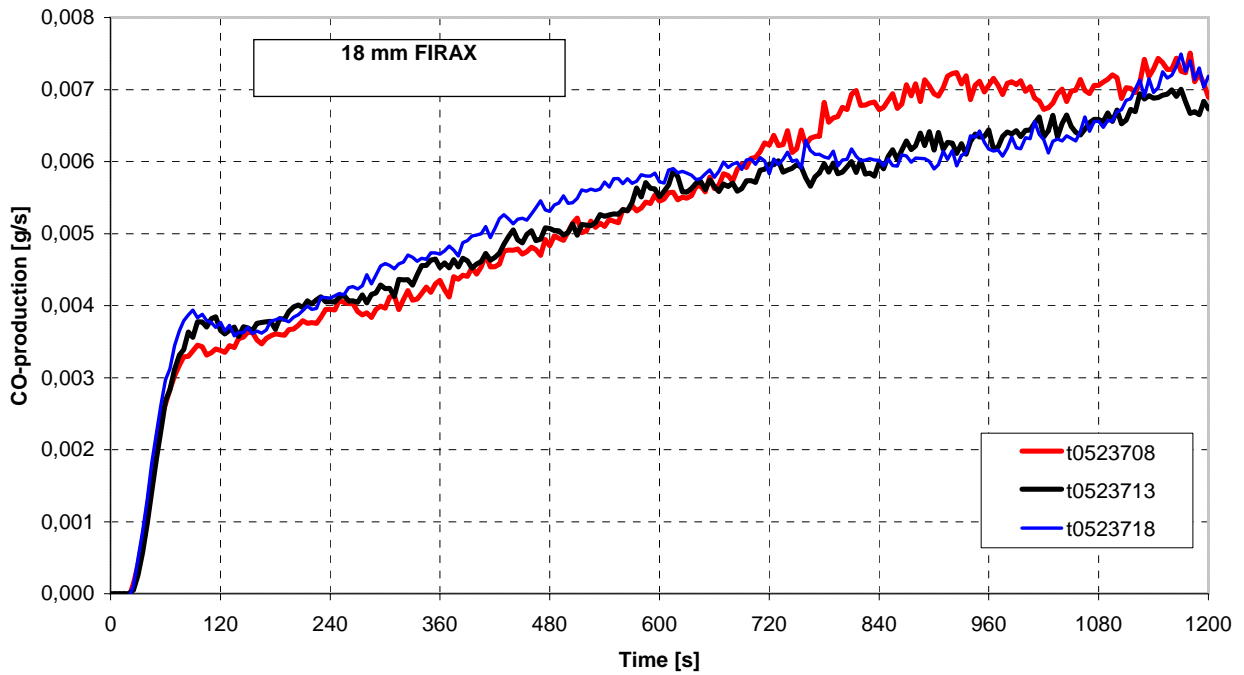
**Figure 9** Specimen mass [g] during testing of **22 mm FIRAX** at irradiance level  $50 \text{ kW/m}^2$

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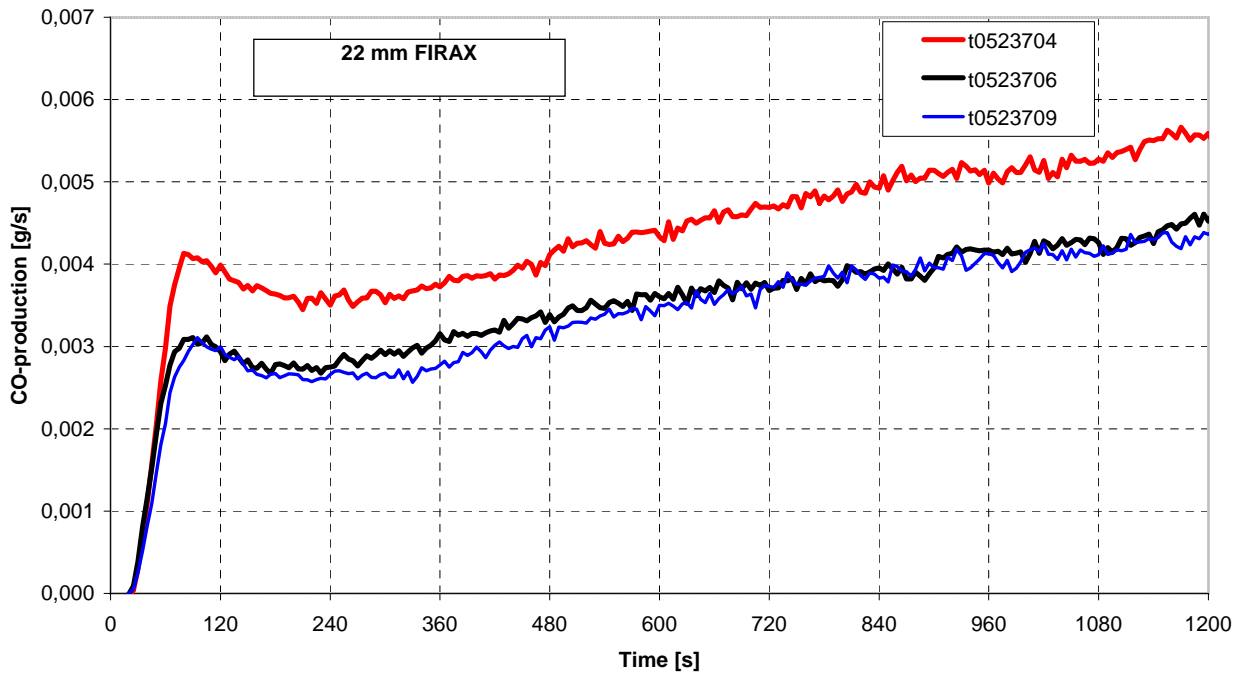
**Figure 10** CO-production [g/s] during testing of **12 mm FIRAX** at irradiance level  $50 \text{ kW/m}^2$

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**Figure 11** CO-production [g/s] during testing of **18 mm FIRAX** at irradiance level 50 kW/m<sup>2</sup>

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**Figure 12** CO-production [g/s] during testing of **22 mm FIRAX** at irradiance level 50 kW/m<sup>2</sup>

## Appendix II – Terms used for materials' reaction to fire

The cone calorimeter test is the most advanced method for assessing materials' reaction to fire. The test gives a possibility to evaluate ignitability, combustibility, smoke production and production of toxic gases. The different levels of irradiance from the cone, ranging from about 10 to 100 kW/m<sup>2</sup>, represent various severity levels of external fires. A flash-over fire may result in heat loads in the range of 100 to 200 kW/m<sup>2</sup>.

Irradiance level from cone [kW/m <sup>2</sup> ]	Represents the test condition by the external heat load to the specimen during fire testing.
Time to ignition [s]	Represents the time it takes to bring the specimen to ignition at the specified irradiance level, when a electrical ignition source is applied.
Total heat released [MJ/m <sup>2</sup> ]	Represents the total heat released from combustion reactions in the test specimen.
Maximum heat release rate [kW/m <sup>2</sup> ]	Represents the peak heat release rate from combustion reactions in the specimen.
Average heat release rate after 180 s [kW/m <sup>2</sup> ]	Represents the average heat release rate from combustion reactions during the first 180 seconds after ignition of the specimen.
Average heat release rate after 300 s [kW/m <sup>2</sup> ]	Represents the average heat release rate from the combustion reaction during the first 300 seconds after ignition of the specimen.
Effective heat of combustion [MJ/kg]	Represents the heat release from the combustion reaction in the specimen per unit mass at a specific irradiance level. (The heat of combustion measured in the cone calorimeter is normally significant lower than values given by other apparatuses. That is related to incomplete combustion in typical the fire conditions given by the Cone Calorimeter test.)
Average smoke production [m <sup>2</sup> /s]	Represents the average extinction area of smoke gases produced during the fire test, i.e. a measure of optical smoke density.
Production of CO (carbon monoxide) [g]	Represents the mass of carbon monoxide produced during the fire test. The value is related to the actual test conditions only, i.e. a well ventilated fire. Other values for CO production may appear in real fires.
Average specimen mass loss [g/m <sup>2</sup> s]	Represents the average mass consumption of the test specimen in the interval of 10% to 90% of total mass loss during the fire test.

## Appendix III – Classification criteria

### Classification criteria according to IMO Res. MSC.90(71) (adopted on 21 May 1999)

The criteria's below are given in IMO Res. MSC.90(71): *Adoption of amendments to the standard for qualifying marine materials for high-speed craft as fire-restricting materials (Resolution MSC.40(64))*.

Tests for materials used for furniture and components other than room lining should be performed according to the standard ISO 5660, the Cone Calorimeter Test. For the purpose of testing products to be qualified as “fire-restricting materials”, the following test conditions should apply. Three test specimens should be prepared and tested in accordance with standard ISO 5660-1 and the standard ISO 5660-2. Irradiance level should be set at  $50 \text{ kW/m}^2$  for all three tests. The test should be terminated after 20 minutes have elapsed since the start of exposure.

Materials used for furniture and other components are considered to be “fire-restricting material” if during testing to the standard ISO 5660, the following criteria are fulfilled:

- .1 the time to ignition ( $t_{ig}$ ) is greater than 20 s;
- .2 the maximum 30-seconds sliding average heat release rate ( $HRR_{30, \max}$ ) does not exceed  $60 \text{ kW/m}^2$ ;
- .3 the total heat release (THR) does not exceed  $30 \text{ MJ/m}^2$ ;
- .4 the time average smoke production rate ( $SPR_{\text{avg}}$ ) does not exceed  $0,005 \text{ m}^2/\text{s}$ ;