transfeu

2nd newsletter

September '10

> A European step forward for engineering fire control

A European Project supported through the Seventh Framework Programme
for Research and Technological Development.

Inside this issue

1. TRANSFEU word from the coordinator

Dear readers,

We are happy to present the progress of the European Project "TRANSFEU" supported through the EC Seventh Framework Programme for Research and Technological Development and the TRANSFEU partners.

The work has started the first April of 2009 and very important progress has been obtained for the following deliverables:

- *Fire test for toxicity of fire effluents* where a very repeatable and reproducible test method has been developed;
- *Conventional pragmatic classification system for the toxicity of fire effluents released from products on trains* where an assortment of mathematical models has been developed. A classification system will be proposed in the first quarter 2011;
- *Fire safety engineering methodology for surface transport* where the fire safety objective, fire risk analysis and design fire scenarios are being finalised;
- *Development of numerical simulation tools for fire performance, evacuation of people and decision tool for the train design* permits the determination of an important process for the use of simulation tools and the way to validate them for trains;
- *Development of assessment criteria of toxic effects on people due to the combustion of products in trains* where the definition and harmonisation of the test protocol between the testing labs for full and real scale tests is being studied. The real scale tests on coaches are at the planning stage, which includes the choice of the measurement systems to be used and the definition of the location of analytical instruments in the coaches.

We are optimistic about the results of this project and the possibility to develop innovative tools for a holistic fire safety based approach for the design of trains.

The following e-newsletter presents this progress.

Alain SAINRAT
TRANSFEU Coordinator

2. Project progress report

2.1 Fire test for toxicity of fire effluents (WP02) – Leader - LSFIRE

The activity of WP02 during the first part of the programme was very intensive, as expected in the logical sequence of the work, shown in detail in the Description of Work.

First of all, the work consisted in realising the method for measuring the production of toxic gases during fire of products used in the transport sector.

This was obtained by using a small scale method (the ISO 5659-2 smoke chamber) and thanks to the use of FTIR for monitoring continuously the species and quantity of gases released, in order to be able to predict afterwards the incapacitation threshold.

As the purpose is to avoid that the available escaping time is shorter than the evacuation time, it was necessary to standardise all the components of the measurement systems in the apparatus, maintaining the control of the parameters that can have an influence on the product combustion, on the gases sampling, on the filtering conditions, etc. in order to identify the gas species and measure the quantity of each gas generated during the test.

Moreover, it was necessary to produce protocols for each required measurement and the testing procedure as well as to decide about the new equipment in the system.

To achieve these objectives it was necessary initially to have an detailed exchange of opinions between the three laboratories (L.S.FIRE, LNE and CURRENTA) involved at this stage. When the first results had been produced colleagues from EW, SP, BRE, RATP and SNCF met several times at LSFIRE to familiarise themselves with the new techniques.

This is the first time, as we understand it, that calibrations amongst the three laboratories have been conducted with the same stock of certified bottles at different concentrations for 12 gases. This exercise involved sending 42 bottles around Europe (from Italy to Germany, then to Paris and return to Italy). A similar exercise also was required with LNE's reference flux meter and LSFIRE's recently certified optical filters. The three laboratories received and used the same tools for positioning the heat flux meter, the test specimen including the container for the liquids.

The first comparative results were conducted using liquid products each coming from the same container:

- chlorinated paraffin,
- polymeric MDI,
- tetramethyl sulphone.

These liquids allow the generation of key gases such as HCl, HCN and SO_2 to be characterised.

Burning these liquid products under identical conditions ensures that the reproducible results can be obtained. This was a good idea since the reproducibility of the measurements was excellent and this proves that the method works correctly if applied to homogeneous products.

Now, the other five laboratories are getting ready and, as soon as they have the correct equipment, the experimental phases of the newly defined calibration comparison and data collection for the second tranche of 30 products will start.

The final text of the standard was presented to the Commission on the 19th May 2010 and the use of it has been authorized for the work of the standardization bodies including CEN TC256 and CENELEC TC9X JWG (Fire precautions for railway vehicles) and ISO TC92 SC1 (Fire initiation and growth) WG12.

Photo A: *10 March 2010: laboratory LSFire in Controguerra (TE) Meeting of FTIR operators from laboratories participating to the test campaign of phase 1 and phase 2. Improvements and changes to the measurement system of smokes and toxic gases in ISO 5659-2 chamber with use of FTIR were discussed.*

Photo B: overall view *of the complete apparatus presented at the meeting in March*

2.2 Development of conventional pragmatic classifications system for the toxicity of fire effluents released from products on trains (WP03) – Leader: Exova Warringtonfire

The objective of WP03 is to develop a classification system for the toxicity of fire effluents from products on railway vehicles, which will be based upon a conventional prescriptive approach. This system will be used to set requirements for inclusion in the revision of CEN/TS45545 Part 2 by the end of 2010.

During the M6 to M12 period, the real locations of the first 30 products, which are to be tested and analysed continuously by FTIR spectrometry in WP02, have been considered with respect to various operation categories of European trains. The modelling requirements for these products have been studied with respect to the Available Safe Escape Times (ASET) for passengers and crew on typical European trains. The TRANSFEU classification system is now being built in relation to the ASET for passengers and crew from a railway vehicle with a fire on board and the Required Safe Evacuation time (RSET) as broadly proposed in CEN/TS 45545-1.

An assortment of mathematical models dependant on the type and location of the train products has been considered in Tasks 3.1 and 3.2 to convert the continuously determined raw FTIR data from WP2.2.2 tests into toxicity effect in relation with time. The toxicity effect will be determined using the Conventional Index of Toxicity (CIT) models as described in CEN/TS 45545-2. These models are being validated in Task 3.3 by comparing the ranking of the materials obtained from them with the ranking based on ASET.

The general approach for determination of ASET is to calculate the time to reach toxic effect (CIT= failure criterion). It is based on the CIT calculation as described in CEN TS 45545-2 under section C.16, although it requires enhancements to capture kinetic aspects. In its base version, the model does not allow to calculate the time when the CIT = 1 criterion is reached.

The prediction of ASET will be based on a 1 – zone model using the following simple equation:

CIT = [Precursor Term] x [Summation Term]

The Summation Term for general products is broadly defined in CEN TS 45545-2 Annex C.16 and uses NIOSH reference values for fire gases.

The Precursor Term is based on a simple 1-zone model and the fire scenario according to the category of train and the product application. The Precursor Term is the ratio of the ISO 5659-2 smoke chamber volume (0.51 m3) to a coach volume (150 m3) times the ratio of the burning area according to the fire scenario (for example, 0.1 m^2) to the exposed surface area of the test specimen in the ISO 5659-2 smoke chamber (0.004225 m^2).

The calculations of CIT in Task 3.3 are based on 3 different groups of products:

A. Interior surface (including flooring) products and light diffuser strips
B. Seats (upholstery and backs) and bedding
C. Cables, electrotechnical and non-listed products

2.3 Fire safety engineering methodology for surface transport - WP04- Leader: Bombardier

Task 4.1 Identification of fire safety objective and associated criteria of performance and acceptance

The following scenarios will be taken into account for real scale test and for classification of the toxic fumes.

Scenario 1A
- Commuter Train operation category 1 according to CEN TS 45545-1
- Single deck open passenger area with 6 doors (3 each side)
- No evacuation to adjacent vehicle

Scenario 1B
- Mainline train operation category 2 according to CEN TS 45545-1 and Cat A TSI SRT.
- Single deck open passenger area with 4 doors (2 each sides)
- No evacuation to adjacent vehicle.

Scenario 2A
- Mainline train operation category 2 according to CEN TS 45545-1 and Cat A TSI SRT.
- Double deck open passenger area with 4 doors (2 each sides)
- With gangways for evacuation to adjacent vehicle.

Scenario 2B
- Mainline train operation category 3 according to CEN TS 45545-1 and Cat B TSI SRT.
- Double deck open passenger area with 4 doors (2 each sides)
- With gangways for evacuation to adjacent vehicle.

The airflow in the passenger vehicle according these scenarios is very important for the consideration of the required evacuation time for passengers in case of a fire in the passenger area.

For scenarios 1 A and 2A:

According to EN 14750-1, the following airspeed shall be taken into account in the passenger area with ventilation:

With the maximum of internal temperature of 27°C and an average of external temperature of 27 ° C the standard ask for an air speed of 0.8 m/s

For scenarios 1B and 2B:

According to EN 13129-1, the following airspeed shall be taken into account in the passenger area with HVAC:

With the maximum of internal temperature of 22°C and an average of external temperature of 27°C, the standard ask for an air speed of 0,25 m/s.

2.4 Development of numerical simulation tools for fire performance, evacuation of people and decision tool for the train design - WP05 – Acting Leader: Bombardier

Selected Tool for Fire Safety Modelling

It was agreed that fire modelling shall be carried out using the CFD code (Computational Fluid Dynamics) *Fire Dynamics Simulator (FDS)*.

FDS has been developed at the National Institute of Standards and Technology (NIST), USA. It is freely available and highly accepted open-source software used by a large number of fire safety engineers and researchers throughout the world. FDS is being continuously further developed and probably the currently best-validated CFD fire simulation software. The software tool *Smokeview*, also developed at NIST, shall be used to visualise the simulation output data.

Validating the material input data for FDS modelling- Selected Products

In total, TRANSFEU has selected 60 Railway Products having a complete picture of used material. From these 60 Railway products, 17 are selected for full scale and real scale tests in the different scenarios. These 17 Railway products shall be used for the material input in the FDS Modelling.

Summary of the products used for the different scenarios

Explanation for colours used on the tables for scenarios 1 to 4

- Yellow: used for validation of the results on the new developed smoke chamber with FTIR described in WP02 and produced by the TRANSFEU laboratories LNE; LSF, CURRENTA, EXOVIA; SP; SNCF and RATP.
- Green: shall be tested by the TRANSFEU laboratories LNE; LSF and CURRENTA
- Red: shall be tested by the TRANSFEU laboratories LNE; LSF, CURRENTA, EXOVIA; SP; SNCF and RATP

Scenario 1 A

Article number	Description in Table 4 TS 45545-2	Product description
IN1-5	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	Painted GRP polyester with Gel coat hand laminated
IN1-7	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	HPL Melamine+polyester film
IN 1-10	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	HPL compact
IN 3-1	Strips	Polycarbonate
IN16-1	Floor composite	Synthetic rubber glued on aluminium sheet
F1A-1-2	Upholstery for passenger seats and head rest. French solution	Vandalise protected. Cover, protection layer, foam

Scenario 1B

Article number	Description in Table 4 TS 45545-2	Product description
IN1-7	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	HPL Melamine+polyester film
IN1-8-1	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	Needle-punched carpet glued on aluminium sheet 2 mm. Vertical position
IN1-8-2	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	Needle-punched carpet glued on glass fibre reinforced phenolic resin. Sealing position
IN 3-1	Strips	Polycarbonate
IN 8-3	Curtains and Sunblind in passenger areas	Polyester fabric
IN10A-1	Tables, folding tables top, including toilette wash basins	Aluminium Honey comb coated with HPL
IN16-3	Floor composite	80/20 % Wool / nylon carpet glued to plywood
F1A-2-2	Upholstery for passenger seats and head rest. German solution	Not vandalised protected Cover, foam

Scenario 2A

Article number	Description in Table 4 TS 45545-2	Product description
IN1-5	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	Painted GRP polyester with Gel coat hand laminated
IN 1-10	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	HPL compact
IN 3-1	Strips	Polycarbonate
IN16-6	Floor composite	Synthetic rubber glued to plywood
IN 8-3	Curtains and Sunblind in passenger areas	Polyester fabric
F1A-1-1	Upholstery for passenger seats and head rest Italian solution	Vandalise protected. Cover + protection layer, foam

Scenario 2 B

Article number	Description in Table 4 TS 45545-2	Product description
IN1-8-1	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	Needle-punched carpet glued on aluminium sheet 2 mm. Vertical position
IN1-8-2	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical Surfaces	Needle-punched carpet glued on glass fibre reinforced phenolic resin, Sealing position
IN 3-1	Strips	Polycarbonate
IN 8-1	Curtains and Sunblind in passenger and staff areas, staff compartments	Wool fabric; Mixed fabric
IN10A-2	Tables, folding tables top, including toilette wash basins	Solid acrylic
IN16-3	Floor composite	80/20 % Wool / nylon carpet glued to plywood
F1A-1-3	Upholstery for passenger seats and head rest, British solution	Vandalise protected. Cover, protection layer, foam

Methods for modelling the fire growth in FDS**:** FDS is a computational fluid dynamic code that allows simulating the fire growth in a given scenario. It uses a global combustion reaction.

Method 1: Prescribed Source

This method is based on the conventional scenarios of CEN TS 45545-1. The surfaces of the materials in fire generate

- heat release rate (HRR) according to ISO 5660-1 test (a vector of HRR expressed in kW/m²);
- effluent gases release according to WP2/WP3 tests (a vector gases expressed in mg/m²/s).

The required input data for the fire design are the location of fire, the heat release rate per unit area versus time (predefined curve – measured experimentally) and the chemical composition of each component.

- Advantages: This method does not need a great quantity of input data and does not require further developments of the current models. Input data needed can be obtained from conventional tests specified in CEN TS 45545-2.
- Disadvantages: This method does not allow taking into account multiple fire sources from various materials. It offers a lean capacity to predict the behaviour of a fire source in a new fire test.
- Usage: The method can be used for fast calculations and engineering purposes. The expected calculation times are of the order of few hours.

Method 2: Imposed Pyrolysis

The solid is divided in several volume elements named mesh. The thermal balance of each mesh is carried out in order to propagate the fire.

The thermal properties (density, thermal conductivity, and heat capacity) and the temperature of ignition of each volume element (mesh) are specified. For each solid element, the first step of the calculation is to heat up the material in order to reach the ignition temperature. If the thermal balance allows reaching this temperature, then the second step starts. This second step consists in applying to the surface a prescribed heat release rate issued from ISO 5660-1 test (a vector heat release rate expressed in kW/m²) and the prescribed effluents release rate following the tests defined in WP02/WP03 (a vector gases expressed in mg/m²/s).

The required data are the location of fire, the predefined curve (HRRPUA versus time), the chemical composition and the thermal properties of each material.

- Advantages: This method does not need any further development on current models. Input data needed comes from conventional tests specified in CEN TS 45545-2 and additional tests for thermal properties and ignition temperature.
- Disadvantages: The method does not consider variations in heat/effluents release rate as a function of the incident heat flux.
- Usage: The method can be used for engineering purposes. The expected calculation times are of the order of few days.

<u>Method 3: Calculated Pyrolysis</u>

This method would fully calculate the fire growth (i.e. pyrolysis and combustion).

The heat release rate is calculated as the product of the combustible mass fraction released by the decomposition of the solid (i.e. pyrolysis) and the effective heat of combustion of the gaseous fuel. The pyrolysis is calculated using the kinetic parameters of the process which are generally found using thermo gravimetric experimental results, a pyrolysis model (e.g. the decomposition of polyurethane can be summarized by 5 reactions) and genetic algorithm (optimization tool).

The required input data are the location of fire, the chemical composition and thermal properties and structure of each material, and the kinetic parameters for each reaction and material.

This method requires a high level of knowledge of the decomposition process of materials. There are two different alternatives to set the kinetic parameters in FDS:

- Alternative 1: It is based on physics approach. From thermo gravimetric experiences, a model of pyrolysis of each material is determined. Input kinetic parameters are obtained with an algorithm genetic.
- Alternative 2: It is based on a parametric approach. From thermo gravimetric experiences, parameters are entered in FDS code. Kinetic parameters are obtained with equations.

- Advantages: This method is closed to the physics and the chemistry of the process. It is the most accurate method available nowadays.
- Disadvantages: The method is complex and need a great quantity of input data, from TGA, DSC and other methods to define the degradation pathways. Improvements are needed to consider different effluents transport equations and oxygen diffusion at the surface of solid fuels (limitation of current mixture fraction models).
- Usage: The method can be used for research purposes, perhaps in specific engineering cases in the future. Calculation time expected is few weeks.

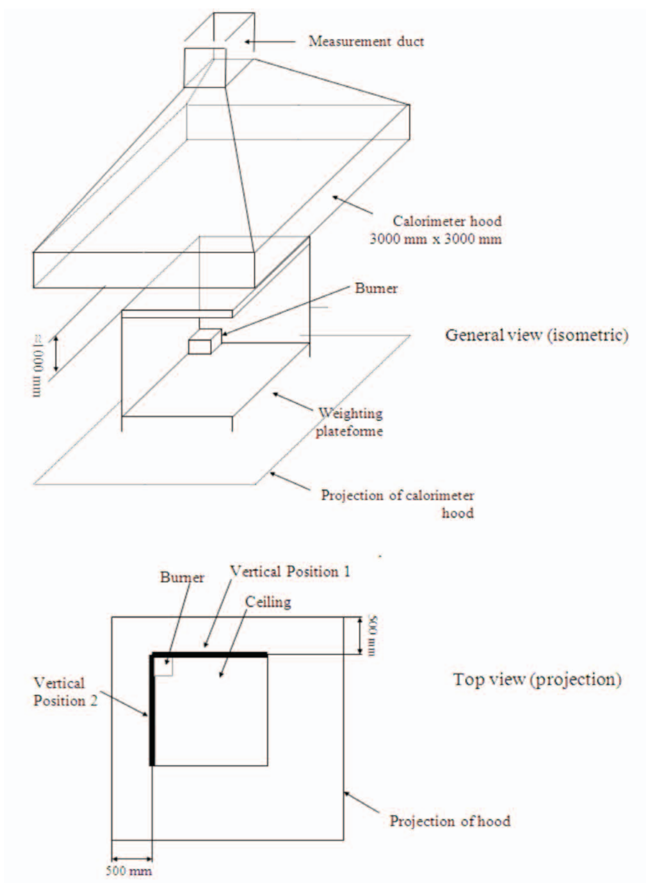
<u>Process Steps for validation of the pyrolysis data for the selected 17 Railway products:</u>

❶ <u>Cone calorimeter EN ISO 5660-1</u>- Deliverable: Validation of the FDS calculation results with the test results from the selected products for full and real scale tests.

❷ <u>Smokebox ISO 5659-2 – X BOX (FTIR)</u> - Deliverable: Only if necessary on specific materials. Validation of the FDS calculation results with the test results of the requested density according the CEN TS 45545-2

❸ <u>Fullscale test</u>- Deliverable: Validation of the FDS calculation results with the test results from the selected products for full scale tests

Description of test bench



4 Pyrolysis model- Deliverable: Validation of the FDS calculation results with the test results from the selected products for the small compartment.

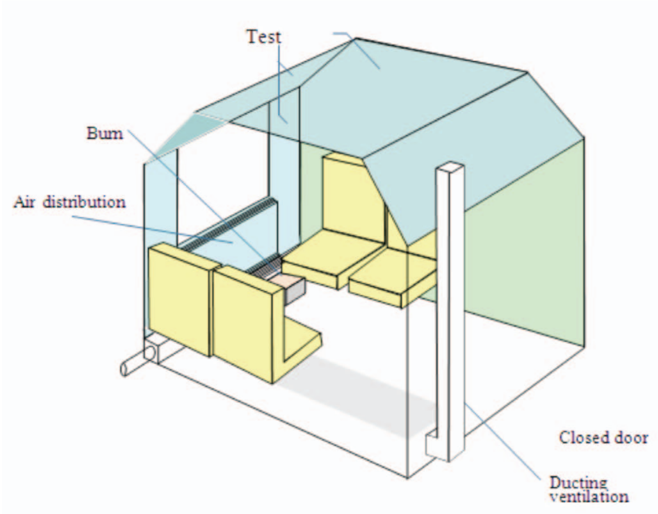
5 Pyrolysis model 3- Deliverable: Calculating, in the small compartment, the selected products with the approved material properties according the model 3 (Pyrolise).

6 Pyrolysis model 1 or model 2- Deliverable: Calculating, in the small compartment, the selected products with the bench scale material properties according the model 1 or perhaps 2.

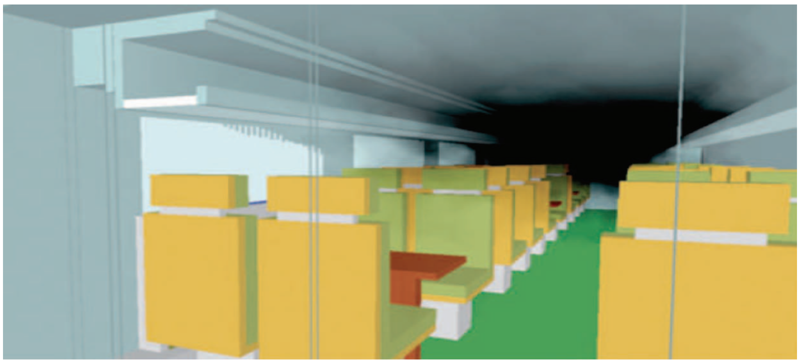
7 Develop an uncertainty factor to compare model 1/2 with model 3- Deliverable: Uncertainty factor for calculation.

8 Real scale tests- Deliverable: Calculating the real scale tests according scenarios 1A; 1B; 2A and 2B with model 1 or 2.

Description of the Pyrolyse test bench



Example of modelling of smoke spread in a real scale railway coach



2.5 Development of assessment criteria of toxic effects on people due to the combustion of products in trains - WP06 - Leader – LNE

The activity of the WP06 is currently on three different frontlines. The final report for the selection of products, representative fire scenarios and real scale test is now at its final validation stage.

The next steps are experimental and include full scale tests on real products and a compartment test, as well as real scale tests on coaches. Due to delay in delivery of the samples, the full scale tests have been significantly delayed. However, an effort has been made in defining and harmonizing the test protocol between the testing labs.

The real scale tests on coaches are at the planning stage, which includes the choice of the sensors to be used and the definition of their location in the coaches. The objective is to provide comprehensive output data to allow the validation of the numerical modelling from WP05, the pragmatically classification from WP03 and to allow the estimation of time available for safe escape.

2.6 Exploitation, Dissemination and Contribution to standards (WP07) Leader – UNIFE

The activity of WP07 from M6 to M12 has been significant due to the evolution of the project, as more information, progresses and activities within the WPs was accessible.

Firstly the general information on TRANSFEU has been published on the Transport Research Knowledge Center website (http://www.transport-research.info), a website financed by the European Commission which gives an overview of research activities at European and national level. The TRANSFEU information published here will be updated accordingly to the progresses of the project.

Furthermore, TRANSFEU was disseminated with articles in different news and magazine such as JT COMPOSITES ET TRANSPORT , L'Antenne and in particular it had four dedicated pages in the EURAILMAG magazine, which delivers news and information on Europe's railway industry, its product offerings and services.

Article on TRANSFEU published in the EURAILMAG magazine

During the second part of the project WP7 has also finalised and publish the Project public website that can be found on the following link: www.transfeu.eu.

TRANSFEU public website

The project also has a fully running internal website with Work Packages division to provide a good working tool.

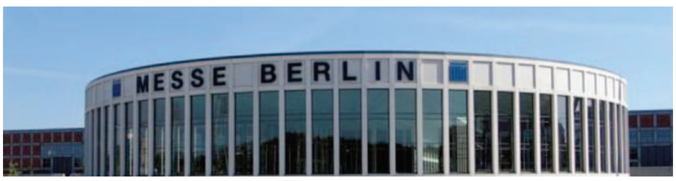
For a wider dissemination of the project different partners have participated in many conferences around the world. In order to have a consistent communication on the project objectives and deliverables, a general and a detailed presentation on TRANSFEU has been produced and distributed among the partners.

TRANSFEU has been present in the following Congresses or Conferences:

- *Fire Protection of Rolling Stock conference, London, UK, 24-25 March 2010*
- *Brandschutztag Schienenfahrzeuge, Germany, 20 May 2010*
- *7th International Rail Forum, Valencia, Spain, 25th- 27th May 2010*
- *IInd International Scientific Conference TRANSPORT PROBLEMS, Katowice - Kraków, Poland, 8 – 11 June 2010*
- *Interflam, Nottingham, UK, 5-7 July 2010*

Regarding the upcoming events, the international transport fair of the INNOTRANS will take place at the Messer Berlin from the 21st to the 24th of September 2010. The TRANSFEU logo will be visible and the leaflets available at the UNIFE stand (Hall 4.2, Stand 120) during the whole fair.

On Thursday 23rd, the TRANSFEU preliminary results and test performed will be shown and explained. Also a TRANSFEU lunch will be offered at 13:00 on Thursday 23rd of September at the stand together with (at least) one TRANSFEU expert present at the stand that will answer all the possible questions that may arise for the different interested people.



3. Impact of preliminary results on forecast standardisation

On 19th May 2010 the progress report of TRANSFEU and the work results on the text of the test standard for the simultaneous measures of optical density and effluent toxicity were presented to Ms. Gurau, Mr. Klima, representatives from the European Commission.

The method is defined for all parts regarding the apparatus (sampling point, flux filtering system, dimensions of the cell in relation to the flow rate, pressure monitoring in the cell, and flux normalization with a refrigeration system), the calibration process (thermal attack, optical system and spectra of different gases with certified bottles) and the test procedure, presentation of results and data obtained.

The Commission authorized us as part of our dissemination requirement to use our work for progressing in the CEN-CENELEC JWG for CEN TS 45545-2 but also in ISO and IMO, where we have expressly asked to present the TRANSFEU standard to WG12 of TC92SC1 for proposing its adoption as an International Standard

The data of repeatability and reproducibility was analysed by VTT, who will send green light to proceed the test, are encouraging. These results where possible thanks to the intense collaboration between the three reference laboratories, but also thanks to the information exchange and solution proposals from all the laboratories.

Where to find us

TRANSFEU partners are actively participating to the major European events that concern fire safety. You can find us at the following conferences:

23rd of September 2010 – Innotrans, Berlin, Germany - Hall 4.2, Stand 120 - UNIFE

29th – 30th September 2010 – FIVE Fires in vehicles, Gothenburg, Sweden

2011, International Fire Security Congress, SCI 2011, Madrid, Spain

14th April 2011 - Brandschutztag Schienenfahrzeuge – Germany

19th – 24th June 2011 - 10th International Symposium on Fire Safety Science, USA

You can now visit us at

www.transfeu.eu

DO NOT HESITATE TO CONTACT US
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