fire protection in transport, toxicity of combustion products

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TRANSPORT FIRE SAFETY ENGINEERING IN THE EUROPEAN UNION - PROJECT TRANSFEU

Summary. Article presents European Research project (of FP7-SST-2008-RTD-1 for Surface transportation) TRANSFEU. Projects undertakes to deliver both a reliable toxicity measurement methodology and a holistic fire safety approach for all kind of surface transport. It bases on a harmonized Fire Safety Engineering methodology which link passive fire security with active fire security mode. This all embracing system is the key to attain optimum design solutions in respect to fire safety objectives as an alternative to the prescriptive approach. It will help in the development of innovative solutions (design and products used for the building of the surface transport) which will better respect the environment.

In order to reach these objectives new toxicity measurement methodology and related classification of materials, new numerical fire simulation tools, fire test methodology (laboratory and full scale) and a decisive tool to optimize or explore new design in accordance to the fire safety requirements will be developed.

INŻYNIERIA OCHRONY PRZECIWPOŻAROWEJ W TRANSPORCIE UNII EUROPEJSKIEJ - PROJEKT TRANSFEU

Streszczenie. Artykuł omawia realizowany w ramach 7 Ramowego Programu UE projekt badawczy (FP7-SST-2008-RTD-1 dla transportu powierzchniowego) TRANSFEU. Projektowe przedsięwzięcia obejmują opracowanie metody pomiaru toksyczności produktów spalania adekwatnej do warunków rzeczywistych oraz holistyczne podejście do bezpieczeństwa pożarowego we wszystkich rodzajach transportu powierzchniowego. Podstawę stanowi zharmonizowana metodologia inżynierii ochrony przeciwpożarowej łącząca pasywne i aktywne środki zabezpieczeń. Ten pełen system jest kluczem do osiągnięcia optymalnych rozwiązań projektowych z poszanowaniem celów bezpieczeństwa pożarowego jako alternatywa do dotychczasowego podejścia normatywnego. Projekt umożliwi rozwinięcie innowacyjnych rozwiązań (projektowanie i produkty stosowane do budowy środków transportu powierzchniowego) bardziej przyjaznych środowisku.

W celu osiągnięcia powyższych założeń zostaną rozwinięte: nowa metoda pomiaru i oceny toksyczności materiałów, nowe narzędzia numeryczne symulacji pożaru, nowe metody badań w skali laboratoryjnej i naturalnej, narzędzia wspomagania optymalizację lub badanie nowego projektowanie zgodnie z wymaganiami bezpieczeństwa pożarowego.

1. INTRODUCTION

Public surface transport (railway, waterborne vessels, and buses) are relatively safe. However there is still a risk that a fire could happen. It can be very dangerous for passengers especially due to the presence of fire toxic effluents from various materials that prevent people to evacuate on time the transport vehicle. In Austria for instance, 155 people died in a funicular fire (Nov. 2000), because of toxic fumes. In Bulgaria (Feb 2008), a train fire and toxic smokes killed 8 people, injured 9 and poisoned many others over the 62 people travelling in this train.

Toxic effect level measurement of materials and their toxicity classification is very important but also the most difficult to assess in order to estimate real evacuation time of passengers in case of fire. In railway vehicles, the current test method of toxic evaluation and classification of materials are described in the TS CEN 45545-2. However there is a lack of confidence in the robustness of the existing product toxicity classification. Indeed it is based only on two points' static measurement for a few products, and then extrapolated for others. This means that this prescriptive product classification can be far from reality. In addition there is no way to compare different national requirements for toxicity as there is no harmonisation regarding the measurement method thus preventing European industry from common safety rules and consequently competitiveness. In order to improve fire safety European standards in railway and other surface transport a new prescriptive classification of products based on dynamic measurements of various material toxic effects is needed.

The current prescriptive approach gives solutions in fire safety design of railway vehicles or waterborne vessels in many cases. However the consideration of larger, complex vehicle structures and designs together with the presence of more complex phenomena due to combined effect of toxic emission, heat release, smoke distribution and active/passive safety on vehicles implies the utilization of an alternative holistic approach. This global or "holistic" approach is possible using a performance-based fire safety methodology, which allows to provide more flexible and economic solutions. This new holistic approach can propose a range of alternative and complementary fire safety strategies using innovative advanced materials able to achieve the design objectives of rail vehicles and other means of transportation, such as marine craft.

2. OVERVIEW

TRANSFEU European Research project [1] has started in April 2009. And these are the following information data of this project:

- budget: 5.54 M€
- duration: 42 months
- labour effort: 314.89 Person month
- consortium: 21 partners:
    - Belgium (UNIFE),
    - Finland (VTT),
    - France (ALMA, ALSTOM, LNE- coordinator, RATP, SNCF),
    - Germany (CENTC256, CUR, DB, SIEMENS, UoW),
    - Italy (AB, LSFIRE, TRENT),
    - Poland (IK),
    - Spain (CIDEMCO),
    - Sweden (SP),
    - Switzerland (BT),
    - United Kingdom (BW, BRE).

3. EXPECTED IMPACT

The expected impact of described project are:

- Close the open point of TS CEN 45545 and facilitate its transition to an international standard,
- Improve the protection of passengers,
- Improve the homologation process and reduce the cost of approval for new vehicles thanks to virtual testing,
- Decrease of 10% of the car body weight, and reduce energy consumption accordingly up to 10% in line with the rail sector and ERRAC objectives,
- Benefits for the Train manufacturers:
  - decrease test price of a fire resisting of the car body structure up to 50%; explore new innovative designs and materials using the fire engineering simulation tools,
- Benefits for the railway suppliers:
  - develop and provide new light materials,
- Benefits for the railway operators:
  - opportunities for interior refurbishment and better designs at lower cost.

4. CONTENT OF THE PROJECT

The principal ambitious objectives of TRANSFEU project are:

- The development of a FSE methodology adapted to surface transport including innovative fire numerical simulation tools and innovative gas toxic test;
- The development of a realistic fire toxic effect classification system for trains based on a scientific approach by using FSE;
- A wide dissemination of results towards all means of surface transport.

In order to reach these objectives TRANSFEU is organized in three principal parts which will be distributed between seven work packages (WP) of which 5 technical (WP2 to WP6), and 2 transversal. Scope of the all WP work are describe below in 4.1 to 4.7 and the interactions between the work packages are shown at the Fig. 1 (by [1]).

4.1. WP1 Management

WP1 concerns the project management and the follow-up of the whole activities of the project. LNE coordinates the project, supported by ALMA that is specialized in European Projects Management being in charge of the operational day-to-day management tasks allowing the partners to focus on the technical tasks.

4.2. WP2 Fire test for toxicity of fire effluents

WP2 is focusing on:

- the development of a small scale test method to measure the type and quantity of toxic gases produced during the combustion of products used in transport in a dynamic procedure. This method will be used for the classification of products that reach the incapacitation and lethality thresholds in the specific scenarios in WP4 for railway vehicles,
- data processing and introduction in a dedicated database to supply the FSE models to assess the time within which the passengers must evacuate from fire scenario before the first critical conditions are reached.

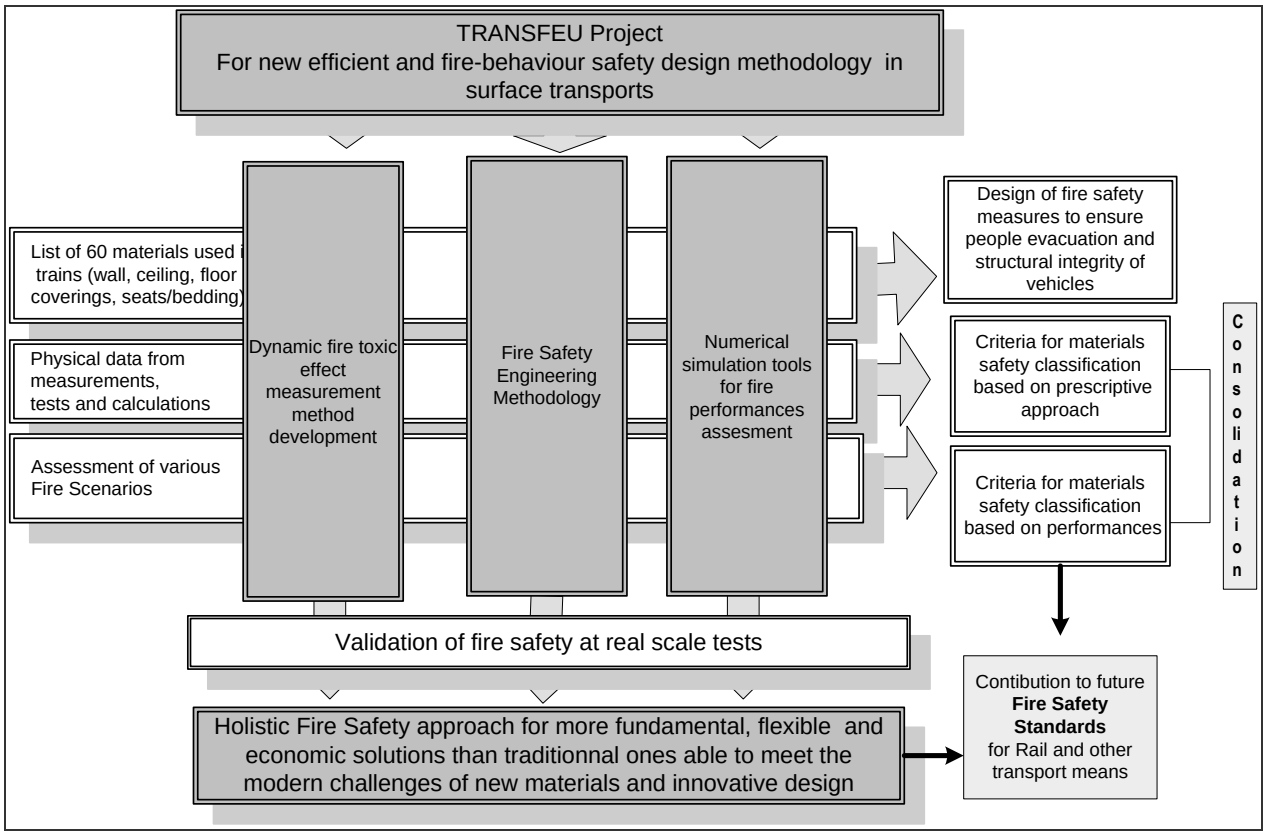

Fig. 1. TRANSFEU concept and the interactions between all work packages
Rys. 1. Koncepcja projektu TRANSFEU i oddziaływanie pomiędzy wszystkimi pakietami roboczymi

4.3. WP3 Development of conventional pragmatic classification system for the toxicity of fire effluents released from products on trains

WP3 deals with the development of 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 TS CEN 45545-2 by late 2010 for its foreseen revision for its vote as a European Norm.

4.4. WP4 Fire Safety Engineering methodology for surface transport

WP4 consists in the development of a holistic fire safety engineering (FSE) methodology for surface transport with special regard to evacuation, rescue, structural integrity and tenability conditions inside the transportation system. This means that all fire effects are regarded as a function of time and the focus is on life safety. It will be possible to use this methodology for proving that alternative designs of vehicles – alternative to prescriptive requirements – lead to an equal level of safety. It shall be applicable to various transportation systems (trains, ships and ferryboats, buses and coaches, etc.). The applicability of the general methodology will be shown in WP5 for the specifics of railway vehicles, i.e. inter alia the typical design features, materials used and necessary safe egress time. Nevertheless the approach will be generic and may be adapted to other areas of surface transport and even for adjoining spaces, e.g. for stations.

4.5. WP5 Development of numerical simulation tools for fire performance, evacuation of people and decision tool for the train design

WP5 is dedicated to:

- the development of numerical simulation tools described in [2-8] for fire performance and evacuation of people adapted to the train scenarios in order to be used in the FSE methodology developed in the WP4,
- a decision tool for the train design.

WP5 has assumed the following Fire risk analysis and Design Fire Scenario:

- Risk analysis based on the following investigations:
  - Analysis of accidental fires with regard to ignition sources, type, intensity and location,
  - Identification of fire hazards (different procedures will be used to identify the hazards; HAZOP, PHA, FMEA etc).
- Design fire scenario will take into account:
  - Vehicle geometry (train, ship, bus),
  - ventilation,
  - passive fire protection (reaction to fire performance of materials and products),
  - fire resistance of structures, escape routes),
  - active fire prevention (detection, smoke extraction, extinguishing).
- Design fire could be determined according to the design fire scenario or conventional approach like TS CEN 45545-1.
- Design fire according to TS CEN 45545-1:
  - flaming source is 3 min duration and average power output of 7 kW generating a flux of (25- 30) kW/m^2,
  - a radiant flux of nominal value 25 kW/ m^2 applied to an area of 0,1 m^2,
  - a radiant flux of nominal value 50 kW/ m^2 applied to an area of 0,1 m^2,
  - flaming source of power 1 kW and 30 s duration,
  - a flaming source generating a radiant flux of nominal value in the range (20-25) kW/m^2 applied to an area of 0,7 m^2 with an average heat of 75 kW for a period of 2 min followed immediately by a flux of nominal value inn the range (40-50) kW/ m^2 applied to the same 0,7 m^2 area with an average heat of 150 kW for a period of 8 min.
- Numerical simulation tools for a FSE study:
  - Fire growth, smoke movements (FDS),
  - Thermal transferes, heat fluxes,
  - Structural behaviour in case of fire,
  - Atmospheric dispersion,
  - Simulation of product reaction or resistance to fire,
  - Toxicity effect.

4.6. WP6 Validation of the conventional toxicity classification and the numerical simulation tools for the prediction of fire effect on people

WP6 addresses the validation of the conventional pragmatic toxicity classification system developed in WP3 with the help of FSE and in the same time the validation of the simulation tools developed in WP5.

4.7. WP7 Exploitation, Dissemination and Contribution to Standards

WP7 will continuously monitor the progress in the project and will provide a means for the project partners to share their knowledge within the consortium and to integrate the research activities as well

as to disseminate and exploit the research results to the community at large. Various dissemination channels will be used such as newsletters, publications, articles, and participation in conferences, workshops and exhibitions. Document on best practices on how to use the fire safety methodology for surface transport will final result of TRANSFEU project. A great effort of dissemination of TRANSFEU results with a significant contribution to European standardization process will also be undertaken. The participation of railway industrials, operators and fire science researchers, professional organizations for railway (UNIFE) and vessels (IMO) and finally standardization organizations (CEN) demonstrates the great interest of TRANSFEU for the harmonization of fire safety in all surface transport.

5. CONCLUSIONS

TRANSFEU main objectives will be to provide:

- A new, accurate measurement tool for toxic gas fire effluents under dynamic conditions for transport application. This new tool will allow a continuous record of gas concentrations versus time to be determined;
- A new and realistic ranking of materials used in railway vehicles according to their toxic effect and their acceptability in trains and other means of transport;
- A methodology able to explore alternative designs, taking into account economical and fire safety requirements, based on fire safety engineering principles and the associated simulation tools.

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