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Dirección General de Servicios de
Alta Velocidad - Larga Distancia

UC
UNIVERSIDAD
DE CANTABRIA

Source: http://www.skycrapercity.com

Real Scale Fire Tests in High-Speed Trains

GIDAI
FIRE SAFETY
RESEARCH & TECHNOLOGY

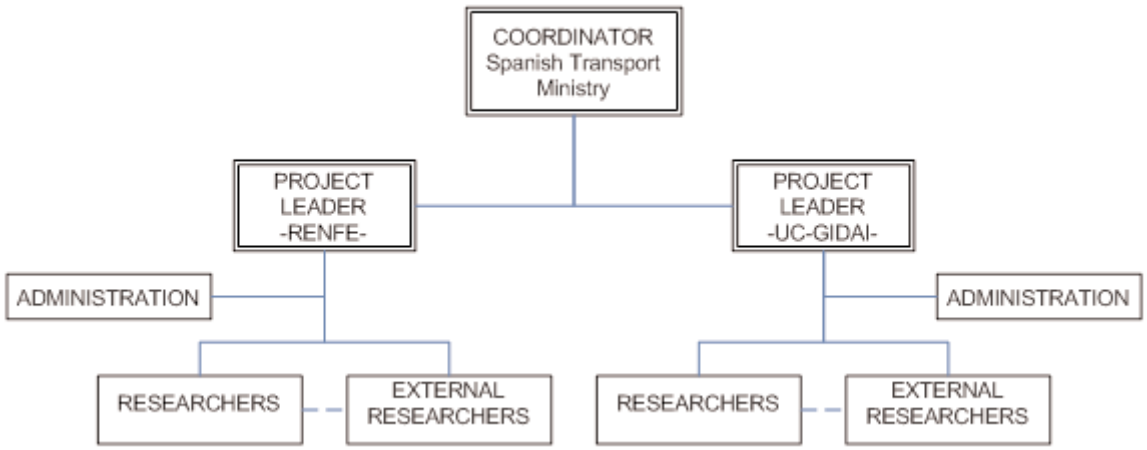
Convocatoria de Concesión de Ayudas a Agrupaciones o Consorcios de Investigación para la realización de proyectos de investigación, desarrollo e innovación tecnológica.
MINISTERIO DE FOMENTO

Introduction

In December 21th 2007, Spanish Transport Ministry Funded for conducting research, development and technological innovation linked to the development of the Strategic Plan of Infrastructure and Transport under the National Plan for Scientific Research, development and technological innovation 2004-2007 was awarded to the General Direction of High Speed-Long Distance Services of RENFE Operadora and the GIDAI Group from the University of Cantabria for the "Real Scale Fire Tests in High-Speed Trains" (BOE. Núm. 306).

Source: http://www.skycrapercity.com

The research team consists of members of the General Direction of High Speed-Long Distance Services of RENFE Operadora, direct by Dr. Jose Antonio Jimenez, Director of Trains and Technological Innovation, and members of the Group GIDAI - Fire Safety - Research and Technology at the University of Cantabria under the leadership of Prof. Dr. Jorge A. Capote and Dr. Daniel Alvear. There is also external collaboration with experts in fire safety in railway passenger transportation.



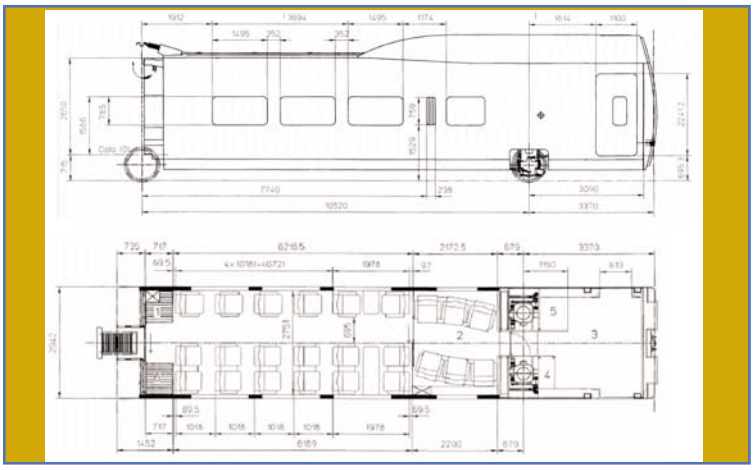

Source: Queensland Fire & Rescue Service

Typology of Trains 112

The Tests program will be realized in a passenger train that will be adapted for it. Test will represent the inside conditions of a Train 112. This Train is a new construction train and it is similar to the Train 102 that nowadays are working in Spain, and it has been manufactured by the consortium Talgo/Bombardier. The firm Patents Talgo SL is the responsibility for producing the cars.

Inside of the train, it will be placed constructive elements and furniture similar to the ones used in the vehicle that at present are in use in order to obtain similar fuel conditions in the vehicle.

Source: http://www.skycrapercity.com



The total length of the train is about 200 m, and the average length of coachs is 13,14 m. That dimension will be taken as a reference for defining the geometry of the coach tested.

To define the conditions of ventilation of the fire was considered the configuration based on individual cars communicated through corridors separated by doors, which provides an environment of the passenger train.

CLUB CAR


Source: Carlos Pérez Amau

DRIVER's CAB

DINING CAR


Source: http://www.skycrapercity.com

PREFERENCE CAR


Source: http://www.skycrapercity.com

High Speed Trains of Passenger are composed of different types of enclosures in which various fire risk factors interact.

OTHER COMPARTMENTS


Source: Neuromancer

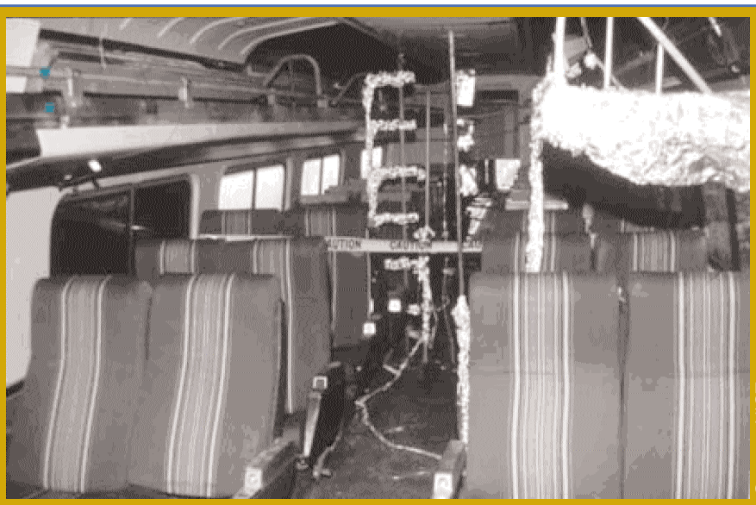
Methodology

The testing programme will be carried out in a passenger train using its structural elements and updating materials and interior conditions in order to represent test conditions similar to the Train 112 inside.

The test program includes the analysis of the fire spread and Safety conditions for people, focusing on the knowledge of the fire manifestations during its use due to the contribution of materials currently used in high-speed passenger trains.

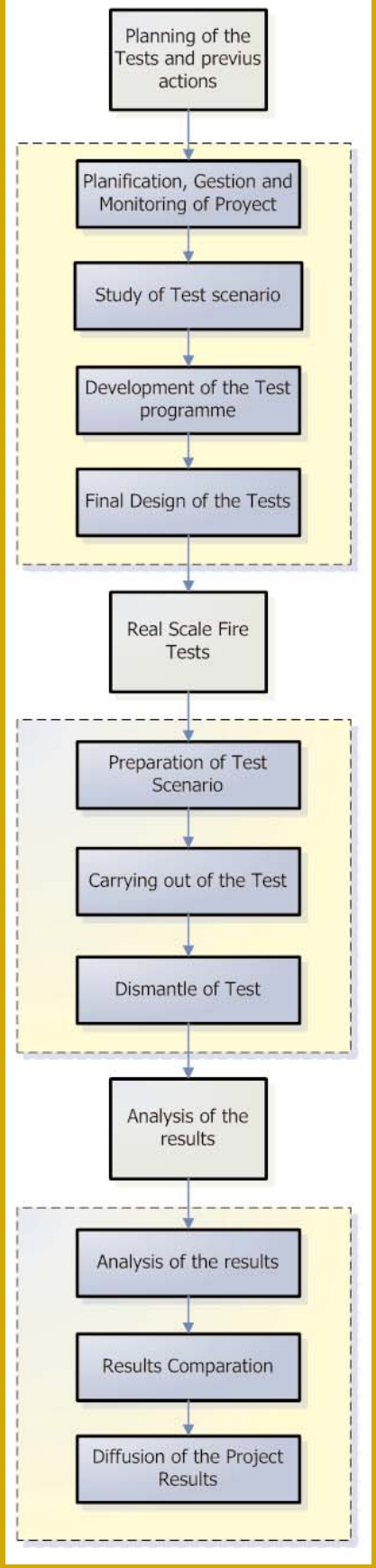
The instrumentation for tests consists mainly of thermocouples, heat flux gauges, obscuration sensors and analyzers of gases concentration (oxygen, carbon monoxide, carbon dioxide, etc.). The thermocouples will be placed in vertical position in order to obtain information of the upper layer temperature, thermal affectation to people and thermal attack to furniture and flooring materials. The heat flux gauge will obtain information of the heat flux to which the surfaces are exposed. Obscuration sensors will collect data of the visibility level in the compartment through the measurement of extinction coefficient which provides an indicator of the level of visibility.

In addition to these measures, the ability to obtain values of heat release rate through the basic principle that relates the level of oxygen consumed versus the amount of energy emitted by combustion of materials will be evaluated. Also, some Fire Safety Companies will prove other commercial sensors for analyzing their ability in Trains.



Source: NIST.

Sensors locations inside a Train.



Methodology designed for the development of the research project.

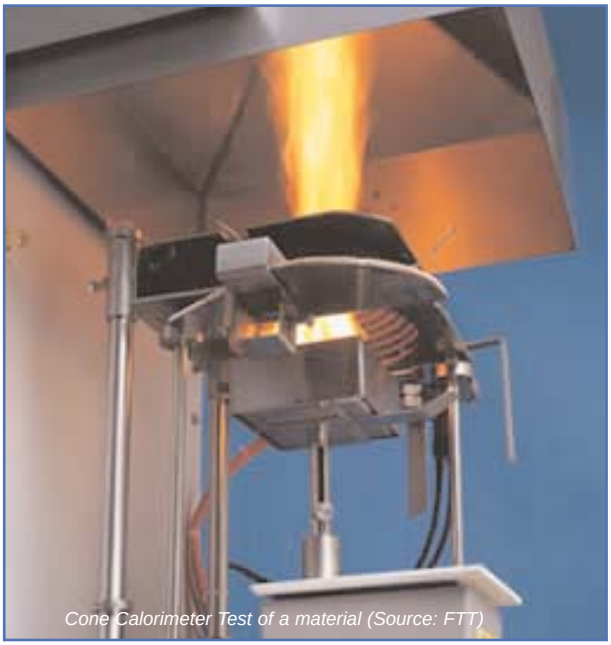
Study of the Test Scenario

A key point for development of the study is the analysis and selection of the Fire Scenario that will be performed on the test, because the successful results of it will come from a good definition of the critical aspects.

This requires a series of prior activities to carrying out the tests which include (1) an analysis of the different parameters to measure, both directly and indirectly, (2) assessing the accuracy of instruments needed to perform these measurements, and (3) conducting preliminary calculations to know preliminarily the conditions of a fire development in the test.

The tests will start with a series of bench scale and intermediate scale tests realized before real scale test in the passenger Train. The tests will be realized in a bench scale Cone Calorimeter for the different materials that are present in the 112 Train and components of the train (eg. seats), so that they provide an estimation of these materials behavior, and provide input to the computer simulations.

Finally, before developing experiments for the calibration of the ignition source will be carried out the test in the full-scale Train compartment. The tests will allow the analyze of different fire scenarios in using conditions.



Cone Calorimeter Test of a material (Source: FTT)

Numbers of Tests	Type of Test	
10	Bench Scale Tests: Cone Calorimeter. 3 samples and 6 heat fluxes per sample.	Floor materials.
		Wall covering materials
		Ceiling materials.
		Thermal and Acoustic Insulation Materials.
		Seat Structural Materials.
		Seat Covering Materials.
6	Calibration Tests.	Calibration of thermocouples and the other instrumentation that will be used during the Tests.
6	Intermediate Scale Tests.	Corner configuration of Fire in a bag.
		Cigarette at the top of a seat.
		Fire in the luggage rack.
1	Real Scale Test.	Corner configuration of Fire in a bag.
1	Real Scale Test.	Cigarette at the top of a seat.
1	Real Scale Test.	Fire in the luggage rack.
1	Real Scale Test.	Influence of the ventilation conditions.

Real Scale Fire Tests

The stage of real scale fire test consists on the following phases that are complemented with the previous studies.

Preparation of the Test Scenario

It will be carried out modifications and/or the necessary adjustments to the facilities of the passenger car tested, including the assembly of the interior design elements for adaptation of the train to the Train 112, the compartmentalization of the different areas (measurement of smoke and HRR), the preparing of the control rooms and checking of instruments and data logger.


Real Scale Fire Test in a Train.
(Source: Queensland Fire & Rescue Service)

Carrying out of the test

Lasts verifications will be carried out in this stage. After that, the tests will be developed and the data of interest will be measured.

Deactivation of Test - Diffusion of the Results

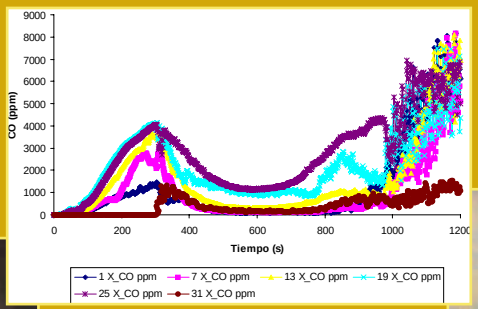
Following the tests, all facilities and instruments mounted will be dismantled of the passenger train and a specific plan for the diffusion of the results will start.

PREVIUS VERIFICATIONS


Source: CSIRO.


Source: http://www.skycrapercity.com

TRAIN ADAPTATIÓN



ANÁLYSIS OF THE RESULTS

REAL SCALE TEST


Source: NIST.

DATA LOGGER


Source: BRE.

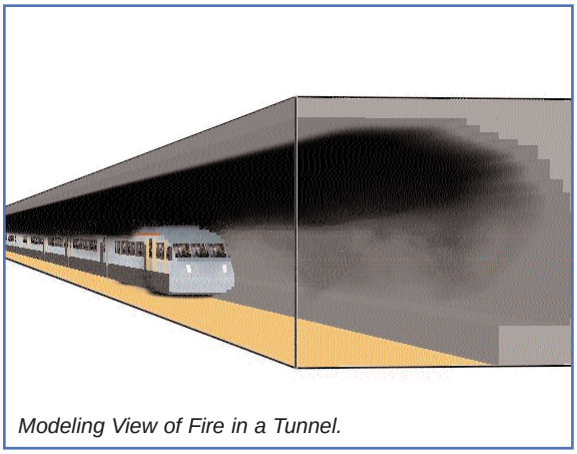
Fire Computer Modeling

'Fire Dynamics Simulator (FDS)', developed by the National Institute of Standards and Technology - NIST (USA) will be the Fire Computer Model used in the project.

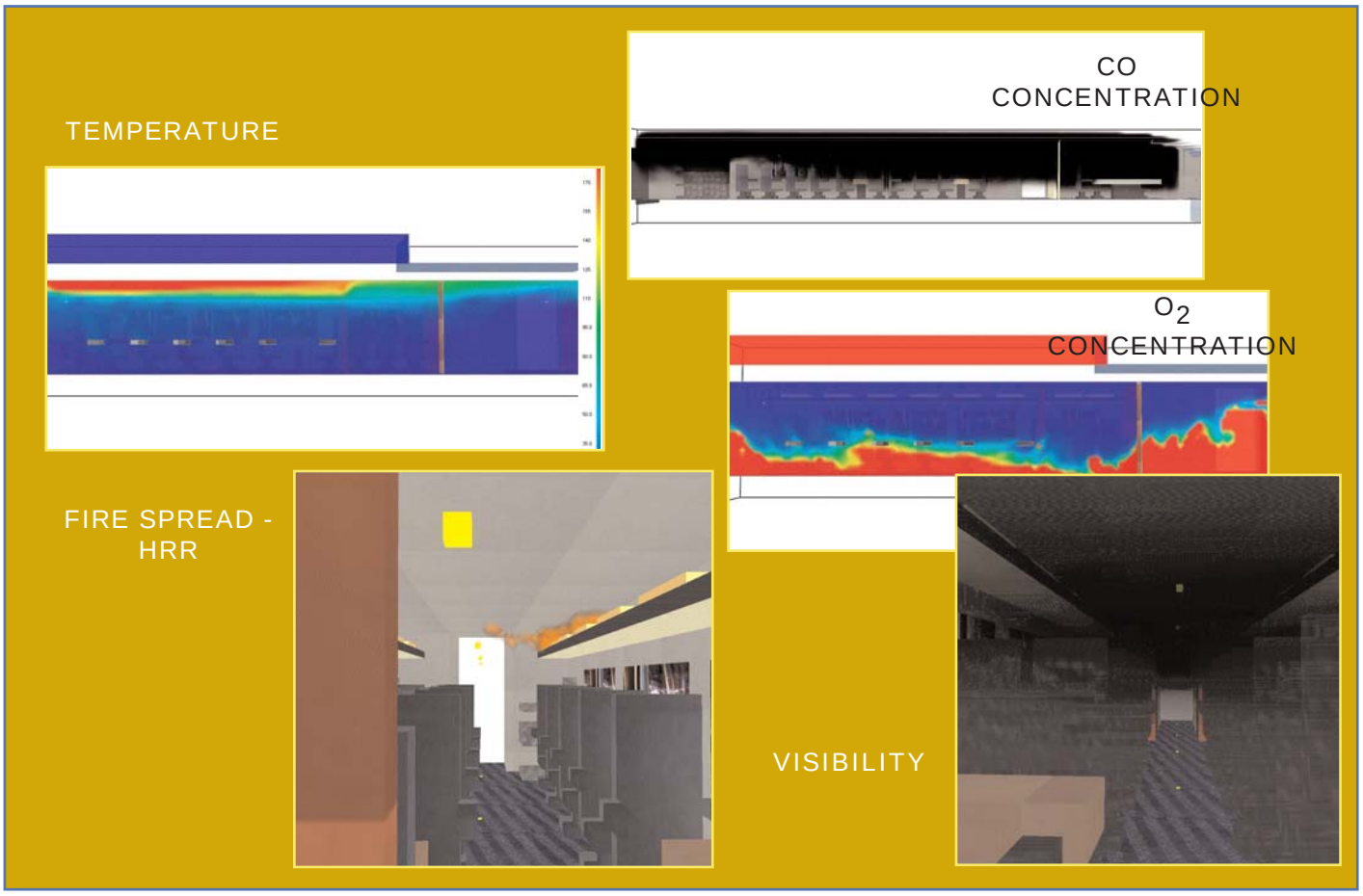
FDS is a computational fluid dynamics (CFD) model of fire-driven fluid flow. It solves numerically a form of the Navier-Stokes equations appropriate for low-speed, thermally-driven flow with an emphasis on smoke and heat transport from fires.

FDS has been aimed at solving practical fire problems in fire protection engineering, after and before the performance of the Fire Tests. The a priori analysis will allow obtaining the fire conditions during the test. Typical output quantities include: Gas and solid temperature, Gas velocity, mass loss rate, Gas species concentration (water vapor, CO2, CO, N2), Smoke concentration and visibility estimates, Heat release rate per unit volume, Mixture fraction (or air/fuel ratio), Gas density, etc.

After conducting the tests, a priori study with the Model will be conducted to check how good are the results for this scenario and use it for a validation of the model.



Modeling View of Fire in a Tunnel.



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