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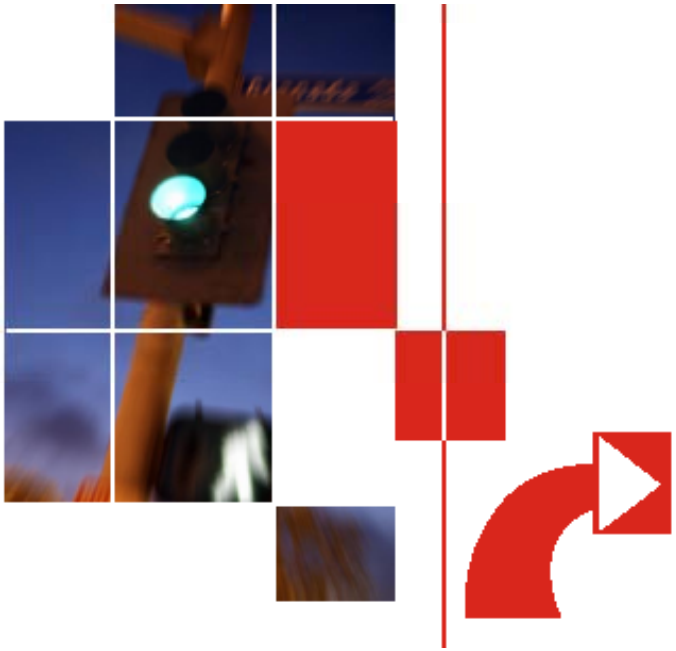

Modelado de situaciones de emergencia en intercambiadores de transporte

Emergency modeling in transport inter-changers

交通换乘枢纽的紧急事件处理模式

Jorge Servert del Rio

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General Framework
总的框架

- Transport inter-changers are a need in large cities.
- 交通换乘枢纽是大城市所必需
- Transport inter-changers leads to:交通换乘带来：
  - Large volume building 大量的建筑
  - High people density and bulk number高的人口密度和数量
  - High combustion loads 高的燃料负荷
  - Complex systems 复杂的系统

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Kind of infrastructures
基础构造的种类

- Car-Bus-Metro- Airplane (Airports)
- 轿车-公共汽车-地铁-飞机
- Car-Bus-Metro (Intown interchangers)
- 轿车-公共汽车-地铁（市中心换乘）
- Car-Bus-Metro-Train (Train stations)
- 轿车-公共汽车-地铁-火车（火车站）

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Interchangers换乘

- Four built with a total investment 250M €
- 将修建4换乘点，总投资2亿5千万欧元

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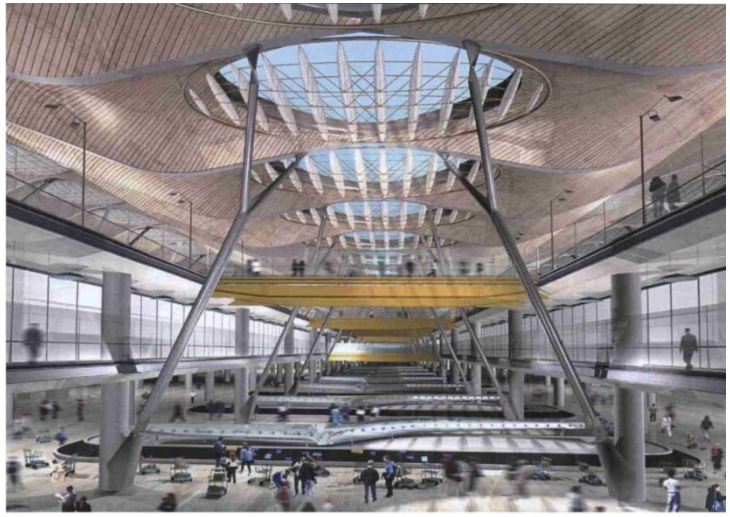
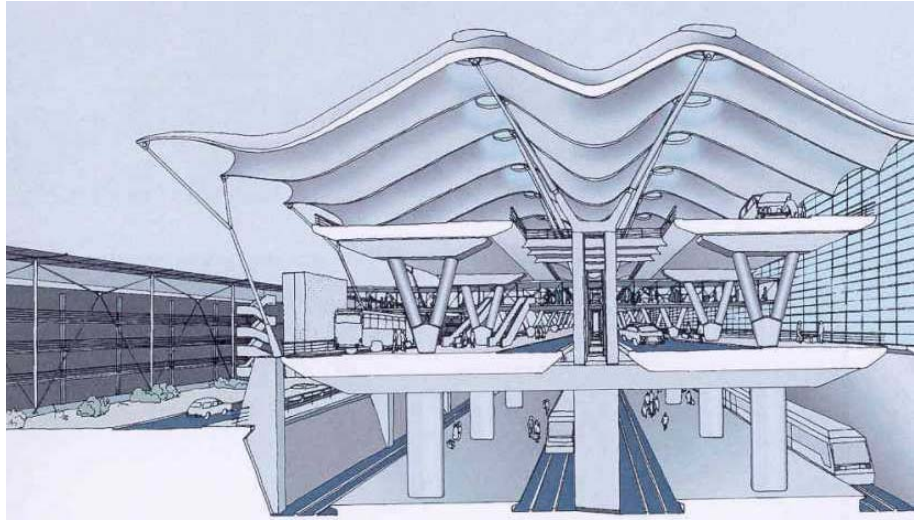
Airport机场

- New Barajas T4 terminal
- 新巴拉哈T4航站台刚刚开始动工。





Train火车

- Two main train stations
- 两个主要的火车站

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Factors要素

- Risks: 风险
  - Intended 蓄意破坏
  - Fortuitous (Fire)偶发因素（火灾）
- Infrastructure: 基础
  - Large Volumes 巨大的数量
  - Passive protection 消极保护
  - Active protection 积极保护
- Human behaviour: 人群的行为
  - Egress 疏散
  - Complex system management 复杂的管理系统
  - Emergency plan 应对突发事件的计划

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First stage第一阶段

Infrastructure knowlege
基础的知识

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Infrastructure knowledge

- Good infrastructure knowledge: 了解基础构造
  - Architecture 建筑
  - Operation 运作
  - Systems 系统
- Risk analysis 危险分析
- First countermeasures 第一措施
  - Infrastructure 构造
  - Organization 阻止
  - Proceedings 过程

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Second stage
第二阶段

Modeling
模型

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Modeling 模型

- Physical modelling CFD 流体力学模型
- Egress modelling 疏散模型
- Effect over people 对人群的影响

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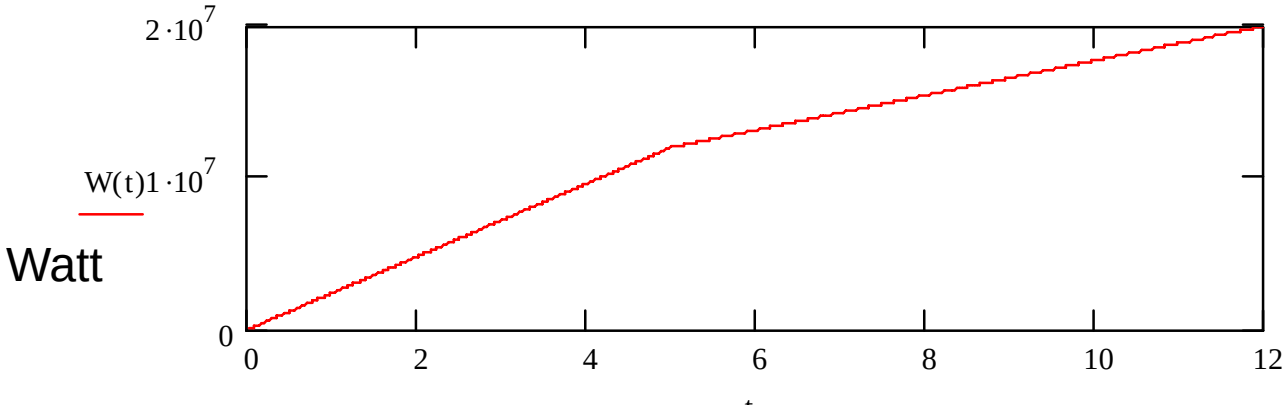
Fire scenario (20 MW 12 min)预想火灾

Table 7-6.1 Fire Data for Typical Vehicles[1]

Cause of Fire	Equivalent Size of Gasoline Pool		Fire Heat-Release Rate	Smoke-Generation Rate		Maximum Temperature[2]	
	ft²	m²	MW	ft³/min	m³/sec	°F	°C
Passenger Car	22	2	≈5	42	20	750	400
Bus/Truck	86	8	≈20	127	60	1290	700
Gasoline Tanker	323–1076	30–100	≈100	212–424	100–200	1830	1000

[1]Source: PIARC Montreal Report, 1995.
[2]Temperature 30 ft (10 m) downwind of the fire with the minimum air velocity necessary to prevent backlayering.

NFPA 502



Watt

minutes

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COMBUSTION MODEL 燃烧模型

- excess oxygen 氧气过剩
- Inferior combustion heat 12.7 MJ/kg O2 次等燃料热度
- $CH_{1,5}$ characterize fuel 燃料特点
- CO2 mass fraction:CO2质量分率
  - YCH / YCO2 = 0,039, YCO / YCO2 = 0,04, YS / YCO2 = 0,17,
  - YHCN / YCO2 = 0,0013, Y HCL / YCO2 = 0,011, YHBR/YCO2= 0,007.
- Source: 来源
  - "Fires in Mass Transit Vehicles: Guidelines for the evaluation of Toxic Hazards" apéndice D realizado por National Academy of Sciences de Estados Unidos "Handbook of Fire Protection Engineering 2nd edition" de la SFPE
  - “大众交通工具火灾：有毒危险物质的评估方针”美国国家科学院
  - ASSESSMENT OF THE FIRE PERFORMANCE OF SCHOOL BUS INTERIORCOMPONENTS NISTIR 4347 realizado por el NATIONAL INSTIUTE OF STANDARDS AND TECHNOLOGY de Estados Unidos
  - 校车内部火势的评估：美国国家标准和技术协会

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Physical modelling 物理模型

- Turbulent fluid mechanics 液体紊乱力学
  - Mass 大众
  - Momentum 动力
  - Energy 能量
  - Turbulence: (SST, Menter 1994)紊乱
- Additionnally: 附加
  - Radiation model: P1 放射模型
  - Soot (smoke solid particles) absorbitivity model 烟雾吸收模型
  - Boundary conditions 条件界定
- Computational Fluid Dynamics model based on finite volumes (commercial code CFX) 计算流体动力学模型基于有限的容量

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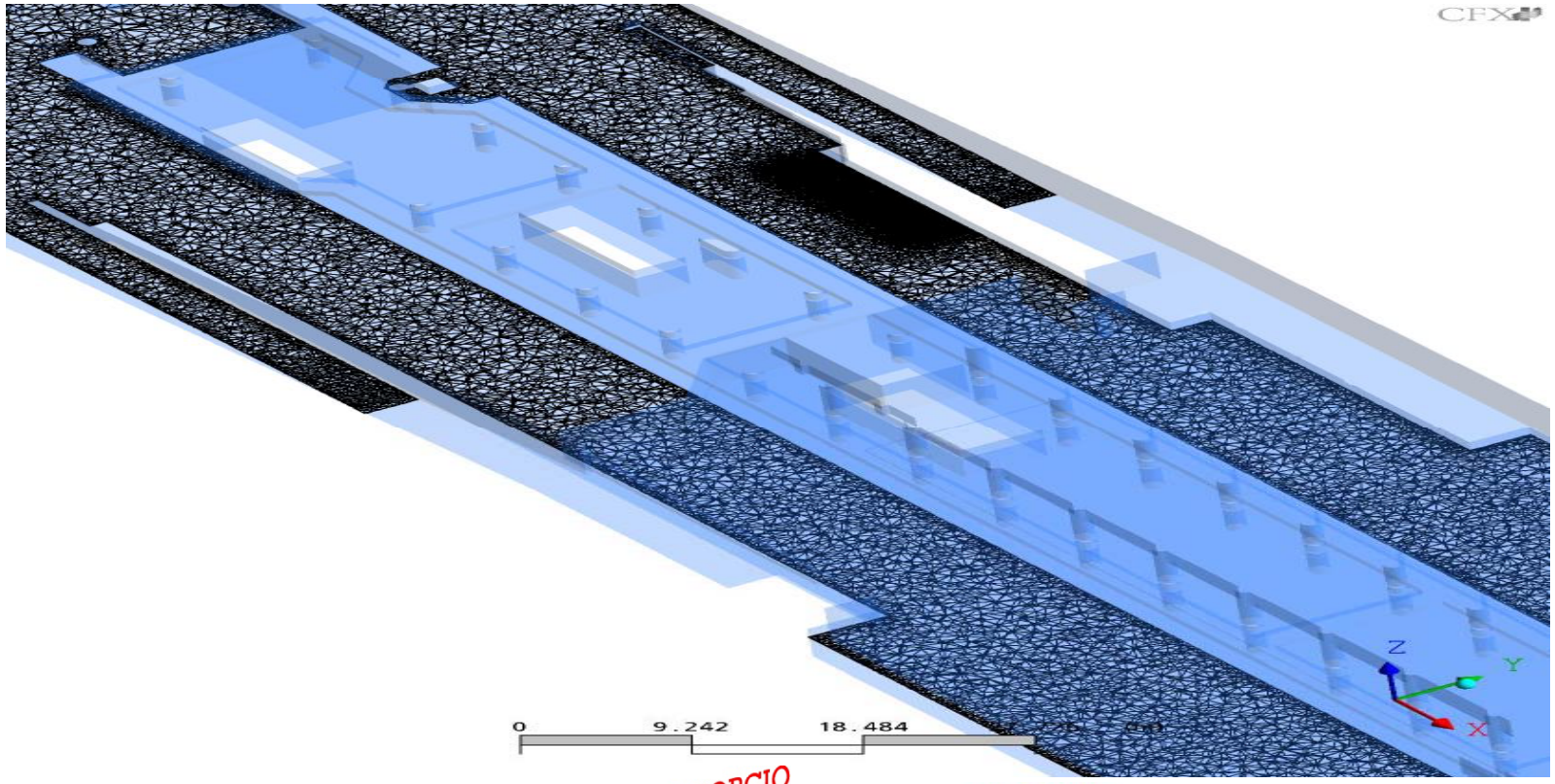
Geometry features 几何特征

- Tetraedric grid counting 2.935.220 cells.
- Simulation of a Bus fire on –2 floor 2层公共汽车火灾模拟
- No physical barriers to the fire nor extinguisher means
- 没有物理障碍也没有灭火手段



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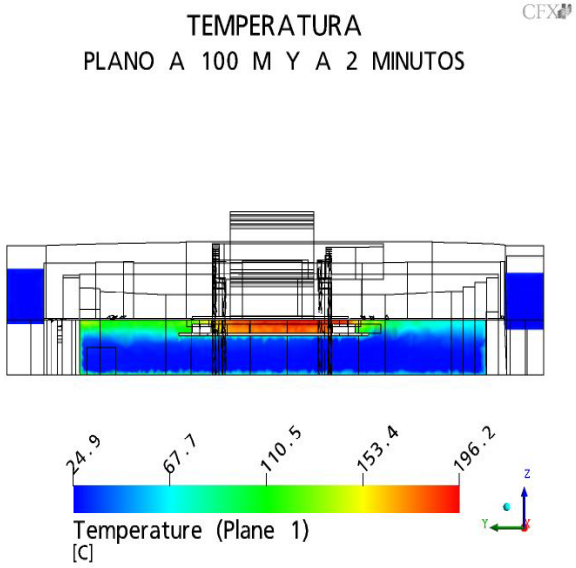
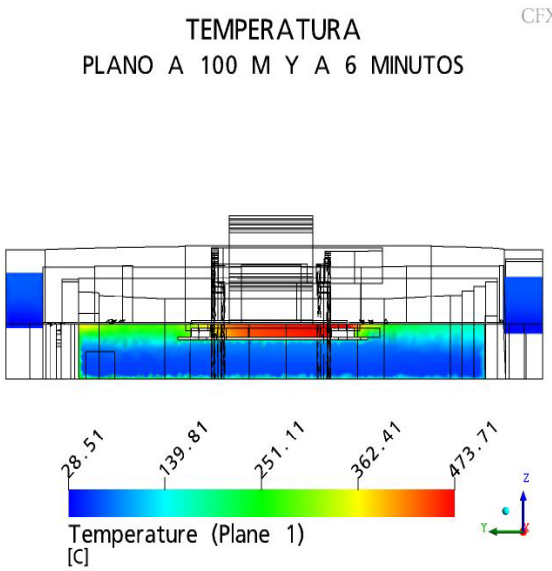
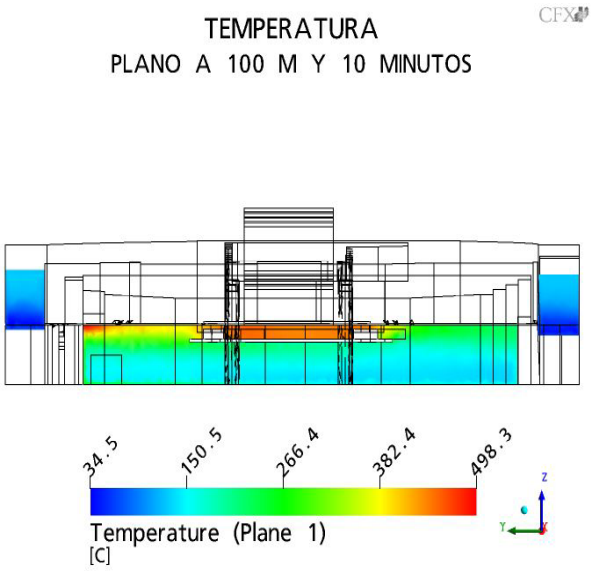
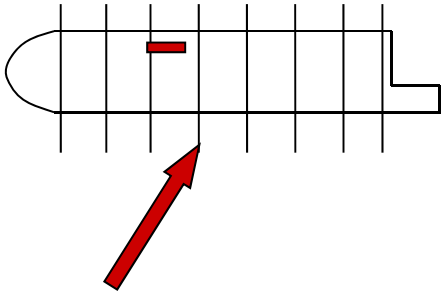
Temperature evolution
温度的发展过程









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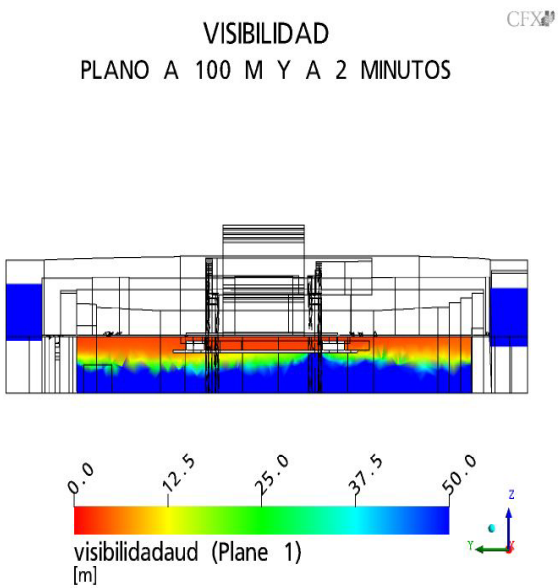
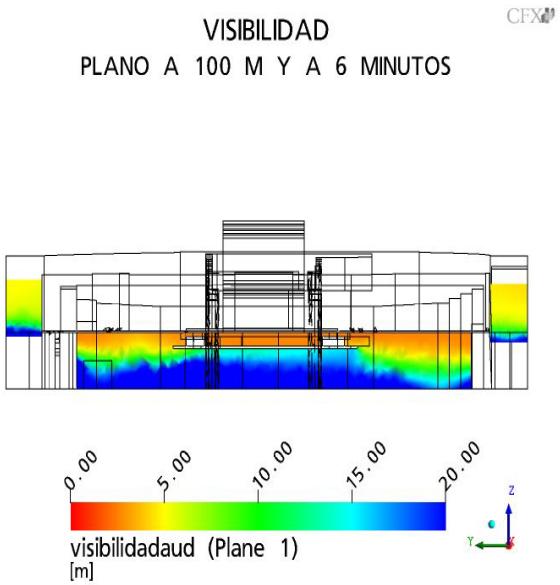
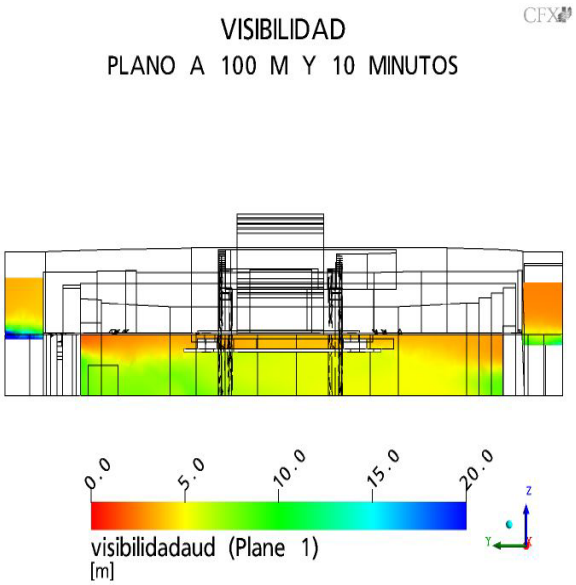
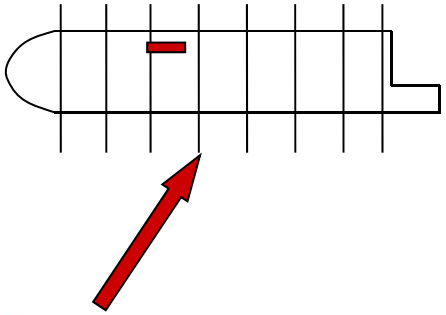
VISIBILITY EVOLUTION
能见度的发展过程









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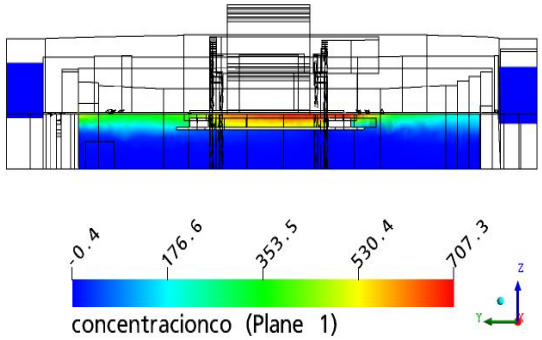
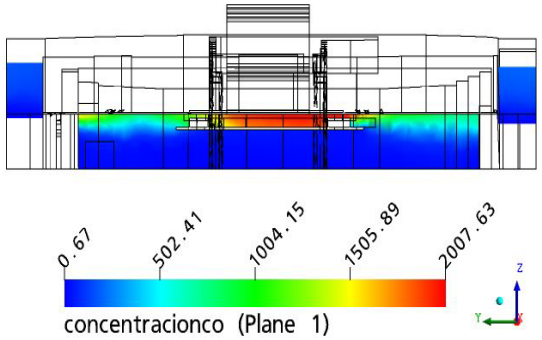
EVOLUCIÓN DE LA CONCENTRACIÓN DE CO
一氧化碳的集中过程

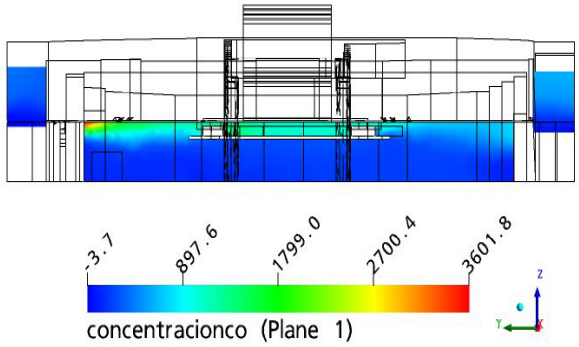
CONCENTRACION CO ppm
PLANO A 100 M Y A 2 MINUTOS

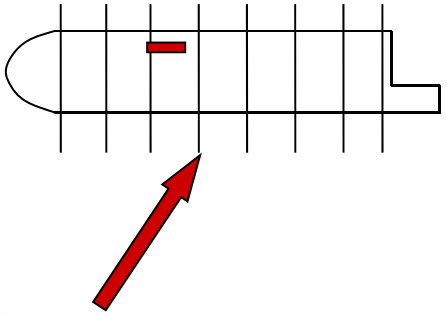


CONCENTRACION CO ppm
PLANO A 100 M Y A 6 MINUTOS



CONCENTRACION CO
PLANO A 100 M Y 10 MINUTOS





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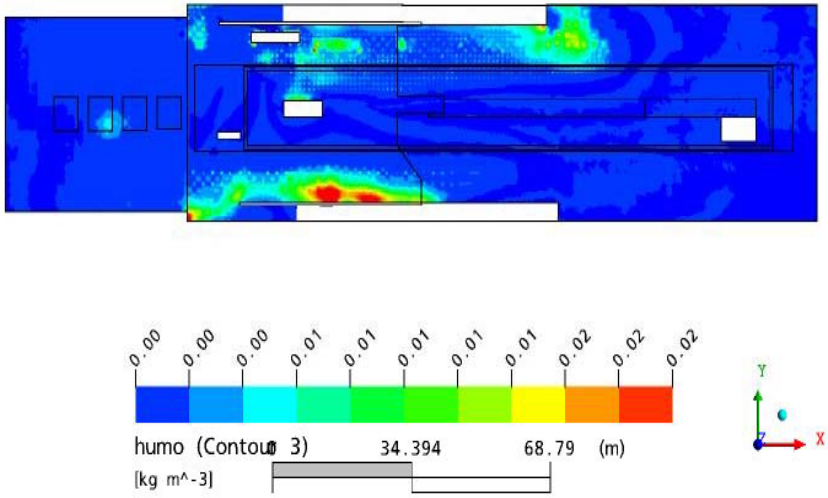
INSTALACIÓN DE MAMPARAS
屏风的安装

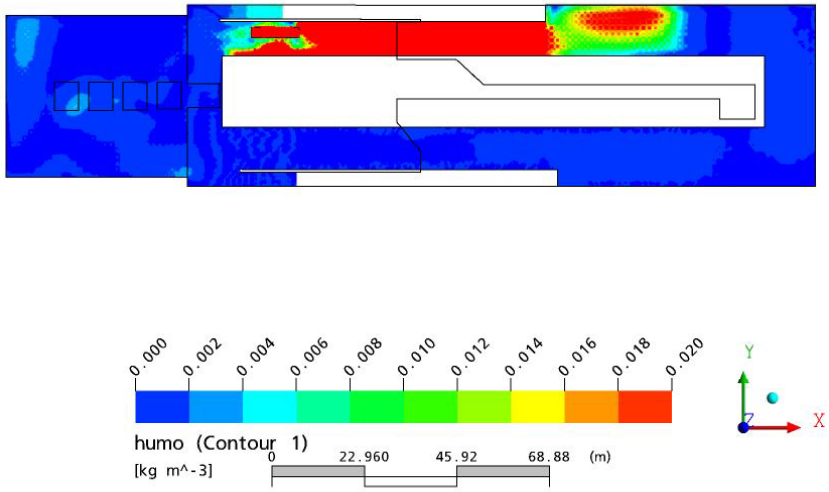
Time a 2 min

Base case 基本状况



t = 2 minutos

Case with partition screens被隔开的状况



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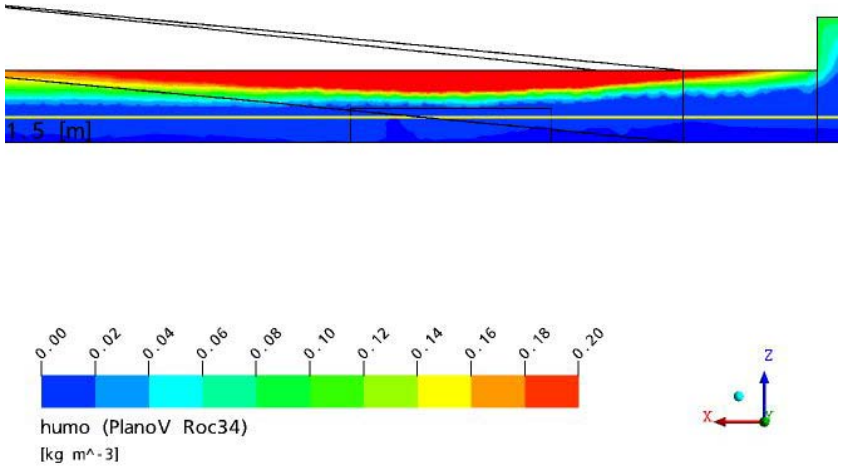
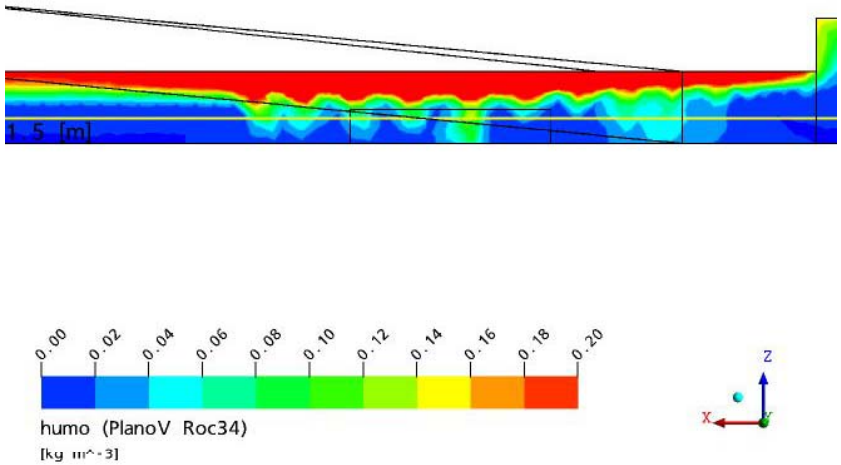
RED DE ROCIADORES AUTOMÁTICOS

- Simulation with 44 sprinklers (4x11) every 3 m. 44自动喷水装置的模拟，每3分钟
  - Decrease smoke by mechanic action (not by thermical action)
  - 机械排烟（不是由热的运动）
  - They are useful only in the nearby the flame
  - 火焰在附近时才有效

Base case 基本状况



Sprinklers case 有自动喷水装置的状况



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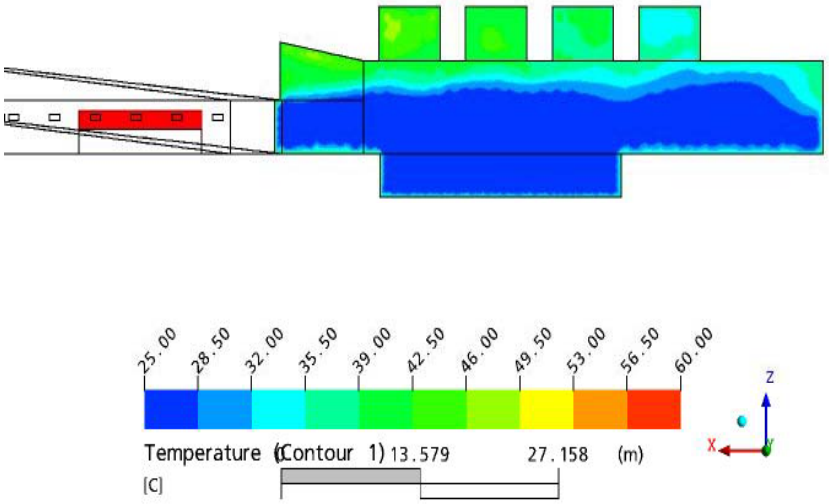
Forced extraction 强制排放

- at 400º C during 2 h. 2个小时达到400摄氏度
- Extraction occurs only nearby the fire
- 火焰在附近时才排放

Time a 2 min

CFX

Caso mamparas 有屏风的时情况

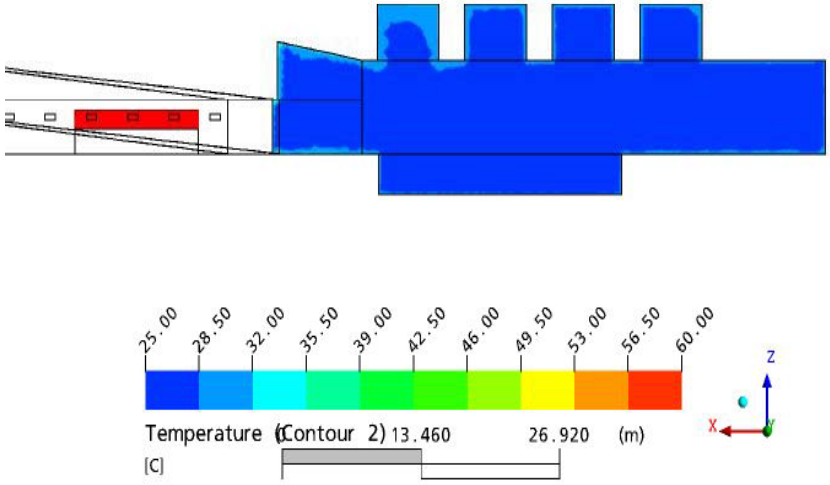


Time a 2 min

CFX

Caso mamparas + extracción

有屏风加排烟时的情况



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Egress 疏散

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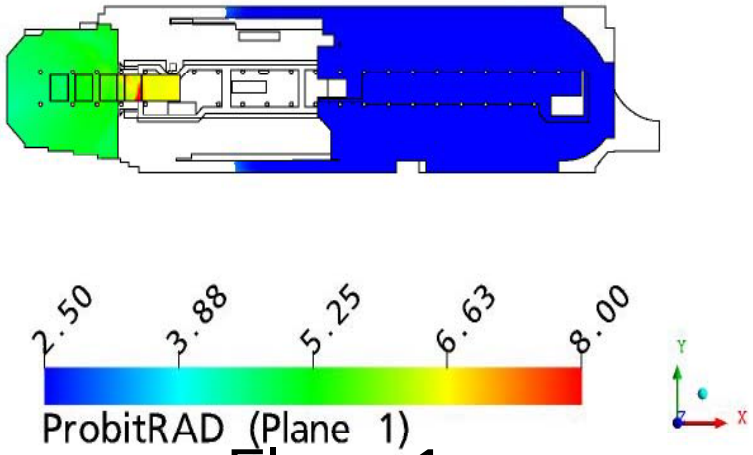
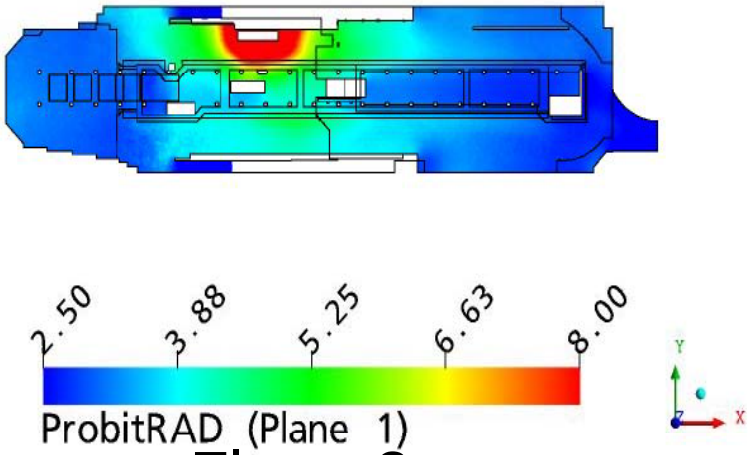
Effect over people
对人群的影响
Probit概率单位



Floor -1



Floor -2

Time 10 minutes

10分钟之内

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Damage evaluation 损伤评估

- Life 生命
- Harms over people 对人的伤害
- Infrastructure 基础结构
- Service recovery 服务的恢复
- System failures 系统故障

Redesign 重新设计

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