

Contribution of IRSN R&D to reducing the risks of airborne pollutants dispersion during the dismantling of nuclear facilities

L. Ricciardi, L. Bouilloux, F. Gensdarmes, E. Porcheron, C. Prévost

IRSN (Institut de Radioprotection et de Sûreté Nucléaire), PSN-RES, SCA, 91192 Gif-sur-Yvette, France

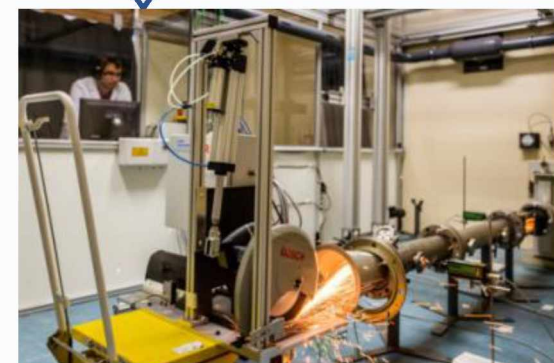
INTRODUCTION

Dispersion of radioactive substances during dismantling operations constitutes a major risk, especially for workers. To assess and reduce this risk, IRSN conducts research work on four main topics: **aerosol source term**, **contamination transfers**, **behavior of containment equipment** and **airborne contamination metrology**.

EXPERIMENTAL MEANS

CAPIMIF

Source emissions of cutting processes and performances of spark arrestors



DISCO

Aerosol resuspension factor due to the fall of contaminated objects



TOSQAN

Aerosol resuspension and mitigation by pool/spray scrubbing



MASSALE

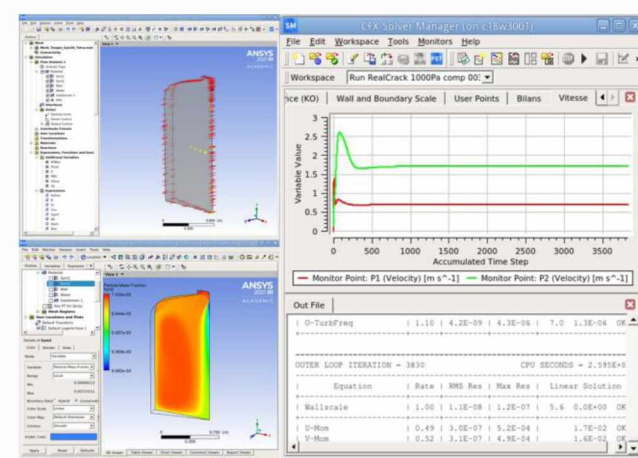
Pollutant leakage through openings on depressurized site airlocks



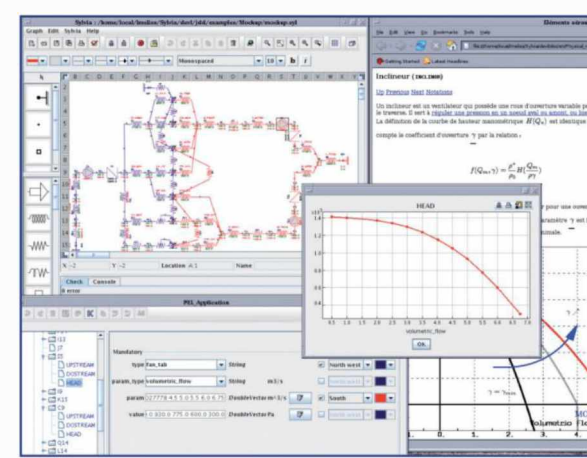
ICARE

Behavior of radioactive aerosol measurement systems

NUMERICAL MEANS



ANSYS CFX® / CALIF³S
CFD codes with specific IRSN models related to aerosol physics [1]



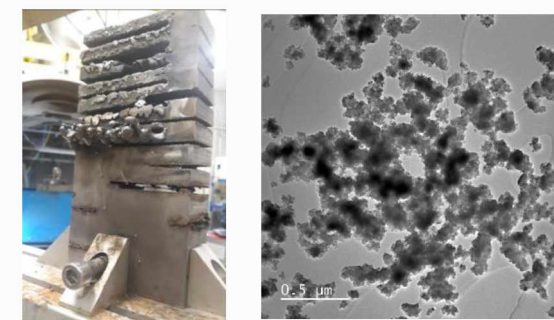
SYLVIA
IRSN zonal code for flow behavior and pollutant transfers in a ventilation network

R&D ON AEROSOL SOURCE TERM

Cutting of materials

Since 1990s, IRSN has been conducting several research projects aimed at characterizing the production of airborne particles emitted by materials cutting [2-3]. More recently, IRSN is involved in a French consortium to assess the production of secondary emissions generated by the cutting of the corium of Fukushima damaged reactors [4].

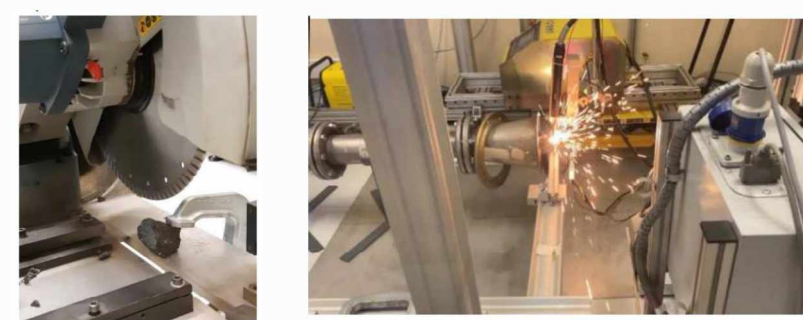
Materials: steel plates or blocks, simulants of corium (in-vessel, ex-vessel),...



Laser cutting of stainless block and submicronic particles produced (LD-SAFE European project)

Cutting tools: laser Nd:YAG (CEA's facility) in air and underwater, grinder, plasma torch,...

Measurements: mass concentration, particle size distribution and morphology



Cutting of corium simulant with a grinder and a plasma torch in the CAPIMIF facility

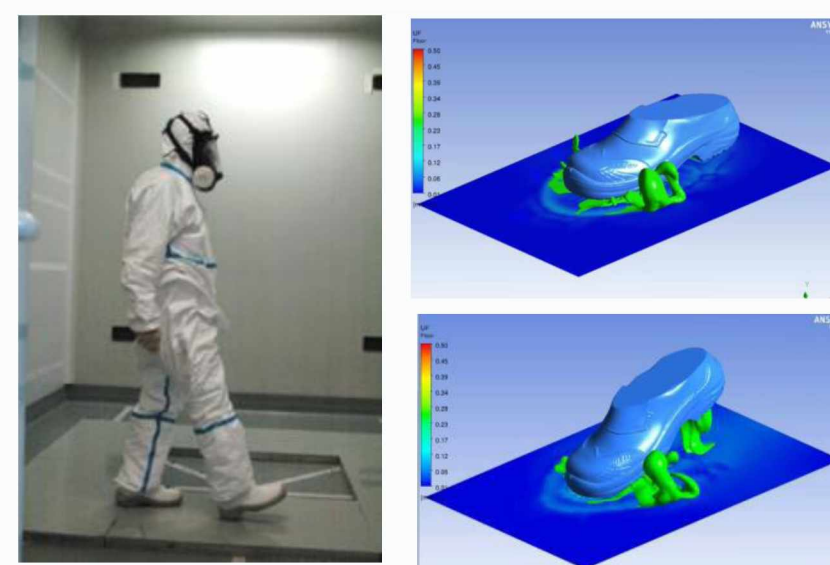
Concrete bush-hammering



Scarifying operations of a concrete slab using a manually propelled industrial milling machine

Concrete structures of nuclear facilities can be activated by the neutron flux (or their surfaces may become contaminated) and must be cleaned up. IRSN measured the particle airborne release fraction during concrete scarifying operations in a confined ventilated chamber (CSTB's facility) [5].

Walking on contaminated floor



Aerosol resuspension during operator walking

Aerosols resuspension due to operators' walking was evaluated by experiments in a ventilated room and by CFD simulations of the pose and lifting of a shoe on the ground.

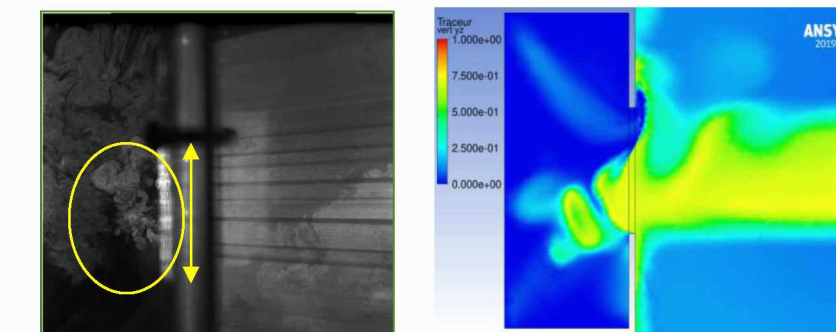
R&D ON CONTAMINATION TRANSFERS

Efficiency of the confinement provided by site airlocks

A dynamic confinement is applied to depressurized enclosures (airlocks) to prevent the leakage of pollutants outside. ISO 16647 standard recommends maintaining a constant value for inward inflow velocity near each nominal or accidental opening, but flow inversion can occur and lead to pollutant leakage. IRSN research enabled a velocity criterion to be defined [6].



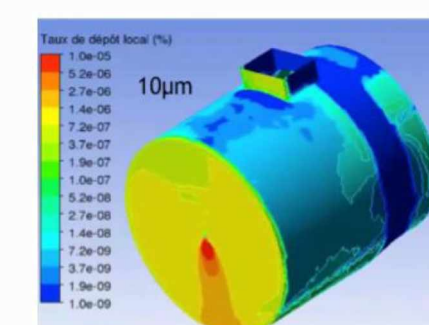
Flexible airlock in the MASSALE facility



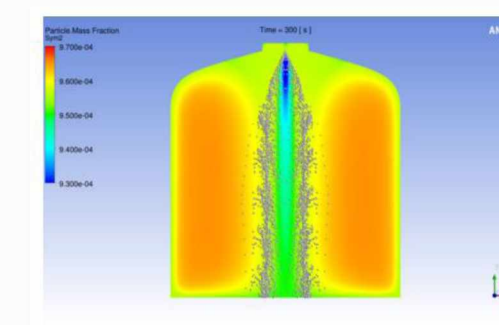
Pollutant leakage through an opening on a depressurized enclosure, induced by an internal counter-jet

Performance of capture and mitigation means

In the framework of Fukushima corium retrieval, IRSN simulated the aerosol transport and deposition inside the reactor pedestal due to the airflows coming from the laser cutting head and assessed the efficiency of sprays to help mitigating the dispersed aerosols [7].



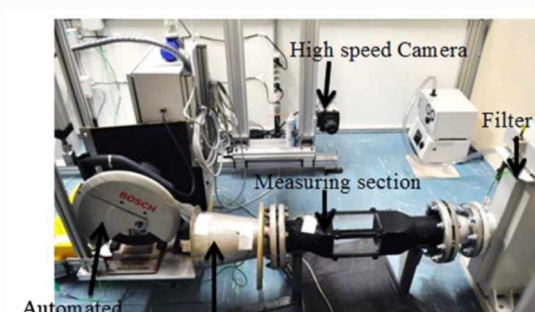
Deposition of 10 µm aerosol on the pedestal of the damaged reactors of Fukushima Daiichi



Aerosol scavenging by spraying droplets in the TOSQAN facility

R&D ON BEHAVIOR OF CONTAINMENT EQUIPMENT

IRSN measured the characteristics (temperature, diameter and velocity) of the incandescent particles produced by a cut-off grinder or a plasma torch [8], and the performance of different spark arrestors aimed at protecting HEPA filters [9].



The CAPIMIF facility with the measuring section of incandescent particles



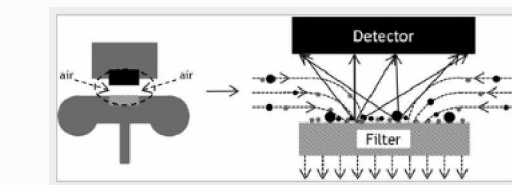
High-speed camera visualization of incandescent particle trails



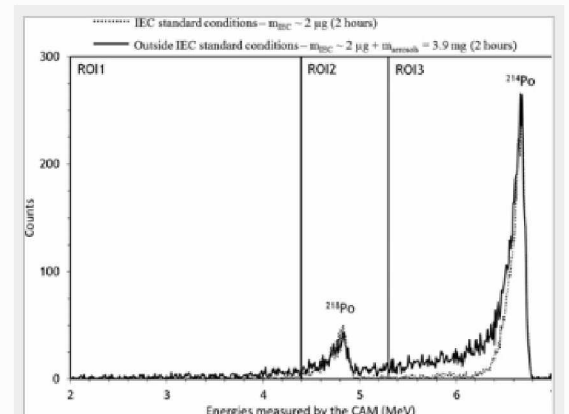
Spark arrestors and HEPA filter tested

R&D ON AIRBORNE CONTAMINATION METROLOGY

IRSN performs assessment and research on Continuous Air Monitoring systems (CAMs) in IEC standard and other conditions. In particular, the presence of dust during dismantling operations can generate false alarms. A correlation was highlighted between the background of the natural radon progenies and the aerosol mass of coarse non-radioactive aerosols sampled by the CAM [10].



Deposition of natural radioactive and non-radioactive particles on the filter of the sampling head



Energy spectra measured by the CAM under IEC standard condition and under simulated dismantling site conditions

CAM used for the study on the impact of the coarse indoor non-radioactive aerosols on the background radon progenies' compensation

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