

## Radiological Analyses and Criticality Safety

### Licensing, Optimization and Emergency Preparedness

#### Challenge

Radiological analyses are not only input to conservative safety demonstrations for nuclear power plant (NPP) licensing, but provide also input to best-estimate assessments, e.g.:

- Emergency preparedness toolboxes for the NPP crisis center
- Interpretation of normal operation conditions and releases to the environment
- Support to equipment qualification and equipment aging studies
- Optimization of radiation fields for medical or industrial applications.

For guaranteeing acceptance by the regulatory bodies each type of analysis requires to find the sweet spot of appropriate level of detail in modelling and sufficient simplicity to provide economic competitiveness. National and international requirements as well as legal regulations to protect workers and survey personnel have to be followed strictly.

Radiological analyses are typically performed with expert or custom-made tools and require special know-how in nuclear physics, radiation transport, chemistry and dosimetry, as well as a good understanding of relevant processes in the target facility and its layout.

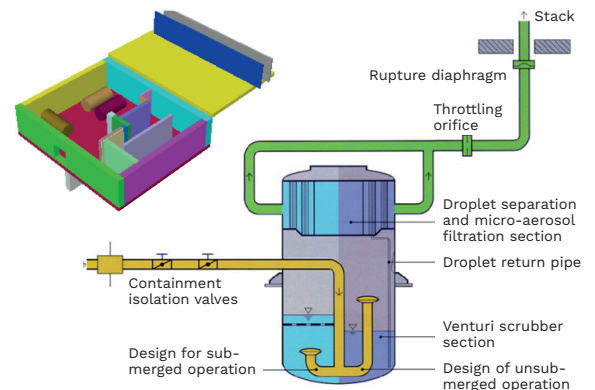
#### Solution

Framatome's sophisticated and versatile radiological analyses and studies support NPP operators and medical and industrial partners worldwide. Our methodology addresses existing and foreseeable situations for design, licensing and emergency preparedness taking a variety of plant-specific data into account, like airborne release (immediate or continuous, evaporation of liquids, equilibrium processes), multi-compartment transport (active ventilation, leakage pathways, bypass), radioactive decay and ingrowth, removal processes (filters, dry deposition, spray) and individual chemical characteristics.

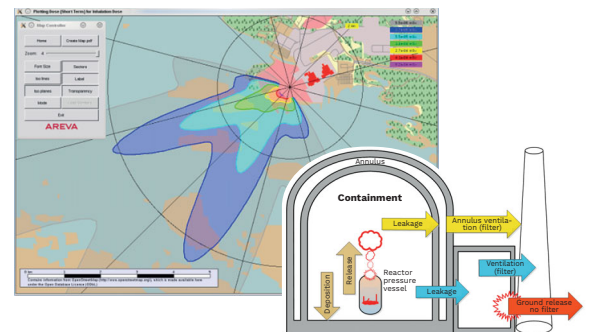
Our analyses comprise shielding and activation studies, nuclear fuel burnup studies, fluence and embrittlement calculations, activity flow analyses and radiological characterizations for nuclear facilities.

Our source term assessments can be coupled to:

- Atmospheric and aquatic dispersion simulations for determining the doses to the environment for radiological consequence analysis
- Point-Kernel and Monte-Carlo gamma and neutron transport codes for computing radiation doses inside and outside buildings and the plant periphery.



Assessment of radiological conditions during filtered containment venting



Atmospheric dispersion simulation with Central Radiological Computer System

#### Customer benefits

We offer you:

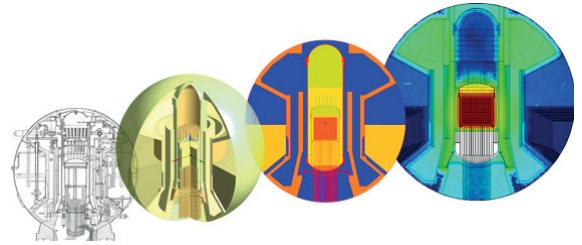
- High expertise in different regulations and long-term experience with diverse foreign customer requirements
- Support of NPP's radiological staff during normal operation and within accident situations
- Improvement of NPP's emergency preparedness
- Compliance and fulfillment of national and international regulations
- Adaptation to various specific requirements by the use of sophisticated in-house tools with high intuitive GUI-based (GUI: graphical user interface) programs and state-of-the-art tools like MCNP, RANKERN and SCALE

**Your performance**  
is **our everyday commitment**

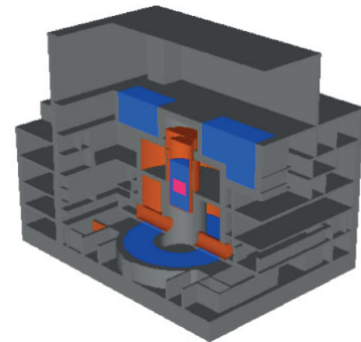
## Technical information

Our versatile radiological analyses and studies include:

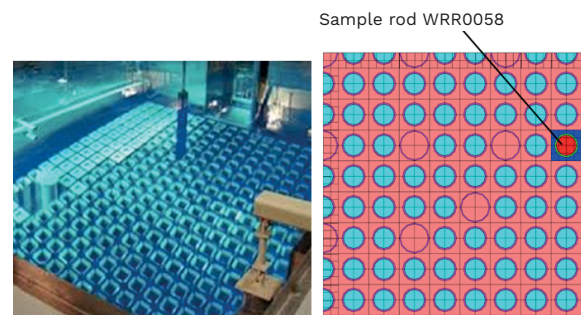
- ALARA procedures based on dose rate mapping of all relevant working areas, compartments, transportation routes, storage areas and components in the plant
- Shielding design and building layout reviews
- Neutron and gamma flux calculations (displacement per atom, reactor surveillance, equipment qualification)
- Calculations of nuclide-specific activity inventories
- Criticality analyses (burn-up credit analyses for transport, storage and re-criticality assessments for severe accident scenarios)
- Assessment of radioactive releases in water and air during normal operation and accident conditions
- Assessment of atmospheric dispersion and radiological consequences for design and licensing taking into account complex topographies, vegetation times and zones, wind fields and wet/dry deposition
  - Dose calculations (cloud-shine, inhalation, beta submersion, ground-shine, ingestion)
  - Dose maps
  - Contamination of foodstuff
  - Radiation exposure to the public (pre-operational, operational and post-operation phase)
- Central Radiological Computer System
  - Installed on site with interface to local instrumentation and control
  - Automatic assessment of current plant conditions
- Evaluation of time-dependent activity inventories in compartments, their distributions and the corresponding dose rates in the reactor building during a severe accident
  - Graphical severe accident dose rate maps.



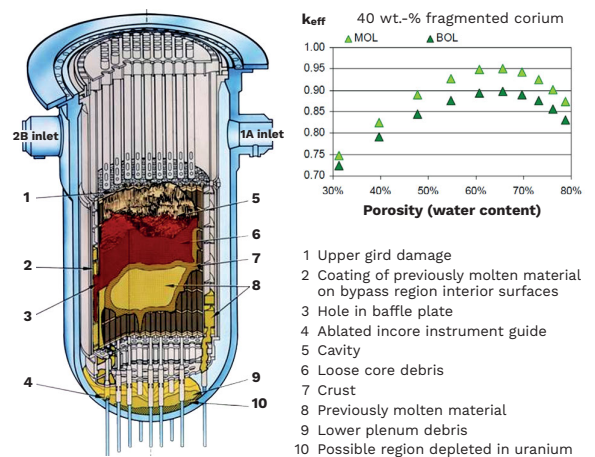
Neutron flux calculation result



Dose rate maps for severe accident conditions



Burn-up credit criticality safety analyses



Re-criticality under core accident conditions

## References

We have performed radiological and criticality analyses for customers worldwide in Belgium, Brazil, Canada, China, Czech Republic, Finland, France, Germany, India, Lithuania, Japan, Netherlands, Romania, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Turkey, United Kingdom.

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