

# Reducing the radioactive aerosol emissions from Forsmark 1, 2 and 3 (BWR)

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- Introduction
- Scope
- Methods and equipment
- Results and possible actions
- Summary and conclusions

## Background

- Forsmark NPP has set a goal to reduce emissions of radioactive aerosols, airborne particles mainly originating from corrosion products such as  $^{60}\text{Co}$ .
- This presentation is a brief summary of the work done over the last three years.

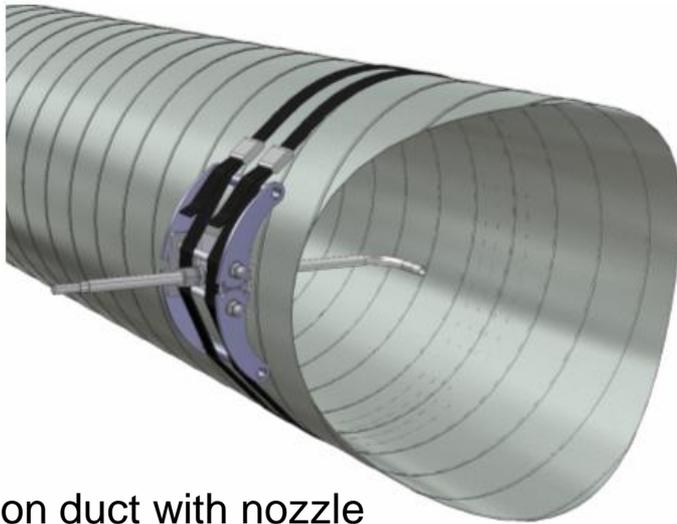
## How do we reach the Goal?

- Recommend possible actions/modifications to reduce emissions of radioactive aerosols.
  - Correlate aerosol discharges, measured in the exhaust ventilation, with events in the plant.
  - Develop instrumentation and methods for air sampling in ventilation ducts.

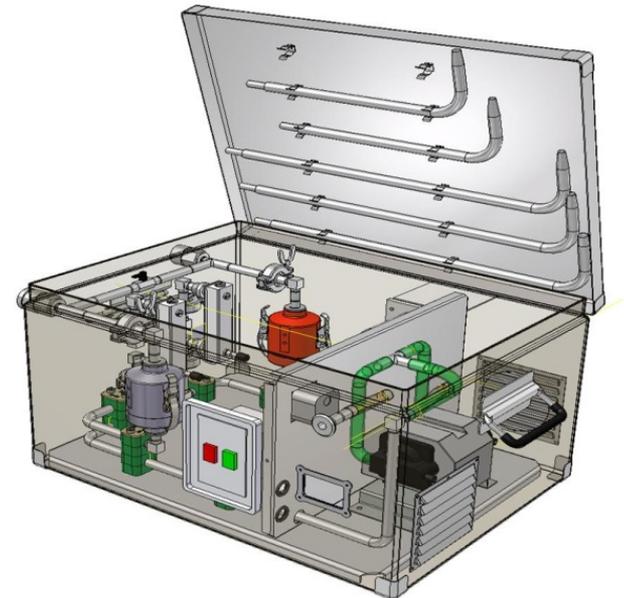
- Mapping aerosol sources
- Methods and equipment
- Aerosol emission during outages
- New equipment for cleaning the reactor pool
- Direct the exhaust airflow to filters during leaks in the primary system
- Mobile filter/fan units
- Filtration during evacuation of empty fuel bottles
- Filtrating of exhaust ventilation from the reactor hall
- Other filter banks in the ventilation system

# Methods and air sampler equipment

- The ventilation air is sampled through a nozzle inserted in the duct and led through a filter cassette using isokinetic flow
- The filter cassette is the same type that are used in the main stack monitoring system and it is analyzed for aerosol content using gamma spectrometric
- Portable air sampler and strategically sample points
- The equipment is developed at Forsmark

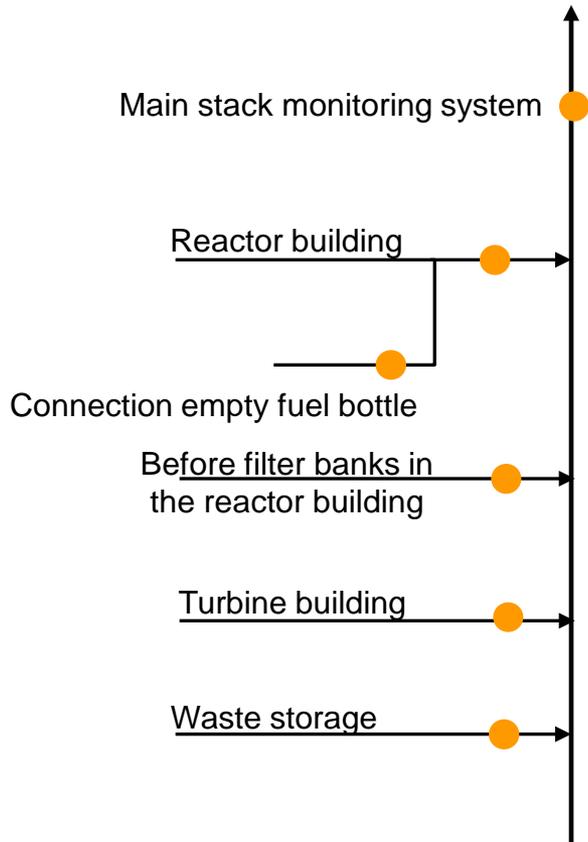


Ventilation duct with nozzle



Air sampler with particle filter

# Mapping of aerosol sources at Forsmark

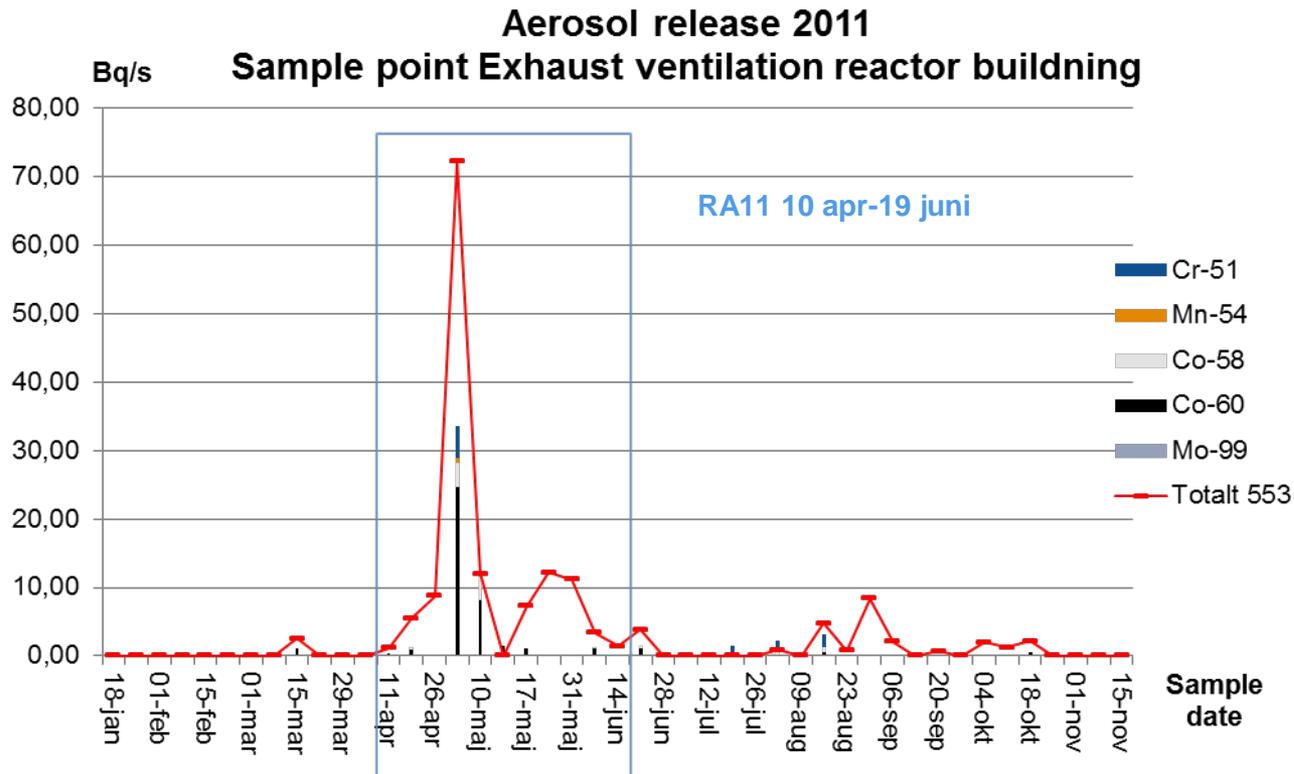


To map aerosol sources we have studied when and where aerosol discharges take place.

- Air samples from different parts of the ventilation system
- Correlation with events in the plant

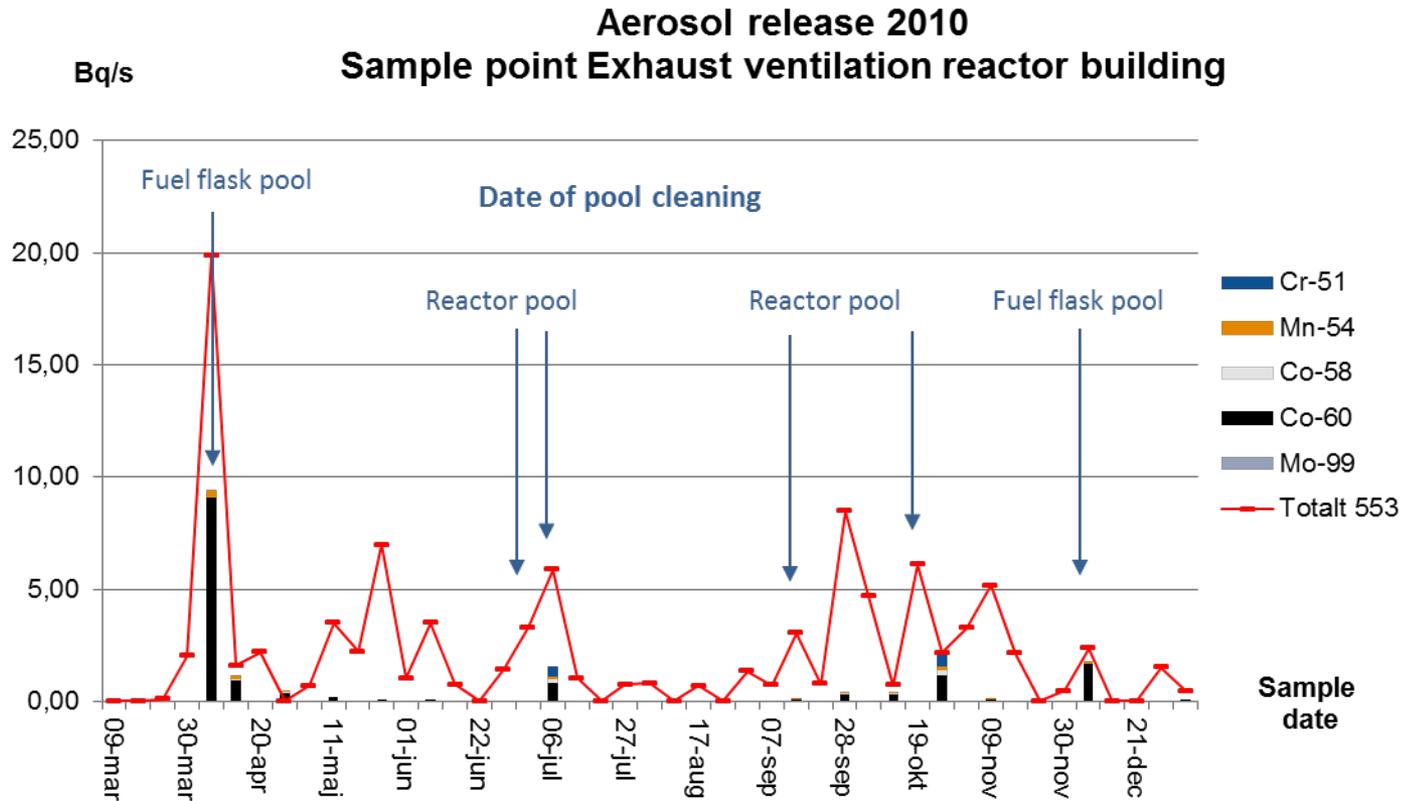
# Results from the outage period

- Forsmark 1, outage period 2011



# Results from cleaning the pools in the reactor hall

- Forsmark 3, pool cleaning 2010



# New equipment for cleaning the pools in the reactor hall

Pool cleaning, some times by using high pressure washers, can result in large emissions of aerosols.

There is no filtration of the exhaust ventilation from reactor hall.

- New prototype for testing
- Cleaning under water
- Improved cleaning
- Faster cleaning
- Reduced dose to operating personnel



# Direct the exhaust air to filter banks

## Filtration of exhaust air during leakages from primary systems

If a leak appears in a system carrying warm pressurized water in contact with the reactor, it is possible to direct the ventilation from that room to filter banks.

Leakage in the primary reactor systems is a significant source of aerosol releases and can:

- Generate a large amount of radioactive aerosols over a short period of time
- Be difficult to identify when and where small leaks occur
- The new air sampler can improve the work with identifying leaks and has been used for that purpose at both Forsmark 1 and Forsmark 3

# Mobile fan units with HEPA filters

This study also includes:

- When and how to use mobile fan units in a nuclear plant
- A market research for existing and suitable units

Mobile fans units with HEPA filters are suitable to use during work with internal parts, such as mechanical processing, brushing and polishing.



# Filtration of the exhaust air

## **Filtration of air during evacuation of empty fuel bottles**

Analyze of air samples collected during evacuation of empty fuel bottles indicates aerosol releases. Today the evacuated air passes to the exhaust ventilation without filtration.

## **Filtration of the exhaust air from the reactor hall**

A considerable part of the released activity during a year derive from the outage period. There is an ongoing study evaluating the possibility to filtrate the exhaust air from the reactor hall.

## **Improved status of exhaust air filtration at Forsmark**

In order to prevent spreading of contamination it is essential that all pre-filters and HEPA-filters in the exhaust systems work efficiently. To achieve that Forsmark has increased the frequency of testing and changing the filters.

## Recommendations

Recommended actions can be either to prevent discharges of aerosols or filtration of released aerosols.

- Direct the exhaust air during aerosol leakages to filters
- An extended use of mobile filter/fan units
- Filtration of evacuated air during water filling of fuel bottles
- New equipment for pool cleaning
- Increased frequency of testing and changing filter in the exhaust system

## Ongoing work

- We are during outages targeting specific activities to increase our understanding of how much they contribute
- Education of the personnel to increase awareness

## Conclusions

- Aerosol emissions correlate with the degree of contamination, surface area, time exposed and dampness (if a surface is wet it reduces the aerosol emissions).
- By analyzing data from the event- and emission correlation study we are able to optimize where:
  - Events occur that could benefit from actions to help reduce the emission of radioactive aerosols.
  - New filters could be introduced
- Education of the personnel is essential to get an increased awareness regarding aerosol emissions

# Thank you for your interest!

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