Competences and measurement needs in environmental surveillance and emergency preparedness

Metrology for regulatory
Pia Keski-Jaskari, 23.10.2023

National Measurement Strategy in Finland

- Published in 2022 by Ministry of Interior.
- The changing security environment has placed demands on the maintenance of a common situational awareness, early warning capability and preparedness, highlighting the importance of cooperation between authorities and societal actors and the ability to communicate and provide guidance to the population.
  - Rapid, versatile measurement and analysis methods that can identify different types of radiation are needed to build up the real-time situational picture.
  - Different measurement methods, e.g. alpha, beta, gamma, neutron.
  - It is pointless to measure the external dose rate if, for example, the contamination is caused by plutonium or polonium.
  - There must be a broad understanding of the situation by the various authorities, but not all of them need to be experts.
  - **However, measurements must be reliable to give a correct picture of the situation.**

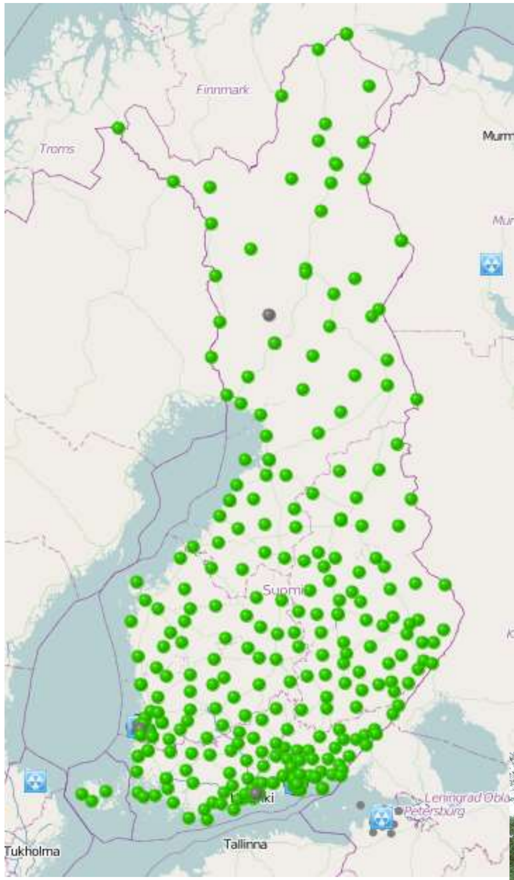
Actions in measurement strategy

- The objectives of the Radiation Measurement Strategy are focused on four different areas:
  - maintaining and developing measurement skills and competences
  - critical radiation measurements
  - common situational awareness among public authorities
  - guidance to the public on radiation measurements
- For each of these regions, different development needs and means have been identified to achieve the objectives of the strategy.
- These cover actions in the early and intermediate phases.

External dose rate network

- Monitoring of ambient external dose with a network of 255 monitoring stations.
- Stations have a dose rate detector and rain sensor. Some stations equipped with a spectrometer.
- Calibrated once in five years.

- Challenges in the measurement:
  - Contamination, how to detect contamination without a separate hand measurement. In case of emergency situation this is important issue but also in malevolent use of radiation.
  - Uncertainty in measurements if they are used in estimation of public exposure.



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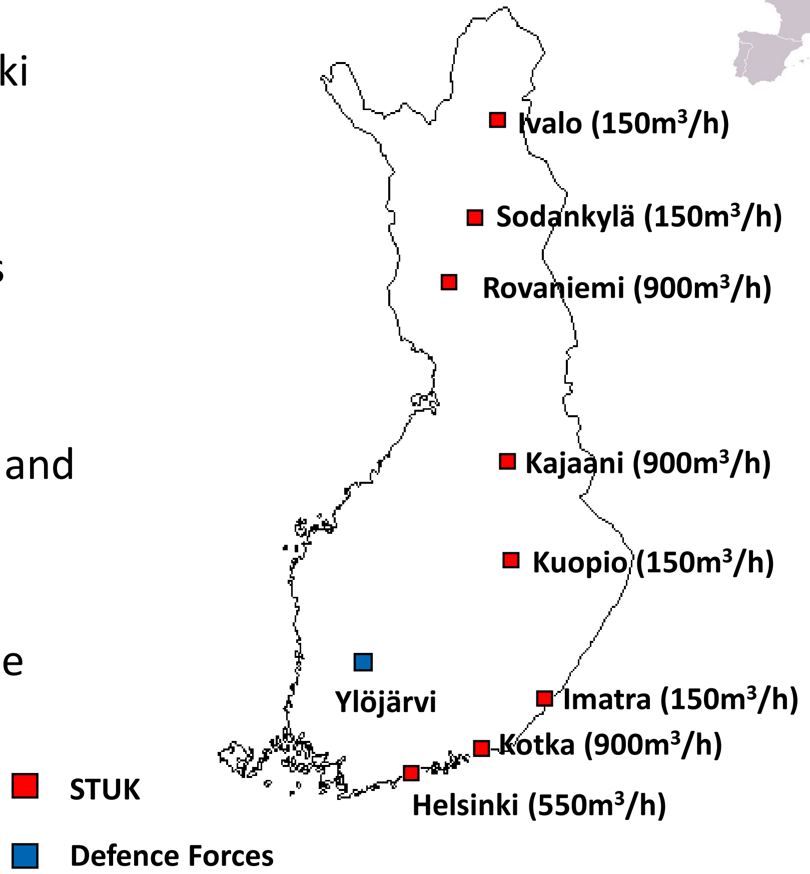
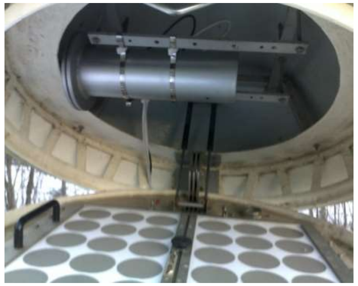
Radioactive substances in ground-level air

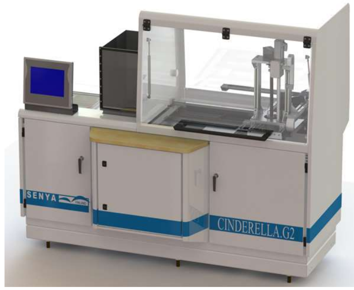
- STUK operates a network of 8 high volume aerosol samplers
- Collection of daily particulate filters in Helsinki (automatic sampler)
- Weekly particulate filters from other stations
- Analysis of gamma emitting nuclides in filters
- Detection limits below 1 µBq/m^3 for many relevant nuclides
- Several days delay between end-of-sampling and analysis results
- 4 sampling stations around NPPs
- Car-borne measurements using STUK's mobile laboratory
- Portable samplers



Sampling equipment and station infrastructure

Senya Snow White
- flow rate 900m^3/h
- Camfill Farr Media glass fiber filter, area 1400 cm^2
- TEDA activated charcoal filter, volume 0.5 l (carbon flow rate ~12 m^3/h)
- Manual filter change

Senya Cinderella
- flow rate 550m^3/h
- Camfill Farr Media glass fiber filter, area 670 cm^2
- Auxiliary manual sampler (Hunter) with TEDA impregnated charcoal filter available for emergency monitoring
- Automatic sample change and measurement (HPGe)

Senya Hunter
- flow rate 150m^3/h
- Camfill Farr Media glass fiber filter, area 420 cm^2
- TEDA activated charcoal filter, volume 0.5 l
- Manual filter change

Challenges:
- Particle size collected
- Air flow , retention at the filter
- Uncertainty estimations for air amount collected !

Fallout sampling

PIRKKO

Dry and wet deposit

Ritva

Tritium collectors

Challenges in collection:

- representativeness and its uncertainty
- a sufficient amount of constitute to representative sample
- (minimum size of the sample collector) -> uncertainty of the sample

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Field measurement

- The field measurement used:
  - Civil protection meter, external dose rate measurement
  - Backpack, cointaining external dose rate measurement, neutron measurement, $LaBr_3$
  - Mobile car with mobile radiation measurements
- Challenges in the measurement:
  - waiting time until the meter is stable, varies by type of measurement, the meter may give erroneous results if you do not wait until the device is stable
  - Activity concentrations are estimated based on external dose rate measurement. Uncertainty for activity measurement need to be estimated.
  - In field sampling e.g. air, uncertainty in the air amount.
  - Distance for automatic measurement e.g. laser correction for results?

Surface contamination measurement

- The field measurement used:
  - Civil protection meter equipped with external surface contamination measuring head
  - Surface contamination meter

- Challenges in the measurement:
  - Waiting time until the meter is stable, varies by type of measurement
  - Distance from the surface.
  - the meter may give erroneous results if you measure radioactivity from different distances. However, you can not keep device too close to the contaminated surface.
  - Measurement of alpha activity using surface contamination meter. Detection efficiensy, need to be very close to the contaminated surface.
  - Alpha activity measurement at normal air pressure?
  - Uncertainty ?

Laboratory measurement

- Different kind of equipment available on the market:
  - E.g. HPGe and NAI detectors
- Requires different skills and financial investment.
  - HPGe is expensive and demands high-level competence.
  - NAI is less expensive and easy to use if you are not a hard-core expert. Suitable for routine measurements e.g. Rn-222, Cs-137.
- Challenges in the measurement:
  - HPGe: high resolution, suitable many kind of measurements but needs competence.
  - NAI: low resolution if the sample contains several radioactive substances emitting different gamma rays.
  - Uncertainty estimates are challenging, requires demanding and wide-ranging skills.



In general, for laboratory measurements:

- The specifications of the device depend on, among other things.
  - What is being measured (alpha, beta, gamma)
  - The level of radioactivity to be measured
  - The skills required to maintain and measure the instrument
  - How much money is available for the purchase of the instrument
  - Uncertainties allowed for different measurement situations

Some thoughts about future needs in general

- Research and development of measuring instruments, different kind of radiation measuring instruments are needed, especially for field measurements, on-line measurements. These are needed e.g. food industry, waterworks where the sample flow is continuous.
  - Uncertainty estimations for these kind of measurements are lacking.
- Measurements in emergency situations need uncertainty estimations if the results are used to estimate public exposure and exposure of radiation worker
  - reliability and speed must be ensured. In such a situation, a lot of different meters will be used, how their data flows will be managed in (almost) real time.
- In the event of a large-scale accident or deposition, the availability of measurement and calibration services will be a bottleneck. This will also involve the introduction of new quantities (ICRU 95). Measurement used in situation should comply with the standard.
- From authority perspective, there must be resilience for these measurement and calibration services (not just meters), including across national borders.

Thank you !