G. Lizin – N. Kelly – J. Végh – R. Dielmann – M. Helmecke – W. Raskob – V. Grigoryan – A. Amirjanyan – M. Simonyan – K. Haroyan

EU Support to Establish an Early Warning Radiation Monitoring Network and to Enhance Nuclear and Radiation Emergency Response Capabilities of the Republic of Armenia

EUROSAFE 2019

CONTENTS

- **The lecture presents an international cooperation project funded by the EU**
- Instrument for Nuclear Safety Cooperation (INSC) and recent INSC projects in Armenia – J. Végh (EC JRC)
- Current status of nuclear and radiation emergency preparedness and response in Armenia – V. Grigoryan (ANRA)
- Design and implementation of the Early Warning Radiation Measurement System – M. Helmecke (Bertin GmbH)
- Installation and customization of the JRODOS decision support system in Armenia – W. Raskob (KIT)
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Instrument for Nuclear Safety Cooperation (INSC) – 1.

- The INSC is a funding instrument established and operated by the European Union
- Main objective: promotion of a high level of nuclear safety, radiation protection and efficient safeguards in eligible third countries* by financing projects supporting
  - The promotion of an effective nuclear safety culture and implementation of the highest nuclear safety and radiation protection standards and improvement of nuclear safety
  - Responsible and safe management of radioactive waste (RAW) and spent nuclear fuel (SNF), as well as remediation of former nuclear sites and facilities
  - The establishment of frameworks and methodologies for the application of efficient and effective safeguards of nuclear material
- INSC budget in the current 2014-2020 period: **€225 million** for 7 years

**INSC covers all third countries, but priority is given to accession and neighbouring countries*

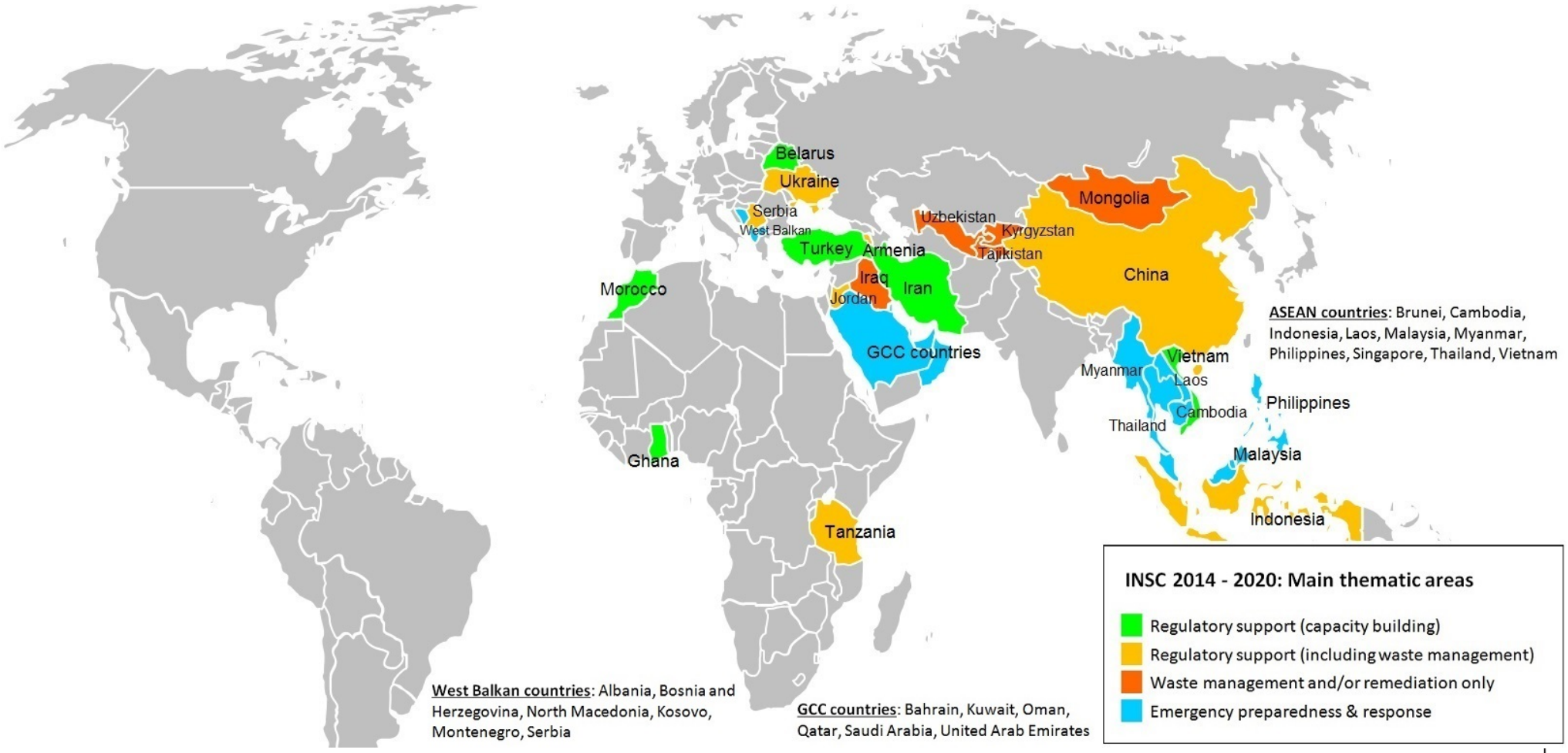
Instrument for Nuclear Safety Cooperation (INSC) – 2.

- New & emerging INSC thematic and geographical areas in the 2014-2020 period:
  - Special program was initiated – in cooperation with the EBRD* - in the most affected part of Central Asia to implement a project for the remediation of uranium mining legacy sites
  - Provision of support in Africa to enhance the regulatory framework to be able to ensure that ongoing and future uranium mining works respect safety & environmental standards
  - Several projects were launched to support the improvement of emergency preparedness and response (EP&R) capabilities (e.g. in Armenia, as well as in the GCC**, ASEAN*** and West Balkan countries)
- INSC budget distribution: **50%** - promotion of nuclear safety; **35 %** - management of RAW and SNF; **10%** - nuclear safeguards; **5%** - support activities

**European Bank for Reconstruction and Development*

*** Gulf Cooperation Council; *** Association of Southeast Asian Nations*

Main thematic areas of current INSC projects around the world



Aerial view of the Armenian Nuclear Power Plant at the Metsamor site

Both ANPP units are VVER-440/V-270 type reactors (seismically reinforced version of VVER-440/V-230), but only Unit 2 is in operation

Recent INSC projects supporting Armenia (2014-2019) – 1.

- Several TACIS and INSC projects supported the Armenian nuclear regulator (ANRA) and the Armenian nuclear operator (ANPP) since **1991**
- Currently on-going assistance projects

Beneficiary	Project ID	Project description / scope	Consortium Leader
ANRA	**A3.01/16A**	Enhancing the capabilities of ANRA and its TSO in reviewing documents demonstrating the long-term safety of Unit 2 of ANPP	**RISKAUDIT**
ANRA	**A3.01/15A**	Supply of an Radiation Monitoring System & computer hardware for the implementation of JRODOS in Armenia	**Bertin GmbH**
ANRA	**A3.01/15B**	Enhancing the capabilities of ANRA in preparedness for and response to a nuclear or radiological emergency	**KIT**
ANPP	**A1.01/16B**	Provision of on-site assistance to the ANPP	**ENCO**

Recent INSC projects supporting Armenia (2014-2019) – 2.

- Recently finished assistance projects

Beneficiary	Project ID	Project title / description	Consortium Leader
ANRA	**A3.01/13**	Enhancement of ANRA & NRSC capabilities for safety review & assessment of radioactive waste management facilities and activities	**ITER Consult**
Ministry of Energy and Natural Resources	**A4.01/09**	Development of radioactive waste and spent fuel management strategy for Armenia	**ITER Consult**
ANPP	**A1.01/11**	Contributions to the ANPP operator for the implementation of the stress sests for Unit 2	**ENCO**
ANPP	**A1.01/09 (C&D)**	Decommissioning planning and licensing development at the ANPP and pilot decommissioning project at ANPP	**NUKEM**

Current situation of environmental radiation monitoring – 1.

- Radiation monitoring practice around ANPP in the supervised area (10 km radius)
  - **Periodic** measurements: air (fallouts), water (sediments), soil, vegetation, dose rates, total β and α activity, γ spectrometry + ^{90}Sr concentration in the environmental samples
  - **Stationary** γ dose rate monitoring stations (BABUKA system) – not operable any more
- External radiation exposure control for inhabitants in the supervised area is carried out by regular dosimetric measurements $\Rightarrow$ no detectable increase is observable compared to the reference level determined in **1976** (i.e. before the start of ANPP)
- Control of airborne releases is done by monitoring devices in the ventilation stack
- Monitoring of liquid effluents is done by taking samples from boreholes located outside of the boundary of the ANPP's rainwater and sewerage systems

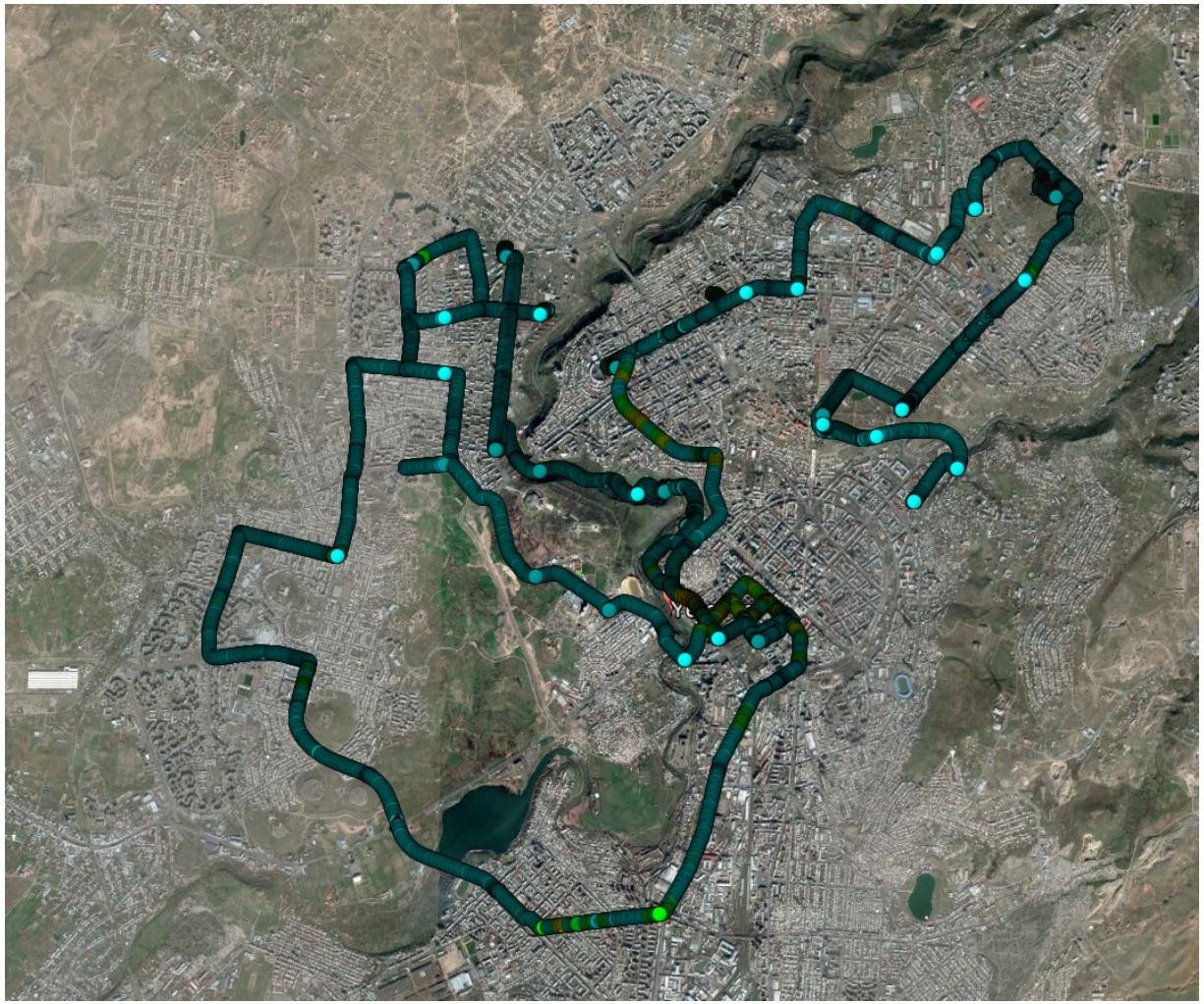
*Emergency preparedness and response

Current situation of environmental radiation monitoring – 2.

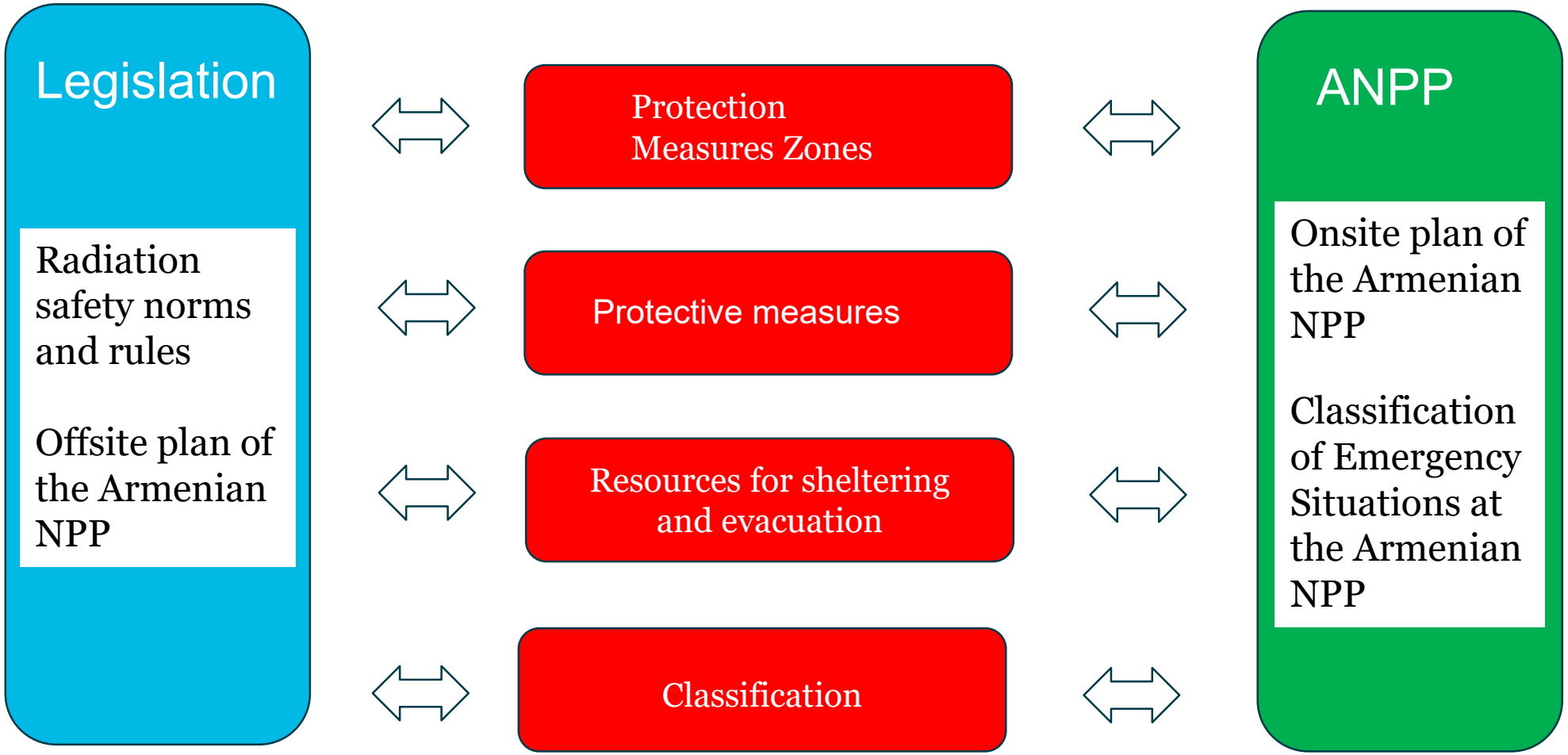
- The following radionuclides give significant contributions to the releases: ^{110m}Ag (41%), ^{60}Co (25%), ^{131}I (20%), ^{137}Cs (8%), ^{58}Co (2%), ^{103}Ru (2%), ^{90}Sr (0.5%)
- Currently ANRA does not have laboratories to perform an independent monitoring of radioactive releases originating from the various Armenian nuclear facilities
- Environmental radiation level checks are carried out by hand-held devices
- In-situ γ dose rates are checked by the SPARCS* mobile measurement system
- The actual field measurements are carried out by experts from the TSO (NRSC)
- ANRA's inspections are the only means to verify environmental monitoring results

**Spectral Advanced Radiological Computer System*

Gamma dose rate scanning measurements by the SPARCS

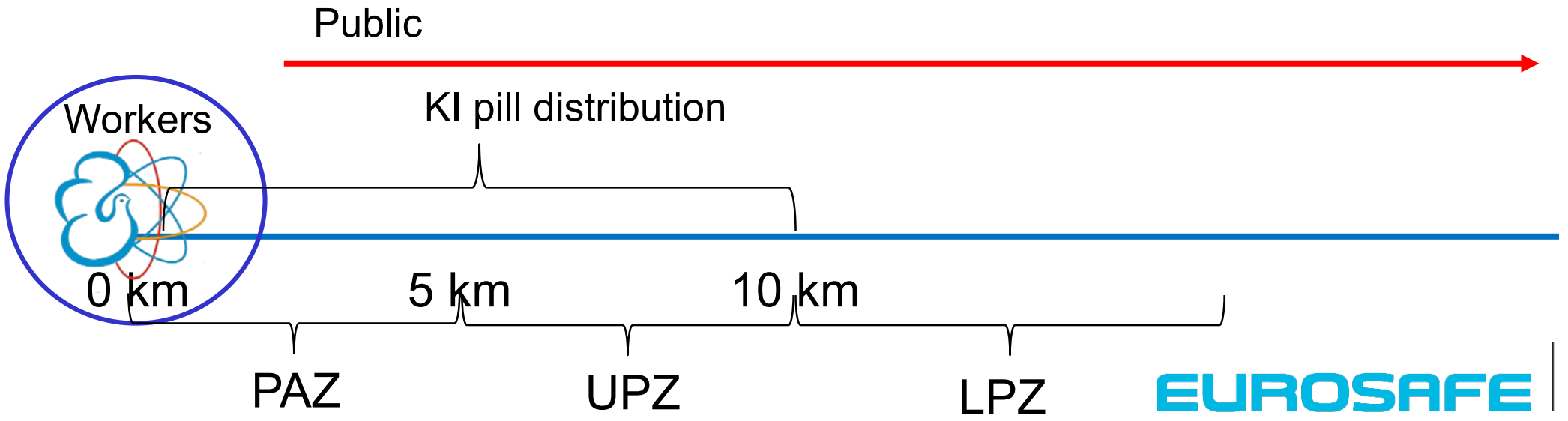


National regulatory context in Armenia – 1.

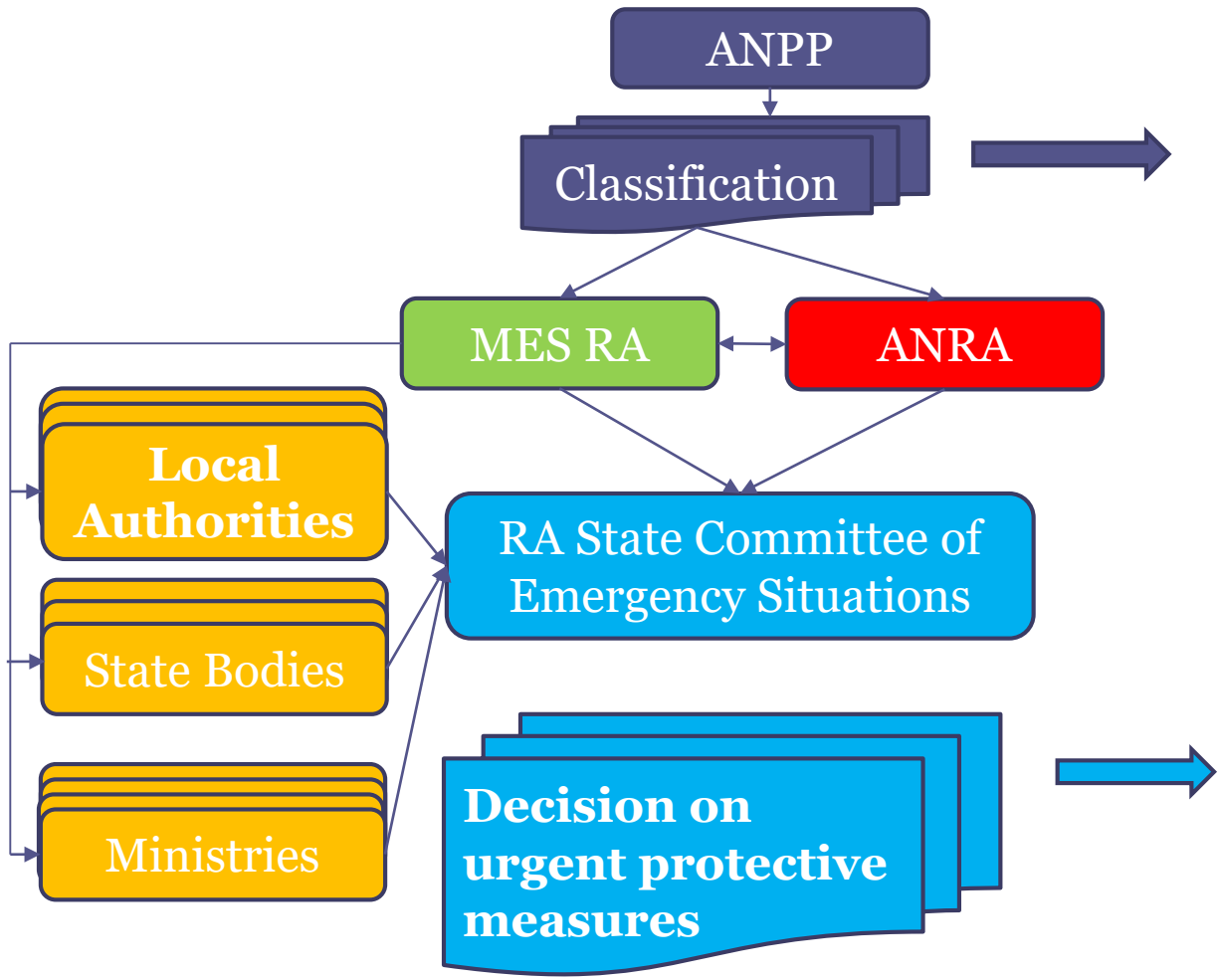


National regulatory context in Armenia – 2.

- Three emergency planning zones were defined:
  - PAZ = Precautionary Action Zone – in this zone pre-planned urgent protective actions will be immediately introduced when the state of "general emergency" is announced
  - UPZ = Urgent Protective Action Planning Zone – in this zone preparations are made to promptly implement urgent protective actions if conditions (e.g. dose levels) justify it
  - LPZ = Long-term Protective Action Planning Zone – in this zone plans are in place for taking protective actions to reduce the long-term exposure from deposited radionuclides



Current EP&R* organisation in Armenia and its functions – 1.

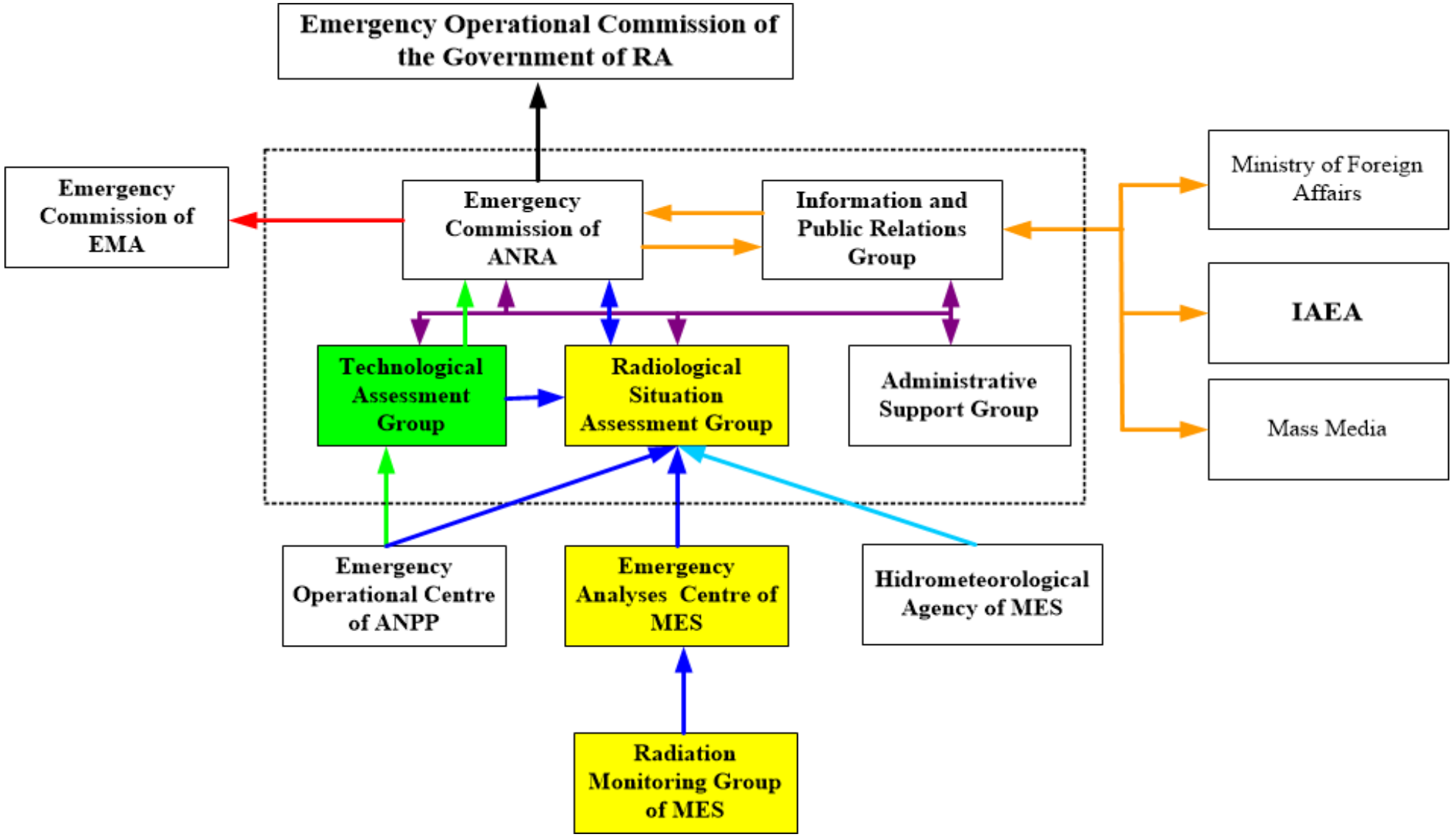


Type of accident
General accident
Local Accident
Alarm/ Preparedness

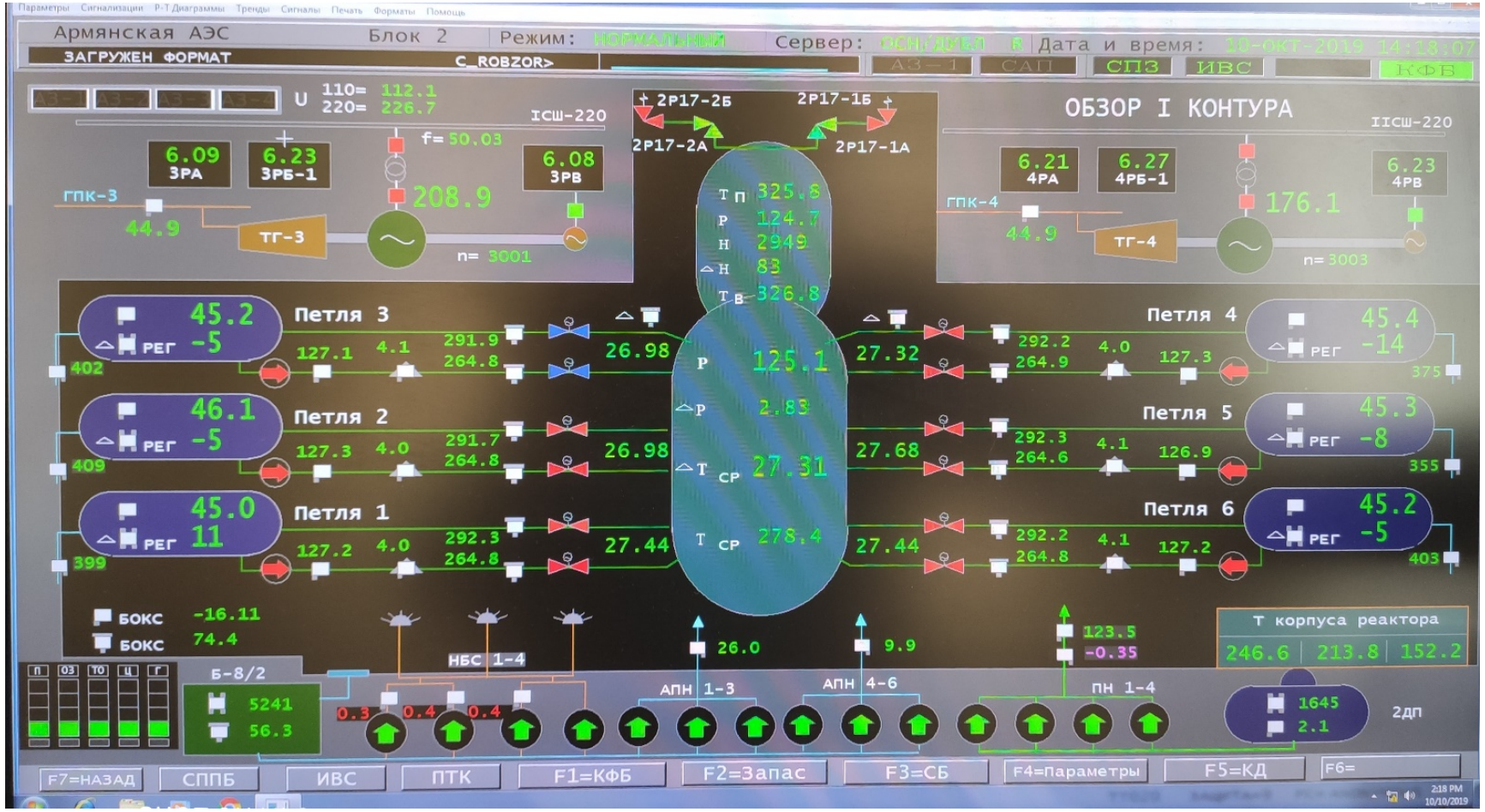
Urgent protective measures
Sheltering
Evacuation
Temporary evacuation
Permanent resettlement
Protection of thyroid
Food usage limitation

*Emergency preparedness and response

Current EP&R organisation in Armenia and its functions – 2.



Current EP&R organisation in Armenia and its functions – 3.



Functions of the ERC operated by ANRA according to emergency procedures:

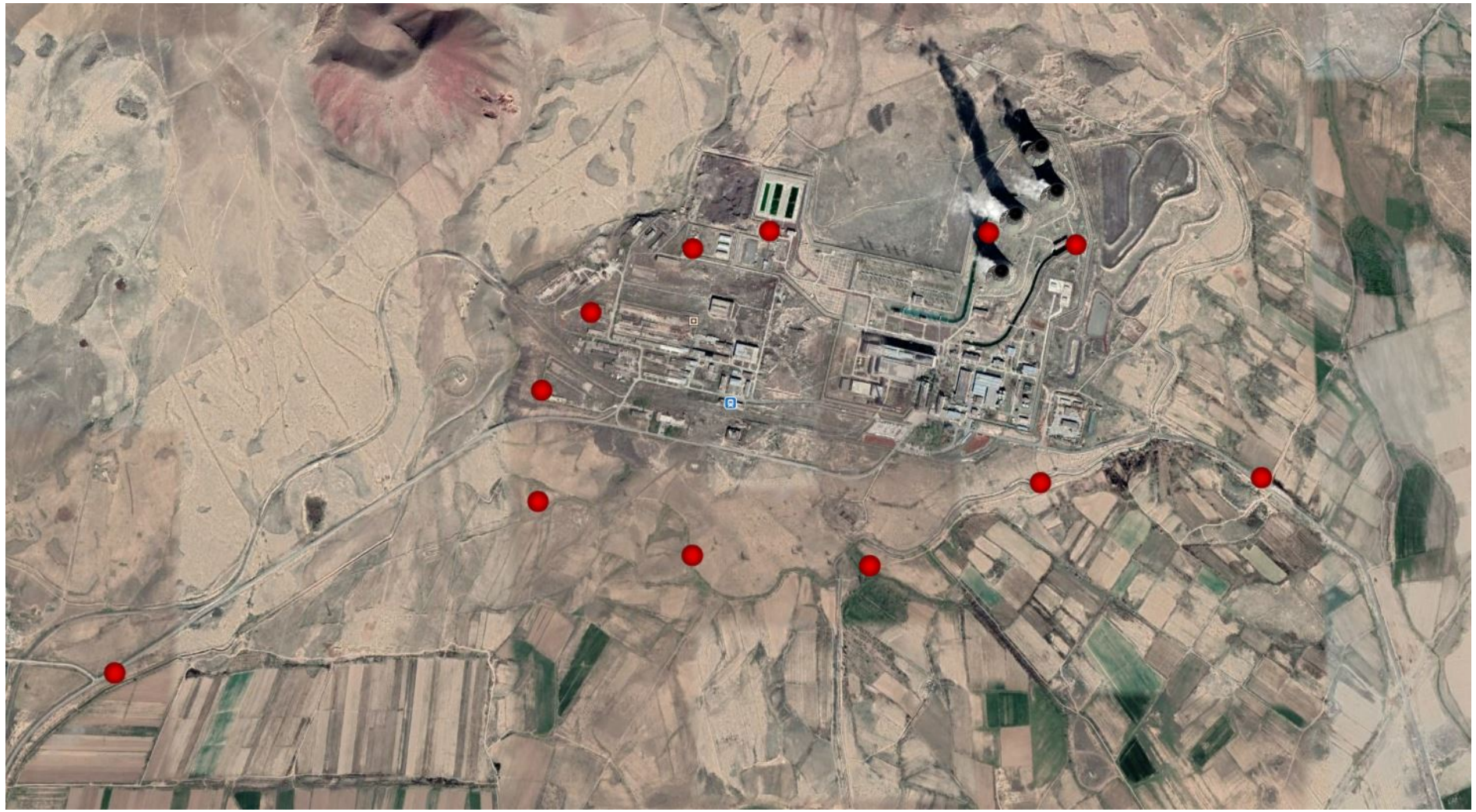
- Assessment of the reactor's condition; provision of prognosis on accident progression
- Assessment & prognosis of radiation conditions; proposals for protective measures
- Provision of information to relevant (including international) organizations and the public

Design architecture, configuration and functions of the EWRMS* – 1.

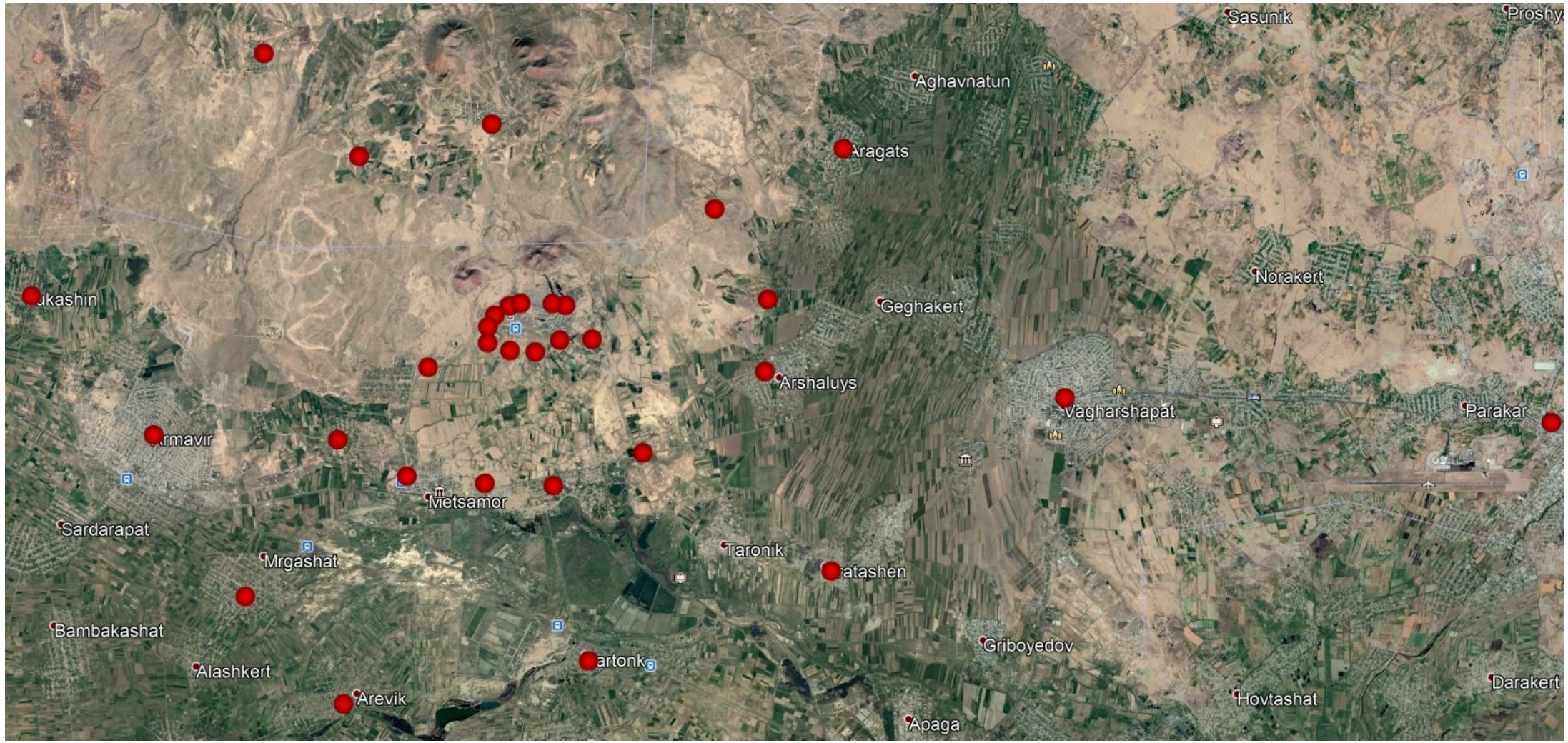
- The implementation of INSC project A3.01/15A (Supply of a radiation monitoring system to Armenia) was awarded to Bertin GmbH by the EC in 2018
- Arrangement of measuring stations and the applied detector types:
  - Measuring stations are arranged on two circles around the ANPP (2 km and 5 km radius)
  - Altogether 32 pcs of γ dose rate measurement probes (type GammaTRACER XL2-2), all equipped with temperature, humidity & movement sensors plus an external rain sensor
  - Measurement range for the GammaTRACER XL2-2: from 10 nSv/h to 10 Sv/h
  - Two mobile devices (type SpectroTRACER) for radionuclide identification via γ spectra
  - Measurement range for the SpectroTRACER Air/Soil: from 1 nSv/h to 200 μSv/h
  - Data from the probes will be transmitted by using 3G** and radio connections

**Early Warning Radiation Monitoring System, **Third generation wireless mobile telecommunications*

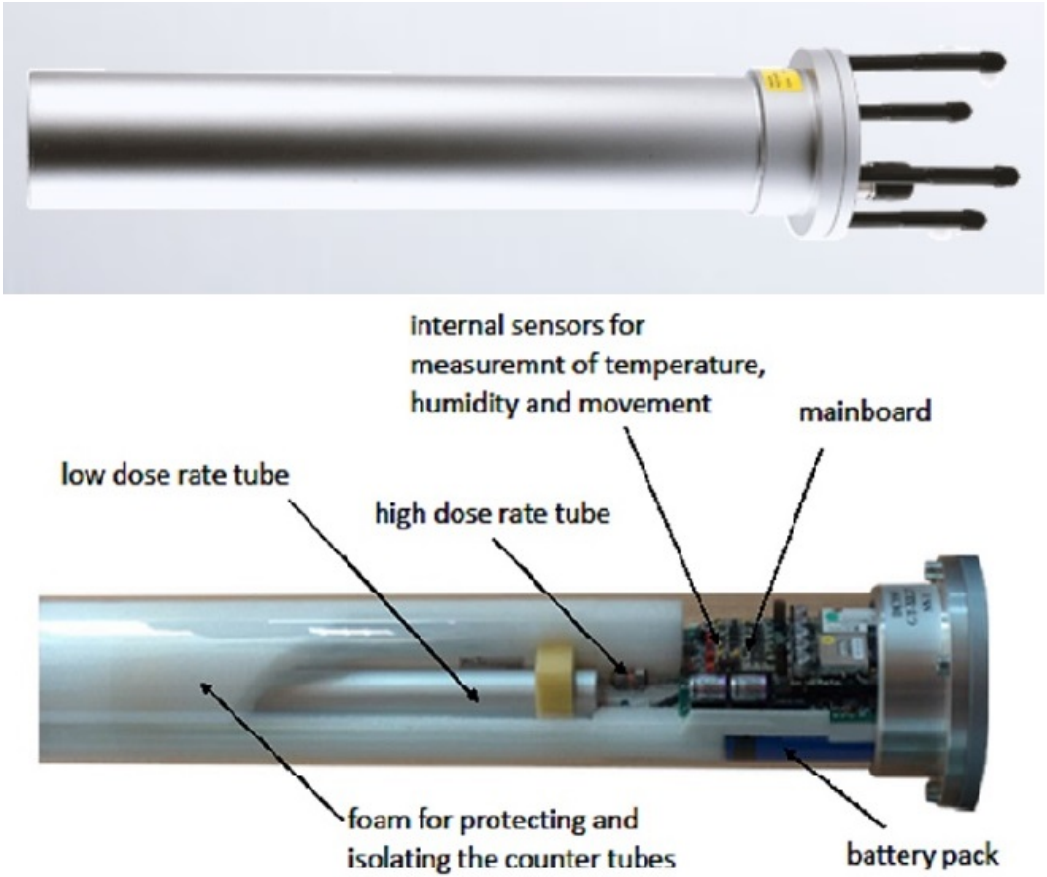
Location of measuring stations at the ANPP site



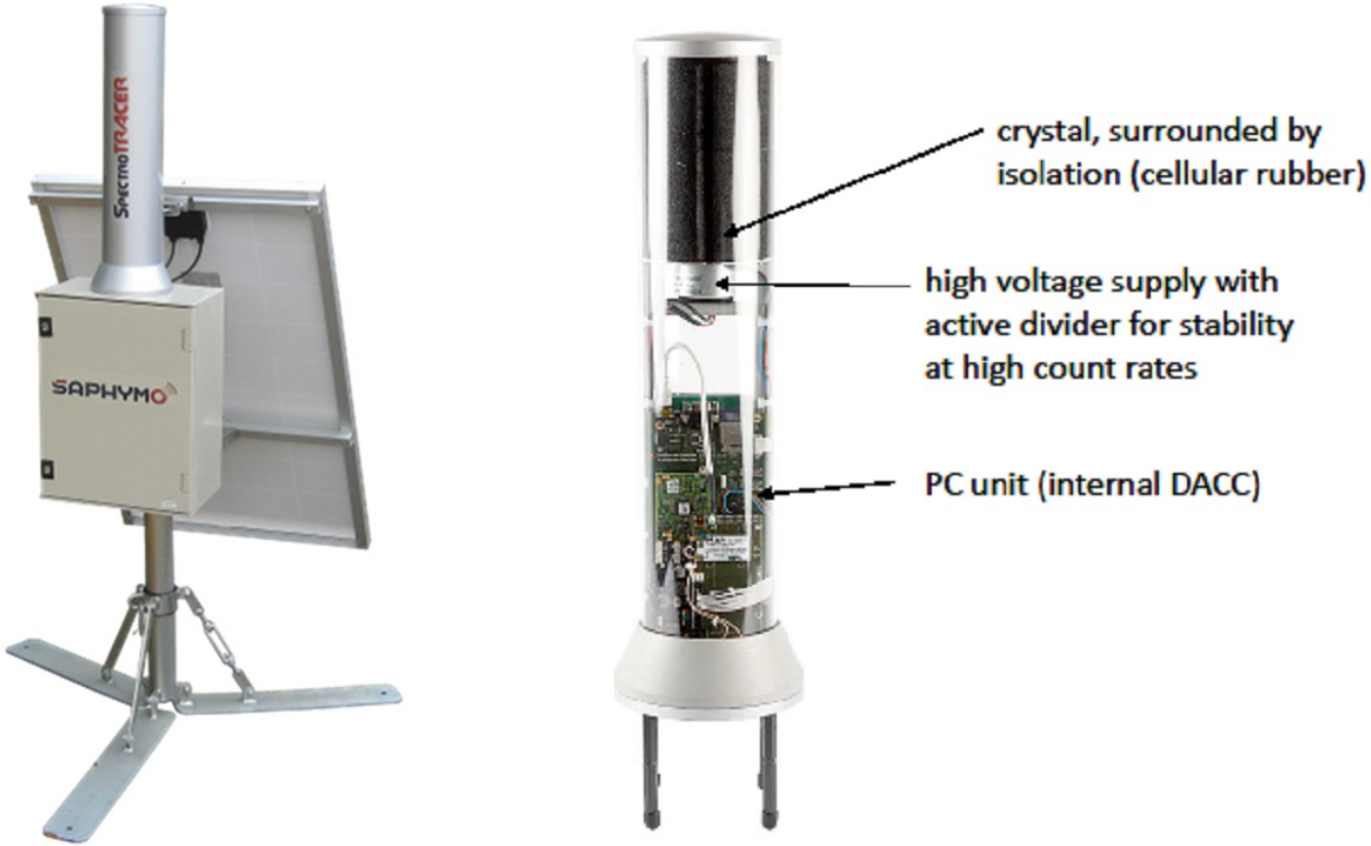
Location of all measuring stations around the ANPP



Measuring stations of the EWRMS



External and internal view of the GammaTRACER XL2-2 device

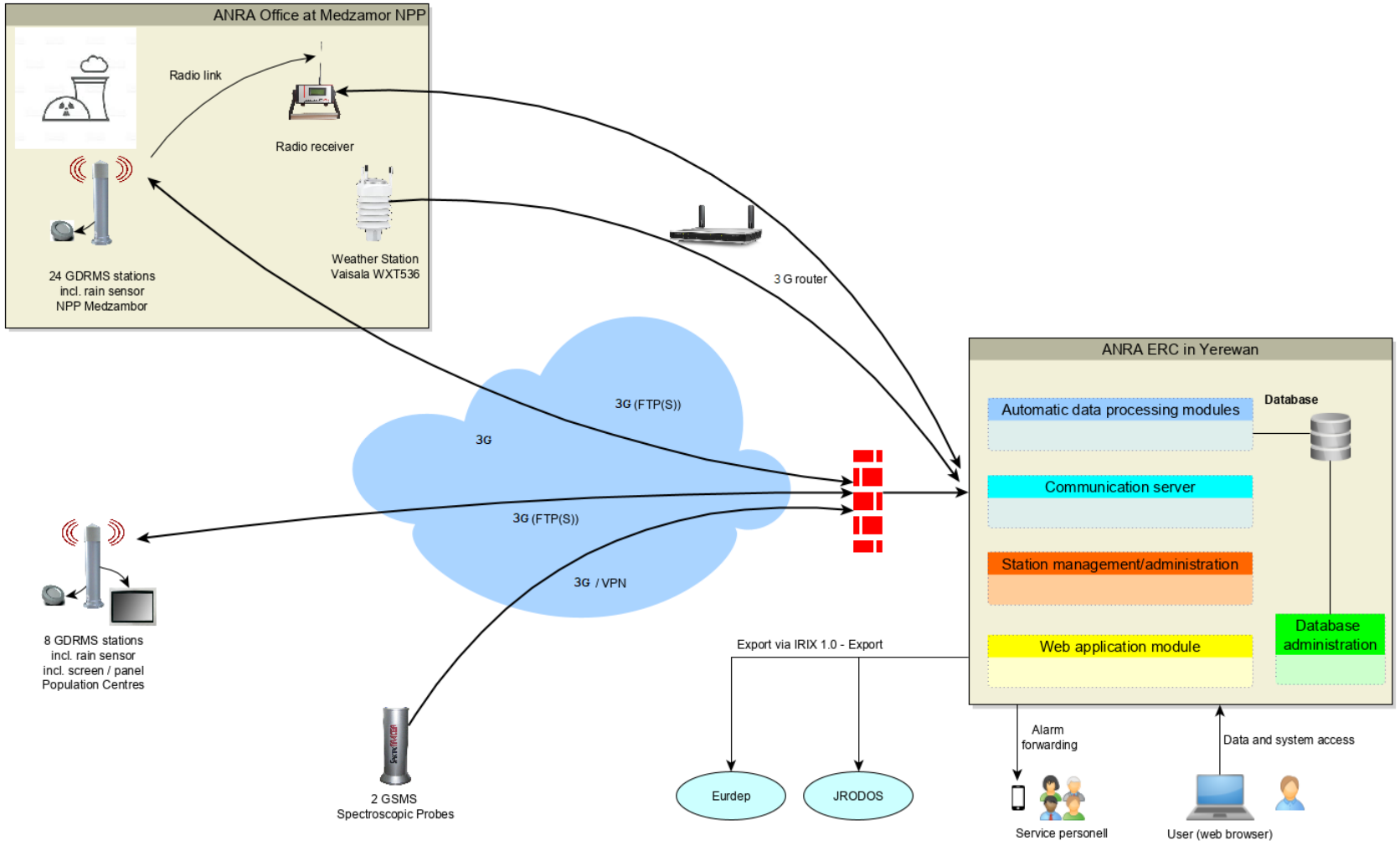


View of the SpectroTRACER Air/Soil device (left) and its internal parts (right)

Design architecture, configuration and functions of the EWRMS – 2.

- Functions of the EWRMS:
  - Continuous monitoring of radiation conditions during normal plant operation and in accident situations
  - Transferring measured data (via 3G and radio) to the dedicated data processing centres
  - Provision of public information via external public displays (all readable from 5 meters)
  - High data availability and reliability is ensured by: multiple power supplies (external, battery, solar) and by diverse communication lines (3G and secured radio transmission)
- Data transmission:
  - The radio mast is mounted on the top of the ANRA building located at the ANPP site
  - Data received by radio transmission is transferred to the ECR of ANRA by a fixed line
  - Data sent by the 3G cellular modems is secured by using the secure FTP/S protocol
  - Each data packet contains a history of previous dose rate values to ensure verifiability

EWRMS architecture and data transfer paths



Implementation schedule:

Site Acceptance Test is planned to take place in

March 2020

System implementation and the use of measured information

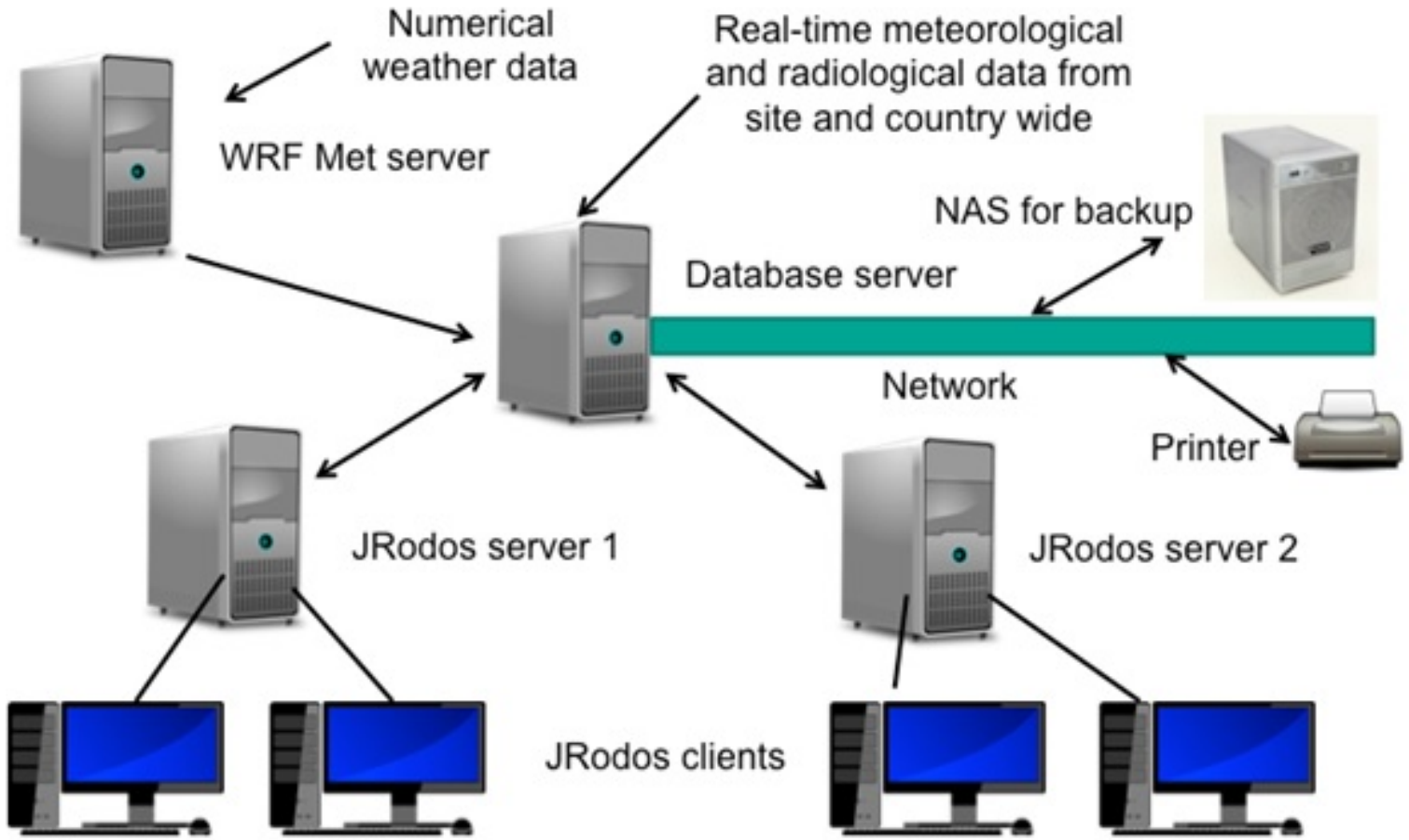
- Data processing and visualisation
  - **DataEXPERT 10**: central data management software performing automatic collection, validity checking, storage, analysis and visualisation of measured data
  - Alarms are generated and displayed automatically if radiation level limits are violated
  - The system's human-machine interface is web-based allowing easy & flexible data access
  - Data can be displayed in tables, charts and on maps with easy report generation features
  - Measured data are transferred to JRODOS and EURDEP in the standard IRIX 1.0 format
- Utilisation of measured information
  - Provision of 7/24 decision support service to manage emergency situations efficiently in the PAZ, in populated areas close to the ANPP, as well as in Yerevan
  - Provision of data on actual radiation situation to the public & other organisations involved
  - Provision of forecast data & assessment the effectiveness of various protective measures

Installation and customization of JRODOS in Armenia – 1.

- **RODOS** = **R**eal-time **O**n-line **D**ecisi**O**n **S**upport system (DSS*)
  - Developed after the Chernobyl accident in the frame of EU R&D programmes
  - Currently the Java version (**JRODOS**) is developed, maintained and distributed by **KIT**
  - JRODOS is run by **30** organisations in more than **20** countries **(a de facto standard DSS)**
  - Recent or ongoing cases: China, Ukraine + ASEAN-, GCC- and West Balkan countries
- JRODOS is a set of modules applicable in terrestrial and aquatic environments for
  - Predicting the spread of radioactive materials after an atmospheric or aquatic release
  - Calculating the current and future radiological situation in contaminated areas
  - Estimating individual and public doses with or without countermeasures
  - Predicting doses resulting from the consumption (ingestion) of contaminated food

**Decision Support System*

Indicative configuration of JRODOS to be installed at the ECR of ANRA



Installation and customization of JRODOS in Armenia – 2.

- Application of JRODOS during emergencies
  - EMC = **Emergency Model Chain** – main JRODOS module to be applied in emergencies
  - EMC includes models for atmospheric dispersion, dose estimation, early countermeasures and food-chain
  - In later accident phases the effect of various countermeasure strategies can be evaluated
- JRODOS can be adapted (customized) to regional and national conditions
- Customization is carried out by developing specific databases for the following data:
  - NPP technology and site characteristics
  - Meteorology, including on-site meteorological data and prognostic data
  - Measurements for source term estimation and radiological data (IRIX or EURDEP formats)
  - Map data showing state and county boundaries, streets, buildings, etc.

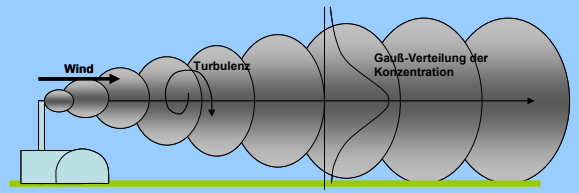
JRodos EMERGENCY chain models

Released activity (Measurement / User)

Meteorological data (Measured / Prognostic / User)

Further data (from JRodos Data bases)

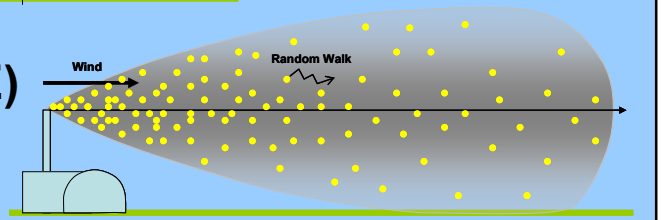
LSMC: Atmospheric dispersion and deposition, local scale (up to several 100 km)



Rimpuff (DEN)

Atstep (IKET)

Dipcot (GRE)
Lasat (GER)



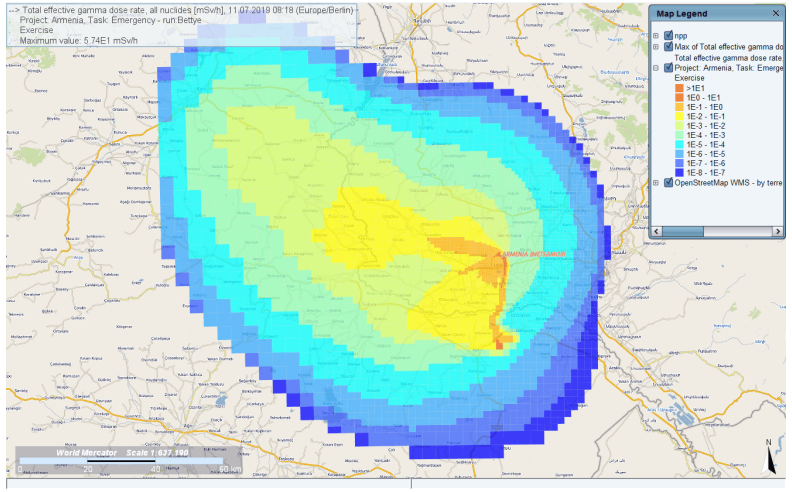
Current dose rate and dose calculation

Early countermeasure simulation

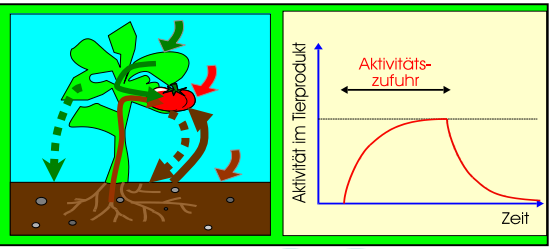
Health effects and costs

Accident

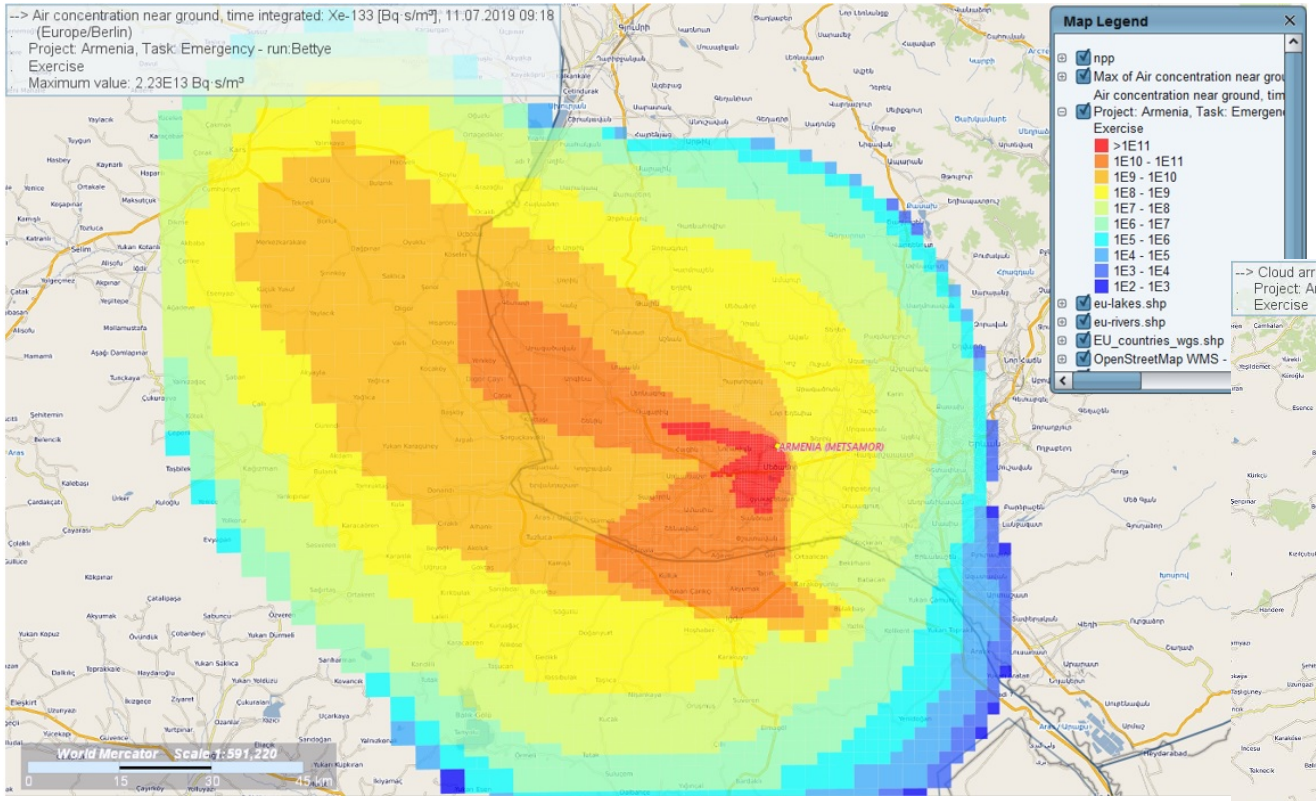
Release of 24 hours



Food chain and dose model, terrestrial FDMT (GER)

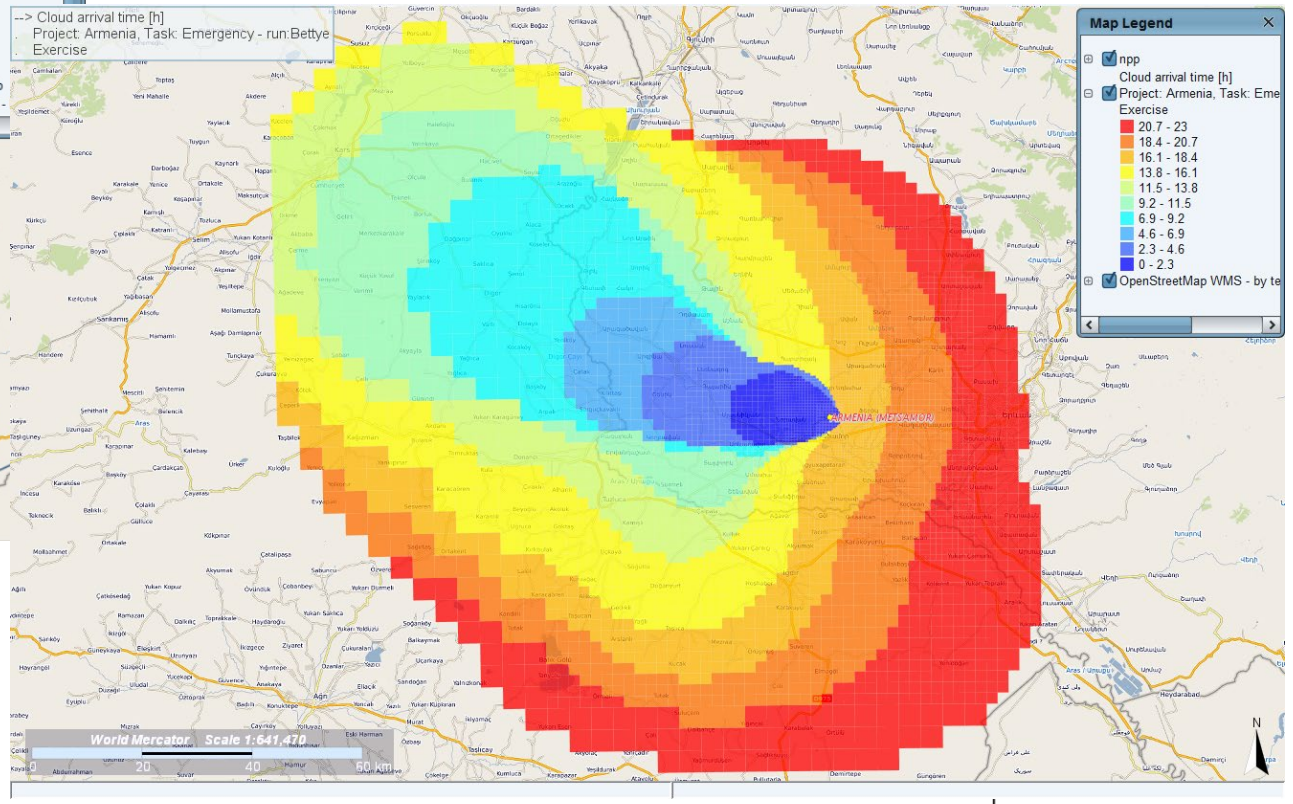


Time-integrated concentration in the air of ^{133}Xe released from the ANPP and Cloud Arrival Time (JRODOS simulation)



TIC-^{133}Xe

Cloud Arrival Time



Installation and customization of JRODOS in Armenia – 3.

- Customization of specific JRODOS databases (continued):
  - Statistical data (population distribution, food production figures, etc.)
  - Parameters for the various food-chain models and the distinguished radio-ecological regions
  - Hydrological data to characterize rivers, lakes and seas in the modelled region
  - National intervention criteria & limits for protective actions (used in the countermeasure model)
  - Data required to customize the user interface (e.g. Armenian language-specific characters)
- It is envisaged that the customized version of JRODOS will be operable not later than **24 months** after the project start
- The default databases installed in the initial phase are suitable to demonstrate the operability and functions of the DSS and can be used for the initial training
- Advanced training will be provided to system administrators and expert DSS operators

Summary and conclusions

- Our presentation intended to provide an overview of the international project to
  - Design, develop, install, test and put in regular operation an **EWRMs** in Armenia
  - Install and customize an internationally recognized **DSS** and couple it to the EWRMS
  - **Train** the staff involved to operate & maintain the new system and to use it with expertise
- The new system will **enhance** the Armenian EP&R capabilities to a great extent
- The complete system should be operational before the end of **2020**
- Experts from the **ANRA** and its TSO (**NRSC**) participate in the work intensively and provide valuable input during the various project phases (design, customization, etc.)
- We believe that the project is a very good example of international cooperation and shows the merits of the project implementation methods used in the frame of INSC

THANK YOU FOR YOUR ATTENTION!

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