TECHNOLOGIES FOR NUCLEAR ENERGY STATE OWNED COMPANY INSTITUTE FOR NUCLEAR RESEARCH



www.nuclear.ro

20

ANNUALREPORT

SUBSIDIARY Institute for Nuclear Research Pitesti

RATEN ICN

Director	Constantin PĂUNOIU
Deputy Director of Nuclear Safety	Dumitru BĂRBOS
Deputy Scientific Director	Daniela DIACONU
Deputy Financial Director	Sofia COSTACHE

This document was drafted according to Appendix 6 of the Memorandum of the Ministry for Public Consultation and Civic Dialogue *"Increasing transparency and standardization in the display of public interest information"*.

The editorial staff of the **Annual Report of RATEN ICN for 2021** gives thanks for the good collaboration to all program managers, project managers and heads of departments.

EDITORIAL TEAM

Coordinator,

Daniela Diaconu, Deputy Scientific Director

The team (data collection, editing, graphics),

Mirela NIŢOI Ileana CREŢU Ştefan PREDA

CONTENTS

About RATEN ICN	1
Identification data	Error! Bookmark not defined.
Short presentation	1
Organizational structure	Error! Bookmark not defined.
Scope	Error! Bookmark not defined.
Human resources	3
Infrastructure	5
Economic and Financial Situation	Error! Bookmark not defined.
RATEN ICN OBJECTIVES AND ACHIEVEMENTS IN 2021	9
Scientific activity	Error! Bookmark not defined.
International cooperation	11
Collaboration at the level of the European Union	11
Collaboration with the International Atomic Energy Agency (IAEA) Vienna	Error! Bookmark not defined.
Other collaborations	22
MEASURES TO INCREASE RATEN ICN'S PRESTIGE AND VIS	IBILITY Error! Bookmark not defined.
Dissemination of research results and knowledge transfer	Error! Bookmark not defined.
RATEN ICN representation at scientific activities, national and international event	s _ Error! Bookmark not defined.
PERFORMANCE INDICATIORS. DEGREE OF ACHIEVEMENTE	Error! Bookmark not defined.
Achieving performance indicators	Error! Bookmark not defined.
	Error! Bookmark not defined.

ABOUT RATEN ICN

Identification data

Name: Technologies for Nuclear Energy State Owned Company – Institute for Nuclear Research (RATEN ICN)

Registration number at the Trade Register Office: J3/1316/2013

Sole Registration Number (CUI): RO32306920

Headquarters: Arges County, Mioveni; Strada Câmpului No. 1

Zip code: 115400; Tel: 0248-213400; Facsimile: 0248-262449; E-mail: office@nuclear.ro

Filed of activity: CAEN 7219

Short presentation

The Institute for Nuclear Research Pitesti was founded in 1971 as a unit of strategic importance, having as field of activity the scientific research, design, technological development and scientific and technical responsibility for the development of nuclear energy in Romania.

The history of over 40 years of activity recorded a series of successive transformations generated by the development of the national economy and by the adaptation of the objectives of the nuclear field to the new requirements of the society which led to changing the institute's name:



1971	It was set up the Institute for Nuclear Technologies (ITN) subordinated to the State Committee for Nuclear Energy (CSEN);
1977	ITN becomes the Institute for Nuclear Energy Reactors (IRNE);
1990	The Institute for Nuclear Energy Reactors (IRNE) is included in the National Authority for Electricity (RENEL) and becomes the Institute for Nuclear Research (ICN);
1992	The Fuel Elements Production Department (SPEC) within ICN becomes distinct economic unit within RENEL, as the Nuclear Fuel Factory (FCN);
1998	ICN is included in the Romanian Authority for Nuclear Activities (RAAN) as subsidiary becoming RAAN- Sucursala Cercetari Nucleare, according to GD 365/1998
2013	Starting 1st October , the Institute for Nuclear Research Pitesti (ICN) becomes a subsidiary of the State Owned Company "Technologies for Nuclear Energy (RATEN)", established under Emergency Ordinance no. 54 from 29th May 2013, approved by Law no. 302/2013.
2021	ICN celebrates 50 years since its establishment as a scientific and technical support organization for the Romanian nuclear program.

Organizational structure

The structure of the research activity in the institute is harmonized with the national and international research programs in the nuclear field. The organizational chart of the institute is structured in departments, laboratories, services, offices, being formed of research&development departments, technical departments, production, maintenance-repairs and administrative offices.

- Reactors Physics, Fuel Performances and Nuclear Safety Department
- TRIGA Reactor Department
- Nuclear Materials and Corrosion Department
- Out of Pile Testing Department
- Radioactive Waste Treatment and Conditioning Plant
- Electronics Department
- Post-Irradiation Examination Laboratory (PIEL)
- Surface Analysis Laboratory
- Reliability and Testing Laboratory
- Radiation Protection, Environmental Protection and Civil Protection

- Metrology & IT Laboratory
- Quality Technical Control Laboratory
- Design Department.
- Nuclear Prototypes Workshop
- Quality Management Office
- Utilities Production and Distribution Department
- Repairs, Maintenance, Chief Mechanic Department
- Support Deparments (Programs, Contracts; Foreign Relations, Technology Transfer, Protocol; Administration, Human Resources, Financing, Accountancy; Procurement, Marketing; Investments, Heritage; Emergency Situations, Prevention and Protection; Legal; Transport; Medical, Toxicology, Analysis; Physical Protection; Safeguards; Protection of Classified Information).

Scope

The Institute for Nuclear Research Pitesti (RATEN ICN) has as main activity objective the scientific research, the fundamental and applied technological development, the exploitation of its own research through technology transfer, design, investments, consultancy, expertise and technical specialized assistance, subordinated to ensuring the scientific and technical support for Romania's nuclear energy sector.

The directions of research, development and innovation-oriented activities of the institute include the following objectives:

- Ensuring the scientific and technical support for the Cernavoda Nuclear Power Plant (CNE) for its entire lifetime;
- Carrying out research&development activites required for the sustainable development of the National Nuclear Programme;
- Development of skills in the field of nuclear materials and fuels, reactor physics, nuclear safety, equipment, instrumentation and control for nuclear applications;
- The management, characterization and treatment of radioactive waste;
- Environment protection and radioprotection;
- Developing the infrastructure, the scientific research capacity and technological transfer services and innovation;
- Carrying out the international cooperation programme for increasing the competitiveness and aligning RATEN ICN to the specific policies of the European Union by developing the capacity to assimilate and apply advanced techniques and technologies;
- Development of human resources in the field of research activities by stimulating professional training and developing the research capacity of young people.

Through its activity, the institute contributes to fulfilling the government's responsibility for energy security, nuclear safety, radioactive waste security, non-proliferation, safety of radioactive sources and the prevention of terrorism.

RATEN ICN provides services in the following fields:

- Reactors physics, fuel performances and nuclear safety;
- Irradiation tests, radioisotopes, post-irradiation examination of materials and nuclear fuel;
- Out of pile testing;
- Testing of nuclear materials in thermo-mechanical and corrosion conditions, compatible with those in operation;
- Radioactive waste management;
- Tests and Qualifications for Nuclear Equipment, Components and Instrumentation;
- Radiation protection. Environmental protection;
- Design of Nuclear Equipment.

RATEN ICN also promotes the development and application of nuclear technologies in medicine, industry or agriculture, adding an important contribution to raising the standard of living for the benefit of citizens.

The main technologies developed by RATEN ICN include:

- manufacturing technologies for experimental fuel elements and advanced nuclear fuel;
- manufacturing technologies for UO₂ sintered powders and UO₂ sintered pellets with controlled microstructure;
- technologies for testing nuclear fuel and materials;
- manufacturing technologies for obtaining radioactive source targets;
- technologies for working with sealed sources;
- manufacturing technologies for radioisotopes used in the fields of health, environment and industry;
- technologies and equipment for testing, commissioning, inspection, maintenance and repairing of components from the Nuclear Power Plant (NPP)
- technologies for the maintenance of NPP equipment;
- out of pile technologies and testing systems;
- technologies and treatment-conditioning and characterization of radioactive waste from the NPP and from other research&development activities in the nuclear field;
- decontamination technologies of components and equipment from the nuclear power plants.

Human resources

În 2021, the total number of employees within RATEN ICN Pitesti was 575, of which 301 employees work in research and development technological engineering, 154 of these provide the operation of nuclear facilities while provide the technical and administrative support for carrying out the R&D activities in optimal conditions as well as ensuring the safe operation of the platform's facilities (ensuring the utilities for RATEN, RATEN ICN, FCN and ANDR Pitesti).





The Institute has 185 certified researchers, specialists with a high level of training in fields like engineering, physics, chemistry and others, authorized by CNCAN, ISCIR, etc.

Most of the specialists in the institute had completed forms of post-university training, masters, doctorates or specialization courses conducted in the country or abroad, becoming experts of the International Atomic Energy Agency (IAEA) or of European programs.

The knowledge gained during the years of training is reflected in the large number of papers elaborated in the framework of research programs, national and international projects.

In 2021, RATEN ICN employees completed the specific annual training programs in the field of nuclear safety, radiation protection and environmental protection, protection of classified information, quality management, environment, occupational health and safety, followed by evaluation and testing stages. At the same time, the researchers and specialists from RATEN ICN had the opportunity to participate in courses / seminars organized by RATEN ICN (2 activities, number of participants: 14), national training courses (6 courses, number of participants – 10, online: 8, number of participants - 10), or internationally (27 activities (most of them online: 23), number of participants - 42).

Also, during 2021, a number of 30 employees attended master's degree studies organized by the University of Pitesti, in the fields:

- Nuclear Materials and Technologies;
- Electronics, Telecommunications and Computers;
- Robotics;
- Energy and Nuclear Technologies;
- Industrial engineering;
- Electronic systems for industrial process management.

A number of 21 employees are engaged in doctoral programmes. These were organized by the University of Pitesti, the Polytechnic University of Bucharest and the University of Wallachia Targoviste, in the fields:

- Electronic Engineering and Telecommunications;
- Applied Chemistry and Materials Science;
- Energy Engineering;
- Electrical Engineering;;
- Economics;
- Nuclear Engineering;
- Materials Engineering;
- Cybernetics and statistics.

In the graph of human resources training at RATEN ICN, we can observe the evolution in the last 5 years in the number of employees who are enrolled in various forms of post-university training, masters and / or doctorates.





From the hereto chart it can be seen that most employees are aged between 45 şi 54 years, closely followed by those aged between 55 şi 65 years, and, of these, some of them being close to retirement age. The average age in RATEN ICN is 45 years and 5 months.

The number of certified researchers has decreased in recent years due to the retirement of some leading specialists. Under these conditions, there is a risk of losing the knowledge acquired in this top field.

In recent years, due to the systematic employment of young specialists in research departments, the staffing structure of RATEN ICN has improved by increasing the number of employees with higher education. In 2021, a number of 60 people were employed, out of which 30 graduates of higher education, 26 graduates of secondary education and şi 4 workers.

As the year 2021 was marked by the pandemic triggered by the SARS-CoV-2 virus, the actions that were programmed within the human and technology transfer strategy were postponed or canceled and some of them moved to the online environment.

However, RATEN ICN honored its obligations through partnership agreements with higher education institutions, such as the University of Pitesti, Polytechnic University of Bucharest, Mansoura University, through which it offered students internships for undergraduate, master's, or practical training.

Infrastructure

RATEN ICN has the following research infrastructure: [https://nuclear.ro/infrastructura/]

- Nuclear Research Reactor TRIGA SSR 14 MW and TRIGA ACPR;
- Post Irradiation Examination Laboratory (PIEL);
- other facilities and laboratories specific to the field, namely:
 - Radioactive Waste Treatment Plant (STDR);
 - Out of Pile Testing Stand (TAR);
 - Analysis and Diagnosis of Corroded Components in Nuclear Installations Laboratory for the (LADICON);
 - Testing Laboratory for the Characterization of Spent Nuclear Fuel and Radioactive Waste (LABORAD);
 - Radiochemistry and Radiometry of Radioactive Waste Laboratory of (LRRDR)
 - Surface Analysis Laboratory (ESCALAB):
 - Radiation Protection. Environmental Protection and Civil Protection Laboratory (LRPMPC);
 - Testing and Reliability Laboratory (LIF);
 - Technical Quality Control Laboratory (CTC);
 - Metrology and Information Technology Laboratory.

This material base is characterized by diversity, performance and reliability, the high level of nuclear safety of the facilities in operation being recognized by national and international regulatory and control organizations, the National Commission for the Control of Nuclear Activities (CNCAN) and the International Atomic Energy Agency (IAEA) Vienna.

In 2017, the research infrastructure of RATEN ICN and the related research services were registered on the ERRIS platform (Engage in the Romanian Research Infrastructures System), <u>https://erris.gov.ro/REGIA-AUTONOM-TEHNOLOGII-PEN-1</u>.

Following the evaluation of the applications submitted for the designation of Installations and Special Objectives of National Interest (IOSIN), the Ministry of Research and Innovation, included in the list [http://www.research.gov.ro/uploads/iin/2018/rezultate-evaluare-iosin-2018.pdf] the RATEN ICN infrastructures:

- TRIGA Reactor and the Post Irradiation Examination Laboratory (PIEL) 84 points;
- Radioactive Waste Treatment Plant (STDR) 79 points;
- Fuelling Machine (F/M) Testing Rig for CANDU Reactors- 71 points.

Economic and Financial Situation

The institute's income in 2021 were provided by:

- National Research Development Programs for Nuclear Energy funded by the Ministry of Energy;
- Research projects within the Research Programs of the European Union (Horizon 2020) and with the International Atomic Energy Agency (IAEA Vienna);
- Economic contracts with various partners in the country.

The main activity of RATEN ICN, the research&development, applications and technological engineering, related to the national technical support and international cooperation, financed according to GEO 144/1999, is carried out within the Annual Research Program of RATEN, on *the development of national technical support and international cooperation for nuclear energy.*

In detail, the breakdown of expenditure of the Annual Research Program of RATEN ICN in 2021 is as follows:

ogramne	Denomination	Performer	Scheduled papers		Completed papers and Settled papers	
Pro			No.	Value (lei)	No.	Value (lei)
1	Nuclear safety	RATEN ICN	23	3,496,290	23	3,496,290
2	Fuel channel	RATEN ICN	15	2,474,576	15	2,474,576
3	Nuclear Fuels	RATEN ICN	20	3,313,187	20	3,313,187
4	Fuel handling system	RATEN ICN	12	3,047,381	12	3,047,381
5	Radioactive waste and spent fuel management in nuclear safety conditions	RATEN ICN	23	8,662,674	23	8,662,674
6	Environment protection	RATEN ICN	23	5,534,531	23	5,534,531
7	Steam generator	RATEN ICN	9	1,874,423	9	1,874,423
8	Process systems and equipment	RATEN ICN	10	1,617,440	10	1,617,440
9	Circuit chemistry	RATEN ICN	14	2,793,819	14	2,793,819
10	Instrumentation and control	RATEN ICN	18	3,750,289	18	3,750,289
11	Analysis of NPP operating events, aging, environmental qualification and increasing the NPP lifetime	RATEN ICN	15	4,461,836	15	4,461,836
12	Advanced nuclear reactors and fuel cycles	RATEN ICN	28	5,159,577	28	5,159,577
13	Ensuring and increasing the performance of the TRIGA ICN reactor	RATEN ICN	59	25,396,860	59	25,396,860
14	Irradiation and radioisotope technologies	RATEN ICN	8	1,600,914	8	1,600,914
15	Computerization of nuclear activities	RATEN ICN	5	600,265	5	600,265
16	Heavy water and tritium	RATEN ICN	3	488,203	3	488,203
17	Applications of nuclear techniques	RATEN ICN	6	995,797	6	995,797
18	Support for international cooperation	RATEN ICN	12	3,474,938	12	3,474,938
TOTA	AL RATEN ICN PITESTI		303	78,743,000	303	78,743,000

In 2021, RATEN ICN Pitesti had ongoing service contracts in the field of nuclear energy and design services concluded with SNN-FCN Pitesti, SNN Cernavoda NPP and other internal and external customers, as follows:

- Contracts concluded with SNN-FCN Pitesti for:

- Valea Vieroşi technical assistance services;
- Technical assistance and monitoring services for ICSI Rm. Vâlcea;
- Environmental monitoring services;
- Services for determining the concentration of uranium and beryllium in urine;
- Laboratory chemical analysis services;
- Radioactive solid waste treatment services;
- Contract for services and utilities (thermal agent and industrial water);
- Radioactive water treatment services from the production activities of the FCN Pitesti Branch;
- Zircaloy-4 (Zy-4) chip compaction services and assembly of the resulting briquettesStudiu privind conformarea cu NSN21 şi încadrarea personalului CNE şi FCN în categorii de risc radiologic, beneficiar: Ernst&Young România.
- Sectoral service contract "Radiation closed source testing services"
- Post-irradiation examination services of spent nuclear fuel bundles, discharged from the reactors at Cernavoda NPP
- Services for checking the tightness of reactivity control units by mass spectrometry (He) method, SNN-CNE Cernavoda
- Radiological impact assessment services for the environment for the CTRF installation, beneficiary: INCD Danube Delta Tulcea
- Radiological analysis services of technological sludge waste, beneficiary: SC Ductil Steel SA Buzău
- Services accompanying and providing radiological assistance for special transport, beneficiary: SC ICCO Medical SRL Braşov
- Analyzes for determining the radioactive indicators from natural mineral water samples, beneficiary: SN Ape Minerale SA
- Development of an integrated environmental and radiological monitoring system for the National Radioactive Waste Management Site in Moldova
- Intervention services for scintigraphic installations in case of radiological emergencies, SC Mecan Petrol S.A Gaesti
- Contract for services for Irradiation and rock analysis gamma measurements, University of Helsinki, Finland
- Processing services by transfer of 117 parts of magnesium alloy having thorium composition for storage as radioactive waste under GN control, SC Turbo Mecanica SA Bucharest
- Services for taking over control of nuclear guarantees and transport of nuclear installations, Vulcan SA Bucharest, SC GRIRO SA Bucharest
- Services for taking over and treating as radioactive waste 12 detection installations type DICI-I-713 and warnings GARAD-D27, SC GRIRO SA Bucharest
- Services for taking over nuclear material by transfer for storage under GN control, SC CND Control SRL Cluj Napoca
- Services for taking over and transporting closed and open radiation sources for final treatment / conditioning and storage, CRSP Timisoara
- Services for taking over, treatment of nuclear materials and radioactive waste, SC SETCAR SA Braila, DSP Cluj Napoca, National Administration of State Reserves and Special Issues UT235 Gura Ochitei
- Services for taking over as radioactive waste, treatment and final storage of 2 sources of Co60, SC DYOMEDICA CND SRL Ploiesti
- Takeover services by transport for storage under GN control, SC INCOM SA lasi, SC MENAROM SA in insolvency Galati
- Services for taking over and transporting nuclear materials, INSP-CRSP Timisoara, SC Walter Tosto WTB Bucharest, INSP-CRSP Bucharest, ANAF Craiova
- Gadolinium nitrate sample analysis services, SC Protehnic SRL Cluj Napoca
- Schooling / training services for foreign researchers, IAEA Vienna
- Isotopic composition analysis of the product gadolinium, SC Interlab Austria SRL Bucharest

- Autoclaving tests in water at supercritical temperatures on 316L stainless steel samples, National Research-Development Institute for Laser, Plasma and Radiation Physics - INFLPR Magurele
- Analyzes for determining the total chlorine content by the method of neutron activation of 2 samples of ion exchange resins, SC Purolite SRL Victoria Brasov
- Analysis services for determining the chlorine concentration as impurities in FRT hydraulic oil, SC ENERGOTECH SA Bucharest
- Neutron field irradiation services, INCDTIM Cluj Napoca
- Maintenance services for CAS 1 air sampling stations (National Research-Development Institute for Cryogenic and Isotopic Technologies ICSI Rm. Vâlcea)
- Metrological verification / calibration services for dosimetric equipment (SC Petraconsult SA Constanța, SC REEP Aparatura Medicala SRL Pitesti, SC OMV PETROM SA Bucharest)
- Contract for services (provision of utilities), ANDR
- Services for delivery of demineralized water, SC Eurotehnic IND SRL Pitesti, SC ALRO SA Slatina, SC ALFAROM Carpati Industrial Grup SRL Pitesti

- Production and delivery of sources

• 64 closed sources of 192Ir were produced and delivered, with a total activity of 2949.92 Ci, to the following beneficiaries: NUCLEAR NDT R&S Bucharest, CONDMAG Braşov, ENERGOMONTAJ Rovinari, EXPROTERM Suceava, TOTAL GAZ Iaşi, MONTICOR Ploieşti, TUV Austria, WELD MILDIN CND Bascov, COMPCONTROL ING Ploieşti, WALTER TOSTO Bucharest, CSD Constanţa, VARD Tulcea, NDT TESTING Odobeşti, RAC Năvodari, DYOMEDICA Ploieşti, MECANPETROL Găeşti, CND CONTROL Cluj Napoca, SNC Constanţa, Sibro EUR, PETROC MOLDOCOR Neamţ, ARGENTA Năvodari.

- Checking the industrial scintigraphy installation type SENTINEL

26 verifications were performed at SENTINEL 880 type installations for 12 companies: SC NUCLEAR NDT RESEARCH & SERVICES SRL Bucharest; SC CND CONTROL SRL, Cluj Napoca; SC WELD MILDIN CND SRL, Bascov; SC NDT TESTING SRL, Odobeşti, Vrancea; SC EXPROTERM SRL, Suceava; SC TOTAL GAZ INDUSTRIE SRL, Iasi; SC COMESAD RO SA Pitesti; ŞANTIER NAVAL CONSTANȚA SA; SC WALTER TOSTO WTB SRL, Bucharest; SC EURO GAS SYSTEMS SRL, Târgu-Mureş; SC COMPCONTROL ING SRL, Ploiesti; SC COMOSERV SRL Oneşti.

Market and customers		of total income
1. The main collaborations on the foreign market	European Community	5,09
	SNN	77,95
2. The main customers	Customers from sales of Ir sources and verifications of Sentinel installations: NDT TESTING, ARGENTA, NUCLEAR NDT, DYOMEDICA PLOIEŞTI, ENERGOMONTAJ, ENERGOUTIL etc	5,47
on the domestic market	ANDR	1,39
	OTHERS	10,10
	TOTAL	100

RATEN ICN OBJECTIVES AND ACHIEVEMENTS IN 2021

Scientific activity

The annual program of RATEN ICN Piteşti includes 18 research-development programs and is carried out in accordance with the objectives of the Strategic Research-Development Program of the Autonomous Authority for Nuclear Energy Technologies regarding the development of national technical support and international cooperation for nuclear energy.

P1	Nuclear safety
P2	Fuel Channel
P3	Nuclear Fuels
P4	Fuel handling system
P5	Radioactive waste and spent fuel management in nuclear safety conditions
P6	Environment protection
P7	Steam generator
P8	Process systems and equipment
P9	Circuit chemistry
P10	Instrumentation and control
P11	Analysis of NPP operating events, aging, environmental qualification and increasing operating lifetime
P12	Advanced nuclear reactors and fuel cycles
P13	Ensuring and increasing the performance of the TRIGA ICN reactor
P14	Irradiation and radioisotope technologies
P15	Computerization of nuclear activities
P16	Heavy water and tritium
P17	Applications of nuclear techniques
P18	International cooperation

În 2021, in the framework of the 18 programs, 303 research papers were elaborated in the form of Internal Reports. These have materialized in studies, technologies, calculation programs, analysis methods, models, prototypes, products, projects, company standards, nuclear safety documentation, reports, etc.

The objectives of the R&DIT Programs, elaborated in accordance with the RATEN Development Strategy 2015 - 2025, the priorities at national and international level, the international agreements and treaties in the field of nuclear energy to which Romania is a party, were oriented towards:

- Operation in nuclear safety and security of Units 1 and 2 of Cernavoda NPP and extension of their lifetime;
- Development of skills and services regarding the economic and predictable operation of the fuel channels in the CANDU reactor at Cernavoda NPP, based on experimental, theoretical investigations and the results of periodic inspections;
- Contributions to the commissioning of Units 3 and 4, based on the acquired experience;
- Implementation of the experience and practice of CANDU power plant operators, by applying the CANDU Owners Group (COG) - Canada Research Programs to Units 1 and 2 Cernavoda, improving the technical and scientific support provided to Cernavoda NPP by increasing the contribution to these programs.

The R&DIT Programs of 2021 are structured on research topics, within which the actual research works are carried out. The research topics are proposed according to the national and international research priorities, the international agreements, conventions and treaties to which Romania is a party, in the conditions of peaceful use of nuclear energy, in

correlation with the objectives and strategic directions of action of the RATEN's 2015-2025 Research-Development Strategy.



The number of papers, associated to each research-development and technological engineering program is presented in the following diagram:

For this purpose, theoretical studies and mathematical modeling were carried out, computer codes were run, tests and experimental tests were performed on structural, fissile or irradiated nuclear materials, experimental fuel elements were manufactured, there were developed and applied specific technologies for radioactive waste management and storage, advanced generation IV reactors were promoted in the medium and long term, the owned critical infrastructure was operated in conditions of safety and nuclear safety (TRIGA Research Reactor, Post-Examination Irradiation Laboratories, Radioactive Waste Treatment Plant), it was continued the activity of education and training of specialists in the field, as well as the promotion of international cooperation. On this line, it is worth mentioning the support activities for the promotion and preparation of projects dedicated to the development of fast lead-cooled reactors, of ALFRED project, according to the Memorandum approved by the Romanian Government in the meeting of 07.01.2014 and the research-development works within the FALCON consortium.

The National Program for Research, Development and Innovation, PNCDI III

The purpose of experimental demonstration projects (PED) is to develop and test demonstration models (functional, experimental) for new products, technologies, methods, systems or services or with significant improvements in areas of smart specialization or public priority.

The competition for PEDs takes place within the National Plan for Research, Development and Innovation 2015-2020, PNIII, 2.2.18, Program 2 - Increasing the competitiveness of the Romanian economy through research, development and innovation, Subprogram 2.1. Competitiveness through research, development and innovation - "Experimental demonstration project", Competition identifier: PN-III-P2-2.1-PED-2021. This program is coordinated by the Executive Unit for the Financing of Higher Education, Research, Development and Innovation (UEFISCDI).

At the competition in 2021 with the submission deadline of September 21, RATEN ICN submitted 4 proposals for PEDs as coordinating organization and 2 as partners.

The projects submitted as **coordinating institution** are the following:

- Development and testing of electrochemical oxygen pumps for corrosion attenuation in liquid metals for nuclear, solar and industrial applications, project director: Dr. Daniela Gugiu (PN-III-P2-2.1-PED-2021-2892, field 3. Energy, environment and climate change);
- Creep test methodology in liquid lead environment for innovative structural materials of Gen IV, project director: Dr. Alexandru Ionuţ Niţu (PN-III-P2-2.1-PED-2021-1758, field 3. Energy, environment and changes climate);

- Vibration data collection system used in predictive maintenance schemes for industrial and nuclear applications, project director: Dr. Mihai-Cătălin Arva, (PN-III-P2-2.1-PED-2021-2292, field 3. Energy, environment and climate change);
- Validation of nitrogen and deuterium interactions with tungsten surfaces by XPS in-situ studies, project director: Dr. Alexandru Marin, (PN-III-P2-2.1-PED-2021-3565, field 4. Eco-nano-technologies and materials advanced).

The project proposals in which you participate as a **partner** are:

- *Electrolytic plasma oxidation of magnesium alloys to obtain black composite ceramic coatings*, UPIT coordinator, project director: Sorin Moga (PN-III-P2-2.1-PED-2021-3804, field 4. Eco-nano- advanced technologies and materials);

- Production of beryllium-containing materials for Tokamak-type fusion reactor studies and ICPOES investigation, INFLPR coordinator, project director Cristian Lungu, (PN-III-P2-2.1-PED-2021-4593, field 4. Eco -nano-technologies and advanced materials).

All proposals are in the evaluation stage.

International cooperation

RATEN's participation in international research programs is a priority of the international collaboration program, supported this year by providing the necessary support to achieve the objectives assumed by RATEN ICN specialists in ongoing projects, as well as maintaining an active presence in the EURATOM Framework Program, European Commission, the IAEA Technical Cooperation Program, but also the NEA / OECD Cooperation Program.

Collaboration at the level of the European Union

RATEN's participation in the Euratom Framework Program was supported by providing the necessary support to achieve the objectives assumed by RATEN ICN specialists in ongoing projects and in-kind projects proposed within the various European structures dedicated to the nuclear field.

This year, the activities foreseen within the projects CHANCE, GEMMA, MEACTOS, TRANSAT, PIACE, EURAD, PATRICIA, ECC SMART, PASCAL, ORIENT NM, PREDIS and ASCOM were carried out and submitted to the competition launched by the European Commission, entitled HORIZON EUROPE 2021, projects: ANSELMUS, SASPAM-SA, FREDMANS, INNUMAT, HARMONISE, ENEN ++, ECOSENS, HARPERS and POAEM.

✓ Research projects, funded by the European Commission, H2020, 2021

CHANCE	Characterization of conditioned nuclear waste for its safe disposal in Europe		
GEMMA	Generation IV Materials Maturity Mitigating Environmentally-Assisted Cracking Through Optimisation of Surface Condition		
MEACTOS			
TRANSAT	TRANSversal Actions for Tritium		
PIACE	Passive IsolAtion CondEnser	2010 2022	
EURAD	European Joint Programme on Radioactive Waste Management	2019 - 2022	
ORIENT NM	OrganIsation of the EuropeaN Research CommuniTy on Nuclear Materials	2020-2022	
PATRICIA	Partitioning and Transmuter Research Initiative in a Collaborative Innovation Action		
ECC SMART	Joint European-Canadian-Chinese Development of Small Modular Super-Critical Water-cooled Reactor Technology	2020-2024	
PASCAL	Proof of augmented safety conditions in advanced liquid-metal-cooled systems		
PREDIS	PRE-DISposal management of radioactive waste		

Within the **CHANCE** project, RATEN ICN contributed to the update of the deliverable completed in 2020 "D2.3 R&D needs for conditioned waste characterization", in order to take into account the comments received following the review carried out by CHANCE EUG representatives.

Through the **GEMMA** project, RATEN ICN approaches the study of materials for advanced nuclear systems through experimental tests to determine the mechanical properties of candidate steels for generation IV reactors subjected to welded joints (TIG - Tungsten Inert Gas and SAW - Submerged Arc Welding) and sample of 15-15Ti. In 2021 RATEN ICN prepared, delivered and revised the reports: D1.3 GEMMA WP 1.3 Test Matrix, The results from the SSRT tests on the 15-15Ti and AFA steel; D2.3 Characterization of mechanical properties and microstructure of reference welds in air and participated in its revision; RATEN ICN Report: GEMMA WP2.3 Test Matrix - The results from the Qualification Tests; GEMMA WP2 Task 2.2 D2.3 Weld Qualification Tests, Results from Bending Tests 316L (TIG & SAW); D2.6 Report on residual stress simulations, benchmarking and validation; RATEN ICN Report: Longitudinal RS distribution for butt welded plates - Literature review ", together with analyzes performed with" ANSYS mechanical "on the issue of the work package.

Within the **MEACTOS** project, activities were carried out within WP6 - Testing for EAC resistance under LWR conditions. The tests scheduled in task 6.1 and task 6.2 have been completed. It participated in the technical meetings organized online (TM no. 11, 14 and 17) and in the meeting no. 4 of the MEACTOS General Assembly. The results obtained in task 6.1 are contained in the report D 6.5. "Effect of selected surface treatments on EAC initiation, screening test results".

Within the **TRANSAT** project, we worked on the elaboration of the stage report.

Within the **PIACE** project, the tasks of RATEN ICN within the WP2 package were performed, consisting in: analysis of the capacity of the SIRIO installation to highlight the sizes / parameters of interest for CNE CANDU, elaboration of a thermohydraulic model of the SIRIO installation with the code RELAP5 / MOD 3.2 and the analysis of the evolutions of the parameters of interest.

The following actions were carried out in WP5:

- Realization Webinar with the title: "CANDU Overview and Isolation Condenser Upgrade" which can be found on the PIACE project website;
- Making announcements and organizing (details on the project page: piace.brasimone.enea.it):
- Webinars;
- Professional training of 5-10 young people (based on competition) in the experimental installation SIRIO of the organization SIET (Italy)

In carrying out the **EURAD** project, RATEN ICN participates in the Work Packages: CORI, FUTURE, ROUTES and UMAN, within which, in 2021, it carried out the following activities:

- FUTURE: Batch sorption tests of Tc-99 (via its chemically stable counterpart Re) were performed on a sample of
 pure clay (montmorillonite) and a sample of montmorillonite with controlled addition of iron ions, tests performed
 under controlled redox conditions.
- CORI: Ni-63 solubility tests in artificial water (ACW) were performed that simulate the composition of the water in the pores of hydrated cement pastes, which are in Stage I degradation. Ni-63 sorption tests (kinetics and isotherms) were started on cement pastes in degradation stage I, under controlled conditions (N2 atmosphere, O2 content and CO2≤ 2 ppm).
- ROUTS: Contributions to the delivery deliverable D.9.5: "Overview of issues related to challenging wastes", under review. The deliverable presents the synthesis regarding the management and storage of the categories of radioactive waste considered problematic by the respondents to the ROUTES questionnaire: radioactive sludges, used ionic resins, organic waste, bituminous waste, waste from decommissioning, closed closed sources, contaminated waste / U, waste containing reactive metals, waste containing chemotoxic substances. Also available in the deliverable are R&D actions proposed to be carried out jointly for a better management of problematic waste.

Within the **ORIENT NM** project, in 2021, the Technical Advisory Groups were created composed of experts in the field of nuclear materials and fuels and the identification sheets of current problems specific to the different types of materials to be investigated and solved were elaborated. In this context, the three expert RATEN, care fac parte din grupul dedicat

of metal alloys for structural components have completed sheets on the R&D aspects of the following materials, of interest to ICN from the perspective of the ALFRED project and CANDU reactors:

- Ni-based alloys 800 alloy, Incoloy 800, Ni-Fe-Cr alloys, proposed for steam generator piping
- o 316L austenitic steels, proposed for ALFRED demonstrator components
- Zirconium alloys, used in the manufacture of CANDU pressure tube.

The objective of the **PATRICIA** project is focused on partitioning research for the efficient separation of Am from burnt fuel, experiments and the development of codes for the study of actinide fuel behavior and support research for MYRRHA reactor licensing. In 2021, he participated in the launch meeting of the "PATRICIA Virtual Meeting" Project, October 2021, where the activities proposed in the work package were presented: "Patricia, WP8-Driver fuel Safety".

ECC SMART is a collaborative project between research organizations in Europe, China and Canada, which aims to contribute to the development of water-cooled modular reactors at supercritical temperatures such as SCW-SMR (Supercritical Water Cooled Small Modular Reactors).

Within the work package 2, (WP 2) in 2021 the following were performed:

- participation in all online meetings within the project (General Assembly) and technical meetings on WP2;
- the water test installation at supercritical temperatures was modernized by installing a pressure monitoring system and a new electrical panel;
- samples of Incoloy 800 and 310 S steel sent by CVR were received;
- the first analyzes imposed on the untested samples were performed (determination of surface roughness, microhardness, metallographic analyzes);
- the first tests were performed at a temperature of 3800 C and 25 MPa for 1000 hours;
- oxidized samples for 1000h were subjected to gravimetric analysis and metallographic analysis by optical microscopy and scanning electron microscopy.

In 2021, within the WP4 package, the main activities aimed at modeling the FQT (Fuel Qualification Test) assembly using the Monte Carlo code, MCNP6.2 and the ENDF / B.VII.1 nuclear data library to evaluate the parameters of interest: the multiplication factor , the axial distribution of power in the fuel, the axial distribution of the neutron flux in the water channels on three energy groups and the axial distribution of the energy deposition in the components of the FQT assembly.

The results obtained were used to meet the first objective of this work package, namely "Selection of appropriate reactor physics codes for modeling the complex behavior of SM-SCWR".

The **PASCAL** project aims to demonstrate the capability of advanced molten lead-cooled nuclear systems in ensuring a high level of nuclear safety. The deliverable D6 - "Plan for Exploitation and Dissemination of PASCAL's Results" was made and submitted to the European Commission.

The development of methods for the treatment and conditioning of radioactive waste for which no suitable or industrially mature solutions are currently available, including scrap metal, liquid organic waste and solid organic waste will be the objective of the **PREDIS** project.

In WP4, preliminary tests of corrosion of aluminum in Portlandit///e saturated solution in were performed and an experimental assembly was performed and tested that allows the direct measurement of the volume of hydrogen generated by the corrosion of aluminum in solution.

The following were made in WP5: contribution to the realization of the interim report "Screening study results & selection of reference formulations", completed in July 2021 (MS33), in which a summary of the experimental results obtained by the partners involved in the Task is presented. 5.3 (CIEMAT, KIPT, NNL, NUCLECO, POLIMI, RATEN, SCK-CEN, SOGIN) and describe the three geopolymer matrices for which additional optimization tests will be performed: a methacholine-based geopolymer recipe, a blast furnace slag geopolymer and a recipe based on mixtures of precursor materials such as methacoline, blast furnace slag and thermal power plant ash.

✓ Other European projects



The ASCOM project brings together the partner organizations' own efforts to transform the ASTEC code into a standard tool for the severe accident analysis for nuclear power plants and spent fuel storage facilities in Europe. Although the project will be carried out without funding from the European Commission, the interest to participate is given by the access to the ASTEC code without license fees, including user support.

Also, the activities coordinated by the European Commission must be mentioned:

Activities as a Member within the following platforms, networks and associations of the European Union:

SNETP - Sustainable Nuclear Energy Technology Platform

Within the Technological Platform for Sustainable Nuclear Energy (SNETP) the main activities carried out were dedicated to the completion of the reorganization process of the platform, initiated 2 years ago. The objective of this process was to obtain the status of legal entity, and to develop the necessary documentation for the organization and operation of the platform. Following the previous discussions and negotiations, it was agreed to officially transform SNETP into a legal entity that will integrate the 3 pillars - NUGENIA, ESNII and NC2I.

As a member of the platform, RATEN ICN has representatives at the level of the general assembly of SNETP and within the ESNII and NUGENIA pillars. Among the important activities carried out within the platform can be mentioned:

- **Position paper on the EURATOM 2021-2025 research program**, January 2021. The document identifies priorities for research, development and innovation in the construction of new production facilities, operation and maintenance of nuclear reactors, qualification and non-destructive examination of components, advanced reactors new generation or small and modular reactors (SMR).

- Completion and publication of the SNETP Research and Innovation Agenda, edition 2021. The research agenda mentions, within the ESNII pillar, the progress made in the period 2010-2018 regarding the technology of fast lead-cooled reactors through the ALFRED project in Romania and the support infrastructure for MYRRHA in Belgium. RATEN ICN contributed through a series of support actions carried out at the level of the FALCON partnership, as well as through lobbying activities, to highlight ALFRED in the document. LFR technology is considered a short-term alternative for generation IV technologies, with the ALFRED demonstrator established to be built in Romania with a research program supported at European level. It is also mentioned that the technology based on molten lead can be developed industrially based on the development of the European Demonstrator (ALFRED), having characteristics oriented towards small modular systems (SMR).

- **ESNII Charter** January 2021. In January, 26 ESNII Charters containing objectives, purpose, organization and functioning (for ESNII and the steering committee) were finalized and signed (26 European organizations). The ESNII represents the technologies of fast reactors cooled with lead, sodium, gas that are of interest to the industry and for which significant research, development and demonstration projects are underway. The priority projects adopted under ESNII are the ALFRED demonstrator (lead, commercial demonstration, 2030-2040, SMR characteristics), ALLEGRO (helium, demonstration of technological viability, after 2040) and the sodium research project to solve pre-commercial challenges in the Western European area, improving economic competitiveness and nuclear security.

- **SNETP 2021 Forum** (February 2-4, 2021). Dedicated to research, development and innovation in the civil nuclear field, the Forum enjoyed the participation of over 600 specialists not only from Europe but also from Japan, the United States, Canada, Ukraine and Argentina. The conference was organized online with a plenary session and 8 technical sessions. During the technical session dedicated to advanced reactor systems, 9 papers on GenIV systems and SNETP priorities were presented, as defined in the ESNII roadmap. After a general introduction of GenIV systems, the session addressed the systems cooled with heavy liquid metals (MYRRHA and ALFRED), sodium (ESFR), helium (ALLEGRO), supercritical water and molten salts. In each presentation, the plans for the development of the system in the near future as well as the priorities for research were addressed. The status of the ALFRED project and the activities planned for the next period were presented by the FALCON representative

- **The ESNII vision document.** The vision document of the 2021 edition presents the mission, the strategy, the stage of the projects in the ESNII portfolio, the strategic areas of development and the modalities of action. The presentation of the ALFRED project emphasizes the importance of international cooperation, considered an asset for the

implementation of the ALFRED project. The structure of the FALCON consortium ensures a wide openness for any organization that shares the vision of its members or that wants to contribute on specific research topics.

NUGENIA - Nuclear Generation II & III International Association

NUGENIA is an association whose mission is dedicated to research and development of nuclear fission technologies, with a focus on Generation II and III nuclear power plants, in which participate institutions belonging to industry, research and academia, committed to developing joint research and development projects. The affiliation of RATEN ICN to the NUGENIA Association ensures the promotion of RATEN ICN within the European Research Framework Programs, creates the favorable framework for the deepening and extension of the obligations already assumed within the Horizon 2020 Projects in progress; facilitates the involvement in the theoretical and applied research regarding the study of materials from the construction of Generation II and III nuclear reactors, as well as the application of the newly accumulated knowledge in the research works carried out for Cernavoda NPP.

ENS HSC (European Nuclear Society - High Scientific Council)

During 2021, ENS made considerable efforts to promote nuclear energy in the process of finalizing the European taxonomy to finance investments in low carbon technologies. The letter sent by ENS to the President of the European Commission, signed by 46 organizations in the field of environmental protection, calls for a reconsideration of the decision on the exclusion of nuclear energy from the taxonomy of eligible activities. It emphasizes that the European Union is threatened by continued dependence on fossil fuels, while scientific assessments have clarified that nuclear energy is needed to address the causes and challenges posed by the threat of climate change. At the end of the letter, it is requested that all low-carbon energy sources be taken into account equally in the ongoing and future discussions at European Commission level on the taxonomy for sustainable investment.

GIF

In 2021 RATEN ICN participated in the activities organized by GIF in collaboration with the IAEA for the analysis of the safety aspects of fast reactors cooled with liquid metals. In this sense, a technical meeting took place (30.03-01.04 2021, 9th Joint IAEA – GIF Technical Meeting on the Safety of Liquid Metal Cooled Fast Reactors). The meeting was structured in three main directions:

(1) discussion of IAEA-GIF cooperation activities in the field of liquid-cooled fast reactors (MRLs),

(2) discussing the status of documents on security recommendations and standards for SFR and LFR technologies,

(3) discussing the progress of the implementation of LMFR technologies in the participating countries.

RATEN ICN presented the evolution of the ALFRED project implementation, with emphasis on the preparation of the authorization process and the construction of the experimental support installations.

SET Plan - Sustainable Energy Technology Plan

In 2021, RATEN ICN represented Romania in the IWG 10 - Nuclear working group, and together with the representative of the Ministry of Energy, it represented Romania in the SET Plan SG and in the SET plan Bureau.

The main activities carried out within the SET Plan aimed at:

(1) coordinating national and European efforts in the field of energy policy, decarbonisation and climate action,

(2) monitoring the activities of the working groups and the stage of implementation of the National Plans for Energy and Climate Change (NECP),

(3) reviewing the work plans of the implementation groups, IGWs, stimulating the increase of cooperation between IWGs,

(4) adapting the energy transition to developments, including increasing resilience in the event of crises such as the pandemic,

(5) carrying out joint actions with other sectors (decarbonisation of transport, reduction of emissions in the materials industry)

(6) starting new working groups (electricity transmission through direct current lines, HVDC)

The annual SET Plan conference was held in 2021 under the chairmanship of Slovenia, marking the importance of the contribution of nuclear energy to the decarbonisation program and actions to prevent / mitigate climate change.

ETSON

Within ETSON, safety assessment activities are carried out under the umbrella of the Technical Council for Reactor Safety (TBRS), the research and development activities being managed by the ETSON research group (ERG).

After obtaining ETSON membership in 2017, RATEN ICN actively contributed to all ETSON activities. Due to the situation created by the pandemic of COVID 19, in 2021 the activities took place largely in the online environment.

Activities ETSON Technical Council

TBRS is a "TBRS network" that can be activated if an ETSON member needs to have information about a particular issue raised in its security analysis or assessment, about how the issue is being addressed by other organizations. The TBRS network thus contributes to stronger, more sustainable and harmonized support for the competent national regulatory authorities.

In the context of developing new reactor concepts, especially small modular reactors, TBRS has started to analyze the challenges posed by these new concepts in terms of demonstrating the level of safety and safety review, such as the intensive use of passive systems.

The state of ETSON-WENRA cooperation was analyzed (following the two directions - input on periodic security review specifications, analysis of possibilities to improve reference levels, and ways to achieve collaboration, which include:

- Look at the current practices of performing the security audit;
- Technical exchanges through seminars;
- Open collaboration with the identification of specific deliverables.

ETSON research group initiatives

ERG considered the following topics as relevant topics for the organization of future seminars among TSO members:

- Management in the last years before the final stop; Implications of outdated security technology for LTO;
- Use of AI in risk assessment; Use of machine learning techniques and data science in licensing applications;
- Water chemistry and environmental effects on fuel and reliability.

The ongoing activities of the ERG Group relate to efforts to update the list of calculation tools used by ETSON members, to map experimental infrastructures and modeling teams, and to revise the ETSON position paper on research needs.

ETSON Bulletin

The new format of the ETSON website now includes ETSON News developed by three TSOs, according to the new rotation program between ETSON members. RATEN ICN has prepared articles for the ETSON bulletin in January, June and December, promoting the institute's activities and ongoing projects.

ETSON Communication Group

The communication group developed the concept and structure of a video to promote the ETSON activity, in a short and a more detailed version. The promotional video was launched on the occasion of the EUROSAFE Forum and was a real success.

EUROSAFE Forum

The EUROSAFE Forum was hosted by the IRSN on 22-23 November in Beffroi de Montrouge. RATEN ICN participated with a paper in the "Nuclear Installation Safety Research" section

Network on Neutron Techniques Standardization for Structural Integrity

The objective of the European Network for the Standardization of Neutron-Based Techniques for Ensuring Structural Integrity (NeT) is to develop and standardize experimental and numerical techniques for the safe characterization of residual stresses in welded structures.

In 2021, two working meetings of the NeT Steering Committee took place, held in videoconference system, with the participation of RATEN ICN. The progress made in the various working groups, resulting from international projects with the participation of NeT members, as well as proposals for future activities were presented and analyzed.

FORATOM

The European Nuclear Industry Association has made remarkable efforts to promote nuclear energy in the process of drafting documents dedicated to the taxonomy of sustainable activities. The study on the role of nuclear energy for achieving a low-carbon Europe demonstrates the contribution of nuclear energy to a European low-carbon economy taking into account the 3 key objectives: decarbonisation and sustainability, security of supply and accessibility / competitiveness.

As part of the FORATOM initiative to publish on the association's website a record of nuclear installations in the European Union, Switzerland, Ukraine and the United Kingdom (nuclear power plants and nuclear power reactors, research facilities, nuclear research reactors (including those in progress decommissioning), etc., the information requested for the RATEN ICN infrastructure has been transmitted. The site, which is being prepared, is intended to understand and promote the nuclear sector in Europe among specialists and the public interested in carbon-free energy issues. For the infrastructure dedicated to LFR technology, data were transmitted regarding the general characteristics, stage, commissioning term, field of use.

Starting with June 2021, the institute appointed a member of the **FORATOM working group "Workforce, Skills & Education".** It covers three important pillars: the need to build skills in the nuclear field, the need to make this field more attractive, and the exploration of retraining / retraining opportunities. Each pillar includes a set of components and deliverables that the group will focus on.

The working group aims to be a good practice and a tool for exchanging experience for E&T providers and human resources managers in Europe. At the same time, it aims to develop an experience exchange program for young professionals in the nuclear sector, between companies in Europe, with the possibility of extending it to organizations outside Europe.

The representative of RATEN ICN is part of 2 subgroups: "Increasing the attractiveness of the nuclear field" and "The need to create skills in the nuclear field". Specific actions and activities will be discussed at the next meetings already scheduled for 2022.

✓ Activities within the European FALCON Consortium (Fostering ALFRED Consortium), between Romania and Italy, aimed at promoting the ALFRED project

The collaboration activity at FALCON partnership level includes cooperation activities between partners, as well as cooperation activities with research organizations that have signed agreements with FALCON. In 2021 the activity continued and was based on the following main tools and working methods: (1) Working group, (2) Workspace, (3) Website, (4) Agreements with other organizations, (5) Participation in other projects or initiatives, (6) Videoconferencing, (7) Consensus in promoting LFR and taking positions, (8) Data sharing, (9) Stimulating the synergistic effect, (10) Contracting.

In 2021, the activity of the 8 working groups continued: (GL1) Research-development and qualification (RD&Q), (GL2) Authorization (LIC), (GL3) Design (DES), (GL4) Implementation of support infrastructure (mP), (GL5) Education and training (E&T), (GL6) FALCON consortium expansion (FLC), (GL7) European Affairs (EUA), (GL8) ALFRED as a major project (MP).

The LIC, mP, E&T, EUA and MP working groups are coordinated by RATEN ICN, the DES and FLC groups are coordinated by Ansaldo Nucleare, and the RD&Q group is coordinated by ENEA.

An important aspect of the collaboration was the construction of a community of practice (CoP). The conceptual elements of the construction of the community of practice involving staff from the partner organizations FALCON were established and the elements of the operating framework were established. The CoP is focused on creating and exchanging knowledge useful for introduction into current work practices. This involves an organization of shared information and processes focusing on filling knowledge gaps. At the same time, it aims to develop, validate and disseminate the best practices that the partners have. Another pragmatic direction covers solving problems of common interest, by using the resources of partners. The CoP also aims to create situations conducive to stimulating the rapid dissemination of new ideas and resources.

The collaboration within the FALCON partnership also involved a better coordination of research programs in the field of LFR, supported by national funds, in order to use resources more efficiently by eliminating parallels, stimulating the capitalization of existing complementarities, reaching a critical mass for some topics and themes. , creating synergistic effects, stimulating research excellence, integrating young researchers and creating a highly motivated environment.

Participation in international projects is a factor that contributes to attracting financial and human resources for the development of LFR technology, contributing to solving open issues and stimulating collaboration between various organizations, teams and experts in the field. In this sense, the collaboration between FALCON members, involving in most situations the participation of organizations that have signed collaboration agreements with FALCON has materialized in 7 proposals: SASPAM-SA (severe accidents), ANSELMUS (safety assessments for HLM systems), FREDMANS (advanced solutions for the manufacture and recycling of nuclear fuel), INNUMAT (innovative structural materials), HARMONISE (harmonization of authorization processes), ENEN ++ (education and training activities), ECOSENS (socio-economic and sustainability assessments of nuclear systems).

The implementation vision of the ALFRED demonstrator also includes the construction of an experimental infrastructure dedicated, especially to the support activities for the authorization process, but also to the realization of RDI activities for the development of LFR technology or education and training activities. The implementation of this infrastructure is based on the use of a financing scheme through European funds. Currently, the first stage for the realization of the infrastructure is being implemented, namely: ATHENA (swimming pool installation for experiments and thermohydraulic tests) and ChemLab (laboratory for lead chemistry), the project being approved in terms of funding, and the activities design, construction and realization of experimental installations being contracted. The activities for the other experimental installations (HELENA2, ELF, HandsON, MeltinPot) and for the realization of the coordination and training center (HUB) are in various phases of preparation. In 2021, activities were carried out to identify new financing possibilities, a search generated by the lack of a new competition in POC. These include the attempt to include experimental infrastructure in the National Recovery and Resilience Program (PNRR). Taking into account the objectives of PNRR, two new infrastructures have been added aiming at a better functioning of an energy system based on renewable sources and nuclear energy: (1) an installation for studying thermal storage, (2) an installation for investigating the performance of hydrogen production by electrolysis. On the other hand, the possibility of financing through other operational programs was investigated and studied.

Collaboration with the International Atomic Energy Agency (IAEA) Vienna

The collaboration with IAEA Vienna was supported this year by the participation of RATEN ICN in the Research Program Coordinated by this international body (CRP research projects), the International Project on Innovative Reactors and Fuel Cycles INPRO (International Project on Innovative Nuclear Reactors and Fuel Cycles), involvement in the Technical Assistance Program and Regional Projects, active participation in the network of analytical laboratories for measuring environmental radioactivity, ALMERA and RANET.

✓ Coordinated Research Project, CRP type

Within the **Research Agreement no. 22755, CRP I31032 - Neutronics Benchmark of CEFR Start-up Tests**, RATEN ICN submitted to the IAEA the contributions to the drafting and revision of the IAEA TECDOC document dedicated to it.

CRP T13017 Project - Management of Waste Containing Long-lived Alpha Emiters: Characterization, Processing and Storage, aims to develop new technologies for the characterization and processing of waste streams containing long-lasting alpha emitters (including obsolete used radioactive sources) by different levels of activity and physical conditions.

In the October 2021 report, the paper "Radiochemical characteristics of freestanding water from dewatering of IRN150 spent resins" was presented. It presented methods for determining the activity of ³H, ¹⁴C, ¹³⁷Cs, ²⁴¹Am and ²⁴²Pu in the water that accompanies IRN150 waste resins in the waste resins storage tanks (freestanding water), using destructive and non-destructive methods, as well as the results obtained from analysis of samples by scintillation fluid spectrometry, gamma spectrometry and alpha spectrometry.

Through the CRP project No. 24320 - Characterization of spent CANDU fuel for long term storage and final disposal (Characterization of spent CANDU type fuel in view of long term storage and final disposal) is proposed:

- Development of a non-destructive method for measuring the thickness of the oxide layer based on the technique of eddy currents and its use for studying the distribution of the thickness of the oxide layer on the surface of spent nuclear fuel;

- Carrying out tensile tests on samples taken from the sheaths of spent fuel elements to determine the mechanical parameters of the material and correlating the results with the microstructure, thickness of the oxide layer and the concentration of hydrides in the sheaths of combustible elements;

- Testing methods for determining the beta-emitter content in samples taken from the fuel analyzed in point 1 and determining the organic and inorganic Carbon-14 content from the fuel element sheath.

In 2021 RATEN ICN Piteşti participated in 3 working meetings:

o Meeting for the launch of the CRP T13018 project "Spent Fuel Characterization", February 16, 2021;

- o Consultancy Meeting on the Coordinated Research Project on Spent Fuel Characterization, June 28 July 1, 2021;
- o First Research Coordination Meeting on the Coordinated Research Project on Spent Fuel Characterization, December 6-10, 2021

The annual report was prepared, which includes the status of the works carried out within the project and a document with a detailed presentation of the works carried out in the first year.

✓ Proposals for new research contracts with the IAEA

In October, RATEN ICN submitted to the IAEA the proposal for a new CRP research contract identified with the code I31038, within the contract entitled "Benchmark of Transition from Forced to Natural Circulation Experiment with Heavy Liquid Metal Loop - Reference cases in thermohydraulics liquid metal cooled reactors analyzed with calculation codes available in RATEN ICN ". The title of the project proposal is the following: "Benchmarking available computer codes in RATEN-ICN Pitesti for thermal-hydraulic analysis of liquid-metals cooled reactors - Experimental calibration of the transition from forced circulation to natural circulation with a liquid heavy metal loop". The aim of the project is to improve the understanding of accident sequences in fast reactors, to validate the computer tools held by the institute and, in particular, to improve technical skills in the field of safety analysis for innovative systems.

✓ Regional projects

The RER 0043 project - Enhancing Capacity Building Activities in the European Nuclear and Radiation Safety Organizations for Safe Operation of Facilities was completed in 2021, and the regional educational network in the field of nuclear safety and security (ERNSSEN) defined within it will take part in other future regional projects.

IAEA project RER / 2/017 "Assessing the role of low-carbon energy, technologies for climate change mitigation " aims to analyze the role of SMR systems in the context of current and future energy market, strategic actions provided by national energy and change plans Climate Change (NECP). RATEN ICN played the role of NCP (national counterpart) through which it coordinated the national activities to achieve the objectives of this project. Within the project, a multitude of technical meetings, seminars and workshops were held in order to: (1) build competencies regarding the use of economic, socio-economic and environmental analysis programs, (2) understand the existing methodologies regarding analysis energy markets, (3) the presentation of the specific problems of the Member States participating in the project.

RATEN ICN completed in 2021 Romania's case study on the potential for implementing SMR systems in the future regional energy market, taking into account climate objectives and policies

✓ Country project

ROM 9/038 - Support for the long-term improvement of radioactive waste and spent fuel management in Romania

The objective of the project is to strengthen the national capacity for the current management of radioactive waste and waste fuel, as well as the capacity for the implementation of fast reactors.

In 2021 RATEN ICN purchased a scintillation liquid spectrometer, which was installed in STDR and 2 people were trained on the use of the spectrometer in measuring the activity concentration of beta and alpha emitters. Also, the necessary documents were drafted for the participation of 6 young researchers from RATEN ICN in professional training activities in the field of LFR with full IAEA funding aimed at developing skills and abilities, lasting 3-6 months in the following organizations: PSI (Switzerland), ENEA Brasimone and ENEA Bologna. The documents requested and submitted to the IAEA consisted of: drafting the terms of reference (ToR) for each specialization; drafting Nominations for each researcher.

✓ INPRO Project (International Program for Innovative Reactors and Fuel Cycles)

1. INPRO-CENESO - Comparative Evaluation of Nuclear Energy Systems Options

The objective of this project is to apply the KIND approach in case studies for the comparative assessment of nuclear energy systems (NES) options / scenarios to be developed by INPRO Member States interested in applying this approach to support decision-making and prioritize the development of nuclear programs.

During the year, the draft report of the final report of the project was uploaded, which was uploaded on the IAEA platform, in June 2021.

2. INPRO ASENES SMR - ASENES pilot study for "Scenarios for implementing small modular reactors"

Implement the IAEA ASENES service in order to support capacity building and increase the skills of national experts for the evaluation of alternative nuclear technologies and collaboration, and in support of strategic planning for the sustainable development of nuclear energy.

Romania's case study aims to investigate scenarios for the development of the nuclear system under the specific conditions of the energy mix, based on the introduction of SMR, the level of penetration of renewables, considering strategic documents and climate policies.

In 2021, the following activities were carried out:

- formulations of solid hypotheses on the future development of the country, estimation of national electricity demand and the most probable energy mix; energy market investigation in order to understand the role of SMR systems by 2050; a double analysis was proposed on 3 levels (global, regional, and national): (1) quantitative analysis based on simulations with the MAED program, set of hypotheses and estimates for the demographic structure, GDP, structure and consumption model, energy required on different sectors, etc.; (2) qualitative analysis considering the impact of factors such as disruptive technologies, possible crises, actions for climate change, etc.

- proposal and investigation of long-term development scenarios of the national energy system with the MESSAGE program, including SMR implementation and complementarity with renewables; multicriteria comparative analysis on SMR technologies and large reactors, including sensitivity analyzes, with the KIND-ET instrument.

3. Update of e-learning and distance learning tools to support INPRO training - Update of e-learning tools and distance education to support INPRO training

INPRO provides interested Member States with e-learning and distance education courses on important issues related to the sustainability of nuclear energy, through the Webex conference system, contributing to increasing the capacity of Member States to develop innovative NES and facilitate the transition to nuclear sustainability based on collaboration between countries. The main objective of these courses is to become familiar with INPRO's activities through direct communication with IAEA experts with significant experience in the field. The lectures include: (1) overview of INPRO activities, (2) INPRO methodology for NES assessment as a whole and for specific areas, (3) NES analysis using INPRO / GAINS analytical framework, (4) results on SMR in INPRO activities, including transportable nuclear power plants.

The main contributions of the RATEN ICN delegates:

- updating and completing training materials (presentations, practical exercises, sets of questions / answers for the final exam) for online training assisted by instructors within the IAEA Learning Management System (LMS) platform. The training materials targeted experts from countries about to start nuclear programs and addressed the following topics: Economic aspects of nuclear energy; Modeling of nuclear energy systems (NES); Comparative evaluation of NES options; Development of plans to improve the sustainability of nuclear energy.

- updating and completing training materials uploaded on the IAEA Learning Management System platform, Module: Newcomer countries, August 2021.

✓ Other actions:

RATEN ICN participation in the activities of ALMERA and RANET networks (*Response and Assistance Network*):

In 2021, the Laboratory of Radiation Protection, Environmental Protection and Civil Protection within RATEN ICN participated in the performance test IAEA-TEL-2021-04 ALMERA, which aimed to verify the level of implementation of

methods for determining the content of natural and anthropogenic radionuclides from simulated water, bamboo and smear samples to test surface contamination.

Also, LRPMPC ensured the representation of the institute at the Annual Coordination Meeting of the ALMERA network, which took place between 22 and 26.11.2021, in an online system.

Within the RANET network, during 2021, LRPMPC participated in the ConvEx-2b type table-top exercise, held between 09 - 11.03.2021 and in the international emergency response exercise ConvEx-3, held between 26-27.10 .2021. This exercise also included an intercomparison test, which was established as a collaborative action between ALMERA and RANET, aimed at testing the capabilities of ALMERA laboratories to provide remote assistance support in the event of a nuclear accident, based on the RANET mechanism.

Participation in the TWG FR group activities (Technical Working Group on Fast Reactors)

As Romania's representative in TWG FR, the RATEN ICN delegate presented a report entitled "Romania's Current Activities in Support of ALFRED Infrastructure Implementation" on the current state of implementation of the ALFRED experimental infrastructure with emphasis on the role of ATHENA and ChemLab facilities in demonstrating aspects of security of the ALFRED Demonstrator. The research and development priorities of the LFR technology and the role of the experimental campaigns scheduled to take place in the 2 infrastructures were highlighted.

International Nuclear Information System (INIS)

The 40th Consultative Meeting of INIS Liaison Officers took place online from 10 to 12 May 2021. The purpose of this meeting was to present the work of INIS (International Nuclear Information System). in the last 3 years - the previous consultative meeting of INIS liaison officers taking place in 2018.

During the meeting, comprehensive instructions were provided on the preparation of documents for storage in the INIS database and how to use it. Thus, each paper submitted to INIS, except for its title, must be accompanied by three indicators of its content, namely: 1) a summary in English, 2) a category of topics and 3) a set of "descriptors" selected from INIS Thesaurus. With the improvement of the IT system related to INIS, by developing a new tool (software), "metadata extraction" (MEP) that will replace in the near future the current FIBER system, will increase the performance of document processing and the quality of final documents stored in INIS.

The information obtained during the meeting will lead to the efficiency of the transmission process of the works carried out within RATEN ICN and of the JNDR magazine in order to develop the INIS - IAEA document collection.

Participation in courses, workshops, technical trainings.

✓ Activities as an ICERR center

On 17.01.2020, following the evaluation of the International Atomic Energy Agency, the Institute for Nuclear Research Pitesti was designated as International Center based on Research Reactor - ICERR for the fields "Education and Training" and "Joint research and development (R&D) projects".

The designation of the institute as ICERR, together with 6 other branded institutes from the USA, France, Korea, Russia and Belgium, represents an international recognition of the research capacity in the field of Romanian nuclear energy represented by RATEN ICN.

Within the TRIGA Reactor department, for the field "Education and Training", training is provided aimed at:

- Nuclear safety
- Reactor physics
- Radiation protection
- Technical irradiation
- Use of neutron beams

For the field "Joint Research and Development (R&D) Projects" the topics can target the following:

- Testing fuels for generation IV reactors
- Production of radioisotopes with applications in medicine and industry
- Irradiation of materials of nuclear interest
- Structural analysis using nuclear techniques

Among the actions carried out in 2021 can be mentioned:

- Updating the IAEA profile website with information about the institute https://www.iaea.org/about/partnerships/international-centres-based-on-research-reactors-icerrs

- During the 65th edition of the IAEA General Conference organized at the Agency's headquarters in Vienna, Austria, Rafael Mariano Grossi, the Director General of the IAEA handed over to the representatives of the Nuclear Research Institute the plaque designating the organization as ICERR for the field "Education and Training". "Joint Research - Development Projects" - September 20, 2021

(https://www.flickr.com/photos/iaea_imagebank/albums/72157719880069206)

- IAEA scholarship for the training of a Jordanian specialist in the field of Research Reactor Safety. Thus, between June 15 and July 14, 2021, the scientific visit of Mr. Tariq Alsharafat took place. The scientific visit in the field of Research Reactor Safety was carried out based on the technical cooperation project JOR1009 "Developing Safe and Effective Operations and Utilization of the Research and Training Reactor" and took place within the TRIGA Reactor department, under the auspices of ICERR for Education and Training (Education and Training) ".

- Training and professional training doctoral student Mohamed Elsayed Mitwalli Tolba Mitwalli, Mansoura University of Egypt, who carried out experimental activities for radiological characterization and analysis by activating environmental samples taken from areas of interest in the area of Lake Manzala (Egypt), during 15 - February 26, 2021 and some rock samples taken from areas of interest in the territory of the Arab Republic of Egypt, between June 9 and 30, 2021. These activities contributed to the completion of the experimental part of the doctoral thesis.

Other collaborations

Activity under existing bilateral agreements

In the context of the pandemic, cooperation with CEA, IRSN and SCK CEN continued strictly within the ongoing EURATOM projects and the European structures SNETP, ESNII, ETSON, STC.

With the signing in October 2020 of the Romania-US Intergovernmental Agreement for cooperation in order to expand and modernize the civilian nuclear program in Romania, the foundations were laid for a long-term cooperation with DoE on nuclear research and development, more specifically in areas such as modular reactors. Regulation of nuclear activities, exchanges between research laboratories and universities, and staff training. RATEN ICN was present at scientific events organized by the DoE as part of its international cooperation program.

Actions under Trilateral Agreement with Mansoura University (Egypt), University of Pitesti (Romania) and RATEN ICN Pitesti (Romania) targeted this year the following activities:

- Coordination of activities of master student Nawal M.M.S. Elbassiony (Mansoura University, Egypt) for the elaboration of dissertation papers and the preparation of public support and for the transmission of scientific paper to the Journal of Taibah University for Science, KSA (M. Sallah, C.A. Mărgeanu, N. Elbassiony, M. Mitwalli, A. Elgarayhi - " Assessment of the radiobiological impact in Monte Carlo protection calculations of spent fuel CANDU "); performing combustion and biological protection calculations using the programs in the SCALE5 package (available with a single-user license).

- Within the Laboratory of Radiation Protection and Environmental Protection, PhD student Mohamed Elsayed Mitwalli Tolba Mitwalli of Mansoura University in Egypt, performed experimental activities for radiological characterization and analysis by activating environmental samples taken from areas of interest in the area of Lake Manzala (Egypt) and rock samples taken from areas of interest in the territory of the Arab Republic of Egypt. These activities contributed to the completion of the experimental parts of the doctoral thesis.

NEA / OECD France

Romania joined the OECD NEA in 2017, thus becoming a full member of this international organization. A number of Romanian specialists, from different institutions, have been appointed to represent Romania in the thematic working groups that address, by combining their own efforts, the current issues of the field of nuclear energy. RATEN represents Romania in the following working groups:

• Working Party on Nuclear Energy Economics (WPNE) - dedicated to the analysis of economic aspects associated with nuclear energy

• Working Group on Reliability and Risk (WGRISK) - dedicated to the safety analysis aspects of nuclear reactors

• Working Group on the Safety of Advanced Reactors (WGSAR) - dedicated to the safety of advanced reactors

• Working Group on Analysis and Management of Accidents (WGAMA) - dedicated to the analysis and management of accidents

• Working Group on Operating Experience (WGOE) - dedicated to the operating experience of research reactors

• Working Party on Technical, Environmental and Safety Aspects of Decommissioning and Legacy Management (WPTES) - dedicated to the technical, environmental and safety aspects of decommissioning and heritage management

• Working Group on the Characterization, the Understanding and the Performance of Argillaceous Rocks as Repository Host Formations (CLAY CLUB) - dedicated to geological storage in clay formations

• Expert Group on Repositories in Rock Salt Formations (SALT CLUB) - dedicated to geological salt storage

• Expert Group on Geological Repositories in Crystalline Rock Formations - Crystalline Club (CRC) - dedicated to geological deposits in crystalline rock formations

• Expert Group on Physics of Reactor Systems (EGPRS) - dedicated to experts in reactor physics

The members of the WGRISK Group of Reliability and Risk Experts have ongoing activities to improve PSA studies and to make efficient use of their results, with reference mainly to dealing with the impact of external hazards, risk aggregation and the multi-unit context.

The activities carried out within the group of experts in economic aspects of nuclear energy WPNE of NEA contribute to the promotion and support of RATEN ICN's involvement in international collaborations aiming at economic aspects related to the development of nuclear energy systems and the fuel cycle.

The WGAMA Group - Analysis and Management of Accidents focuses on the main challenges regarding thermohydraulics, CFD, severe accidents. It is possible that in the future it will also address issues related to Generation IV reactors.

The Clay Club Group attaches great importance to the abnormal water pressure in clay, observed in several underground laboratories made of sedimentary rocks. Measuring it, understanding the causes and defining the constitutive laws governing the abnormal increase in pressure are practically the current challenges of the scientific community interested in this rock. Also, the challenges related to the area affected by clay excavation, such as biogenic corrosion, the unpredictability of the spatial distribution of stresses after excavation and the cement-clay interaction that reduces the swelling capacity of bentonite, still require careful investigation by the group.

Between May 27 and 28, 2021, the action "Kick-off Meeting of the Working Party on Technical, Environmental and Safety Aspects of Decommissioning and Legacy Management (WPTES)" took place online.

The meeting of the Expert Group on Physics of Reactor Systems (EGPRS), from the NEA / OECD member countries, was organized on February 18, 2021, through the zoom platform.

During 2020, a restructuring of the WPRS activity and of the associated subgroups of experts took place, aiming at prioritizing the efforts and aligning the purpose of the activities carried out in different expert groups. Two groups of experts resulted, namely: the Expert Group on the Physics of Reactor Systems (EGPRS) which also included the EGRTS expert group, and the Expert Group on Multi-physics of Reactor Systems (EGMUP). Other mandates, including that of WPRS, have been updated to reflect the new structure and activities of the associated expert groups.

A new joint international NEA project "HORONOBE International Project (HIP)" has been considered, with the aim of being launched by the end of 2022. The project has an implementation period of three years and the possibility of an extension of another four years. -a second phase. The conditions for participation were presented and discussed at the virtual working orientation Orientation Meeting on NEA Joint Project, on September 1, 2021, which aimed at the overall presentation of the NEA's international cooperation program and the necessary procedures to be considered. at the

launch of a joint NEA project, such as the HORONOBE project. On October 27, 2021, the NEA officially launched the call for the recruitment of collaborating partners for a new joint project in the Horonobe Underground Research Center - Japan.

Following the launch of the call, RATEN ICN expressed its interest in participating in Activity A of the HORONOBE International Project with experimental tests on radionuclide migration on rock samples and modeling activities of radionuclide transport in fractured clay rocks, and CITON said it was interested. of the results of Activity C regarding the thermo-hydro-mechanical-chemical modeling (T-H-M-C) of the evolution of the engineering barrier system.

The NEA organized a series of seminars, workshops, bringing together participants from regulatory and control bodies, research institutes, nuclear fuel manufacturers and nuclear industry manufacturers. Discussions confirmed that a multinational framework is needed to address current and future experimental needs. As a result, the international community is now coming together under the auspices of an NEA initiative to form a new multinational framework for nuclear and material testing, hereinafter referred to as the Framework for Irradiation Experiments (FIDES). The initiative has received strong long-term support from NEA member countries.

Thus, on April 20, 2021, RATEN ICN participated in the meeting of FIDES experts. The presentations and discussions of the experts revealed the purpose of FIDES (2021-2024), namely to develop certain experiments in order to test the fuel and component materials of the active area in existing nuclear installations (research reactors).

MEASURES TO INCREASE RATEN ICN'S PRESTIGE AND VISIBILITY

Scientific events organized by RATEN ICN

The COVID-19 pandemic affected both the organization and physical participation in the forms of training anticipated for 2021, numerous courses and seminars were canceled or postponed for 2022, and the remaining ones were held in the virtual environment. By transferring the activities in the online environment, logistical problems have appeared first of all (platforms and computers capable of supporting the online participation of a large number of students in good quality audio-video conditions are needed), and in secondly, issues related to the ability and rigor of communication in the virtual environment of the participants.

In the context of the COVID-19 pandemic, RATEN ICN decided that the NUCLEAR Conference 2021 "Sustainable Development through Nuclear Research and Education" will take place online, between 26 and 28 May 2021.

The conference organized by the Pitesti Nuclear Research Institute under the auspices of the Romanian Academy, in collaboration with the University of Pitesti, the Romanian Academy of Scientists and the Romanian Academy of Technical Sciences,



promoted themes and activities of research that illustrates the contribution of nuclear energy in the energy security of each country and in reducing greenhouse gas emissions.

The main objective of the conference was to promote nuclear energy as part of the energy mix that ensures the sustainable development of society by highlighting its contribution at national, European and global level to achieving the objectives assumed by conventions and treaties, strategic development directions, stage achieved by research in the field in pursuit of these objectives.

At the same time, the Conference aimed at:

• presenting, disseminating and promoting the research activity and capabilities of Romanian institutions, as well as the most recent and original results obtained in the development of this state-of-the-art technology, contributing to increasing the visibility of Romania's nuclear research potential.

• facilitating a better knowledge of the state reached at European and international level in the developments destined for the field of nuclear energy, with special emphasis on the development of Generation IV reactors, nuclear safety, advanced materials, radioactive waste management, radiation protection.

• strengthening the interface between university education, represented by teachers and students, and research to stimulate the interest of young graduates in the nuclear field and to attract the younger generation to this field facing an acute shortage of staff to take over existing knowledge and thus ensure continuity a high qualification in nuclear energy.

• strengthening collaboration between research, industry, operators and national authorities, so as to meet together the major objectives assumed at national, European and international level aimed at reducing carbon emissions, security of energy supply and competitiveness.

Also, in 2021 the Institute for Nuclear Research Pitesti celebrated 50 years of activity, and this event was included in the Conference program. In the plenary session, for the opening of the conference, Mr. Academician Nicolae Zamfir addressed both his congratulations for the anniversary of the institute and from Mr. Acad. Marius Peculea, leader in the field. At the same time, on behalf of the RATEN management, Mrs. Diaconu Daniela, Scientific Director, presented the "RATEN ICN at 50 years old", authors: Constantin Păunoiu, Şerban Valeca, Daniela Diaconu, Dumitru Bărbos.

The event attracted over 200 participants from: Belgium, Italy, France, Austria, Sweden, Ukraine, Spain, Lithuania, Germany, Egypt, the Russian Federation and Iran, representing the research community and academia, the nuclear industry, the nuclear authorities and decision makers. During the thematic sessions they were presented progress in the continuous improvement of nuclear safety, the



development of advanced nuclear systems and SMRs, the improvement of radioactive waste management and radiation protection, as well as in the modernization of the education process and the strengthening of collaboration in nuclear research for sustainable development.

In addition to organizing the 2021 Nuclear Conference, RATEN ICN managed to organize / host the following events:

- ✓ Visiting the nuclear and radiological installations within RATEN ICN and carrying out experimental activities for the radiological characterization and analysis by activating some environmental samples, 15 - 26 February 2021 and 9 June - 16 July 2021, 1 person;
- Scientific visit in the field of RR Security based on the IAEA technical cooperation project JOR1009, June 15 -July 14, 2021, 1 person;
- ✓ Carrying out the research and improvement internship, "Ferdinand 1" Military Technical Academy, Bucharest, July 5 - 16, 2021, 1 person;
- ✓ Working visit of the General Inspectorate of the Romanian Gendarmerie (IGJR) and the Federal Bureau of Investigation (FBI / USA), July 16, 2021, 9 people
- ✓ Documentation visit in the field of nuclear research, UPIT, 12 13 October 2021, 22 people;
 - Inspection for the annual verification of the physical inventory of PIV nuclear materials subject to the control of nuclear safeguards performed by inspectors of EURATOM, IAEA and CNCAN representatives at RATEN - Pitesti Nuclear Research Institute, WRME material balance area, in accordance with the provisions of the Agreement of Nuclear Guarantees (INFCIRC / 193), 9 - 10 June 2021, 2 persons;
- Inspection
- Routine inspection. Information and clarifications related to studies and tests performed for the technology of obtaining sintered tablets mixed thorium and uranium oxide for the manufacture of experimental fuel elements, November 24, 2021, 2 persons.

Dissemination of research results and knowledge transfer

- Regarding the dissemination of the R&D IT activity in RATEN ICN, this was done by:
- Publication by RATEN ICN of the following works:
 - 14 scientific / technical papers listed or indexed by the International Institute of Statistics (ISI) and WoS;
 - 36 scientific / technical papers indexed in international databases;
 - 2 scientific / technical papers in journals, other than those listed or indexed;
 - 67 scientific papers presented at conferences with international participation;

- 9 specialized books or chapters from published books;
- RATEN ICN Pitesti edited issues 20,21 and 22 of the Journal of Nuclear Research and Development, ISSN 2247-191X; ISSN-L 2247-191X (<u>www.jnrd-nuclear.ro</u>).

In the field of knowledge transfer, the researchers and specialists from RATEN ICN, as coordinators or mentors, ensured at national level the coordination of higher education graduates, for the completion of bachelor's and dissertation papers and doctoral students for the completion of doctoral theses.

In 2021, students in their final years at UPIT, UPB and Mansoura University, Egypt benefited from guidance from RATEN ICN specialists for undergraduate and dissertation work, as shown in the table below:

University / Organization	Field / Specialization	Nr. graduates / master students / doctoral students
	Applied Chemistry and Materials Science	1 graduate
Polytochnia University of Pucharost	Energy and Nuclear Technologies	1 graduate
(UPB)	Nuclear Engineering	1 master students
University of Pitesti (UPIT	Energy and Nuclear Technologies	19 graduates
	Nuclear Materials and Technologies	21 masters students
"Ferdinand 1" Military Technical Academy, Bucharest	Carrying out research and improvement training	1 (research and advanced training)
Mansoura University, Egypt	Carrying out experimental activities for radiological characterization and analysis by activating some environmental samples	1 phd
Mansoura University, Egypt	Realization of combustion and biological protection calculations with the help of the programs from the SCALE5 package for the elaboration of the dissertation and the preparation of the public support.	1 master students

RATEN ICN representation at scientific activities, national and international events

Although many of the events planned for 2021 have been canceled due to pandemic restrictions, some have been moved to the virtual environment. RATEN ICN specialists participated in events and manifestations organized at national level as follows:

- International Scientific Conference, "Applications of chemistry in nanosciences and biomaterials engineering -NanoBioMat", online, 25 - 26 June 2021;
- 13th International Conference on Electronics, Computers and Artificial Intelligence ECAI 2021,, 1 3 July 2021;
- Conference Days of the Romanian Academy of Technical Sciences ZASTR 2021, online, October 21-22, 2021;

23rd International Conference "New Cryogenic and Isotope Technologies for Energy and Environment" - EnergEn 2021, Băile Govora, Romania, October 26 - 29, 2021..

In 2021, 120 RATEN ICN specialists participated in 86 international actions, their missions highlighting the following priorities:

I. Participation in events under the auspices of the EC in ongoing and future projects:

a. working meetings and annual meetings of the European Projects contracted with the EC within the EURATOM H2020 Program, for the presentation and reporting of the status of the works undertaken, the finalization of the future responsibilities correlated with the objectives of the projects;

b. activities within the European Technological Organizations, Networks and Platforms.

II. Participation in actions organized by the IAEA on:

- a. coordinated research projects, CRP;
- b. technical cooperation projects;
- **c.** meetings of technical and working groups;

d. participation in seminars, workshops, technical meetings organized by the IAEA.

III. Participation in conferences and other actions through which the results obtained in the research-development and technological engineering activity of RATEN ICN at international level were disseminated, the delegates supporting specialized works;



Participation in these actions has contributed to the professional development of staff, to the harmonization of knowledge with those internationally, to the knowledge and acquisition of new practices and technologies in the field of activity.

The adjacent diagram highlights the share of foreign participation of RATEN ICN delegations.

PERFORMANCE INDICATORS. DEGREE OF ACHIEVEMENT

Achieving performance indicators

• Technical - Scientific Indicators

	Indicator	Percentage achieved
1	Number of R&D IT papers produced and received within the RATEN ICN Annual Research and Development Program (303 papers)	100%
2	Number of informative reports sent to Cernavoda NPP for ensuring the technical-scientific support and supporting the research topic of interest in the operation of the plant (24 Cernavoda reports)	100%
3	Number of progress reports submitted to the European Commission under the EURATOM Program (3 reports)	100%
4	Number of stage reports submitted to the IAEA Vienna, within CRP projects (7 reports)	100%
5	Number of orders / contracts / services provided by RATEN ICN (110 contracts / orders)	100%

Din analiza indicatorilor tehnico-ştiinţifici se pot concluziona următoarele:

- The research-development works, proposed and approved by the Ministry of Energy, were handed over and received, at the terms established within the RATEN 2021 Annual Research-Development Program, within the allocated budget;
- The commitments to ensure the technical and scientific support to CNE-Cernavoda were 100% respected;
- The commitments made within the projects carried out by the international bodies (IAEA Vienna and the European Commission) were respected;
- RATEN ICN complied with all its commitments assumed for 2021 through service contracts.

CONCLUSIONS

In 2021, RATEN ICN's activities were focused on the safe operation and safety of the owned infrastructure, in compliance with national norms, international agreements and treaties in the field, as well as on maintaining the research capacity and competence in the field of nuclear energy.

Thus, the most important achievements that can be highlighted:

- compliance with the commitments assumed within the national, European and international projects;
- handing over and receiving at the established deadlines the research-development papers, elaborated within the Annual Research Program RATEN 2021, regarding the development of the national technical support and the international cooperation for nuclear energy;
- the use of the owned infrastructure and the competence in the field for the production of radioactive sources for medical / industrial use, respectively for the decommissioning of the obsolete ones;
- consolidating the participation in the European research and the involvement in major projects (implementation of the ALFRED demonstrator in Romania);
- timely provision of services, contracts and orders engaged, in compliance with contractual requirements;
- identification of new sources of financing through the use of the RATEN ICN infrastructure and the competence in the field:
 - decommissioning the cobalt therapy installations from medical units in Romania;
 - production of radioactive sources for industrial use, decommissioning of obsolete ones, verification of industrial scintigraphy installations;
 - provision of services in the field of radiation protection, treatment and conditioning of radioactive waste, metrology, engineering and design.
- increasing the prestige and visibility of RATEN ICN, by representation at the actions organized at national and international level, at scientific manifestations and events as well as the inclusion of researchers in the editorial teams of some recognized WoS journals or included in international databases;
- active involvement in the field of knowledge management and transfer in the field of nuclear energy;
- carrying out the activities as "International Center based on Research Reactors (ICERR)" for the fields of "Education and Training" and Joint Research and Development (R&D) Projects".



TECHNOLOGIES FOR NUCLEAR ENERGY STATE OWNED COMPANY INSTITUTE FOR NUCLEAR RESEARCH

tel. +40 248 213 400; fax +40 248 262 449 CP 78, Piteşti Câmpului Street, no. 1, 115400, Mioveni, Argeş County ROMÂNIA

> http://www.nuclear.ro E-mail: office@nuclear.ro