ROSATOM INTEGRATED OFFER: LARGE-SCALE NPPs
Dear colleagues,

As a leading global energy and technology company, Rosatom provides both experienced and newcomer countries with an efficient reference-based and time-tested approach to developing large-scale nuclear power plants. Our Integrated Offer for overseas markets is simultaneously a unified and tailored solution which allows our partners to access Rosatom’s full range of products and services from a single vendor throughout the entire lifecycle of their Nuclear Power Plant.

In Rusatom Overseas we have accumulated vast expertise in delivering ambitious, large-scale nuclear projects coupled with a long and successful record of developing complex international solutions based on our Integrated Offer. Rusatom Overseas is ready to become your reliable energy partner and we welcome you into this lifelong journey.

Evgeny PAKERMANOV, President, Rusatom Overseas
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RUSATOM OVERSEAS IS THE ONE-STOP-SHOP FOR ROSATOM OVERSEAS PARTNERS THAT MAKES THE WHOLE RANGE OF PRODUCTS AND SERVICES AVAILABLE TO THE CUSTOMER.

RUSATOM OVERSEAS ENABLES DIRECT INTERACTION BETWEEN CUSTOMER COUNTRIES AND ROSATOM COMPANIES.

ROSATOM OVERSEAS IS A SET OF SOLUTIONS AND SERVICES DESIGNED BY ROSATOM TO PROVIDE COMPREHENSIVE SUPPORT TO THE NATIONAL NUCLEAR PROGRAM IN THE CUSTOMER COUNTRY FROM A SINGLE SUPPLIER.

ROSATOM GROUP OF COMPANIES

PUBLIC ACCEPTANCE
HUMAN RESOURCES DEVELOPMENT
NUCLEAR INFRASTRUCTURE DEVELOPMENT
BACK END
OPERATION & MAINTENANCE
FUEL SUPPLY
INDUSTRIAL SOLUTION LOCAL INDUSTRY INVOLVEMENT
ENERGY SOLUTION

CUSTOMER
ROSATOM IS A RELIABLE PARTNER FOR LARGE-SCALE NUCLEAR PROJECTS IMPLEMENTATION

**Rosatom expertise is backed by >70 years of experience of Russian civil nuclear industry.**

**ROSATOM SUPPORTS ITS CUSTOMERS THROUGHOUT THE WHOLE CIVIL NUCLEAR PROGRAMME**

- **FUEL SUPPLY**
  uninterrupted fuel supply throughout NPP lifecycle

- **OPERATION & MAINTENANCE**
  managing safe operation and cost-effective power generation at NPPs

- **BACK END**
  providing eco-friendly solutions for spent nuclear fuel and radwaste treatment as well as nuclear facilities decommissioning

**INDUSTRIAL SOLUTION**

- enabling local suppliers involvement into national nuclear project

**ENERGY SOLUTION**

- based on VVER-1200 state-of-the-art technology

**HUMAN RESOURCES DEVELOPMENT**

- training professionals for nuclear program development and safe operation of NPPs

**PUBLIC ACCEPTANCE**

- raising public awareness of nuclear energy

**NUCLEAR INFRASTRUCTURE DEVELOPMENT**

- preparing the customer country to host a nuclear facility

**NUCLEAR PROGRAM STRATEGY DEVELOPMENT**

- preparing the customer country to host a nuclear facility

**INFRASTRUCTURE DEVELOPMENT**

- ensuring safe operation and cost-effective power generation at NPPs

**NPP OPERATION**

- managing safe operation and cost-effective power generation at NPPs

**NUCLEAR PROGRAM FURTHER DEVELOPMENT**

- ensuring safe operation and cost-effective power generation at NPPs
WHAT?
Nuclear infrastructure is a ‘check list’ to make sure your country is compliant and ready to host nuclear technologies.

WHY?
Nuclear infrastructure comprises 19 crucial issues to be developed by the newcomer country in order to ensure:
- safe NPP operation;
- safety at nuclear fuel cycle facilities;
- customer country is ready to efficiently respond to very unlikely emergency situations.

WHO?
Rosatom supports and navigates its customers on their way to successfully establishing nuclear infrastructure.

According to IAEA the country is fully responsible for its nuclear infrastructure development.

NOT SURE HOW TO START?
NO PROBLEM! ROSATOM’S TAILORED ACTION PLAN IS READY…

Rosatom supports and navigates its customers on their way to successfully establishing nuclear infrastructure.

COUNTRY IS READY TO OPERATE ITS FIRST NPP
PUBLIC ACCEPTANCE

STILL NOT SURE?
ROSATOM ASSISTS ITS PARTNERS IN RAISING DOMESTIC LEVEL OF PUBLIC ACCEPTANCE AT 3 MAJOR STAGES

1. ANALYSING
2. PLANNING
3. RAISING

ROSATOM PROVIDES PR SOLUTION FOR CUSTOMERS THROUGHOUT THE WHOLE NATIONAL NUCLEAR PROGRAM

TRANSPARENCY IS THE MAIN TOOL: Rosatom success

- 6 nuclear information centers globally
- Success stories in 20 countries
- Technical tours to the real NPPs plants

PUBLIC ACCEPTANCE IS AN IMPORTANT TOOL TO SUPPORT CONTINUOUS NUCLEAR POWER GENERATION AND ITS PEACEFUL USE
**WHAT PERSONNEL?**

**ROSATOM** offers a full range of Human Resources Development options and solutions that incorporate the company’s extensive experience.

**HOW TO TRAIN?**

**COMPREHENSIVE HUMAN RESOURCES DEVELOPMENT PLAN FOR PARTNER COUNTRIES**

**ROSATOM’S KEY APPROACH** to personnel training EMBRACES ALL STAGES OF HUMAN RESOURCES DEVELOPMENT: from higher specialized education (technical college or university) to training for specific positions ranging from regular members of staff to top managers.

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<tr>
<th>PERSONNEL CATEGORIES</th>
<th>TRAINING ORGANIZATION</th>
<th>PHASE 1</th>
<th>PHASE 2</th>
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<td><strong>NPP PERSONNEL</strong></td>
<td>Training consortium</td>
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<td><strong>CONSTRUCTION-ENGINEERING PERSONNEL</strong></td>
<td>Universities and training organizations</td>
<td>Personnel for non-energy sector projects</td>
<td>Courses for PhD, researchers etc.</td>
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<td>*<em>SCIENTIFIC &amp; RESEARCH PERSONNEL</em></td>
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<td><strong>YOUNG SPECIALISTS AND PROFESSORS</strong></td>
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<td>Techacademy Rosatom</td>
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*The category is not a part of NPP project solution, but can be included in Rosatom HRD Offer

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**CAREER PLANNING FOR EVERY EMPLOYEE**

**NPP START**

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**RUSATOM OVERSEAS**

**ROSATOM INTEGRATED OFFER: LARGE-SCALE NPPS**
Rosatom offers **NUCLEAR EDUCATION IN RUSSIA**. All the training programs incorporate the considerable expertise of major Russian universities that focus on educating future nuclear specialists.

**WAYS OF COOPERATION:**
- Joint educational programs
- Academic exchanges (professors, students, interns)
- Train-the-trainer for faculty staff
- Joint scientific projects
- Open lectures, conferences, seminars, seasonal schools, etc.
- Translation and publication of study materials

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**MOSCOW**
- National Research University MEPhI
- National Research Moscow State University of Civil Engineering
- Pushkin State Russian Language Institute
- Bauman Moscow State Technical University
- D. Mendeleev University of Chemical Technology of Russia
- National Research University "Moscow Power Engineering Institute"
- National University of Science and Technology MISiS

**MOSCOW OBLAST**
- MEPhI production area (Obninsk)
- Joint Institute for Nuclear Research (Dubna)

**VOLGODONSK**
- MEPhI production area

**NOVOVORONEZH**
- Training center with an up-to-date simulator

**SAINT PETERSBURG**
- Saint Petersburg State University
- Peter the Great St.Petersburg Polytechnic University
- Petersburg Nuclear Physics Institute named after Boris Konstantinov
- National Research Centre 'Kurchatov Institute'

**IVANOVO**
- Ivanovo State Power Engineering University named after Vladimir Lenin

**YEKATERINBURG**
- Ural Federal University

**NOVOSIBIRSK**
- Novosibirsk State University

**TOMSK**
- National Research Tomsk Polytechnic University

**NIZHNY NOVGOROD**
- Lobachevsky State University of Nizhni Novgorod (UNN) National Research University
- Nizhni Novgorod State University named after Rostislav Alexeyev

**SAINT PETERSBURG**
- more than 1400 students from 40 countries received training in leading Russian universities*

* in 2016
**WHAT TO LOCALIZE?**
Level of localization depends on the partner technical qualification, financing model, performance of local suppliers, and applicable certifications.

- Rosatom scope of supply
- Local manufacturing & engineering of heavy and specialized equipment
- Engineering services and other balance of plant equipment
- Non-critical parts and ancillary equipment
- Full or partial responsibility for the civil works and erection
- Local labor, construction materials, consumables, tools and materials on site, site infrastructure

**WHEN TO LOCALIZE?**

1. Civil works, erection and non-safety equipment – from the beginning (unit 1)
   - Fast track, well established local infrastructure
2. Localization of safety-related equipment is relevant in case of serial npp construction (>5 units)
   - Depends on local industry readiness

**HOW TO LOCALIZE?**
Various patterns of cooperation can be considered

- Subcontract
- Technical assistance
- License
- JV creation

**WHY TO LOCALIZE?**
NPP construction results in comprehensive spillover effects for the country’s economy:
- Localization of safety-related equipment is relevant in case of serial npp construction (>5 units)
- Depends on local industry readiness

**RUSATOM OVERSEAS ROSATOM INTEGRATED OFFER: LARGE-SCALE NPPS**

Rosatom is ready for partnership with local companies to ensure efficient NPP project implementation

**NATIONAL DEVELOPMENT**

- Public income
- Employment
- Power sector sustainability
VVER-1200 is universally recognized as a state-of-the-art, safe and economically efficient reactor technology.

Rosatom offers VVER – water cooled and water moderated energy reactor technology (pressurized light water reactor) as a time-tested and highly referential power generation solution. This technology combines successful experience in NPP operation with cutting-edge safety standards while meeting the most stringent requirements.

**MAIN COMPONENTS OF NUCLEAR ISLAND**

1. Reactor
2. Steam generators
3. Reactor circulating pumps
4. Pressurizer
5. Reactor coolant pipeline

**PERFORMANCE INDICATORS**

- **Nominal output**: 1 200 MWe
- **Lifecycle**: 60+
- **Efficiency**: 37%
- **Own power consumption**: ≈ 7.5%
- **Availability**: > 0.9
- **Maneuverability**: 100-50-100
- **Maximum fuel burn-up**: up to 70 MW*day/kg U
- **Safety systems**: active + passive
- **Reference**: In commercial operation since Feb, 2017

**VVER-1200 DESIGN EVOLUTION**

- Double containment
- Design extension conditions management
- Passive heat removal
- Core catcher in an unlikely event of core meltdown

MORE THAN 70 VVER UNITS BUILT BOTH IN RUSSIA AND ABROAD OVER 5 DECADES
**RUSATOM OVERSEAS**

**ROSSATOM INTEGRATED OFFER: LARGE-SCALE NPPS**

**EVOLUTIOARY DESIGN OF REACTOR VESSEL:**
- Extension of design service life of the reactor vessel by **up to 60 years**
- Increase of thermal power output
- Fuel cycle lengths: **12-18 months**

**UNIQUE HORIZONTAL STEAM GENERATORS**
Enable VVER to lose water slower in case of feed water supply failure

**MAIN CIRCULATING PUMPS**
Two special design features:
- Main circulating pump hydraulic part bearings are water cooled and water lubricated, not oil lubricated

**VVER-1200 – A MIXTURE OF TECHNOLOGICAL HERITAGE AND INNOVATIONS**

**ROSATOM OFFERS A FLEXIBLE AND TAILOR-MADE APPROACH TO TURBINE SELECTION AND ASSISTS PARTNER COUNTRIES IN CHOOSING THE MOST SUITABLE SOLUTION ACCORDING TO VARIOUS PARAMETERS:**

**TURBINE TYPE:**
- High-speed turbines – **3000 rpm**
- Low-speed turbines – **1500 rpm**

**COUNTRY OF ORIGIN:**
- Russian referenced technologies (Power Machines)
- Overseas solutions (GE, Doosan, Skoda Power, Siemens, etc.)

**NUCLEAR ISLAND**

**TURBINE ISLAND**
NUCLEAR SAFETY IS OUR TOP PRIORITY. ROSATOM BOASTS OF HAVING PERFECTED ITS COMPLIANCE WITH POST-FUKUSHIMA SAFETY REQUIREMENTS

4 PHYSICAL BARRIERS (Rosatom's Defense-in-Depth principle)

1. FUEL PELLET - prevents fission products release inside fuel cladding
2. FUEL CLADDING - prevents fission products release into the primary circuit
3. PRIMARY CIRCUIT - prevents fission products release into the containment
4. DOUBLE CONTAINMENT SYSTEM - prevents fission products release into the environment

PASSIVE HEAT REMOVAL SYSTEM - provides alternative ultimate heat sink in case of loss of the main one

SPRAY SYSTEM - reduces pressure inside the containment in case of the primary coolant leak

HYDROGEN REMOVAL SYSTEM - prevents hydrogen explosion (located at the upper part of containment premises)

CORE CATCHER - Prevents molten core from leaking out of the containment

NUCLEAR SAFETY IS OUR TOP PRIORITY.

PROTECTION from external impacts

Aircraft crash
Earthquake
Tornadoes, storms
Shock waves

GEN 3+

FLOODING

RUSATOM OVERSEAS
ROSATOM INTEGRATED OFFER: LARGE-SCALE NPPS
NOVOVORONEZH NPP II, unit 1 (RUSSIA) 2016

“Moscow AEP” design

THE 1ST COMMISSIONED GENERATION III+ NPP IN THE WORLD

LENINGRAD NPP II (RUSSIA) 2017

“St. Petersburg AEP” design

2 nuclear power plant designs available • Depending on customer site requirements

OSTROVETS NPP (BELARUS) estimated 2019

THE 1ST GENERATION III+ REACTOR COMMISSIONED OVERSEAS

RUSATOM OVERSEAS ROSATOM INTEGRATED OFFER: LARGE-SCALE NPPS
WHY ROSATOM FUEL?

- Every 6th power reactor in the world runs on ROSATOM nuclear fuel
- ROSATOM has 2nd largest uranium reserves in the world
- ROSATOM ships nuclear fuel using various means of transport
- ROSATOM has 2 fuel production facilities in eastern and western parts of Russia

THAT IS WHY ROSATOM FUEL

- Reliable fuel supply throughout NPP service life
- No risks for Plant operator in finding and purchasing NFC Front End products and services
- Optimized proposal due to package supply of all front-end nuclear products and services
- Fuel cycle: 12–18 months

Rosatom long-term fuel contract is a cost-effective and competitive solution

UNIQUE HEXAHEDRAL FUEL ASSEMBLIES
TIGHTER FUEL PACKAGING IN THE REACTOR
WHAT IS ROSATOM O&M SOLUTION?

ROSATOM BOASTS VAST EXPERTISE IN PROVIDING NPP O&M SERVICES

EXAMPLES OF SUCCESSFUL COOPERATION

METSAMOR NPP (ARMENIA)

TIANWAN NPP (CHINA)

WHY O&M WITH ROSATOM?

- Ensuring safe operation while reducing customer risks
- Convenience due to a single O&M contractor
- Transfer of experience and localization
- O&M contract signed at the beginning of project implementation to plan long-term activities and resources

ROSATOM O&M success:

- Overseas orders service portfolio >$1 billion
- Present in 8 international markets
- Holds leading positions in China, Bulgaria and Armenia
SPENT NUCLEAR FUEL AND NUCLEAR WASTE MANAGEMENT ISSUES ARE COVERED BY ROSATOM EFFICIENT & FLEXIBLE BACK-END SOLUTION

SNF MANAGEMENT

SNF MANAGEMENT OPTIONS

TEMPORARY TECHNOLOGICAL STORAGE WITH FURTHER RETURN

SNF transfer to Russia for temporary technological storage and FURTHER MANDATORY RETURN to the country

Storage terms and conditions are set out in the foreign trade contract

TEMPORARY TECHNOLOGICAL STORAGE WITH FURTHER REPROCESSING AND RETURN

Return of the reprocessed products to the country

Return of the reprocessed products after short storage

Extention of reprocessed products storage period may be additionally agreed

RW MANAGEMENT

• WASTE
  Radioactive waste generated at the NPP is to be safely disposed on the territory of Partner country

• TREATMENT
  RUSSIA HAS VAST EXPERIENCE in constructing and operating near-surface repositories for LLW and short-lived RW

• REPOSITORY
  The construction of a final disposal facility for long-lived RW and HLW is underway IN RUSSIA AND WORLDWIDE

DECOMMISSIONING

ROSATOM IS READY TO SHARE ITS EXPERTISE IN DECOMMISSIONING WITH ITS PARTNERS TO OFFER TAILOR-MADE SOLUTIONS

NPP decommissioning strategy planning helps to correctly calculate and allocate funds for the final stage of NPP lifecycle
PRODUCT

UP TO 7100 M³/H
(170 000 M³/DAY)
OF POTABLE WATER TO BE PRODUCED BY HYBRID TECHNOLOGY (MED + REVERSE OSMOSIS)*

BENEFITS

- Possibility to produce up to 170 000 m³/day of desalinated water
- Modular desalination units
- Does not require significant changes in NPP design
- CAPEX and OPEX optimization
- A desalination complex integrated with NPP provides a cost-effective solution due to smart allocation of energy resources and shared infrastructure

Government bodies

Local communities, large industrial consumers

KEY CLIENT

AKKUYU NPP (TURKEY)

ROSTOV NPP (RUSSIA)

*R Basic proposal
The signing of an IGA on Peaceful Atom is an indispensable condition for beginning a dialogue on nuclear project implementation between Rosatom and partner country.

Optional documents aimed at identifying the basic parameters of the nuclear project to be implemented in the partner country.

The signing of an IGA on NPP construction finalizes the basic nuclear project parameters and launches negotiations on Rosatom Integrated Offer contract package.

ARE YOU A NEWCOMER COUNTRY?
WE ASSIST STEP BY STEP

1. INTERGOVERNMENTAL AGREEMENT ON PEACEFUL ATOM
The signing of an IGA on Peaceful Atom is an indispensable condition for beginning a dialogue on nuclear project implementation between Rosatom and partner country.

2. MOU / PDA ON NPP CONSTRUCTION
Optional documents aimed at identifying the basic parameters of the nuclear project to be implemented in the partner country.

3. INTERGOVERNMENTAL AGREEMENT ON NPP CONSTRUCTION
The signing of an IGA on NPP construction finalizes the basic nuclear project parameters and launches negotiations on Rosatom Integrated Offer contract package.

4. CONTRACTS PACKAGE

PRESALE CONTRACTS
- Preliminary engineering survey
- Nuclear Infrastructure assessment and further development

4 TAILOR-MADE CONTRACTS
- EPC
  - NPP construction
  - Commissioning
  - First fuel loading
- FUEL CONTRACT
  - Fuel supply throughout NPP entire lifecycle
- O&M
  - Staff training
  - NPP operation and maintenance
- BACK-END
  - SNF and RW treatment
A COMPREHENSIVE APPROACH TO PROJECT IMPLEMENTATION

A FULL RANGE OF PRODUCTS AND SERVICES AVAILABLE FROM A SINGLE SUPPLIER WITH SOLID EXPERIENCE

PROJECT SUPPORT THROUGHOUT ITS ENTIRE LIFECYCLE
ROSATOM INTEGRATED OFFER:
LARGE-SCALE NPPs

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