“International research center based on the multipurpose sodium fast research reactor MBIR”.

Alexander Zagornov (ROSATOM)

Research reactors have contributed substantially to the development of nuclear science and technology for the last half century. The world reactor fleet is inevitably aging. By IAEA database there are less than 250 operating research reactors in the world. Over two-thirds of them are pushing past thirty years of age, many are close to half a century, some will be close to the 60^{th} anniversary by 2020.

Replacing progress is slow and is dominated by facilities with average flux, which are good for fundamental research, isotope production and material research basics as well as education and training, but insufficient for the development of innovative technologies components, which require higher technical parameters.

Among the reactors under-construction only two have got the high flux and substantial (MBIR, Russia) or notable (JHR, France) fast flux.

The major drawback of the high flux research reactor is its high capital cost. Solution may be in the multilateral concept of a research facility project which has been promoted by IAEA for quite some time and operators of the two new high flux research reactor construction projects - Russian and French - have been awarded the status of International Centers of Research Reactors (ICERR) which certifies their availability for international cooperation.

This status will be applicable also to MBIR - a multipurpose fast research reactor under construction at the site of the Research Institute of Atomic Reactors (RIAR) in Dimitrovgrad.

Basic technical parameters:

- Thermal power 150 MW, Electric Power – up to 55 MW;
- Coolant - liquid metal (sodium), Fuel – MOX, vibro type;
- Max flux in the channel 5.5×10^{15} $cm^{-2}s^{-1}$;
- Min. diameter of fuel element - Ø 6.0 mm;
- Linear heat rate - max. 500 W/cm, maximum temperature on the cladding - 700 ^{0}C;
- Total payload volume of a single assembly like this amounts to ~2,28 l;
- Inner size of a flat-to-flat cell is 6.92 cm, the height of the fuel column is 55 cm.

MBIR will have a three circuit system. First and second circuits will use sodium as a coolant, the third one (turbine circuit) will be using water.

The reactor will be equipped with 3 simultaneously operating independent loops which can use different coolants, 3 instrumented cells and 14 cells for MTA as well as a substantial space in the blanket for experiments in the thermal and thermalized spectrum.

In addition there will be up to six outlets for horizontal channels and 12 vertical channels.

Fluence in the central part of the core will go up to 33-34 dpa/year, in the peripheral channels - 20 dpa/year on average, max 24 dpa.

Average fluence in the blanket zone is projected to 11-14, max 17 dpa/year.

According to the Gen IV roadmap, MBIR will be put into operation at the moment when major innovative initiatives will be approaching the stage of a prototype design and construction which requires justification of the technology safety and reliability under operating parameters. MBIR will be best equipped for the task.

The following research can be conducted on MBIR:

- research of the structural materials for the active zones, fuel elements tests under high dose of the fast neutrons irradiation with different temperature parameters;
- research & development of the radiation, temperature and corrosion resistant materials for the fusion and other advanced types of reactors.

Important area is research of fuels and fuel elements: testing of fuel compounds, fuel rods and cladding for the new generation of reactors for attestation, codes development and safety recommendations for the fuel design and fabrication.

Perspective topic for multilateral research is closed fuel cycle technologies, including long living radioactive elements handling and testing of the dense fuel containing minor actinides.

When independent loops are fully functional the scope of research will widen covering also the study of the coolants performance and simulation of the active zones elements behavior within different coolants.

Demand for the research in fast spectrum has been growing recently and today more than half of the BOR-60 capacity (fast research reactor in operation at RIAR site) is utilized by foreign users.

Therefore, Rosatom calls for setting an International Research Center based on MBIR which will coordinate the allocation of the reactor resource and serve as a platform for multilateral research collaborations.

The center will have a binary structure: the reactor complex as an asset will be owned by Russian Federation and operated by an authorized entity – RIAR which will be responsible for the reactor safe operation and for the due execution of the research programs and additionally will provide on-site laboratory research at request.

The research activity will be assigned to a special purpose structure – the International Research Center, which will formally be a sole reactor user under a long term framework agreement.

The main advantage of the consortium approach is reduction of the capital cost compared to creation of the similar scale national facility.

Share in IRC MBIR will certify a pro rata share of the reactor neutron flux available for the participant.

The ultimate perspective goal of the flux sharing concept is to set up a system where the title for the flux share of the reactor may become a marketable product applicable not only within IRC MBIR community but also outside as a cross-reactors trade.

Participation formats may be different. At first the IRC will be formed by the key partners which will join at an earlier stage and which have the long-term research programs requiring the reactor resource for decades. They will be co-founders of IRC and will define priorities for equipping and joint research areas.

If and when there will be available reactor resource, it will be allocated to contractual users, however the price will be at commercial market level and not at cost as for the IRC founders and key members.

It is also planned to launch the multilateral research program for the challenging topics of the nuclear applied sciences being of interest for many parties among which may be minor actinides burning or high resistant materials testing, including composite materials.

The draft research program and further coordination of the resource allocation and multilateral programs execution will be managed by the Advisory Board consisting of the IRC members, regular participants of the multilateral program(s), operator representatives and independent experts, representing the leading research and industrial regional and international organizations.

Senior governing body will be the Steering Committee consisting of key participants' representatives and those of strategic long term users if approved by the first.

Summarizing the points above - the reactor complex MBIR is a unique tool for development of the promising new age technologies and also for the studies intended to improve the current NPP technologies.

Merging financial and scientific resources will help to improve the efficiency of research work. Cost sharing via the international syndicate provides best value for money vs construction of the same size national research reactor and saving on the national infrastructure required to build and operate such research reactor.

Research institutions with the aging reactors will have an opportunity to continue their respective research in case their own reactors will be shut down and will get extra time to make the strategic decisions on replacing options.

Operator with 60 years impeccable track record of research reactor managing experience and on-site supporting facilities will guaranty safe and due performance of the reactor and research programs execution.