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Summary

This report describes the bilateral interactions and opportunities for international cooperation as seen by the Nuclear Cogeneration Industrial Iniative mid 2015.

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Bilateral Interactions and International Cooperation Opportunities for NC2I

1 Background

Several countries have already built and operated HTGRs: Great Britain, the USA, Germany, Japan and China. Even more countries have been working on HTGR development such as France and RSA and in present days we see additional interest in HTGR deployment in Poland, Indonesia, Korea and from other sides.

Although it is clear that HTGRs can be built in such a way that they fulfil Gen IV conditions featuring real inherent safety with the exclusion of core melt by design, this technology has a supposed drawback: It is more expensive than LWR technology if comparing investment costs to the installed capacity in terms of MW_e, an argument which is not completely overruled by the ability for cogeneration and by Gen IV qualities. Frequently it is highlighted that the small size of HTGR modules makes the technology well suited for countries with not (yet) very well developed grids or with widely scattered industrial consumers. Moreover, the possibility of incremental capacity addition as well as inherent safety should be appreciated in particular by embarking nations. But the reality observed is as follows: countries which cannot afford a large LWR generally do not enter nuclear at all. And most countries which are thinking of nuclear new build at all finally show a certain tendency towards large LWRs[1].

Despite these adversities, the NC2I partners and many others around the world are convinced of HTGR technology and its indisputable advantages not only for the cogeneration of process heat. But these adversities do show that it is very important in this context to partner and help each other globally to promote HTGR technology.

2 Activities in the Frame of the International Atomic Energy Agency

As can be seen from the following sections, the activities at IAEA and initiated by IAEA are providing very good opportunities for NC2I to keep ourselves informed, follow-up and remain involved in HTGR- and cogeneration-related activities world-wide. This can touch and be quite close to new build of HTGRs and cogeneration projects. It is highly desirable that NC2I representatives achieve and maintain their availability for IAEA as they have done for the activities and actions described here below.

2.1 Coordinated Research Project on Modular High Temperature Reactor Safety Design

In the wake of the Fukushima Daiichi nuclear accident in March 2011, the IAEA focused increased attention onto HTGRs as they can be designed in such a way that they are able to cope with challenges of the type hitting Fukushima Daiichi. The intrinsic properties of modular HTGRs can, depending on the detailed design, minimize or even eliminate concerns about availability of off-site or on-site electrical power, active safety systems and urgently required operator actions in order to avoid large radionuclide releases. In order to emphasize and strengthen the corresponding prospects of HTGR technology coming along with a high-level

[1] Whereat we have to admit that this tendency is supported by a certain lack of choice and competition.

safety philosophy, in December 2013 the IAEA has approved a new Coordinated Research Project to investigate and make proposals on modular HTGR design criteria, in particular safety design criteria.

In April, 2014, the IAEA hosted international experts (a significant part of whom were NC2I-R colleagues) for a Technical Meeting on HTGR safety in the light of the Fukushima Daiichi accident /01/. In the meeting, the participants exchanged information on the individual HTGR programs and (safety-related) R&D as well as ideas for requirements towards the new CRP. A participant from the JRC outlined the contact points and cooperation opportunities between this CRP and the two EU projects NC2I-R and ARCHER in particular with respect to safety and licensing /02/.

In a subsequent “First Research Coordination Meeting on Modular High Temperature Gas Cooled Reactors Safety Design” in June, 2015, the new CRP on “Modular High Temperature Reactor Safety Design Criteria” (I31026) was launched officially. Detailed project plans and contributions from participants were proposed and discussed on the basis of existing safety criteria, licensing experience, reference designs and definitions as well as national boundary conditions /03/. The presentations and discussions suggest that it will not be possible to establish a single set of safety design criteria without considering detailed designs. In this context, there might be two or three different design variants to be addressed (at least partly individually), these variants relying on the two large historically established branches with two types of prismatic core (fixed block type cores) on one hand and with a (permanently regenerating) pebble bed core on the other hand. The reason is that these different reactor designs necessitate different systems, structures and components (“SSC”) with different functions. If the anticipated safety design criteria shall not remain extremely generic, hypothetical events and corresponding failure modes of these different SSC have to be considered in detail and such a detailed consideration needs well-defined SSC as a basis.

The CRP will pursue a two-fold strategy. On one hand, for well-established LWR safety criteria (e.g. from IAEA Safety Standards No. SSR-271: Safety of Nuclear Power Plants: Design) the possibilities of a transfer and adaptation to HTGRs will be investigated. On the other hand, existing experience with respect to licensing of HTGRs in member states will be compiled and distilled. The result will be two reports to be published:

- An “IAEA Nuclear Energy Series” (NE series) Technical Report will contain the finally proposed modular HTGR Safety Design Criteria.
- An IAEA TECDOC will report on the specific work done within the CRP and on the individual country contributions.

As far as possible (i.e.: if invited), NC2I-R correspondents should continue to participate in this CRP and take care for NC2I positions and needs to be respected in the anticipated documents.

2.2 Coordinated Research Project on HTGR Application for Mineral Processing

At the URAM 2014 Symposium (International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle: Exploration, Mining, Production, Supply and Demand, Economics and Environmental Issues /04/) in Vienna, a new IAEA Coordinated Research Project was proposed on “Using High Temperature Gas-Cooled Reactors for Energy Neutral Mineral Development Processes”

The idea behind this proposal is that a possible high future demand for uranium and thorium or other mineral commodities at high purity levels coming along with the availability of large amounts of clean (in terms of low-carbon) process heat could pave the way to the exploitation of resources which cannot be considered mineable or economic today. This might cover low-grade as well as unconventional resources such as coal ashes and seawater. Even the impurities to be separated from certain materials in order to get a high-grade end product might be used as raw materials for other products.

This Coordinated Research Project aims at techno-economic feasibility studies on the combination of the following aspects: (1) the use of unconventional uranium (and thorium) resources as future nuclear reactor fuel, (2) the use of thermal processing to extract minerals and by-products in mining and mineral development processes and (3) the study of the sustainability of these two processes (individually or combined) with the utilization of HTGRs as the electricity/heat source.

Moreover, the CRP is to generate basic data on the availability and characteristics of such low grade mineral resources and the impurities. Finally, the possibility of an energy neutral value addition in sustainable mineral development projects shall be evaluated on the basis of the uranium/thorium recovered in the other processes and possibly fed back via production of process heat provided by HTGRs.

The project could officially be launched in April, 2015 under the topic “CRP-T110066-UTHAM-Uranium/Thorium Fuelled High Temperature Gas Cooled Reactor Applications for Energy Neutral and Sustainable Comprehensive Extraction and Mineral Product Development Processes” /05/. It brings together experts and proposals from Argentina, Egypt, Germany, India, Indonesia, Kuwait, Morocco, Pakistan, Philippines, Poland, Tanzania, Tunisia and USA and will last until April, 2018. A corresponding Research Coordination Meeting will be held in November 2015.

2.3 Technical Meetings on HTGR Temperature Limits

In continuation and extension of activities in the years 2012 and 2013, when the performance of coated particle fuels at high temperatures had been reviewed, the focus of an IAEA Technical Meeting on high temperature qualification of HTGR-materials in 2014 /06/ was put on the performance of high temperature structural materials such as graphite, metallic materials and carbon-fiber composites. The objective of these activities was and is a confirmation of safety from an updated point of view and an identification of challenges, if any.

The 2014 meeting concluded that graphite and metals for HTGRs are available today for near term deployment of reactor outlet temperatures up to 800°C (gas temperature). For higher temperatures work is in progress to have materials qualified in the foreseeable future.

An interesting new question is the applicability of Oxygen Dispersed Steels (ODS). Indonesia is performing research and development to do a design of an IHX based on local resources and specifically ODS development.

Graphite shrinkage and growths, phenomena which are depending on graphite grade, temperature and neutron fluence, continue to be challenging. On an atomic scale, they are not yet fully understood.

In the 2014 meeting, the idea of a TECDOC was emerging which summarizes the state of the art and the issues to be solved in the future.

At the IAEA Technical Meeting on Re-evaluation of Maximum Operating Temperatures and Accident Conditions for High Temperature Reactor (HTR) Fuel and Structural Materials in January 2015 /07/, D. Petti from INL reported encouraging results of UCO TRISO fuel investigations. Irradiation and safety testing as well as post-irradiation examinations (PIE) had confirmed satisfactory fuel performance even up to 1800°C under accident conditions.

The ASME code is under extension with respect to HTGR applications. After code extensions for HT metals made until 2014, now a graphite standard is introduced as well.

In these meetings, as in other IAEA activities, every now and then IAEA reference designs for HTGRs are mentioned /06/, /08/. In particular for IAEA activities with respect to the uncertainty in analysis and modelling (UAM) of HTGRs, the IAEA uses two reference models which are defined at a high degree of detail in order to be able to consider plant behavior and incidents on a sound basis.

The first reference design used is a MHTGR with a prismatic (ring) core and a power of 350 MW_{th}. This design is based on an earlier General Atomics design.

The second design is based on the German HTR-MODULE with a pebble bed core where the power is upgraded to 250 MW_{th}.

2.4 IAEA Activities for and in Indonesia

If requested by a national government or by a dedicated facility, the IAEA can conduct an International Physical Protection Advisory Service (IPPAS) mission. This type of mission is intended to help States (and facilities) to improve their nuclear security organizations. The missions provide peer advice on implementing international instruments and IAEA guidance on the protection of nuclear and other radioactive material and associated facilities.

In October 2014, an IAEA IPPAS mission was carried out in Indonesia to review the current status of the State's Physical Protection Regime of nuclear and other radioactive material, as well as associated facilities and activities. This covered the present Indonesian nuclear security-related legislative and regulatory framework and the physical protection systems at nuclear research sites and radioactive facilities. The mission also reviewed how the recommendations of two earlier IPPAS missions in 2001 and 2007 had been implemented.

Among the mission team there were members of BriVaTech and Forschungszentrum Juelich (FZJ), both of which have close contact to NC2I.

The mission team acknowledged that Indonesia had improved its national security regime, in particular its legislation and regulations. The IAEA team made some new recommendations and suggestions aiming at further strengthening the overall regime. Generally the mission and the Indonesian progress for their nuclear security were judged very successful. /09/.

One of the regulations made by Indonesia after the first two IPPAS missions (Governmental Regulation # 43 from 2006) implies a restriction with respect to entities operating an NPP. Operation of commercial power reactors is reserved for private as well as state-owned or -co-owned economic companies. National agencies such as BATAN, the National Atomic Energy Agency of Indonesia, are only allowed to operate "non-power" reactors, e.g. experimental reactors.

More recently, the IAEA executed an Integrated Regulatory Review Service (IRRS) mission in Indonesia. The purpose was to review Indonesia's regulatory framework for nuclear and radiation safety. The mission team concluded that in Indonesia the Nuclear Energy Regulatory Agency BAPETEN is implementing a regulatory framework that provides a good protection of public health and safety. The team gave also recommendations and suggestions for the further optimization of the installed bodies and procedures which will help to strengthen BAPETEN's role as a national regulatory body /10/.

During this mission, there were as well discussions treating the question how to go forward with the aim of designing a small HTGR (10 MW_{th}).

From Oct. 19 through 23, the IAEA will organize a Training Course on HTGR Technology which will be held at BATAN in Serpong (Indonesia), close to Jakarta. This training is one out of 12 HTGR seminars planned by the IAEA for international attendance, the first of which had been carried out from Oct. 22 to 26, 2012 at the Tsinghua University at Beijing with NC2I representatives from FZJ and AREVA GmbH among the lecturers. The seminar at Serpong will be the second training course in this series. The main topics will be core calculations, components, safety and test facilities. The lecturers will be form the Netherlands, Germany (BriVaTech), RSA (STL – for this company: see below) and other countries.

3 Indonesia

First plans for HTGR deployment in Indonesia were made in 1989 in the context of oil refinement on Sumatra. A joint assessment of Indonesian bodies together with German KWU (nowadays AREVA GmbH) had suggested a total of four INTERATOM-designed "HTR-MODULE" reactors to cogenerate steam (up to 4,000 t/h) and electricity (up to 300 MW) /11/, plans which obviously were not followed up to their end.

Indonesian representatives intensified their contacts to the HTGR community at IAEA in 2014 /12/, /01/.

Indonesia is in fact taking decisive steps today to introduce nuclear energy into the national electricity infrastructure. Besides conventional LWRs on some larger and more developed islands, Indonesia intends to build Pebble Bed HTGRs with electrical outputs of up to 100 MW_e for provision of electricity and process heat (e.g. for seawater desalination and possibly H_2 production) on smaller islands.

The renewed interest in nuclear is presently still driven largely by a central national interest as can be seen from the identity of the most active entity in this field which is the Atomic Energy Agency BATAN.

Before the construction of commercial power reactors in Indonesia (what is meeting the objectives of the state but which cannot be done by the state, according to what has been written above), BATAN is presently preparing to build a small HTGR-based Experimental Power Reactor which is referred to as RDE or MPPR (Multi Purpose Power Reactor, this denomination clearly referring to cogeneration). The RDE project has not only technical objectives but as well social ones as it is aiming at an increase of public acceptance for commercial NPPs /13/.

In parallel, BATAN is presently starting R&D on HTGR fuel and HT materials /14/.

The decision for a pebble bed core for the RDE was taken in the first semester of 2015 /13/, /03/.

This experimental reactor will have a thermal power of only 10 MW /03/. Construction time is estimated to be 4 years. A conceptual design phase was started in April/May 2015 by award of a contract to a German-Russian-Indonesian consortium and it will last 8 months. The result of this conceptual design will be a lean safety assessment report. The German consultant BriVaTech is involved.

The German-Russian-Indonesian consortium is comprising Rekayasa Engineering (Indonesian) and Kogas Driyap Consultant which is part of NUKEM Technologies GmbH, a subsidiary of the Russian State Corporation Rosatom. For execution of the project, NUKEM will collaborate with other subsidiaries of Rosatom.

For the beginning of 2016 a call for tender is expected for an EPC-contract.

Indonesia is expecting support and technical assistance from developed countries. This support may be given by IAEA as well as by other parties. Indonesia hopes for assistance, training and experienced experts /06/. It is recommended to NC2I to build a good contact to BATAN.

4 China

Late in 1988, INTERATOM, KFA Juelich (today FZJ) and the Institute for Nuclear Energy Technology INET of the Tsinghua University (Beijing) signed a contract for a German-Chinese R&D cooperation. During this cooperation German pebble bed HTGR (HTR-MODULE) know-how was transferred to China and jointly developed further on. The working name of a (then anticipated) first 10 MW_{th} pebble bed test reactor in China was “Test Module”.

The late result of this cooperation is what is known today as HTR-10, the design of which is largely based on German Siemens/INTERATOM technology and know-how /15/. The experience with respect to construction and operation of the HTR-10 paved the way to the fully industrially sized Chinese demonstration project HTR-PM (Pebble-bed Modular). The HTR-PM design /16/ is by nature very close to the Siemens/INTERATOM design for the HTR-MODULE. The Chinese plant which is under construction since Dec. 2012 at Shidaowan in the Shandong Province uses a steam cycle on the secondary side. It features two modules with 250 MW_{th} each, providing their steam to one single turbine yielding an electrical output of anticipated 210 MW_e. Operation is foreseen to start in 2017.

And Chinese plans are flying higher: Still in 2017, it is foreseen to start construction of a 1200 MW_e HTR plant comprising 12 modules with 250 MW_{th} each at Ruijin in the Jiangxi Province /17/.

These are ambitious plans and they bear the potential to lead to a triumphal procession of the HTGR technology.

The other side of the coin is as follows: The plans for the 1200 MW_e HTR plant rely on HTR-PM. Most technical details of HTR-PM have never been publicly disclosed. We just know that HTR-PM relies on HTR-10 and HTR-10 has been shut down since the Olympic Games in Beijing in 2008. The reasons why there have not been any publicly known operations, tests or experiments at HTR-10 after 2008 are not really clear and this feeds concerns about the status and suspicion of technical problems at HTR-10.

The owners of HTR-PM are the China Huaneng Group (CHNG) with 47.5 %, the China Nuclear Engineering Corporation (CNEC) with 32.5 % and INET (meaning today: Institute of Nuclear and New Energy Technology) at the Tsinghua University with 20 %. The Huaneng Group is a major power company in China. Their main businesses are electricity, coal, finance, science & technology and transportation. Nuclear is a relatively new field for them. It was no earlier than 2012 when they became the fourth Chinese Central Enterprise recognized to be qualified for nuclear power development.

According to different private communications, we may anticipate that within the owners’ consortium of HTR-PM there are strategies and interests which are not always coherent but sometimes counteracting. Of course it would be just natural if HTR engineering experience from abroad were being consulted for areas where the Chinese technical solutions deviate from the design of HTR-MODULE or other proven designs. On the other hand (and due to the spirit of fulfilling plans) there might be interests to avoid anything which could delay the project[2], even if it concerns engineering questions. This could become a major risk for HTR technology globally.

Hence, NC2I and the NIA share a strong interest to avoid failure of the HTR-PM project. At the HTR conference at Weihei in China in October 2014, representatives of NC2I and NIA tried to start a discussion with Chinese project stake holders. Unfortunately we have to conclude (and this is confirming the above assumption) that up to now there is no strong single voice from the side of the project asking for advice, support, assistance or anything comparable. And with the exception of individual personal contacts there is presently no serious collaboration between China and Europe or the US. On the other hand, CHNG will be interested to see whether the design of HTR-PM would be licensable in western countries. Hence there are more than one good reasons why the Chinese constructors should be susceptible for discussions.

[2] Tendencies of this kind could be strengthened by national economic problems such as the slow-down of the growth of the Chinese economy in recent years and the downtrends of stock exchange prices for Chinese papers observed in summer 2015.

It is strongly recommended that NC2I and the NIA work to find a way how to support HTR-PM and make available know-how, engineering expertise and operating experience for them where it is reasonable and appropriate.

China has its own fuel pebble production capacities. The corresponding factory at Baotou (Inner Mongolia) was completed recently and is presently under commissioning. The production processes are based on a trial production line developed by INET. The new factory will produce 300,000 fuel pebbles per year at 9% enrichment /18/.

5 Korea

In Korea, there is a national interest in a decrease of the large dependency on energy imports. This goes beyond electricity. In 2006, the government started a project on “Development of Key Technologies for Nuclear Hydrogen”. The Korean Atomic Energy Research Institute KAERI plans this industrial scale hydrogen production by means of very high temperature gas cooled reactors.

Presently R&D is ongoing in Korea on development of codes for design and analysis, mastering of the fuel production process as well as on structural materials for very-HT application and their qualification. Several small to medium size test facilities have been set up. /06/, /07/. The Helium Experimental Loop („HELP“, 150 kW) for tests of key components such as an intermediate heat exchanger was completed early in 2012 and is now in operation. Moreover, a Natural Cooling Experimental Facility for testing the Reactor Cavity Cooling System is operational /19/.

In 2009, a Korean Industry Alliance for Nuclear Hydrogen was formed comprising Doosan Heavy Industries, KHNP (Korea Hydro & Nuclear Power Ltd.), KEPCO (Korea Electric Power Corporation), Hyundai, Samsung and others as well as KAERI.

In 2013 this alliance signed a Memorandum of Understanding with the US NGNP Industry Alliance /19/.

Private communication in August 2015 indicated that KAERI/Korea made a shift with respect to their (prismatic-core) reference design from 600 MW_{th} down to 350 MW_{th}.

6 Japan

In Japan, the JAEA (Japanese Atomic Energy Agency) constructed the HTTR (High Temperature Test Reactor) with a core power of 30 MW_{th} at the Oarai Research and Development Center from 1991 until 1996. First criticality was reached in 1998 /20/. The HTTR uses a prismatic core in a special (national) variant.

Japan sees itself among the leading countries with respect to some key HTGR technologies such as coated particle fuel production, quality of graphite structures, Helium turbine technology and hydrogen production. Japan is supporting Kazakhstan, with which there is cooperation and a collaboration agreement since 2009 for the preparation of a low-power HTGR demonstration plant. (In the longer term, Kazakhstan plans to industrially use HTGR technology and cogeneration /01/.)

Presently Japan is not following any own domestic commercial HTGR deployment program.

After the disaster at Fukushima, the HTTR was shut down (just as all commercial NPPs in Japan) but a recommissioning is anticipated still in 2015. JAEA is foreseeing an active (i.e.: experimental) participation in the OECD/NEA Loss of Forced Cooling International Collaboration Test program /21/.

Presently, the Japanese HTGR policy is focused on Hydrogen production and since the accident at Fukushima Daiichi, there is a considerable focus on basic regulatory aspects of HTGR technology such as HTGR safety requirements. Japan is actively participating in the IAEA Technical Working Group on HTGR Technology and Safety.

7 United Kingdom / South Africa: HTMR

The company HTMR Ltd., which is registered in UK, was established jointly by the “Neopanora-Institute”, the Company STL from RSA (Steenkampskraal Thorium Ltd.) and additional investors. HTMR Ltd. is advertising a HTGR ("small, modular, super-safe, simple and user-friendly") with a pebble bed core and a steam output of 100 MW_{th} or 25 MW_{th}, respectively. Electricity production needs an additional steam turbine. The company name "HTMR" refers to a "High Temperature Modular Reactor" based on HTR-MODULE.

Their subsidiary HTMR Asia Development Ltd. is registered in Hong Kong. HTMR Asia promises affordable satisfaction of the energy needs of developing countries or regions without access to well developed, powerful grids. They are aiming openly at Indonesia /22/.

The "Neopanora Institute-Network of Energy Technologies" (with their center in Vienna) claims to be a non-profit international networking organization aiming at the deployment of "sustainable integrated energy systems" and making available nuclear energy for the "populace".

STL is a South African company owning the Thorium rights at the Steenkampskraal Monazite mine. They are shareholder of THOR Energy in Norway where they have irradiation tests of LWR-suited, Thorium-containing fuel being performed at the Halden Reactor. STL claims that their core business is the development of a Thorium value chain from mining to the production of nuclear fuel /23/. Moreover, STL has been advertising a 100 MW_{th} pebble bed reactor since years (based on HTR-MODULE/THTR for a Thorium cycle).

STL clearly communicates that they derived their design on the basis of PBMR experience /24/. They do not mention, however, that the PBMR development activities were allowed for by a "contract for the provision of technology transfer and license agreement" with the German HTR-GmbH and that the corresponding license is still binding South African ESKOM and PBMR Ltd. to keep the transferred know-how within South Africa.

8 USA: X-Energy

The US Maryland based company X-Energy /25/ is advertising their Xe-100, a HTGR design with a pebble bed core going back to old but well known German designs (AVR 10 and HTR MODULE) and further development activities made by the ESKOM daughter PBMR Ltd. in RSA. The Xe-100 has a core power of 125 MW_{th} and it can either deliver electricity (48 MW_e) or steam at temperatures up to 540°C for industrial applications or combinations of electricity and steam.

In earlier versions of their website, X-Energy explicitly mentioned their experience on South Africa's pebble bed modular reactor activities, skipping, however, that the PBMR development activities were facilitated by a license agreement with the German HTR-GmbH and binding South African ESKOM and PBMR Ltd. to keep the transferred know-how within South Africa.

For the Xe-100, a US patent has been filed and is pending. It is considered possible that the US patent office will reject the application because the patent relies too much on earlier inventions.

There is no direct cooperation between NC2I or NIA with X-Energy.

In spring 2015, X-Energy was reported to be in talks with US utilities /26/. They plan to submit a design certification application to the NRC in 2017.

9 USA: GEMINI

The collaboration between NC2I and the US NGNP Industry Alliance is aiming at deployment of the HTGR technology in Europe, in the U.S. and worldwide.

The joint NC2I and NIA "GEMINI Initiative calls for U.S. and EU partners to work with their governments under a simple, transparent, and accountable arrangement to facilitate the design and regulatory work for the first modern commercial HTGR. The scope of GEMINI includes the definition of HTGR specifications for both, the U.S. and EU design and the completion of regulatory documentation for the review and approval by the appropriate regulatory authority – the NRC in the U.S. and the appropriate authority in the presumed EU host country. Such an arrangement will help to provide the confidence necessary to inspire private sector and Government investment to support the successful implementation of the GEMINI Initiative. In turn this will provide the framework for the construction of "sister" or "twin" prototype projects in both the U.S. and EU, and the ultimate widespread commercialization and utilization of this intrinsically safe and versatile nuclear technology." /27/

The collaboration is described more in detail in NC2I-R Deliverable 5.41 /28/.

10 Russian Federation

Back in the 1980ies, there were intensive discussions between Siemens and Russian Ministries, represented by OKBM (Nizhniy Novgorod) and the Kurchatow Institute (Moscow), on HTGR implementation in Russia. The talks lasted until 1995 but they had no tangible results. The basis of these discussions had been the design of the HTR-MODULE and afterwards, the Russian HTGR design was strongly evocative of this design. In the year 2000, the US and the RF signed a treaty on the burn of weapon grade plutonium. For this process, partly the 600 MW_{th} GT-MHR (Gas-Turbine Modular Helium Reactor; with a prismatic core) designed by General Atomics was foreseen for application in both countries. The program was stopped 2013/2014. Since then, HTGR relevant information from Russia is rare with occasional exceptions at IAEA meetings. Presently, work has been resumed in the RF on a pebble bed design (200 MW_{th}) with an indirect cycle /29/. The main design corresponds (again) to HTR-MODULE. Moreover, there are engineering studies for the Indonesian Experimental Reactor RDE.

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