Lithuania's views on the Committee's scientific and technical questions to be considered during a review of the environmental impact assessment documentation related to the Ostrovets nuclear power plant (hereinafter – Ostrovets NPP)

1. *What is the size, according to current international rules, recommendations, guidelines and other relevant guidance documents, of the area around the commercial nuclear power reactor for which the population density has to be assessed in order to take into account the radiological impact of a major accident and to prepare accordingly the emergency measures? Was it respected in the case of the Ostrovets nuclear power plant?*

Accident at the Fukushima NPP has shown again that a severe nuclear accident anywhere in the world cannot be excluded. Therefore, HERCA and WENRA (*HERCA-WENRA Approach for better cross-border coordination of protective actions during the early phase of nuclear accident*, 2014) propose a methodology for common European approach that recommends to plan **urgent protective actions within the radius of 100 km from a nuclear power plant**. The same approach after the accident at the Fukushima NPP is used in the IAEA safety standards **– IAEA also recommends to adopt 100 km extended planning distance around a NPP site** (*Actions to Protect the Public in an Emergency due to Severe Conditions at Light Water Reactor, 2013*).

The general requirement for the site selection and evaluation is determined in Convention on Nuclear Safety (CNS). In accordance with CNS Article 17.2 (Siting) <u>each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented for evaluating the likely safety impact of proposed nuclear installation on individuals, society and the environment.</u>

The more specific requirements for the site selection and evaluation are determined in IAEA Safety Requirements "Site evaluation for Nuclear Installations" NS-R-3 (Rev. 1), which were also mentioned in the IAEA reply to Implementation Committee as of 27 February 2018.

In accordance with NS-R-3 (Rev. 1), para 2.1, in the evaluation of the suitability of a site for a nuclear installation inter alia **the population density and population distribution** and other characteristics of the external zone in so far as they could affect **the possibility of implementing emergency response actions** and the need **to evaluate the risks to individuals and to the population** shall be considered. Also in accordance with NS-R-3 (Rev. 1), para 2.27, in relation to the characteristics and distribution of the population, the combined effects of the site and the installation shall be such that the radiation risks to the population associated with accident conditions, including those that could warrant emergency response actions being taken, are acceptably low.

According to the IAEA Safety Guide No. NS-G-3.2 "Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants", Chapter 5, the distribution and characteristics of the regional population should be studied in the site evaluation for a nuclear power plant in order to evaluate the potential radiological impacts of normal radioactive discharges and accidental releases; and **to assist in the demonstration of the feasibility of the emergency response plan**. The para 5.14 states that information should be used to demonstrate also that, on the selected site, **the radiological risk to the population that may result from accident states at the plant, including those which may lead to the implementation of emergency measures, is acceptably low** and in accordance with national requirements, account being taken of international recommendations. The para 6.3 states that many **site related factors** should be taken into account in demonstrating the feasibility of an emergency plan. **The most important ones are** population density and distribution in the region, and **distance of the site from population centres**.

The para 6.4 states that the **presence of large populations in the region** or the proximity of a city to the nuclear power plant site **may diminish the effectiveness and viability of an emergency plan**. According to the IAEA's Emergency Preparedness and Response series publication "Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor", 2013, section 4, Extended planning distance (EPD) **is up to 100 km radius from the NPP.**

Ostrovets NPP. **Lithuania maintains that the international rules, recommendations, guidelines and other relevant documents related to emergency preparedness, radiological impact of a major accident, population density evaluation, etc., were not respected in the case of the Ostrovets NPP.** All above-mentioned site related factors **– the population density and population distribution –** were not evaluated by Belarus during the site selection and assessment in Ostrovets as the distance from the Ostrovets site to Lithuanian capital Vilnius is only 40 km. 1/3 of Lithuanian population (in 100 km – extended planning distance – from NPP site) might be affected in the case of severe accident and it would be extremely difficult for governmental organisations to manage such an emergency situation in the capital region. In accordance with NS-R-3 (Rev. 1) (2.1, and 2.27) **the selected site shall be deemed unsuitable for the location of a nuclear power plant.**

Moreover, Lithuania insistently urged Belarus to invite **full scope** (all six modules) IAEA Site and External Events Design Review Service (SEED mission) in order **to evaluate all site related factors**, including population density and distribution. However, on 16-20 January 2017 Belarus hosted the IAEA SEED mission that, at the request of Belarus, consisted only of one module – Module 6 „Safety Review of Structures, Systems and Components against External Hazards“ – related only with the Ostrovets NPP design robustness against external hazards. Modules, related to site selection, site evaluation review and environmental impact assessment review processes (**Module 2** "Review of the Site Selection Process“, **Module 3** „Site Evaluation Review“ and **Module 4** „Environmental Impact Assessment Review“) were omitted and were not considered during the above mentioned mission.

2. According to current international rules, recommendations, guidelines and other relevant guidance documents, should the contamination of rivers and groundwater by radionuclides through direct discharge of contaminated water into the environment following a major accident or through the air be assessed before building a commercial nuclear power reactor? Was such an assessment undertaken in the case of the Ostrovets nuclear power plant?

According to IAEA Safety guide No NS-G-3.2 "Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants" states that a detailed investigation of the hydrosphere in the region should be carried out and calculations of dispersion and concentrations of radionuclides should be made to show whether the radiological consequences of **routine discharges and potential accidental releases of radioactive materials into the hydrosphere are acceptable** (para 3.2). Para 3.4 of this document states that the results of the hydrospheric investigation should be used for the **confirmation of the suitability of the site.** Para 3.24 states that a discharge of radioactive material from a nuclear power plant may contaminate the groundwater system in the region either **directly or indirectly**, via earth, atmosphere or surface water, in the following three ways:

(1) Indirect discharge to the groundwater through seepage and infiltration of surface water that has been contaminated by radioactive material discharged from the nuclear power plant;

(2) Infiltration into the groundwater of radioactive liquids from a storage tank or reservoir;

(3) Direct release from a nuclear power plant; an accident at the plant might induce such an event, and radioactive material could penetrate into the groundwater system. The protection of aquifers from such events should be considered in the safety analysis for postulated accident conditions, and a geological barrier to provide protection should be considered.

All these requirements should be considered in the EIA documentation.

It is important to underline that Compilation of recommendations and suggestions were prepared (http://www.ensreg.eu/sites/default/files/Compilation%20of%20Recommendationsl_0.pdf) after the Peer Review of stress tests performed on European nuclear power plants after the accident at the Fukushima NPP. One of the suggestions is related with large volumes of contaminated water during severe accident management (clause 3.3.11) and requires the conceptual preparations of solutions for post-accident contamination and the treatment of potentially large volumes of contaminated water. This suggestion shall be incorporated in the new NPP design and severe accident management guidelines.

***Ostrovets NPP.* In case of the Ostrovets NPP the international rules, recommendation, guidelines and other relevant documents related to possible contamination of rivers and groundwater by radionuclides were not followed and the assessment was not undertaken.** The water of the river Neris is envisaged to maintain the cooling systems for the NPP. The river Neris flows through the Lithuanian capital Vilnius and belongs to the Nemunas river basin, which covers 72 percent of Lithuanian territory. Water intakes from the river Neris plays an important role in the balance of potable water resources for the Vilnius region.

In the EIA report of the Ostrovets NPP, Belarus considered releases of radioactive substances only to the air, modelled the dispersion of radionuclides in a small territory and assessed possible consequences of a medium-level accident; however, Belarus did not consider the consequences of the most severe accident (INES 7). The accident in Chernobyl NPP demonstrated that dispersion and diffusion of radionuclides can cover very large areas. Significant radiological impact is possible as a consequence of a major accident beyond the design-base or disaster at NPP, because in such situations discharges of radionuclides are not controlled and can get into the watercourse through direct liquid discharges and from the air.

A special study „Evaluation of possible impact of Ostrovets NPP to groundwater resources of well fields located on riverside Neris“ was prepared in 2014 by Lithuanian experts (References – Požeminio vandens būklė ir jo sąveika su paviršinio vandens telkiniais Vilniaus, Kauno bei Kuršių Nerijos ir pamario požeminio vandens baseinuose/Gregorauskas M., Klimas A.; UAB "Vilniaus hidrogeologija". - Vilnius, 2014. - 142 p.: 66 pav. – LGT fondas; Nr.19704). The reduction of exploitable resources of well fields located on riverside of Neris in case of major accident in Ostrovets NPP was calculated based on detailed mathematical model. The study demonstrates that from 57% to 95% of exploitable resources in the cities of Vilnius, Kaunas and Jonava could become unusable. Therefore, there is a need for a special plan for drinking water supply in case of a major accident for Vilnius, Kaunas and Jonava cities.

3. According to current international rules, recommendations, guidelines and other relevant guidance documents, should the management of radioactive waste and spent fuel from a commercial nuclear power reactor (near surface repository or deep geological disposal) be decided before building such a reactor? Was there any mention of the waste management policy in the EIA of the Ostrovets nuclear power plant?

The general requirement of Art. 19 of the Convention on Nuclear Safety states that **each Contracting Party shall ensure that any necessary treatment and storage of spent fuel and waste directly related to the operation** and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

The general requirement of Art. 4 and 11 of Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management states that each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste and spent fuel management individuals, society and the environment are adequately protected against radiological, other hazards and radioactive waste must be managed in such a way as to avoid imposing an undue burden on future generations.

The same statement is in the Principle 7 of „Fundamental Safety Principles“, SF-1 IAEA.

The more specific requirements:

IAEA safety requirements “Site evaluation for Nuclear Installations” NS-R-3 (Rev. 1) para 2.9 states, that **in the analysis to determine the suitability of the site, consideration shall be given to additional matters relating to safety, such as the storage** and transport **of** input and output materials (uranium ore, UF_6, UO_2, etc.), fresh fuel and **spent fuel and radioactive waste.**

According to para 12 of “Safety of Nuclear Power Plants: Design”, No. SSR-2/1 (Rev. 1) IAEA, <u>special consideration shall be given at the design stage of a NPP</u> to the incorporation of features to facilitate radioactive waste management and the future decommissioning and dismantling of the plant. <u>**The design of NPP shall take into account the management and storage of radioactive waste generated in operation as well as provision for managing the radioactive waste that will be generated in the decommissioning of the plant.**</u>

According to para 78 of “Safety of Nuclear Power Plants: Design”, No. SSR-2/1 (Rev. 1) IAEA, systems and facilities shall be provided for the management and storage of radioactive waste on the NPP site for a period of time consistent with the availability of the relevant disposal option.

According to para 80 of “Safety of Nuclear Power Plants: Design”, No. SSR-2/1 (Rev. 1) IAEA, fuel handling and storage systems for spent fuel shall be designed in order to facilitate maintenance and future decommissioning of fuel handling and storage facilities as well as to facilitate the removal of fuel from storage and its preparation for off-site transport.

Ostrovets NPP. The following radioactive waste management policy has been specified in the EIA documents presented regarding the Ostrovets NPP:

- The spent nuclear fuel (SNF) after a certain period in cooling pools at the nuclear reactor shall be transported to the Russian Federation for reprocessing “in accordance with the intergovernmental agreement”.
- High Level Waste resulting from the NPP operation will be stored in the NPP territory during the full operation life-time of the NPP.

- Very-low, Low and Intermediate Level Waste resulting from the NPP operation will be stored in radioactive waste storage in the NPP territory for 10 years. After that period, the waste shall be transported to the new Belarusian radioactive waste disposal facility, to be built.

Lithuania maintains that Belarus' approach to radioactive waste management is not in line with the current international rules, recommendations or guidelines. Of special concern is the management of spent nuclear fuel, which is the most dangerous material because the above mentioned intergovernmental agreement between Russia and Belarus on SNF reprocessing is still not signed. It is also not clear, what would be the fate of High Level Waste, resulting from the reprocessing of spent fuel. Provisions of this bilateral agreement remain unclear. If the agreement in question is not concluded on time, or there is no agreement at all, without an alternative plan there is a real threat that the SNF is kept in the storage pools for an extended period of time. Storage of High Level Waste resulting from the NPP during the full operation life-time of the NPP cannot be considered as final solution for the management of it. Availability of waste management facilities must be ensured before start of operation of reactors at the Ostrovets NPP. Availability of disposal facilities within 10 years after start of operation of Belarusian NPP would be a challenge.

4. What are the selection and exclusion criteria (for example, geological and seismo-tectonic structure of the site, seismic hazard assessment (probabilistic assessment), etc.) that a country has to apply, according to current international rules, recommendations, guidelines and other relevant guidance documents, when assessing the suitability of a nuclear power plant site? Were such criteria applied in the selection of the Ostrovets site in comparison with the other sites that were also examined and were the data provided in the EIA documentation sufficient to have an idea of the selection process?

Site selection and exclusion criteria are determined in the IAEA safety requirements "Site evaluation for Nuclear Installations" NS-R-3 (Rev. 1) para 2.1, 2.2:

1) The effects of external events (natural origin and human induced, for example, earthquakes, surface faulting, meteorological events, flooding, geotechnical hazards, soil liquefaction, aircraft crashes, chemical explosions);
2) The characteristics of the site and its environment that could influence the transfer to persons and to the environment of radioactive material that has been released;
3) The population density and population distribution;

If the site evaluation for the three aspects cited indicates or if subsequent reviews indicate that the site is unacceptable and the deficiencies cannot be compensated for by design features, measures for site protection or administrative procedures, the site shall be deemed unsuitable (more details are presented in paras 2.25, 2.28, 3.7, 3.36, 3.40, 3.47, 3.50, 3.55).

In accordance with NS-R-3 (Rev. 1), para 3.7, where reliable evidence shows the existence of a capable fault that has the potential to affect the safety of the nuclear installation, **an alternative site shall be considered**.

In accordance with NS-R-3 (Rev. 1), para 3.40, **if the potential for soil liquefaction is found to be unacceptable, the site shall be deemed unsuitable unless practicable engineering solutions are demonstrated to be available**.

IAEA safety guide „Evaluation of Seismic Hazards for Nuclear Power Plants" NS-G-3.3 and safety guide „Seismic Hazards in Site Evaluation for Nuclear Installations" SSG-9 provide recommendations on the methods for determination of the ground motion hazards for NPP at a particular site, probabilistic and deterministic assessment of seismic hazards and the potential for surface faulting and capability of faults.

SSG-9 para 1.2 indicates **need for seismic hazard curves and ground motion spectra for the probabilistic safety assessment of external events for new and existing nuclear installation**s.

In accordance with para 3.3 the site area investigations are aimed at developing the geotechnical database. In order to achieve consistency in the presentation of information, data should be compiled in a geographical information system (GIS) whenever possible **and all data, evaluations and interpreted products should be displayed on a consistent scale to facilitate comparison**.

Para 3.19 states that site area studies should include the entire area covered by the nuclear power plant, which is typically one square kilometre. The primary objective of these **investigations is to obtain detailed knowledge of the potential for permanent ground displacement phenomena associated with earthquakes (e.g. fault capability, liquefaction, subsidence or collapse due to subsurface cavities)** and to provide information on the static and dynamic properties of foundation materials (such as P-wave and S-wave velocities), to be used in site response analysis as defined in detail in Ref. [6] (*Evaluation of Seismic Safety for Existing Nuclear Installations, IAEA Safety Standards Series No. NS-G-2.13*).

Para 4.12 states that the maximum potential magnitude m_{max} associated with each seismic source should be specified, and the uncertainty in m_{max} should be described by a discrete or continuous probability distribution. For each seismic source, the value of m_{max} is used as the upper limit of integration in a probabilistic seismic hazard calculation and in the derivation of the magnitude–frequency relationship, and as the scenario magnitude in a deterministic seismic hazard evaluation. **For sites in intraplate settings, the largest observed earthquake may not be a good estimate of m_{max}.** The use of global analogues is important, and care should be taken to determine the appropriate seismotectonic analogue. **The sensitivity of the resulting hazard to the selection of the m_{max} distributions should be tested.**

In accordance with para 6.4 results of probabilistic seismic hazard analysis are typically displayed as the mean or median annual frequency of exceedance of measures of horizontal and vertical ground motion that represent the range of periods of importance with regard to structures, systems and components. An acceptable method for propagating the epistemic uncertainties through the probabilistic seismic hazard analysis is the development of a logic tree, which can be evaluated by one of the following methods: (1) complete enumeration of the logic tree branches; or (2) Monte Carlo simulation. **The mean, 16th, 50th (median) and 84th fractile hazard curves are typically used to display the epistemic uncertainty for each measure of ground motion. These hazard curves can be used to develop uniform hazard spectra (i.e. spectral amplitudes that have the same annual frequency of exceedance for the range of periods of interest with regard to structures, systems and components) for any selected target hazard level (annual frequency of exceedance) and confidence level (fractile).** Where a probabilistic seismic hazard analysis is used in determining a design basis level, an appropriate annual frequency of exceedance should be considered together with the corresponding measure of central tendency (mean or median).

Para 8.4 states that on the basis of geological, geophysical, geodetic or seismological data, a fault should **be considered capable if the following conditions apply:**

(a) If it shows evidence of past movement or movements (such as significant deformations and/or dislocations) of a recurring nature within such a period that it is reasonable to conclude that further movements at or near the surface may occur. **In less active areas, it is likely that much longer periods (e.g. Pliocene–Quaternary, i.e. the present) are appropriate.**

(b) **If a structural relationship with a known capable fault has been demonstrated such that movement of the one fault may cause movement of the other at or near the surface.**

(c) If the maximum potential magnitude associated with a seismogenic structure, as determined in Section 4, is sufficiently large and at such a depth that it is reasonable to conclude that, in the current tectonic setting of the plant, movement at or near the surface may occur.

Investigations necessary to determine capability are indicated in para 8.5 – sufficient surface and subsurface related data should be obtained from the investigations in the region, near region, site vicinity and site area to show the absence of faulting at or near the site, or, if faults are present, to describe the direction, extent, history and rate of movements on these faults as well as the age of the most recent movement.

Para 8.8 describes capable fault issues for new sites – where reliable evidence shows that there **may be a capable fault with the potential to affect the safety of a plant** at a site, **the feasibility of design, construction and safe operation of a plant at this site should be re-evaluated and, if necessary, an alternative site should be considered**.

The IAEA specific safety guide NS-G-1.6 Seismic Design and Qualification for Nuclear Power Plants presents the requirements for the scope and formats of data to be gathered. Para 2.3 states that according to Ref. [2] (*Evaluation of Seismic Hazards for Nuclear Power Plants, Safety Standards Series No. NS-G-3.3*) two levels of ground motion hazard should be evaluated for each plant sited in a seismic area. Both hazard levels should generate a number of design basis earthquakes grouped into two series, seismic level 1 (SL-1) and seismic level 2 (SL-2), following the procedures outlined in Ref. [2] and according to the target probability levels defined for the plant design.

Ostrovets NPP. **The first site related factor.** The criteria for prioritisation of the Ostrovets site were not explained – in the EIA report the major characteristics and prohibiting factors of the three sites for nuclear facilities (Kukshinovsk and Krasnopolyana and Ostrovets sites) were just stated, but not described and not motivated by data. In different documents submitted by Belarus earlier the information about geological, seismotectonic and hydrologic structure of the three alternative sites was inconsistent.

Belarus has **not provided potential soil liquefaction assessment** and its results in EIA report, there is **lack of information about the geological structure** of the Ostrovets site **proving the absence of** geological conditions for activation of **suffusion-karst processes.** It is stated that the active faults are absent within the Ostrovets site, but there is **no explanation of capability of faults** in/adjacent to Ostrovets site as defined in the IAEA documents. Justified information on the fault system in the Ostrovets site and its structural relationship with capable Ashmyany fault was not provided. Belarus did not discuss the issues of capability of faults in the understanding of the IAEA documents.

Belarus stated that seismic safety assessment was carried out in accordance with the national legislation and the IAEA safety standards; however, there is **no information how exactly seismic hazard was assessed** in terms of obtaining ground motion values (SL-1 and SL-2) for design basis such as the design earthquake and maximum design earthquake for Ostrovets and other sites. Furthermore, the selection of Ostrovets site is not justified as the seismological investigations used for seismic hazard assessment did not provide clear justification of probabilistic and consistent complementary deterministic seismic hazard assessment according to IAEA safety standards SSG-9 “Seismic hazards in site evaluation for nuclear installations”. Different assumptions and methodologies have been adopted for deterministic assessment of seismic hazards for 3 different seismogenic zones influencing the Ostrovets site. According to para 4.12 of SSG-9 the parameter M_{max} for intracratonic areas of low seismicity has to be assessed using commonly accepted safety margin of 0.5 and has to be calculated as $M_{max}=M_{max\_observed} + 0.5$. Lithuania noted that Belarus in the deterministic seismic hazard evaluation for the two closest seismogenic zones (Daugavpils and Ashmyany) to the Ostrovets site used only the assumption that $M_{max}=M_{max\_observed}$.

The other sites were not equally evaluated in terms of **hydrological conditions**. Even though the information provided concluded that engineering-geological and hydrogeological conditions of the Kukshinovsk site were complicated and drainage of ground and surface water was relevant only at the Krasnopolyana and the Kukshinovsk sites, the EIA report proved that such phenomenon was also relevant at the Ostrovets site. The Ostrovets site was not evaluated in terms of potential risk of technogenic flooding due to artificial water-bearing infrastructure failure, groundwater flooding and pluvial flooding (not caused by natural exceedance of rivers) and possible change of soil water regime. Due to the complicated hydrological conditions in the Ostrovets site, the safety of the facility could be affected and additional measures would be needed to avoid dangerous surface and soil water factors. Belarus informed about the engineering-geological and hydrogeological conditions of the Kukshinovsk site and on the technogenic flooding of the Ostrovets site caused by the river Neris and the foreseen corresponding measures, but did not exactly answer the question regarding hydrological conditions.

The third site related factor, i.e. the population density and population distribution, was not evaluated during site selection and assessment by Belarus. As the distance from the Ostrovets site to Lithuanian capital Vilnius is only 40 km, 1/3 of Lithuanian population (within the radius of 100 km – extended planning distance – from NPP site) might be affected in the case of severe accident and it would be extremely difficult for governmental organisations to manage such an emergency situation in the capital region. In accordance with NS-R-3 (Rev. 1) (2.1, and 2.27) **the selected site shall be deemed unsuitable for the location of a nuclear power plant.**