GeoZS
Geološki zavod
Slovenije

Odzivno pismo na delavnico v Celovcu

Response letter to the Klagenfurt/Celovec workshop

Ljubljana, 2017

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GEOLOŠKI ZAVOD SLOVENIJE LJUBLJANA 1

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Vsebina / Table of Contents

Index

INTRODUCTION

This document is a response to the published report (REP-0612) summarizing the Fact Finding Workshop on the active Tectonics of the Krško Region, held in Klagenfurt/Celovec on April 7, 2016. The workshop was organized by the Environment Agency Austria and the Land Kärnten and convened by dr. Kurt Decker, Universität Wien, Department für Geodynamik und Sedimentologie who is also the author of the report prepared for the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, I/6 General Coordination of Nuclear Affairs (BMLFUW-UW. 1.12/0008-I/6/215). This response is prepared on behalf of GEN Energija d.o.o. (order GEN/2017/319, technical specifications TS-PA17006, contract GEN/66/2017 or GeoZS 1130-85/2017).

The response is prepared to clarify and correct the record regarding presentations by GeoZS and RIZZO representatives as well as findings by GeoZS and RIZZO in the past and ongoing projects in the Krško basin. No response is made to claims or statements that do not concern results by GeoZS and RIZZO. In cases where a response cites ongoing research, this is clearly stated.

In summarizing the Workshop presentations, report REP 0612 (Section 3) uses a two-part format. For each presentation made at the Workshop, a brief summary of the contents is provided (»Outline of contents«) first. Second, a »Remarks« section provides additional notes and commentary by the author of the Workshop report, Dr. Kurt Decker. A response is added by GeoZS and RIZZO regarding author's interpretation of the presentations as summarized in this report. The response is bilingual – in English (»Response«) and Slovene (»Odziv«).

This response document is structured using the following format:

- Introduction (this page): provides the purpose and scope of the document.
- Report/Response: for each section of report REP 0612 the text from the report is copied in full and responses are inserted where applicable. Each response is marked with »RESPONSE«.
- References: cited references are listed at the end of the document.

The transcript of the original report REP 0612 by Kurt Decker is using black fonts while all responses and comments by GeoZS-RIZZO are dark blue.

UVOD

Ta dokument je odziv na poročilo (REP-0612), ki povzema vsebino delavnice z naslovom "Fact Finding Workshop on the active Tectonics of the Krško Region" v Celovcu 7. aprila 2016. Delavnico je organizirala Avstrijska okoljska agencija in Dežela Koroška, poročilo pa je bilo pripravjeno za avstrijsko Zvezno ministrstvo za kmetijstvo, gozdarstvo, okolje in vodooskrbo (BMLFUW-UW. 1.12/0008-I/6/215). Delavnico je vodil dr. Kurt Decker, Univerza na Dunaju, Oddelek za geodinamiko in sedimentologijo, ki je tudi avtor poročila. Ta odziv je pripravljen za podjetje GEN Energija d.o.o. (naročilo št. GEN/2017/319, tehnične specifikacije TS-PA17006, pogodba GEN/66/2017 oz. GeoZS 1130-85/2017).

V Odzivu pojasnjujemo in popravljamo navedbe v zapisu o predstavitvah predstavnikov GeoZS in RIZZO na delavnici ter navedbe, ki se dotikajo rezultatov in ugotovitev GeoZS in RIZZO med preteklimi in potekajočimi projekti v Krški kotlini. Na navedbe, ki se ne dotikajo rezultatov GeoZS in RIZZO se ne odzivamo. V primerih, ko se pri odzivu opiramo na trenutno potekajoče raziskave, to jasno navajamo.

Pri povzemanju predstavitev na delavnici, je v poročilu REP 0612 (Sekcija 3) uporabljen dvodelni format. Za vsako predstavitev na delavnici je najprej naveden kratek povzetek ("Outline of contents"), ki mu sledi sekcija "Remarks" z dodatnimi opombami in komentarji avtorja poročila Kurta Deckerja. GeoZS in RIZZO dodajamo odziv na avtorjeve povzetke oz. interpretacije predstavitev na delavnici. Odziv je dvojezičen - v angleškem jeziku ("Response") in slovenskem jezik ("Odziv").

Odzivno pismo ima naslednjo strukturo:

- Uvod (ta stran): navaja namen in obseg dokumenta.
- Poročilo / odziv: za vsako sekcijo poročila REP 0612 je besedilo kopirano v celoti, odzivi pa so vstavljeni kjer je potrebno. Vsak odziv je označen z "ODZIV".
- Reference: citirana literatura, na koncu dokumenta.

Prepis poročila REP 0612 Kurta Deckerja je v črni barvi, odgovori in komentarji GeoZS-RIZZO pa v temno modri barvi.

Response to REP-0612

SUMMARY

The Environment Agency Austria and the Land Kärnten invited 26 geoscientists from six countries to a technical workshop on the seismicity and active tectonics of the region around the Slovenian nuclear power plant (NPP) Krško. The workshop was supported by the Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW). It was held in Klagenfurt on 07. April 2016.

The Austrian concerns about the seismic safety of the NPP root in the assessment of the plant during the Stress Tests performed on European Nuclear Power Plants in 2012. Based on this assessment the European Nuclear Safety Regulators Group (ENSREG) suggested in its Stress Tests Country Report for Slovenia that *"The regulator should consider requesting to update the seismic design basis".* Concerns are aggravated by the discovery of a number of active faults next to the NPP in the time after the Stress Tests[1].

RESPONSE: The possible activity of faults mapped or inferred in the vicinity of nuclear power plant Krško (JEK) is indeterminate. Geomorphological, geological, geophysical, geochronological, and paleoseismic investigations are currently being conducted by GEN energija d.o.o. (GEN) to characterize the faults for assessing possible fault activity and possible fault capability.

ODZIV: Morebitna aktivnost kartiranih in predpostavljenih prelomov v bližini jedrske elektrarne Krško (JEK) ni dokončno določena. GEN energija d.o.o (GEN) trenutno v Krški kotlini izvaja geomorfološke, geološke, geofizikalne, geokronološke in paleoseizmološke raziskave, ki so namenjene tudi ugotovitvi morebitne aktivosti in zmožnosti *(capability)* prelomov.

The workshop confirmed that Krško is located in a tectonically and seismically active area. It further confirmed the existence of several active faults close to the NPP. Geological data particularly highlight the Orlica, Artiče and Libna faults as well as an unnamed thrust fault below the Artiče flexure as potential sources for earthquakes. The correct assessment of the degree of activity of these faults is of vital importance for the derivation of reliable seismic hazard values. Although experts mostly agreed on the existence of these faults, no common opinion existed on their degree of activity. It appeared that this is mainly due to a lack of paleoseismological data. Many experts therefore highlighted the importance of acquiring additional data to proof or disproof the activity of the faults and to establish a reliable dataset of fault geometry, kinematics, and slip rates as input for seismic hazard assessment.

RESPONSE: Ongoing activities in the Krško Basin supported by GEN aim at acquiring such additional data.

ODZIV: Potekajoče aktivnosti v Krški kotlini, ki jih podpira GEN, so namenje pridobivanju teh podatkov.

The workshop results lead to the suggestion that BMLFUW should follow up the issue and consider to stress in its communication with Slovenian institutions that:

- seismic safety of the NPP Krško is of key importance;
- a new and broadly accepted seismic hazard assessment should be completed by independent experts as soon as possible;
- seismic hazard assessment should be based on reliable paleoseismic data;
- the possibility for Austrian and international observers to follow up data collection and seismic hazard assessment would foster confidence in the reliability of the results;

the seismic design basis of the NPP Krško should be updated as soon as possible.

RESPONSE: RIZZO-GeoZS representatives pointed out during the workshop that GEN has an ongoing program to collect additional geomorphological, geological, geophysical, geochronological, and paleoseismic data within the proposed Nuclear Power Plant Krsko 2 (JEK 2) site near region (25-km radius). The program includes use of these data to assess fault capability and to perform an updated PSHA. The PSHA is being carried out taking into account guidance from the International Atomic Energy Agency (IAEA), the United States Nuclear Regulatory Commission (US NRC), and the American National Standards Institute (ANSI)/American Nuclear Society (ANS), which describe the latest approches for assessing seismic hazards.

ODZIV: Predstavniki RIZZO-GeoZS so na delavnici predstavili, da GEN izvaja program raziskav za pridobitev dodatnih geomorfoloških, geoloških, geofizikalnih, geokronoloških in paleoseizmoloških podatkov v 25-km polmeru okrog lokacije JEK 2. Program raziskav vključuje tudi uporabo teh podatkov za oceno zmožnosti prelomov in nov izračun PSHA. Program se izvaja v skladu s smernicami Mednarodne agencije za atomsko energijo (IAEA), Jedrske regulatorne komisije Združenih držav Amerike (US NRC) in Ameriškega državnega inštituta za standarde (ANSI) / Ameriškega jedrskega združenja (ANS), ki opisujejo najnovejše postopke in pristope za ocenjevanje potresne nevarnosti.

1. BACKGROUND AND WORKSHOP OBJECTIVES

Seismic hazards and the protection of nuclear installations against the effects of earthquakes are key issues of nuclear safety. This was clearly demonstrated by the Fukushima accident, the subsequent *Stress Tests performed on European Nuclear Power Plants* (ENSREG Stress Tests) performed by the EC in 2012, and the development of common European standards for hazard assessment and safety demands by the Western European Nuclear Regulator's Association (WENRA-RHWG) in 2014[3].

In both, the Stress Tests and the development of new safety standards Austria was among the driving countries highlighting that the assessment of seismic hazards requires the application of the latest scientific and technical methodologies and that hazard assessments should be updated regularly. These Austrian positions are widely reflected in the Stress Tests report[4] and the WENRA Safety

Reference Levels which stipulate that nuclear power plants (NPPs) must resist earthquakes with an average return period of 10,000 years[5], and that hazards and protective measures shall be re-evaluated as frequently as necessary, but at least every 10 years. The latter ensures that assessments account for the rapid advance of science and technology.

The assessment of seismic hazards for the NPP Krško has been a matter of almost permanent debate between Slovenia and Austria since Slovenia's independence. Discussions started in 1992 and 1993 when Austria was engaged in the international commission *"Independent Analysis of the Safety of the Nuclear Power Plant Krško – ICISA"* and continued after the implementation of the bilateral agreement on the exchange of information on nuclear issues („Nuklearinformationsabkommen") in 1998. Since then seismic safety was regularly discussed at bilateral consultations and expert workshops.

In the past Slovenia has performed a number of geological and geophysical investigations to update the seismic hazard assessment for the NPP Krško including investigations in the PHARE-Program, which was supported by the European Commission. The Austrian request to perform state of the art paleoseismological investigations, however, has not been addressed.

Paleoseismological investigations are an important tool to assess rare strong earthquakes with long return periods[6]. Earthquakes with average return periods of 10,000 years which must be considered for nuclear safety cannot be assessed from historical records alone as historical earthquake data only cover few hundred years. It is therefore necessary to expand the historical observation period by paleoseismological methods which are able to provide data from pre-historic earthquakes which occurred up to several hundred thousand years ago.

Paleoseismological investigations were only initiated when EVU GEN-Energija started investigating a site for the construction of a possible new NPP adjacent to the existing power plant. The investigations were performed by an expert consortium which initially included the Slovenian Geological Survey (GeoZS), the French Geological Survey (BRGM) and the French Institut de Radioprotection et de Sûreté Nucléaire (IRSN). The results of these investigations,

which are highly relevant for the hazard assessment of the existing NPP, led to a controversial discussion between the members of the consortium which was made public via the web page of the Slovenian nuclear regulator SNSA.

RESPONSE: Paleoseismological investigations in the Krsko vicinity were conducted prior to GEN's initiation of investigations for a possible new nuclear power plant (NPP). Paleoseismological investigations were first conducted during siting of the NPP Krško (Arsovski et al., 1975). This was followed with investigations on the Libna fault (Verbič, 1996; Poljak (ed), 1996; 1997a; 1997b), a Slo/Cro bilateral research project (Poljak et al., 1999, 2000), a paleoseismological study near Drnovo (Bavec et al., 2003), and a study for siting the radwaste disposal site near Krkšo (Celarc et al., 2009). State-of-practice paleoseismological investigations were carried out on the Libna fault with 4 trenches over the period 2008 to 2010 (Bavec, 2010, 2011; 2013). This previous work was all listed at the worksop.

The "controversy" in the Consortium discussion was primarily on estimation of the age of observed deformation in paleoseismological trenches along the Libna fault. The position of IRSN was disputed by GeoZS. Subsequent age determinations confirmed the position of GeoZS, as presented at the workshop in presentation “Seismotectonic characteristics of the Krško Basin in light of past and ongoing geologic investigations”.

As part of GEN's ongoing investigations to address seismic hazards that may impact the planned JEK 2 sites, additional field investigations are being carried out including addtional trenching in the Krško vicnity to address fault capability as part of the scope of the new PSHA project, which was noted at the workshop.

ODZIV: Paleoseizmološke raziskave so v okolici Krškega potekale tudi pred začetkom raziskav za morebitno novo jedrsko elektrarno (JEK II). Prve so bile izvedene že med raziskavami lokacije za obstoječo Jedrsko elektrarno Krško (Arsovski in sod., 1975). Sledile so paleoseizmološke raziskave na Libenskem prelomu (Verbič, 1996; Poljak (ur), 1996; 1997a; 1997b), bilateralni raziskovalni projekt Slo/Hr (Poljak et al., 1999, 2000), paleoseizmološki izkop na Drnovem (Bavec in sod., 2003) in raziskave za izbor lokacije za odlagališče nizko in srednje radioaktivnih odpadkov pri Krškem (Celarc in sod., 2009). Najsodobnejše paleoseizmološke raziskave so bile izvedene na Libenskem prelomu in sicer s 4 paleoseizmološkimi izkopi med leti 2008 do 2010 (Bavec, 2010, 2011, 2013). Slednje je bilo predstavljeno na delavnici.

»Kontroverznost« v diskusiji Konzorcija je bila prevsem v različnih interpretacijah starosti opazovanih deformacij v paleoseizmoloških izkopih vzdolž Libenskega preloma. GeoZS je nasprotoval stališču IRSN. Naknadne ocene starosti so potrdile stališče GeoZS, kar je bilo predstavljeno na delavnici v predstavitvi “Seismotectonic characteristics of the Krško Basin in light of past and ongoing geologic investigations”.

V sklopu potekajočih raziskav, ki jih je naročil GEN za oceno potresne nevarnosti za možne lokacije JEK 2 se izvajajo tudi dodatne terenske raziskave, vključno s paleoseizmološkimi izkopi,

za oceno zmožnosti prelomov, kar je bilo predstavljeno na delavnici.

At the 15th Bilateral Meeting between Austria and Slovenia in 2013 the Austrian side consequently asked the Slovenian counterpart for more information on this issue. At this time, however, the Slovenian regulator preferred not to interfere with the ongoing scientific discussion.

Having a keen interest in the safety of the NPP Krško, the Austrian Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW) supported the initiative of the Province of Carinthia (Land Kärnten) and the Environment Agency Austria to organize a technical workshop on the seismicity and active tectonics in the surrounding of the Slovenian Nuclear Power Plant (NPP) at Krško. The purely technical meeting should provide an opportunity to follow up the continued scientific and technical discussion on the assessment of seismic hazards and the protection against such hazards of the NPP.

2. GEOLOGICAL BACKGROUND

The NPP Krško is located in a tectonically highly mobile belt between the Adriatic and European (Pannonian) plates where the collision of the two plates results in high seismicity (Fig. 1), relatively frequent strong earthquakes, and therefore high seismic hazard (Fig. 2). Examples are the earthquakes of Idrija 1511 (Magnitude M=6.8), Krško 1628 (M=5.0), Medvednica 1880 (M=6.5), Ljubljana 1895 (M=6.1), Medvednica 1905 (M=5.6), Medvednica 1906 (M=6.1), Brežice 1917 (M=5.7) and Bovec 1998 (M=5.7). Earthquakes are generated by the numerous active faults which compensate the Adriatic-European plate convergence.

RESPONSE: Considering moment magnitude estimates given in the SHARE (Seismic Hazard Harmonization in Europe) project catalog, the size of the cited earthquakes are: Idrija 1511 (Magnitude Mw=6.89), Krško 1628 (Mw=5.57), Medvednica/Zagreb 1880 (Mw=5.99), Ljubljana 1895 (Mw=5.93), Medvednica 1905 (Mw=5.4), Medvednica 1906 (Mw=5.3), Brežice 1917 (Mw=6.2) and Bovec 1998 (Mw=5.4). Only one strong (Mw≥6) earthquake (1917) occurred within 25 km of NPP Krsko and only two occurred within 100 km.

If more recent results from the ongoing PSHA project are considered, which take into account updated magnitude conversion relations that give a Mw 5.7 and Mm 5.0 for the 1917 Brezice earthquake (Živčič et al., 2015, 2017), it is concluded that no M≥6 earthquakes are documented within 25 km of NPP Krško, and only one is known within 100 km. This information and other relevant geological, geomorphological, geophysical, geochronological, paleoseismological, and seismic information are being considered to develop the seismic source characterization and ground motion characterization inputs to the ongoing PSHA.

ODZIV: V katalogu projekta SHARE (Seismic Hazard Harmonization in Europe) so ocenjene navorne magnitude močnejših potresov naslednje: Idrija 1511 Mw=6.89, Krško 1628 Mw=5.57, Medvednica/Zagreb 1880 Mw=5.99, Ljubljana 1895 Mw=5.93, Medvednica 1905 Mw=5.4, Medvednica 1906 Mw=5.3, Brežice 1917 Mw=6.2 in Bovec 1998 Mw=5.4. Le en močen (Mw>6) potres (1917) se je zgodil znotraj polmera 25 km okoli JEK in le dva znotraj polmera 100 km.

Novi rezultati, pridobljeni v okviru trenutnega projekta PSHA, temeljijo na novih relacijah za pretvorbo magnitud. Magnituda Brežiškega potresa 1917 je po tem izračunu Mw 5.7 in Mm 5.0 (Živčić in sod., 2015, 2017) iz česar sledi, da znotraj 25 km radija okoli JEK ni dokumentiranih potresov z M>6 in da je v 100 km polmeru tak potres eden. Ti in drugi relevantni geološki, geomorfološki, geofizikalni, geokronološki, paleoseizmološki in seizmološki podatki so uporabljani pri karakterizaciji potresnih virov in opredelitev (potresnega) nihanja tal v potekajoči študiji PSHA.

Austrian institutions and scientists are particularly concerned about the recently discovered

active faults in the site vicinity and near-region[7] of Krško and their potential impact on the safety of the existing plant[8]. The Austrian concerns are mainly driven by the following findings:

(1) Paleoseismological investigations performed for the siting of a possible new NPP near Krško included the excavation of paleoseismological trenches across the so-called Libna fault, which is located at a distance of only 1 to 5 km from the existing plant. Trenching indicated that the Libna fault is active and a "capable fault" in the sense of IAEA[9]. The paleoseismological evidences were heavily discussed among scientists from different countries and institutions. However, no agreement could be reached on whether the fault needs to be classified as capable or not. It must be noted that the identification of a capable fault in the site vicinity (less than 5 km distance) has severe consequences for the safety of a nuclear power plant[10].

RESPONSE: New tectonic geomorphology and age dating work (RIZZO, 2014) brings into question previous interpretations of the Libna Fault. The previous investigations did not recognize that the Libna trench was excavated in an area of karst structures and mass wasting, which is clearly evident from more recent analysis of Lidar data.

ODZIV: Novejše delo v tektonski geomorfologiji in oceni starosti (RIZZO, 2014) postavlja dvome v predhodne intepretacije Libenskega preloma. Analiza novih Lidar podatkov kažejo, da so paleoseizmološki izkopi na Libenskem prelomu izvedeni na območju zakrasevanja in pobočnih masnih procesov, česar predhodne raziskave niso upoštevale.

(2) A probabilistic fault displacement analysis completed by RIZZO Assoc. in 2015 describes as many as 10 newly discovered active ("capable") and potentially active faults in the near-region of the NPP (less than 25 km distance). The results have been published at an IAEA conference in Vienna (Cline et al. 2015) and on the web page of the Slovenian Nuclear Safety Administration. A question of specific interest is whether the hazard contribu- tion of these faults is reflected by previous seismic hazard assessments. It is questionable if the currently valid seismic design basis parameters envelope the associated hazard.

RESPONSE: The probabilistic fault displacement hazard analysis (PFDHA) was carried out to assess the hazard from surface displacement at sites being considered for a possible NPP Krško 2 (JEK 2). Sites being considered are east and west of the existing NPP Krško. While it is generally inappropriate to include conservative assessments in a probabilistic hazard analysis, because the focus of the PFDHA was on suitability rather than design basis, it was conservatively assumed that mapped and inferred faults in the vicinity of the JEK 2 sites were active, in spite of the general lack of reliable evidence suggesting activity. No faults were »newly discovered« during the PFDHA study. Results showed that the predicted frequency of exceedance of surface

displacement values of engineering significance (taken as 5 cm or greater) was very low. Because data to evaluate potentially active faults were sparse, GEN has continued to support fault characterization studies in the JEK 2 vicinity. Results of those investigations will be considered in assessment of fault capability and in the ongoing PSHA.

ODZIV: Probabilistična analiza nevarnosti premika ob prelomih (PFDHA) je bila izvedena za oceno nevarnosti površinskega pretrga na potencialnih lokacijah JEK 2. Analiza je obravnavala lokaciji vzhodno in zahodno od obstoječe JEK. Čeprav v takšni raziskavi načeloma ni primerno vključiti konzervativne ocene, ker je PFDHA usmerjena v oceno primernosti lokacije in ni namenjena projektiranju, je tokratna raziskava konzervativno privzela, da so kartirani in predpostavljeni prelomi v okolici lokacij za JEK 2 aktivni, navkljub temu, da dokazov za njihovo aktivnost ni. Študija ni »odkrila novih prelomov«. Rezultati študije so pokazali da je verjetnost površinskega premika ob prelomu, ki bi lahko vplival na tam postavljen objekt (5 cm ali več) zelo majhna. Ker je podatkov za oceno potencalne zmožnosti prelomov malo, GEN podpira dodatne raziskave v okolici JEK 2. Rezultati teh raziskav bodo vključeni v oceno zmožnosti prelomov in v potekajočo PSHA.

(3) Analyses of the seismic robustness of the nuclear power plant at Krško performed during the European Stress Tests in 2012 showed that the plant has limited safety margins. This is due to the fact that the plant has originally been designed for a hazard level[11] of a peak ground acceleration PGA=0.3 g. Repeated hazard re-assessments increased the hazard level from this initial design basis value to PGA=0.56 g as determined from the latest hazard assessment in 2004. Based on this very significant increase of the hazard level the ENSREG Stress Tests Country Report for Slovenia in 2012 suggested that *"The regulator should consider requesting to update the seismic design basis."* Slovenia so far provided no conclusive information to the Austrian experts to show that this has been done and that adequate protection of the NPP for this hazard level is in place. In addition, a number of active faults have been identified in the vicinity of the Krško NPP since the hazard assessment in 2004 (see (1) and (2) above). The hazard contribution of these faults are consequently not included in the hazard assessment of 2004 raising severe doubts about the adequacy of the hazard level of 0.56 g and calling for a re-assessment of both, the seismic design basis and the adequacy of the seismic protection of the plant.

The technical meeting was scheduled as an international workshop to exchange scientific views on seismological and geological data and models in order to support the understanding of the seismic hazard of the Krško site. The work-shop should discuss the information gained so far, by various scientists, on the active tectonics and seismicity of the Krško region.

The Environment Agency Austria and the Land Kärnten therefore invited 26 geoscientists from six countries (Slovenia, Croatia, Italy, France, USA and Austria) and 13 scientific institutions to discuss these issues. The scientists invited have been and partly still are involved in related scientific and technical projects.

Representatives of the federal and provincial governmental administrations of Austria participated as observers of the technical meeting.

RESPONSE: Seven potentially active faults (Libna, Orlica, Artiče, Stara vas, Močnik 1, Močnik2, Gorica faults) have been mapped, inferred, or speculated to exist in the site vicinity. These faults and others are being evaluated to assess capability; however, to date none have been confirmed active. The ground motion hazard contribution of potentially active faults within the site near-region is being considered in the ongoing JEK 2 PSHA.

ODZIV: V polmeru 5 km okrog lokacije JEK je sedem potencialno aktivnih prelomov (Libenski, Orliški, Artiški, prelom Stara vas, Močnik 1, Močnik 2, Goriški), katerih položaj v prostoru je bil doslej bodisi ugotovljen s kartiranjem, geološko predpostavljen ali pa se je o njihovem obstoju ugibalo na podlagi posrednih znakov. Našteti in drugi prelomi so upoštevani v trenutno potekajoči oceni zmožnosti prelomov, vendar nobeden od naštetih prelomov ni potrjeno aktiven. Prispevek potencialno aktivnih prelomov k potresni nevarnosti bo ocenjen v potekajoči PSHA za JEK 2.

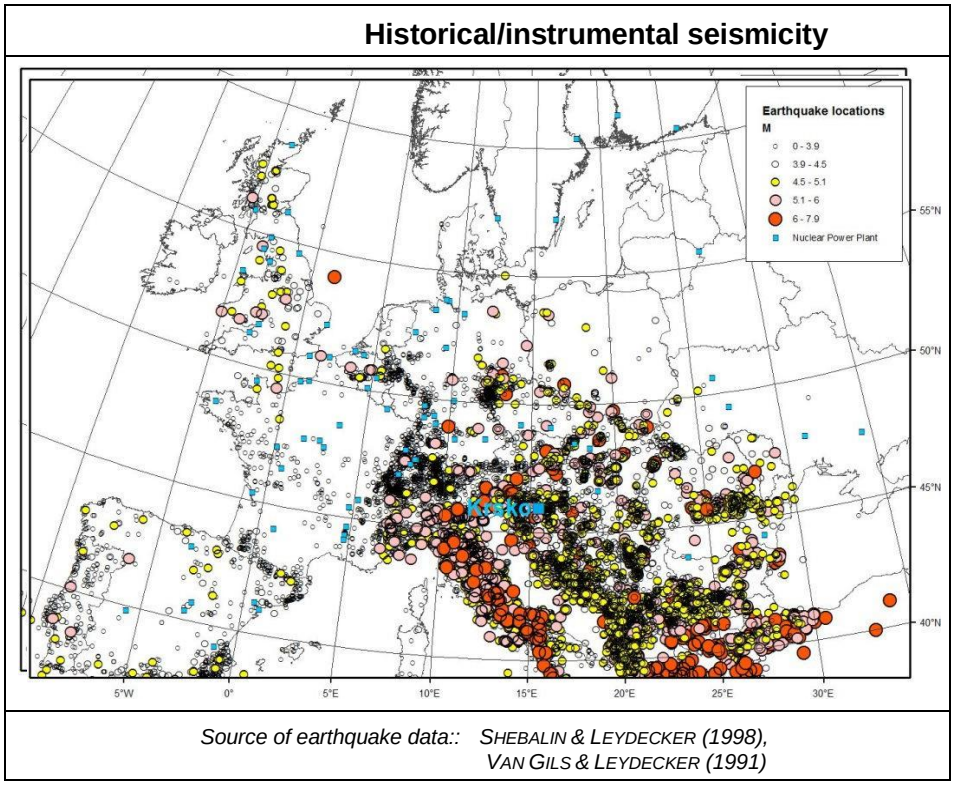

Figure 1: Historical/instrumental seismicity and the locations of Krško and other European NPPs.

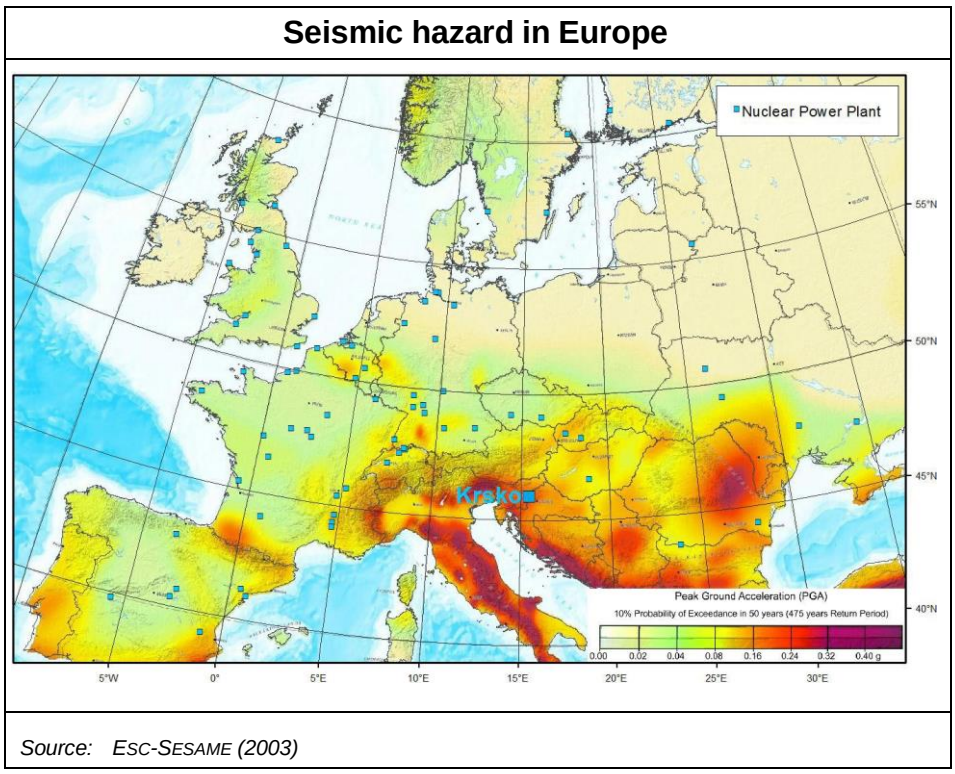

Figure 2: Seismic hazard in Europe and the locations of Krško and other European NPPs.

3. SUMMARY OF WORKSHOP CONTRIBUTIONS

To advance the mutual understanding of the different technical approaches and interpretations and to benefit from this enormous amount of combined expertise of the contributing scientists, all participants were asked to prepare presentations addressing their view on the active tectonics, site seismicity, and its effects on the safety of the NPP Krško. The following paragraphs include short outlines of the contents of these presentations. All outlines were reviewed by the authors[12].

Remarks printed in italic below the Outline of Contents contain explanations and assessments added by the author of this report. These comments solely reflect the opinion of the author of this report.

3.1 Marko Vrabec (University of Ljubljana)

Active tectonics at the Alps – Dinarides junction: Current data and ideas, and possible implications for the Krško site

Outline of contents: During his talk Marko Vrabec summarized the current plate tectonic boundary conditions in the region under consideration and provided insight into a regional seismotectonic model of the Slovenian territory. Active tectonics and seismicity in the region are driven by the convergence between the Adriatic Plate and stable Europe which amounts to about 3.5 mm/yr. GPS and geological data prove that fault slip rates of many of the major faults in the area exceed 1 mm/year (Periadriatic, Lavanttal, Idrija, Sava, and Vodice Fault). Robust GPS data also indicate that 1 mm/year of NNW-SSE shorting is accommodated across the Sava Folds in the geographic region around Krško. The presentation further described in great detail the advanced seismotectonic models which are available for the Sava fault system, the Sava folds, the Ljubljana basin, and the Idrija fault system.

RESPONSE: Only the maximum estimates of fault slip rate exceed 1 mm/year for the Periadriatic, Lavanttal, Idrija and Sava Faults; minimum estimations are on the order of 0.1 mm/year (e.g. Kastelic and Carafa, 2012; Jamšek Rupnik et al., 2012; Basili et al., 2013; Moulin et al., 2016; Atanackov et al., 2016). Slip rate estimates for the Vodice fault range between 0.1 and 0.5 mm/year (Jamšek Rupnik, 2013).

We advise the reader to compare these values of measured horizontal displacement along the four most prominent faults within the 200-km region around the possible JEK 2 sites with the summary of S. Baize's presentation in which 1.7 mm/year of (only) vertical displacement is attributed to the Artiče fault.

ODZIV: Le pri največjih regionalnih prelomih (Periadriatski, Labotski, Idrijski, Savski) največje

ocene hitrosti premikov ob prelomu presegajo 1 mm/let, medtem ko so minimalne ocene reda velikosti 0.1 mm/leto (e.g. Kastelic in Carafa, 2012; Jamšek Rupnik in sod., 2012; Basili in sod., 2013; Moulin in sod., 2016; Atanackov in sod., 2016). Ocene hitrosti premikov ob Vodiškem prelomu so med 0.1 in 0.5 mm/leto (Jamšek Rupnik, 2013).

Bralcu svetujemo primerjavo teh vrednosti (hitrosti premikov ob najizrazitejših atkivnih prelomih znotraj radija 200 km od potencialnih lokacij JEK 2) z vrednostjo v povzetku predstavitve S. Baizea, kjer pripisuje Artiškemu prelomu kar 1.7 mm (le) vertikalnega premika na leto.

3.2 Petra Jamšek Rupnik (Geological Survey of Slovenia GeoSZ)

Database of active faults in Slovenia

Outline of contents: The presentation informed about the ongoing activities to collect a comprehensive database of active faults in Slovenia as a basis for the re-evaluation of seismic hazard on the national scale. Previous hazard assessments are regarded insufficient as they are exclusively based on earthquake data. Hazard re-assessments are regarded crucial at the background of the seismicity in Slovenia with several strong historical earthquakes affecting the area (Idrija 1511, M=6.8; Villach 1348, M=6.4; Ljubljana 1895, M=6.1; Villach, 1690, M=5.9; Brežice 1917, M=5.7; Bovec 1998, M=5.7). Most of these earth- quakes were generated by large or fault systems that generally do not extend into the site near-region of Krško (i.e. Idrija fault, Ravne fault, and the Periadriatic fault system).

The new parameterized fault database should include all currently known active and potentially active (Quaternary) faults which are longer than 5 km. Fault parameters considered in the database include slip rate, fault orientation, fault kinematics, fault dimensions and maximum earthquake magnitudes (estimated from fault dimensions) which are said to reach up to Mmax=7.6 for multi- segment ruptures breaking the entire length of the Sava or Idrija fault (such events are regarded very unlikely) and Mmax=7 for single-segment ruptures.

Remarks: *The version of the map of active and potentially active faults shown in the presentation included four faults (five fault segments) in the near-region of Krško (less than 25 km distance) with estimated slip rates of up to about 0.1 mm/year and maximum magnitudes reaching up to about Mmax=7.*

RESPONSE: The Map of Active and Potentially Active Faults in Slovenia (Atanackov et al., 2016) contains no active, probably active or possibly active faults within the 25-km radius of the JEK 2 sites for which their lengths would suggest a potential for M>>7 full-length or M≥7 single-segment ruptures.

ODZIV: Karta aktivnih in potencialno aktivnih prelomov v Sloveniji (Atanackov et al., 2016) ne vsebuje aktivnih, verjetno aktivnih ali potencialno aktivnih prelomov znotraj polmera 25 km okoli potencialnih lokacij za JEK 2, katerih dolžine bi nakazovale potencial za potres z M>>7 ob multisegmentni aktivaciji po celi dolžini preloma ali za potres z M≥7 ob aktivaciji posameznega

segmenta.

3.3 Stephane Baize (IRSN)

Active Tectonics in the Krško Region and IRSN perspectives

Outline of contents: In the first part of his presentation Stephane Baize presented a concise and credible kinematic and seismotectonic model of the Krško Region highlighting the importance of the Orlica and Artiče faults, which are lo- cated at very close distances to the NPP. According to the model which was proposed the consortium gathering IRSN, BRGM and GeoZS, the two sinistral faults are linked via a restraining bend forming the Artiče flexure. Evidence for the current uplift with a rate of about 1.7 mm/year is provided by geomorphological data and uplifted fluvial sediments. The surface flexure is related to a blind fault at depth which strikes towards the site of the Krško NPP and may continue into the Libna fold. In this tectonic scenario the Libna fault may be regarded as a small dextral tear fault at the termination of Artiče flexure which delimits two parts of the Libna fold. The Orlica-, Artiče- and the blind fault are regarded as the main seismotectonic structures in the near-region of Krško and were used to update previous seismogenic source models for the assessment of vibratory ground motion hazards (geometry, Mmax, slip rates). The updated model formed the basis of a hazard assessment completed in 2010 (GG&S Report 2010). The results of this report are not public.

RESPONSE: The basis for the uplift rate of 1.7 mm/year was not provided and conflicts with estimates determined as part of the BRGM/GeoZS/IRSN/ZAG consortium and other known studies. In the BRGM/GeoZS/IRSN/ZAG consortium Geology report (Bavec et al., 2010a), in his contribution titled MORPHOMETRIC ANALYSIS OF THE SITE VICINITY AND NEOTECTONIC IMPLICATIONS, S. Baize states on page 96: *“the Artiče structure is suspected to be the surface expression of the Southern limit of a large-scale block uplifting (up to the Orlica hills). The rate of uplifting is low, at a maximum of 150 m during the last 5 Ma (maximum age of Plio-Quaternary base surface) or 1.5 Ma (minimum age of Plio- Quaternary top surface according to Verbič, 2005) (i.e. 0.03 to 0.1 mm/a).”*

Further, in the Seismic Source Models report co-signed by GeoZS, IRSN and BRGM (Bavec et al., 2010b) it is stated on page 51: *"Slip rate (0.12 and 0.06 mm/yr) is calculated from the 120 m vertical (structural) relief in the Plioquaternary deposits (estimated to 1,000,000 to 2,000,000 years) across the Artiče fault."*

The GG&S Geology Report (Bavec et al., 2010a) has been published on Slovenian Nuclear Safety Administration (SNSA) website since 2013.

ODZIV: Osnove za oceno dviganja 1.7 mm/leto niso bile predstavljene in so v nasprotju z ocenami iz raziskav konzorcija BRGM/GeoZS/IRSN/ZAG (2010) in ostalimi znanimi raziskavami. V

geološkem poročilu (Bavec in sod., 2010) konzorcija BRGM/GeoZS/IRSN/ZAG S. Baize v svojem prispevku MORPHOMETRIC ANALYSIS OF THE SITE VICINITY AND NEOTECTONIC IMPLICATIONS na strani 96 piše: *»domnevamo, da je Artiška struktura površinski izraz na južnem robu dviganja bloka velikega merila (do Orliškega hribovja). Hitrost dviganja je nizka, maksimalno 150 m v zadnjih 5 milijonih leti (največja starost spodnje meje Pliokvartarja) ali 1.5 milijonih let (najmanjša ocenjena starost zgornje meje Pliokvartarja po Verbič, 2005) (t.j. 0.03 do 0.1 mm/leto)«*.

Nadalje, na strani 51 v Poročilu za model potresnih virov (Seismic Source Model report), podpisan s strani GeoZS, IRSN in BRGM (Bavec in sod., 2010b) piše: »*Hitrost premikov (0.12 do 0.06 mm/leto) je izračunan iz 120 m vertikalnega (strukturnega) reliefa v Pliokvartarnih sedimentih (ocenjenih na starost 1 do 2 milijona let) preko Artiškega preloma.«*.

Geološko poročilo projekta GG&S (Bavec et al., 2010a) je objavljeno na spletni stran URSJV od leta 2013.

The second part of the presentation summarized the consortium's (IRSN, BRGM, GeoZS) conclusions 2011 on the paleoseismological trenching of the Libna fault, which is located at close distance to the NPP. Trenching revealed clear evidence for faulting of sediments which are younger than 200,000 years[13].

Physical age dating is confirmed by the finding of a human artefact (Mousterian tool). Trench data provide evidence for Pleistocene and even Holocene strike-slip faulting as fault planes include Holocene soil. Reopening of the fault plane must therefore have happened in the Holocene. These observations may be indicative for coseismic and recurrent displacements. The Libna fault should consequently be considered capable in line with the definition by IAEA (2010). The interpretation was validated by expert consulting by Daniela Pantosti (INGV) who confirmed that fault slip was triggered either by tectonic reactivation of the fault or by ground shaking induced by an earthquake which occurred at another nearby fault. According to Stephane Baize and the other members of the geological team of the 2011 Consortium the observations in the Libna trenches cannot be explained by landsliding.

RESPONSE: This section is extensively debated in the GeoZS/IRSN/BRGM report on paleoseismological studies on the Libna fault (Bavec et al, 2011, 2013). Faulting younger than 200,000 years is one of the statements that was disputed and on which the team did not agree. The dispute is described in the report. Moreover, later age dating (by a method that is here referred to as "physical") showed that such low age for the Plio-Quaternary sediment is not feasible. If 200 000 years refers here to the age of the Mousterian tool, it has to be noted that its position in the sediment was heavily debated and there was no consensus between the IRSN and GeoZS teams regarding the potential to date the sediment with it.

It is clearly stated on page 36 in the GeoZS/IRSN/BRGM report (Bavec et al., 2011, 2013) that these options are also discussed (quote):

• *the human activity that produced the silex artefact is isochronous with the silt (either this formation is colluvial or fluvial),*

• *bioturbation may be the cause of a deep infiltration,*

• *human activity isochronous with deposition of the (uppermost) silt,*

• *infiltration into desiccation or slope movement-related cracks,*

• *artifact was dragged down from surface by excavator during trenching.*

Furthermore, there was no agreement on whether the observations in the Libna trenches could be explained by coseismic or aseismic slip.

ODZIV: Tej temi je namenjena obsežna razprava poročila GeoZS/IRSN/BRGM o paleoseizmoloških raziskavah na Libenskem prelomu (Bavec in sod., 2011, 2013). Prelamljanje mlajše od 200.000 let je ena od trditev, o kateri se avtorji poročila niso bili soglasni in je to zapisano v poročilu. Kasnejše določanje starosti sedimenta (z metodo, ki je tukaj navedena kot "*fizikalna*") je pokazalo, da tako majhna starost Pliokvartarnega sedimenta ni možna. Nadalje; če se starost 200.000 let v tem primeru nanaša na najdeno Mousteriensko kamnito orodje, izpostavljamo da je bila lega tega orodja v sedimentu predmet intenzivne razprave in da med ekipami IRSN in GeoZS ni bilo soglasja glede primernosti/potenciala za datacijo sedimenta s tem orodjem.

Na strani 36 v poročilu GeoZS/IRSN/BRGM (Bavec in sod., 2011, 2013) so tako navedene različne možnosti, med katerimi nobena ni ovrednotena kot bolj verjetna:

- *človeška aktivnost je bila sočasna (izohrona) z nastankom melja in je ta formacija bodisi koluvialna ali fluvialna,*
- *možen vzrok za globoko infiltracijo artefakta je bioturbacija,*
- *človeška aktivnost je izohrona z odložitvijo zgornjega melja,*
- *infiltracija artefakta v izsušitvene razpoke ali razpoke povezane s pobočnimi masnimi premiki,*
- *artefakt je v sedanjo lego potegnil bager med kopanjem izkopa.*

Ekipa ni bila soglasna tudi v oceni, če je opazovanja v izkopih na Libni možno pojasniti izključno s koseizmičnim ali aseizmičnim premikom oz. premikanjem, kar je dokumentirano v poročilu.

Remarks: *IRSN was actively involved in the assessment of potentially capable faults in the*

Krško area between 2007 and 2012. At this time the Institute was part of an expert consortium together with BRGM, ARSO and GeoZS. Work in the consortium ended due to a disagreement with GEN Energija on the necessity to acquire new data. The acquisition of additional geological data was re- garded necessary by IRSN.

The presentation stressed the importance of the Orlica- and Artiče faults and the blind fault below the Artiče flexure for the assessment of seismic hazards. It further concluded that trenching of the Libna fault provided strong indications for repeated fault slip in the last 200,000 years and in the Holocene (<14,000 years). This interpretation is not shared anymore by the Slovenian Geological Survey and Rizzo Assoc. who after 2012 question the reliability of age dating (although physical age dating is confirmed by different methods and the finding of human artefacts) and relate the surface displacement observed in the trench to land- sliding although the observed fault geometries are apparently not in line with such an interpretation.

RESPONSE: The reliability of the Libna trench age dating was debated not only after 2012, but originally in the report co-signed by GeoZS, IRSN and BRGM (Bavec e tal., 2011, 2013). Later cosmogenic radionuclide (CRN) dating (RIZZO, 2014) confirmed the GeoZS position correct and this was presented at the workshop. RIZZO also states that certain features on Libna Hill are first related to karst activity and landsliding.

ODZIV: Zanesljivost datacij v Libenskih izkopih je bila predmet razprave ne le po letu 2012, ampak tudi že v prvotnem poročilu, ki so ga so-podpisali raziskovalci GeoZS, IRSN in BRGM (Bavec et al., 2011, 2013). Kasnejša datacija s kozmogenimi radionuklidi (RIZZO, 2014) je potrdilo stališče GeoZS, kar je bilo predstavljeno tudi na delavnici. RIZZO v svojem poročilu tudi navaja, da so nekatere oblike na Libni v prvi vrsti povezane z zakrasevanjem in plazenjem.

3.4 Miloš Bavec (Geological Survey of Slovenia GeoZS)

Seismotectonic characteristics of the Krško Basin in light of past and ongoing geologic investigations

Outline of contents: Miloš Bavec, geologist at the Geological Survey of Slovenia and manager of the recent geologic project in Krško for GeoZS, summarizes the contents of previous and on-going geological and geophysical investigations in the Krško basin and its surrounding. Past and current efforts include the acquisition of 2D reflection seismic, shallow geophysics, geological mapping and the analysis of earthquake data. Analyses further comprise the interpretation of high-resolution digital elevation models (LiDAR-data) with quantitative geomor- phological techniques to identify active faults by lineament analyses, analyses of mountain-front sinuosity, channel sinuosity, stream profiles and drainage ba- sin morphology. Earthquake records are shown to be of limited use for identify- ing active faults. Seismicity is scattered and only three faults can reasonably be associated with earthquake clusters. Analyses highlight the importance

of NE- SW striking sinistral strike-slip faults.

Miloš Bavec further explains that four different seismic source zone models were used for a seismic hazard assessment performed in 2010 (GG&S Report 2010). Accordingly, Model A used in this study consists of four seismic zones (Dinarides, Sava, two sub-zones of the Mid Hungarian Zone [MHZ]), Model B comprises of three zones (Dinarides, Sava, MHZ), Model C includes two zones (Dinarides, Sava including MHZ), and Model CRO is seismicity-focused and not structurally defined. A fault specific model of seismic sources (with a back- ground seismicity zone) was also elaborated and used in calculation as one of the alternatives. He further informs that a novel probabilistic seismic hazard assessment (PSHA) shall be initiated for the NPP Krško.

Remarks: *The NE-SW striking sinistral strike-slip faults mentioned in the presentation correspond to the Orlica- and Artiče fault highlighted in the presentation by Stephane Baize. The cited seismic hazard study (GG&S Report 2010) is not public.*

RESPONSE: The cited seismic hazard study (GG&S Geology Report; Bavec et al., 2010) is public and has been available on the SNSA web page since March 29th 2013.

ODZIV: Citirano poročilo (GG&S Geology Report; Bavec et al., 2010) je javno in dosegljivo na spletni strani URSJV od 29. marca 2013.

3.5 K. Michel Cline, M. Logan Cline (RZZO Assoc.)

Probabilistic fault displacement hazard analysis – Krško NPP 2 sites – Slovenia

Outline of contents: The authors report on the outcome of a probabilistic fault displacement analysis (PFDHA) which was performed as part of the evaluation of two sites to support decision making by the utility and regulator regarding the safety of the site for the construction of a possible new NPP ("Krško 2") adjacent to the existing plant. The approach used follows that of Petersen et al. (2011), with considers both on fault and off fault displacement for all faults considered in the analysis. 11 faults with assessed probabilities of being active be- tween P=0.3 and P=1 were considered for the analysis *[Remark: Probability P=1 is assigned to proven active faults]*. The mean annual probability of exceeding 0.1 – 50 cm of surface displacement within a 200 x 200 m area at each site was calculated. The study procedure came to the conclusion that displace- ments between 5 and 10 cm (such displacements are generally considered by nuclear engineers to be significant for an NPP) are extremely unlikely with mean annual frequencies of exceedance less than 10^{-8} to 10^{-9}.

Remarks: *The study by Rizzo Assoc. exclusively addresses the hazard of sur- face displacement, the hazard of vibratory ground shaking is not considered. Rizzo's study was reviewed by the independent experts L. Serva, C. Costantino and A. Gürpinar who state that: "A PSHA [for ground shaking hazards]*

study was recently completed for the KRSKO site and a new study is currently being conducted. There are many common input parameters between the PSHA and PFDHA [for fault displacement hazards] related to fault characteristics, recurrence values, etc. The consistency of these studies need to be checked and differences (if any) need to be appropriately justified." Seismic hazard assessment for the existing NPP must therefore properly account for the finding of these active faults.

RESPONSE: The input parameters for the PFDHA were provided by the same GeoZS professionals who participated in the subject PSHA. The same faults that were considered for the PSHA were included in the PFDHA. Fault inputs for the PFDHA used the same Tectonic Map of the Krško Basin as was used in the PSHA; however, the faults modeled in the PFDHA were conservatively assumed to have some probability of their being active, even if there was no reliable evidence to confirm their activity. The JEK 2 PSHA, currently underway, is considering the inputs of the previous PSHAs, and new data that has been compiled since the previous PSHAs were completed.

Dr. Sirovich (Università di Trieste) commented during the meeting that the PFDHA only addresses surface fault rupture along a fault and not ground tilting/deformation, and the hazard it poses to a NPP. He expressed concern about the safety of the NPPs critical structures. At the time the PFDHA was completed the focus was on the probability of exceeding a defined amount of surface fault displacement within a defined area surrounding the nuclear island. New guidance has been issued by the American Nuclear Society (ANSI/ANS Standard 2.30-2015) that addresses both surface fault rupture and ground deformation; however, the PFDHA results suggest that the probability of surface fault rupture is below regulatory concerns. This would likely be the same for surface deformation. The PFDHA informs the design engineers of the probability of surface fault rupture. Surface fault rupture is only one of many factors taken into consideration regarding the safety of critical facilities.

ODZIV: Vhodne parametre za PFDHA so priskrbeli isti predstavniki GeoZS, ki so sodelovali tudi v PSHA. V PSHA so upoštevani isti prelomi kot v PFDHA. Vhodni podatki za prelome v PFDHA so vzeti iz Tektonske karte Krške kotline, ki je uporabljena tudi v PSHA, vendar je za PFDHA konzervativno privzeto da imajo prelomi enako verjetnost aktivnosti, čeprav za njihovo aktivnost ni zanesljivih podatkov. Trenutno potekajoča JEK 2 PSHA upošteva vhodne podatke predhodnih PSHA in novejše podatke.

Dr. Sirovch (Università di Trieste) je med delavnico komentiral, da PFDHA pri oceni tveganja za jedrsko elektrarno upošteva le površinske pretrge vzdolž preloma in ne upošteva deformacije/nagiba površine. Izpostavil je zaskrbljenost glede varnosti kritičnih struktur v jedrski elektrarni. PFDHA se je osredotočila na verjetnost preseganaja določene vrednosti površinskega premika ob prelomu v vnaprej definiranem območju okoli jedrskega dela. Ameriško jedrsko združenje je izdalo nove smernice (ANSI/ANS Standard 2.30-2015), ki obravnavajo površinski pretrg ob prelomu in deformacijo površja. Rezultati PFDHA v Krškem nakazujejo da je verjetnost površinskega pretrga manjša od mejne. Isto verjetno velja za deformacijo površja. Rezultat PFDHA je verjetnost površinskega pretrga ob prelomu, kar je le eden izmed številnih faktorjev, ki so upoštevani pri ovrednotenju varnosti kritičnih objektov.

In his presentation M. Cline, however, stressed that the performed study as- sumed capable faults in the near region of the site rather than confirming them. It was explained that this more conservative approach was used because the analysis focused on site suitability and not on design purposes. This raises the question why very conservative assumptions should be made for the capable fault analysis (PFDHA) while much less conservative assumptions should be admissible for the analysis of vibratory ground motion hazards (PSHA).

RESPONSE: The term "conservative" was used to characterize certain assumptions that were made in the PFDHA that would lead to higher predicted frequencies of surface displacement exceedance than if a realistic assessement was used. For example, faults for which no reliable evidence existed that they were active were, nevertheless, treated as active. The objective was to carry out a "what if" analysis: What would be the surface displacement hazard if the faults were active. Because the focus of the study was whether possible sites for JEK 2 were suitable, it was acceptable to use conservative assumptions: If suitability can be demonstrated using conservative assumptions then use of more realistic assumptions would also lead to a demonstration of suitability. If the purpose of the study was to determine a design basis or to support a seismic probabilistic safety assessment, conservative inputs would be inappropriate. For a design basis, an appropriately conservative annual frequency of exceedance (i.e., hazard level) is selected (e.g., mean of 10^{-4}) or prescribed by regulation, assuming the probabilistic hazard analysis inputs are realistic. Similarly, for a PSA, the hazard results should be based on a realistic (and not conservative) assessment of uncertainties such that seismic-related risks can be compared to risks from other external and internal initiators. For the ongoing PSHA, inputs will be based on realistic assessments, unless it can be demonstrated that the impact on hazard of conservative inputs is negligible.

ODZIV: Pojem "konzervativno" je bil uporabljen za opis nekaterih predpostvk v PFDHA, ki v izračunu vodijo k večji napovedani frekvenci preseganja površinskega premika ob prelomih, kot pa če bi uporabili bolj realistične ocene. Na primer: prelomi, za katere ni bilo zanesljivih dokazov o aktivnosti so v PFDHA obravnavani kot aktivni. Namen izračuna je bil izvesti "kaj če" analizo. Ocenjevali smo torej, kakšna bi bila nevarnost za površinski premik ob prelomih, če bi bili vsi prelomi aktivni. Ker je bil PFDHA namenjen oceni primernosti lokacije, je bilo sprejemljivo uporabiti takšne konzervativne predpostavke. Če tak izračun nakazuje na primernost lokacije, bi namreč tudi izračun, utemeljen na bolj realističnih predpostavkah, v takem primeru lahko pokazal primernost lokacij. Če pa bila, nasprotno, študija namenjena projektiranju objekta ali verjetnostnemu izračunu potresne nevarnosti, bi bili konzervativni vhodni podatki neprimerni. Pri projektiranju morajo biti vhodni podatki za verjetnostni izračun realistični, saj je zahtevana ocena verjetnosti postavljena ustrezno nizko (npr. 10^{-4} letno oz. jo predpisuje regulatorni organ). Podobno morajo biti tudi pri rednih ocenah nevarnosti (PSA) negotovosti ocenjene realistično (in ne konzervativno). Na tak način je mogoče potresno nevarnost obravnavati skupaj z ostalimi potencialnimi nevarnostmi. Vhodni podatki za potekajoči PSHA bodo temeljili na realističnih ocenah. Izjememoma bodo ocene lahko tudi konzervativne, a le v primerih, ko bo mogoče

dokazati, da taka sprememba ne bo vplivala na oceno nevarnosti.

3.6 Wolfgang Lenhardt (ZAMG Vienna)

Cross-border monitoring of seismic activity

Outline of contents: The author reports on the coverage of the Austrian seis- mic network, its linkage with the seismic observation networks in Austria's neighbouring countries, and data exchange with these countries. The presentation provides insight into the detection threshold of the network in Austria.

3.7 Marijan Herak, Davorka Herak, Bruno Tomljenović (University of Zagreb)

Seismicity and Neotectonics in the Greater Zagreb Area

Outline of contents: In the first part of the presentation Marijan Herak informs about the seismicity in the Croatian territory east of the NPP Krško. Historical earthquakes in the area reach up to about M=6. A significant effort was undertaken to relocate earthquakes which occurred between 2004 and 2014. The results revealed new and more reliable hypocenter depth distributions showing that all earthquakes occurred in the upper crust. First arrival analyses (fault plane solutions) show N- or S-dipping thrust faults (in particular in the area be- tween the Slovenian border and the Medvednica Mountain) and NW-striking dextral strike-slip faults as seismic sources. Normal faulting is not observed. Shortening directions are uniformly oriented N-S. Gutenberg-Richter analyses for the greater Medvednica Mountain area indicate that one M=6 earthquake occurs about every 500 years. The hazard contribution from this area for Krško is PGA=0.10 g and PGA=0.28 g for the return periods of 75 years and 10,000 years, respectively. *[Remark: It is understood that this would be the hazard at the Krško site if no other seismic sources were considered.]*

In the second part Bruno Tomljenović discusses the active tectonics of the Medvednica Mountains and the greater Zagreb area. He shows that the main structural elements of the Krško basin, the ENE-WSW trending Krško syncline and the Orlica-Artiče uplift, extend to ENE into Croatia. Seismic and geological data show that the Medvednica Mountains are thrust towards the N over a syn- cline filled with Pliocene and Quaternary sediments. The location of the thrust coincides with the relocated hypocenters of earthquakes which occurred be-tween 12 and 5 km depths. The fault surface of the Medvednica thrust is estimated with 300 km².

Remarks: *The Medvednica thrust is located at a distance between 26 and 32 km from the Krško site. The fault surface of 300 km² suggests that the fault is capable of producing*

earthquakes up to magnitude Mmax=6.6. It appears that previous seismic hazard analyses for the Krško site did not consider the fault as a seismic source.

RESPONSE: The detailed seismotectonic model was made in 2010 for the 25-km radius, which does not include the Medvednica thrust (North Medvednica Boundary Fault - NMBF). All seismic sources in the >25 km radius were included in the background seismicity. In the 2010 study (Bavec et al., 2010), the Medvednica source was encompassed within the Sveta Nedelja - Zagreb seismic source zone. NBMF is being considered in the ongoing PSHA.

ODZIV: Leta 2010 (Bavec 2010a) je bil izdelan podroben seizmotektonski model za polmer 25 km okoli JEK, ki ne vključje preloma Medvednica (*North Medvednica Boundary Fault - NMBF). V okviru študije leta 2010 so bili vsi viri izven 25-km radija vključeni v seizmično ozadje. V isti študiji je bil prelom NMBF vključen v seizmični vir Sveta Nedelja – Zagreb. Prelom NMBF je upoštevan v trenutni PSHA.*

3.8 Mladen Živčić (Slovenian Environment Agency)

Seismicity of the Krško region

Outline of contents: The presentation provides information on the history of the earthquake observation network in Slovenia. Accordingly, systematic earth- quake records were made in the time between 1895 (starting after the Ljubljana earthquake) and 1918. Between 1918 and 1958 data were collected only spo- radically. Seismic stations were established as follows: Ljubljana 1897 – 1918 (no records preserved); Zagreb from 1906 onwards; re-establishment of a seismograph in Ljubljana in 1958; installation of seismographs at Cernica 1973, Vojsko 1984, and Bojanci 1986. After the 1989 Krško earthquakes (28. December, M=3.6; 30. December, M=2.6, epcenter next to the NPP) seven additional stations were installed between 1990 and 2003. Stations were supplemented by the accelerometric network NEK II in 2008. The completeness of earthquake records was said to be very poor for the time interval between 1918 and about 1960. Completeness increased slowly from 1963. The strongest pre- instrumental earthquakes in Slovenia occurred in NW Slovenia 1511 (Intensity I=X), Krško 1628 (I=VII), Carniola 1632 and 1640 (I=VII and I=VI–VII),

Medvednica 1880 (I=VIII), and Brežice 1917 and 1928 (I=VIII and I=VII). The currently used earthquake catalogue is the NEK 2015 catalogue covering an area of 200 km perimeter around Krško and Friuli. The catalogue is harmonized using moment magnitude and lists events with Mw>3.5. However, most of the original data is based on macroseismic intensity.

The strongest recorded earthquake in the Krško area occurred on 29. January 1917 (Mw=5.0, MLH=5.7, I_0=VIII). It was analysed by a commission of the K&K Academy of Sciences.

Fault plane solutions from recent earthquakes around Krško include thrust faults (N- and S-dipping thrusts) and strike-slip faults (NW-striking dextral and NE- striking sinistrale faults). P-axes and shortening directions inferred from the fault plane solutions are oriented mostly N-S.

Remarks: *The presentation provided detailed information on the completeness of earthquake observations in Slovenia showing that instrumental earthquake records are complete for 50 years at the best. Such short data records limit the reliability of seismic hazard assessments for long recurrence intervals[14] very significantly as it is not allowable to extrapolate statistics over several orders of magnitude (i.e., from 50 to more than 10,000 years). It is further concluded that the accuracy of hypocentre determination is insufficient for seismotectonic int erpretation and that large uncertainties exist with respect to the determination of the magnitudes of strong historical earthquakes. The insufficiency of the earthquake data stresses the need of accurate geological and paleoseismological data as input for the seismic hazard assessment.*

RESPONSE: As part of the ongoing PSHA, geological and paleoseismological data are considered in developing inputs and characterizing their uncertainty.

ODZIV: Geološki in paleoseizmološki podatki so uporabljeni za pripravo vhodnih podatkov in oceno njihove negotovosti v okviru potekajoče PSHA.

3.9 Esther Hintersberger (University Vienna)

Estimating paleo-earthquake parameters from multiple trench observations

Outline of contents: An important aspect of fault characterisation for seismic hazard assessment are the parameters of pre-historical earthquakes derived from paleoseismological trenching. Especially in regions with low or moderate seismicity, paleomagnitudes are normally much larger than those of historical earthquakes and therefore provide essential information about the seismic potential and expected maximum magnitudes of a certain region. The presentation introduced a novel method for deriving seismological parameters of paleo- earthquakes based on a probabilistic approach combining observations in sev- eral trenches across the same fault to better constrain the possible range of parameters such as earthquake magnitude. The contribution further showed that by combining several observations, the associated uncertainty for the magnitude of a paleoearthquake decreases rapidly, seemingly with a minimum of 4 to 6 observation points to obtain highly reliable results. Tests of the method with data from earthquakes with known magnitude and surface displacement reproduced magnitudes which are promisingly close to the instrumentally determined magnitude. Therefore, the approach is a suitable method to combine observations from different locations to derive paleo-earthquake parameter values ac- counting for the natural variances of observed along-strike surface displacement.

Remarks: *The presentation showed that the uncertainties of paleoseismological interpretations made in single trenches can be reduced very significantly by using data from multiple trenches. The approach is particularly suitable to reduce the uncertainties of the assessment of the Libna fault near Krško.*

3.10 Vanja Kastelic (INGV Roma)

Contribution of active fault and geodynamic data to seismic hazard assessment

Outline of contents: In her presentation Vanja Kastelic introduced methods for physical models-based seismic hazard studies in which predictions of the future seismicity are mainly or exclusively based on active fault and geodynamic data instead of historical/instrumental earthquake observations. The approach uses fault properties (dimension, orientation, kinematics and slip rate) to derive seismic moment rates. Earthquake rates for single faults or fault elements are subsequently computed using the SHIFT hypothesis (Bird and Liu 2007). The method was applied to three of the active faults identified in the vicinity of the NPP Krško, the Hrastnik-, Orlica- and Libna fault, using the fault parameters published by Cline et al (2015). The results show the importance of good knowledge of fault geometry and even more so of the fault slip rates, as with just considering the used data, the expected number earthquakes for different magnitude varies significantly. Mrs. Kastelic also pointed out the need of developing self-consistent active fault models (considering 3D fault geometries) and that care is needed when estimating fault slip rates from surface data as the re- sults may also be influenced by non-tectonic processes.

In general, the results of the study indicate that strong earthquakes (M=6 and higher) are expected to occur on the studied faults at time intervals of several hundred to few thousand years only. The purely physics-based predictions were validated by the historical and instrumental earthquake record. Vanja Kastelic concluded that active fault and geodynamic data are a valid input for probabilistic seismic hazard analysis (PSHA). For this purpose, it is of key importance to have good knowledge of fault geometry, kinematics, and slip rates.

Remarks: *The contribution introduced a novel physics-based approach of seismic hazard assessment and applied the methodology to estimate the expected number of future earthquakes and their related recurrence periods for the Hrastnik-, Orlica- and Libna fault near* Krško. *The estimate revealed that, based on the currently known fault data, severe earthquakes with M>6 are expected to occur in intervals of centuries to few thousand years. If proven by ad- ditional investigations such earthquake recurrence intervals would be highly rel- evant for the seismic hazard of Krško. Future active fault investigation should consider this fact and strive for a good knowledge of active faults as this data is of key importance for a reliable physics-based seismic hazard model.*

RESPONSE: Research on this matter is being undertaken within the scope of the ongoing PSHA.

ODZIV: Raziskave s tem namenom potekajo v okvirju trenutne PSHA.

3.11 Livio Sirovich, Franco Pettenati (Università di Trieste), Giovanni Costa, Peter Suhadolc (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, O.G.S)

Questions and doubts on the seismic hazard of the Krško NPP site

Outline of contents: In their presentation the authors highlighted the need for a comprehensive seismic hazard assessment for the site. To support their view- point they cited a publicly available document of IRSN saying that IRSN considers *"the Libna capable fault … in the vicinity of the existing Krško I plant site … as well as its potential structural relationship to nearby faults …"* of utmost im- portance for the safety of the existing plant.

The presentation showed that the site is located in a seismically active region with the 1917 Brežice earthquake as the strongest known historical event. For this earthquake different earthquake catalogues (Ribarič 1982, Grünthal & Wahlström 2012) list magnitudes ranging from Mw=5.7 to 6.2. However, this earthquake was either not included in a seismicity dataset which has been pre- sented to the Slovenian Nuclear Safety Administration by GEN energija, or it was included with a too low magnitude[15]. They also noted that the earthquake has not been investigated with up-to-date methodology (e.g., intensity-based source inversions to identify the ruptured fault), and that an Ml=4.2 earthquake occurred on 01. November 2015 in the same area (c. 10 km from Krško).

RESPONSE: The Brežice earthquake has been included in all catalogues and datasets relevant to seismic hazard calculations in Krško basin. Sirovich and co-authors do not provide a technical basis for their assertion that the earthquake was included in datasets with a too low magnitude. An earthquake catalog for the Krško region deveoped as part of the ongoing PSHA study used the latest magnitude conversion relations and data for the 1917 earthquake to determine a Mw of 5.7 (Živčić et al., 2015).

OPIS: Brežiški potres je vključen v vseh katalogih in naborih podatkov relevantnih za izračun parametrov potresne varnosti v Krški kotlini. Sirovich in soavtorji ne navajajo osnove za njihovo mnenje, da je magnituda tega potresa v katalogih in naborih podatkov prenizka. Katalog potresov, izdelan za trenutno PSHA raziskavo, ki je za magnitudno pretvorbo uporabil najnovejše relacije, za Brežiški potres 1917 podaja magnitudo Mw 5.7 (Živčić in sod., 2015).

In the last part of their presentation Livio Sirovich and his co-authors stressed the importance to seismic hazard of the Orlica-, Artiče- and Libna faults in the vicinity of the Krško plant. In the discussion about the tectonic significance of the observations made in the paleoseismological trench across the Libna fault they expressed strong doubts on interpreting the excavated Quaternary faults

as the results of landsliding. They substantiated their doubts by the analysis of LIDAR-derived digital elevation data. Although this data confirms the existence of mass movements on the Libna hill, the direction of the landslide seems hardly compatible with the kinematics of the fault.

RESPONSE: The issues related to abovementioned faults including results of paleoseismological and geomorphic studies were thoroughly described at the workshop and are also partly presented in the report REP 0612. Investigation of these faults has been a focus in all relevant studies of the Krško basin. There is no basis to suggest the landslides are in a direction inconsistent with fault kinematics.

ODZIV: Teme, povezane z zgoraj navedenimi prelomi, vključno z rezultati paleoseizmoloških in geomorfoloških raziskav, so bile temeljito opisane na delavnici in so delno predstavljene v poročilu REP 0612. Raziskave na teh prelomih so bile v žarišku vseh pomembnih študij v Krški kotlini. Nobene osnove ni za trditev, da usmeritev zemeljskih plazov na Libni ni skladna s kinematiko prelomov.

4. CONCLUSIONS

During the workshop it appeared that a common view of the experts exists on the seismotectonic boundary conditions of the Krško region[16]. Convergence across the geographic area under consideration is significant. GPS derived velocity fields suggests about 3 to 3.5 mm/year convergence between the Adriatic plate and stable Europe (M. Vrabec). Out of this general convergence about ~1 mm/year of N-S-directed shortening is currently accommodated by seismotectonic processes across the Sava Folds area (i.e., the region around Krško; M. Vrabec). N-S-directed compression causes seismic slip on NE-striking sinistral strike-slip faults, NW-striking strike-slip dextral faults, and N- or S-dipping thrust faults (M. Vrabec, B. Tomljenović, M. Živčić, V. Kastelic).

RESPONSE: The range of results is slightly larger than the 3 to 3.5 mm/year stated above: 2 to 4 mm/year (e.g., Weber et al. 2010; Nocquet, 2012).

ODZIV: Razpon rezultatov je nekoliko večji od navedenega (3 do 3.5 mm/leto): 2 do 4 mm/leto (e.g., Weber in sod., 2010; Nocquet, 2012).

The most important faults in the region around Krško belong to these fault sys- tems. Faults important for hazard assessment include the NE-striking Orlica- and Artiče faults (M. Cline, S. Baize), which may be linked via a restraining bend and a blind thrust fault below the Artiče flexure (S. Baize), the NW-striking Libna fault, the NW-striking Hrastnik fault (V. Kastelic) and the Medvednica thrust (B. Tomljenović). It appeared that all experts generally agreed on the existence of these faults. All faults are located at close distances to the NPP site. Slip velocities of the faults are estimated to be in the order of magnitude of0.1 mm/year (P. Jamšek Rupnik, M. Cline). Based on the dimensions of these faults maximum earthquake magnitudes of up to about Mmax=7 may be expected (P. Jamšek Rupnik, M. Cline). Faults in the near-region of Krško are included in the database of active faults in Slovenia (except for the Libna fault; P. Jamšek Rupnik).

RESPONSE: A relatively small fraction of faults in the Database of Active and Potentially Active Faults in Slovenia (Atanackov et al, 2016) are long enough to be considered capable of producing an Mmax=7 event. The Libna fault is less than 5 km long and thus does not fit the criteria for inclusion in the Database of Active and Potentially Active Faults in Slovenia that only considers faults with a > 5 km long fault trace. The 5 km limit in the Database of Active and Potentially Active Faults in Slovenia was selected due to the cutoff to the magnitude cutoff of M 5.5 for the map of active faults. I.e. only faults capable of generating earthquakes of M 5.5 or larger were taken into account. Using empirical relationships (Wells&Coppersmith, 1994) - M 5.5 earthquake is generated by a rupture length of 5 km.

ODZIV: Sorazmerno majhen delež prelomov na Karti aktivnih in potencialno aktivnih prelomov v Sloveniji (Atanackov in sod., 2016) je dovolj dolgih, da jih je mogoče smatrati kot možne vire

potresov z Mmax=7. Libenski prelom je krajši od 5 km in ne ustreza pogojem za vključitev na Karto aktivnih in potencialno aktivnih prelomov v Sloveniji, saj karta (in baza) vključuje prelome s površinsko traso dolgo >5 km. Ta meja je določena na podlagi kriterija, da v Karto aktivnih in potencialno aktivnih prelomov v Sloveniji vključimo le prelome, ki so zmožni generirati potres najmanj z magnitudo 5.5. Po empiričnih relacijah (Wells in Coppersmith, 1994) je za potres magnitude 5.5 potreben pretrg dolžine 5 km.

Dedicated paleoseismological studies were only presented for the Libna fault. According to the presentation by S. Baize paleoseismological trenching revealed evidence for a dextral strike-slip fault which was repeatedly active in the last 200.000 years. This interpretation of the trenching results was originally agreed by all members of the Consortium which included GeoZS (M. Bavec), BRGM and IRSN (S. Baize) in 2011 – 2012. The results were described in a common report.

RESPONSE: The above conclusion is incorrect. The issue with respect to age determinations is clearly and extensively described in the GeoZS/IRSN/BRGM report "Paleoseismological trenches on the Libna Hill" Revision 1.0 and revision 1.1 (Bavec et al., 2011, 2013). On page 31 (Bavec et al., 2013) three options are summarized for the age of the deformed sediments indicating ages may span anywhere between 130 ky to over 5.5 My and commented: *'' Up to now, we consider not to have enough conclusive arguments to favour any of these 3 options. An extensive and multi-method campaign of datings is required to conclude as there is no known single absolute dating method that would guarantee reliable age dating of the deformed sediments in trench on Libna and consequently the age of deformation.''*

In the Conclusions chapter of the Libna Hill trenching report (Bavec et al. 2013) it is stated*: ''Comparison of various age dates of the Plio-Quaternary sediments in the area gives inconsistent results, which sheds doubts about the age of displacement along the Libna fault. ''*

ODZIV: Zgoraj naveden zaključek je napačen. Vprašanje datacij je jasno in obširno opisano v konzorcijskem poročilu GeoZS/IRSN/BRGM z naslovom »Paleoseismological trenches on the Libna Hill«, reviziji 1.0 in 1.1 (Bavec in sod., 2011, 2013). Na strani 31 (Bavec in sod., 2013) so povzete tri možnosti za starost deformiranih sedimentov, ki kažejo na to, da je starost lahko kjerkoli med 130.000 leti in 5.5 milijoni let. Dodan je komentar: »*Trenutno nimamo dovolj trdnih argumentov za katerokoli od teh treh možnosti. Za določitev starosti deformiranih sedimentov v izkopu Libna in posledično starosit deformacij bodo potrebne obsežne datacije z več metodami, saj ni nobene znane posamezne metode, ki bi dala dovolj zanesljive rezultate«.*

V zaključku poročila o izkopih na Libni (Bavec et al. 2013) je zapisano: Primerjava različnih datacij pliokvartarnih sedimentov daje neskladne rezultate. Zato je ocena starosti premika ob Libenskem prelomu pod vprašajem.

After 2012, however, some experts (M. Bavec, M. Cline) did not further support the interpretation by the Consortium arguing that dating of the fault slip events is uncertain and the deformations observed in the trenches could be due to land- sliding or other mass wasting

processes. Paleoseismological investigations from other faults (Orlica, Artiče, Hrastnik etc.) have not been presented and it appeared that such investigations do not exist. During the workshop information was obtained that additional studies including a new PSHA are planned (M. Bavec, M Cline).

RESPONSE: The inference that the GeoZS and IRSN teams were originally in full agreement on the interpretation of the trench is incorrect. Differences were mainly about the timing of events (i.e. age dating of sediments) and this was clearly stated in the report GeoZS/IRSN/BRGM. The position of GeoZS was later proven correct after additional age-dating results were obtained by CRN dating.

This paragraph also refers to the results of the geomorphic study of RIZZO Associates (RIZZO, 2014) that used newly acquired Lidar data to determine that landsliding and mass wasting processes had affected Libna Hill. It is clarified that GeoZS (or M. Bavec as stated by K. Decker) did not participate in that study. The weight of evidence presented by Rizzo (2014) brings into question the age reported in original reports (Bavec et al., 2011, 2013) and the apparent displacement.

ODZIV: Namig, da sta bili ekipi GeoZS in IRSN prvotno v popolnem soglasju glede interpretacije izkopa, in da se je sprememba zgodila kasneje, je napačna. Razlike med interpretacijama so nespremenjene in se nanašajo predvsem na čas dogodkov (npr. datacije sedimentov), kar je tudi jasno navedeno v poročilu GeoZS/IRSN/BRGM. Stališče GeoZS, ki ga je kasneje potrdila tudi datacija z kozmogenimi radionuklidi, se ni spremenilo.

Ta odstavek se tudi nanaša na rezultate geomorfoloških raziskav RIZZO Associates (RIZZO, 2014), kjer je uporaba novo pridobljenih Lidar podatkov pokazala, da so na Libni močni vplivi plazenja in pobočnih masnih premikov. Pojasnjujemo, da GeoZS (ali M. Bavec, kot navaja K. Decker) ni sodeloval pri tej raziskavi. Dokazi iz te študije (RIZZO, 2014) postavljajo vprašaj k diskusiji o starosti sedimentov in navideznem premiku ob prelomu, kot je to opisano v originalnem poročilu (Bavec et al., 2013).

During the discussion K. Decker and E. Hintersberger pointed out that the cur- rent paleoseismological information is not satisfactory due to the large uncer- tainties in the interpretation of the Libna fault and the lack of data from other faults. They argued that propagating the uncertainties of the interpretation of the Libna fault through a full-scope probabilistic seismic hazard assessment would likely lead to very large uncertainties of the resulting ground motion values. It should therefore be considered to acquire additional data and open more

trenches in order to arrive at a commonly accepted interpretation of the Libna fault. Paleoseismological investigations should be extended to other important faults such as the Orlica-, Artiče-, and Hrastnik fault. The acquisition of additional data has previously also been

proposed by IRSN (S. Baize).

RESPONSE: Acquisition of additional data was not proposed by S. Baize of IRSN but by the whole consortium BRGM, GeoZS, IRSN, ZAG. This was done formally and in a number of reports. It has also been reported by GeoZS, RIZZO and ARSO participants at the workshop that an extensive effort is underway that is aimed also to characterize seismic sources and perform paleoseismic investigations in Krško basin.

ODZIV: Pridobivanja novih podatkov ni predlagal le S. Baize ali IRSN, ampak celoten konzorcij BRGM, GeoZS, IRSN, ZAG. Predlog je bil formalen in je dokumentiran v več poročilih. Na delavnici so predstavniki GeoZS, RIZZO in ARSO udeležencem sporočili, da trenutno v Krški kotlini poteka obširna študija za karakterizacijo potresnih virov in paleoseizmološke raziskave.

The importance of reliable fault data for probabilistic seismic hazard assess- ment was also stressed in the presentation of V. Kastelic. She pointed out that seismic hazard studies based on physical active fault models and geodynamic data enable predictions of the future seismicity. The major advantage of the ap- proach is that it is widely independent from inaccurate or incomplete historical and instrumental earthquake records. This aspect of physical based hazard studies appears important given the short and incomplete earthquake records which are available from the area. For the Slovenian territory complete instru- mental earthquake records are only available for about the last 50 years, and both locations and magnitudes of significant historical earthquakes are affected by large uncertainties (M. Herak, M. Živčić).

During the general discussion information was obtained that a new probabilistic hazard assessment for the site of the NPP Krško should be performed in the near future.

Concluding remarks of the response team

The responses in this report directly address statements in the workshop report that are either misleading or incorrect, primarily with respect to work performed by GeoZS and RIZZO. When previous work has been superceded by new results, this is pointed out. There is no attempt, however, to evaluate how accurately the report documents the presenations and discussion of other workshop participants.

Zaključne pripombe avtorjev odzivnega poročila

Odzivi v tem odzivnem poročilu se nanašajo neposredno na navedbe v poročilu z delavnice, ki so bodisi nepravilne ali zavajujoče in se v prvi vrsti nanašajo na delo, ki sta ga doslej opravila ali ga še opravljata GeoZS in RIZZO. Kjer rezultatom predhodnih del sledijo novi, je to jasno navedeno. V odzivnem poročilu se ne opredeljujemo do predstavitve in diskusije v poročilu, ki se nanaša na predstavitve drugih sodelujočih na delavnici.

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