

**NOTES OF
PROGRESS MEETING 11: EXPERT PANEL ON NATURAL HAZARDS - SEISMIC**

DATE: 13-14 November 2019

VENUE: ONR, Redgrave Court, Merton Road, Bootle, UK

OBJECTIVES

- TAG13 – Proposed revisions
- Review developments in Relevant Good Practice (RGP) and ideas for future research
- Review and discussion of the Expert Panel Research Paper on Fracking
- Review of generic and site-specific project work

ATTENDEES:

[REDACTED]

Invited: [REDACTED] - ONR **Apologies:** [REDACTED] - ONR

Actions

No	ACTION	Responsible
1/11	Co-ordinate and produce a document recording the proposed changes for the next update of the EP paper.	[REDACTED]
2/11	Discuss with the ONR external hazards team the new schedule of updates for the EP paper.	[REDACTED]
3/11	Circulate a draft of the geotechnical annex and any other relevant TAG17 material to the panel for comment.	[REDACTED]
4/11	Discuss the level of input required by the panel to support the ONR letter to BRB.	[REDACTED]
5/11	Produce a summary note on CFS following the December workshop to support the ONR letter.	[REDACTED] support from [REDACTED]
6/11	Follow up the open points from [REDACTED] review of EDF's proposal and engage with EDF to obtain further information.	[REDACTED]
7/11	Send geology map to [REDACTED] for incorporating into the research fracking paper.	[REDACTED]

8/11	Send [REDACTED] the evidence to support the BEIS statement in relation to the Springfields Fuels Ltd site.	[REDACTED]
9/11	Enquire about the underlying geology of Heysham 1 and 2 AGRs and send to [REDACTED] for inclusion in the fracking paper.	[REDACTED]
10/11	Update the fracking research paper to include all comments and feedback already received and those discussed at the EP meeting - for summer 2020.	[REDACTED]

The agenda is included as an appendix. PowerPoint (ppt) presentations can be found at 2019/375136.

Wednesday 13 November 2019

1. Introduction

[REDACTED] welcomed everyone and summarised the agenda (see appendix to these notes). [REDACTED] noted that there were many topics to discuss and that [REDACTED] hoped to finish on time.

[REDACTED] referred to the previous notes for Progress Meeting 10 and read out the seven actions listed. It was agreed that Action 1 was no longer relevant, and that Actions 2-6 had been completed. [REDACTED] agreed to follow up Action 7/10 – providing a link to the external hazards handbooks, and it is reproduced here:

(<https://www.imeche.org/policy-and-press/energy-theme/enabling-resilient-uk-energy-infrastructure>)

2. RGP and Guidance: TAG13 and Expert Panel Paper

[REDACTED] commenced by emphasising that one of the primary purposes of the panel was to advise ONR of developments in relevant good practice and to reflect this via regular updates to the TAG 13 Annex 1 and supporting reference paper. [REDACTED] envisaged these updates should occur on a yearly basis to avoid a major re-write in years to come and thought this could be achieved by early 2020. [REDACTED] held an alternative view and proceeded to present [REDACTED] reasons for not updating the Annex and EP paper.

During [REDACTED] presentation, [REDACTED] emphasised that it was important not to make changes on a yearly basis as industry would be looking for stability in ONR's guidance rather than something that was changing annually. [REDACTED] also noted that there were relevant studies which were being conducted at the moment on site response and that it would be beneficial to wait for them to be completed for incorporation into any updates. [REDACTED] added that the current USNRC project on site response within PSHA will have its first workshop in January 2020 and the project is expected to be completed within a year. [REDACTED] was concerned that this timescale was too long and that [REDACTED] would prefer small changes rather than big ones. [REDACTED] added that updates provided tangible outputs from the panel and this, in turn, justified the money spent on the panel. [REDACTED] suggested that an update every 3 years seemed more appropriate. [REDACTED] also added that EDF work on a three-year timescale for their safety cases. Following discussion, there was a consensus of opinion that three years was reasonable and this could be reviewed at the next progress meeting. [REDACTED] stated that Annex 1 will still be updated in line with the other TAG13 Annexes; however these changes will be minor and not substantive.

In discussion, it was agreed to record the proposed updates in a summary document. [REDACTED] agreed to coordinate the changes that have, so far, been identified with input from the relevant panel members, and produce this document. The changes identified were as follows:

- The need for the CF and PSHA reports to be read together and to be consistent [REDACTED]
- The requirements (composition, etc) of IPR for technical coverage and procedures for minimising cognitive bias [REDACTED]
- Expanded text on dynamic site characterisation: multiple Vs measurements, and QA on measurements and interpretation [REDACTED]
- Encourage openness (publication) and exchange of information, citing Hinkley Point C papers as good examples [REDACTED]
- Expand text on the development of clear criteria and consistent use of evidence in seismic source modelling [REDACTED]
- Placeholder on seismic hazard assessments for GDF [REDACTED]
- Check for mention of site instrumentation (eg. seismometers) and add if missing [REDACTED]
- Add reference to EPP on fracking-induced seismicity [REDACTED]

Following the recommendation to not update the EP paper on a yearly basis, [REDACTED] will discuss this new schedule with the ONR external hazards team.

[REDACTED] to coordinate and produce a document recording the proposed changes for the next update of the EP paper (Action 1/11).

[REDACTED] to discuss with the ONR external hazards team the new schedule of updates for the EP paper (Action 2/11).

[REDACTED] reported that TAG17, which is the technical assessment guide covering Civil Engineering was being updated, and it would be useful for the panel to be aware of this in relation to the External Hazards section. In particular, to look at the interface between the two guides (13 and 17) and make references to TAG17, where appropriate. [REDACTED] is coordinating the production of a geotechnical annex ([REDACTED] is reviewing it) and will circulate a draft to the Panel when completed, for information. [REDACTED] added that the revisions were on a much shorter time scale than TAG13 and they hoped to have a draft by early 2020.

[REDACTED] to circulate a draft of the geotechnical annex and any other relevant TAG17 material to the panel for comment (Action 3/11).

[REDACTED] invited [REDACTED] to present on capable faulting developments. [REDACTED] began with the definition of the evaluation of fault capability taken from SSR-1 (IAEA2010) which states that: *“Geological faults larger than a certain size and within a certain distance of the site and that are significant to safety shall be evaluated to identify whether these faults are to be considered capable faults. For capable faults, potential challenges to the safety of the nuclear installation in terms of ground motion and/or fault displacement hazards shall be evaluated.”*

■ concluded with three questions:

- 1) Should fault-related, near-surface fissures (ancient & active) be referred to in our guidance? Are these 'capable' structures?
- 2) Whilst many fissures are subsidence &/or mine related, some are likely to be related to the very recent reactivation - by creep - of geological faults possibly due to rising minewaters...if we include fracking, should we not also make reference to these anthropogenic phenomena?
- 3) SSG-9 makes reference to solution-related cavities below nuclear sites -*"If necessary, for example in limestone areas, boreholes should also be drilled deep enough to confirm that no cavities or karstic features are underlying the foundations of a nuclear installation."*
Should we include this advice also - gypsum & limestone dissolution cavities are very common in eastern England?

3. Project Work - Summary of Progress - Seismic Hazard

Bradwell B progress

■ invited ■ to give a brief overview of the status of the Bradwell project. ■ explained that ■ was the lead assessor and that ■ was leading the PSHA supported by ■. ■ added that ■ was leading the BRB flood risk and platform height ALARP study. ■ reported that they had attended three workshops in July this year (Seismicity Model, Ground Motion Model and Site Response). ■ showed the timetable of report/output delivery and explained that a number of PSHA reports will be delivered this month and, overall, they had made good progress in terms of the ground investigations. ■ added that ONR is attending a workshop on Capable faulting on 13 December this year. ■ commented that ■ had not received any information regarding the PSHA overall source zone model and in particular the Weymarks fault. ■ agreed to follow this up and sent an email during the meeting to seek clarification. ■ reported that BRB had requested a letter from ONR, which was to provide some regulatory assurance regarding the work BRB had completed so far. The aim was to provide assurance to BRB in support of their site suitability studies whilst maintaining regulatory independence. ONR have agreed to send it by 10 January 2020. ■ asked if ONR required input from the Expert Panel on the BRB PSHA reports expected this month. ■ said that, once the reports have been received, ONR will consider what input they require from the Expert Panel and decide on a timescale for this input.

■ invited ■ to give ■ presentation on the Bradwell capable faulting update. ■ summarised the overall geology of the area and mentioned that they had attended two workshops in March and May this year. ■ added that there had been an impressive volume of work completed but the Weymarks fault capability issue is not wholly resolved and will, therefore, rely on "weight of evidence arguments" based on regional studies. ■ also commented that there had obviously been good interactions with the PRT (Peer Review Team) and that they had clearly influenced the ground investigation programme. ■ thanked ■ for ■ presentation and added that ONR and EP members will be attending the workshop in December, and that ■ is looking for some input from the panel so that ONR can send the requested letter to BRB in January 2020. ■ agreed to take the lead in producing a summary note on CFS following the December workshop to support the ONR letter.

█ and █s to discuss the level of input required by the panel to support the ONR letter to BRB (Action 4/11).

█ to produce a summary note on CFS following the December workshop to support the ONR letter (Action 5/11).

█ briefly explained that ONR had not yet started any engagement in relation to flood risk or platform height for the BRB site. ONR and the EA have a meeting with BRB which is scheduled for 12 December to discuss these topics. █ explained that BRB is a low lying site and is unlikely to meet the IAEA dry site requirement. █ added that a foundation assessment report had been expected at the end of October but, so far, it had not been received. █ also explained that access to deep water is challenging and that BRB were considering various cooling options e.g. cooling towers.

Sizewell C progress

█ invited █ to summarise key points from the Sizewell C site visit in September this year (24th-25th). █ provided a presentation regarding the overall geology of the area and highlighted the various techniques they are using for their ongoing site investigations. █ explained that rotary and sonic rigs were being used to core the pre-Quaternary and Quaternary, respectively. █ added that on Day 2 they visited the core store where they observed sample cores from both onshore and offshore surveys. They were able to identify lithology markers like the Harwich stone band and ashes together with unconformities and faults with slickenlines. █ reported that, following a logging workshop in July this year, they had produced a list of outcomes and recommendations which were regarded, by ONR, as an excellent example of best practice.

█ presented an overview of the project and noted that the September workshop provided a useful insight into the current ground investigations (GI). However, both ONR and the PRT felt that the overall GI strategy was not clear and that there had not been enough engagement, at an early stage, to have an opportunity to influence the GI. █ added that the PRT had requested more information re the GI, including timings and a schedule. █ explained that EDF are proposing to install a downhole seismic array in the next 5-6 months using the same instrumentation as BRB. █ added that the sharing of information and interactions between BRB and SZC was positive. █ also noted that a number of workshops are planned for the future but ONR had not been invited yet. However, █ expects the invitations will be made soon.

Progress on Other Projects

HPC Progress

█ invited █ to deliver █ review of seismic input motions for assessment of the graphite core at the HPB and HNB Nuclear Power Plants. █ outlined the issues and raised some concerns regarding the overall narrative and quality of the safety case documentations. Some important technical clarifications were also required.

█ to follow up the open points from █ review of EDF's proposal and engage with EDF to obtain further information (Action 6/11).

Regarding HPC, █ provided a brief overview of the current status via a suite of

construction photographs. ■ reported that everything was moving forward as planned with no further panel input envisaged.

Wylfa Progress

■ reported that there was no progress on WYB, the project remained suspended but the site had not been abandoned.

AWE

■ reported that ■ had attended a meeting at AWE regarding their PSHA and that Jacobs had identified that there were some gaps against RGP. This may need some further studies to be conducted to investigate these issues.

GDF

■ explained that RWM Ltd had already started engagement with the communities in relation to GDF and that ONR and EA will be jointly regulating them. No new information was available.

4. General Panel Business

■ reported that ■ had submitted the business case to extend the Expert Panel work for 2 years and that it had been recently approved – this means that all contracts will be extended to finish on 31 March 2022. ONR are, at the moment, looking at the value of each of the contracts to reflect the amount of work each individual is involved in. ■ added that ■ will be in touch with panel members to discuss each individual member's contract. ■ also reported that members of the Met and Coastal flood hazards sub-panel were also extended to March 2022.

■ thanked everyone and closed the meeting.

Thursday 14 November 2019

5. Introduction

■ welcomed everyone and, in particular, ■ thanked the external visitors from the Environment Agency, BGS, OGA and the University of Bristol for attending the meeting. ■ invited introductions around the table and reminded everyone that this was a meeting to discuss the ONR research paper on fracking. ■ added that the work had been carried out by ■ and ■ with input from others, and invited ■ to present the progress on the paper.

6. Expert Panel Research – Fracking

■ explained that the publication of the paper had been held back so that OGA could publish their 2018 studies on Preston New Road (PNR) – these can be found at the following link: <https://www.ogauthority.co.uk/onshore/onshore-reports-and-data/preston-new-road-pnr-1z-hydraulic-fracturing-operations-data/> . However, since their publication, the Government have announced a moratorium on shale gas operations. The official government press release can be found at: <https://www.gov.uk/government/news/government-ends-support-for-fracking>.

█ reported that █ had received a number of comments which were circulated to the group prior to the meeting. █ stressed that the paper would likely be classified as a research document and not an EP paper to reinforce that it was not a statement of ONR policy - it will be used by ONR to develop their regulatory guidance and policy on fracking issues related to nuclear sites. █ confirmed this would be classified as an Expert Panel Research Paper.

█ provided some background to the OGA studies which had been commissioned in March 2019 and focused on 2018 data from the PNR fracking site. █ added that Cuadrilla started fracking in early summer and produced a number of events which culminated in the 2.9ML event on 26 August 2019 - at that point OGA suspended all operations at PNR. █ added that █ considered that clearer guidance may be needed on how to operate safely so as not to produce earthquakes that are felt strongly. █ emphasised the need for more work to be done in the area around PNR including producing geomechanical models and more geotechnical investigations. █ added that there were still some difficult unanswered questions that needed to be addressed. In discussion, █ said it was the operators who apply to conduct further operations and that this process was still open. █ explained that the current moratorium only applies to associated high volume hydraulic fracturing.

█ announced that OGA had commissioned further studies which will use the 2019 data, and they are anticipated to be published by mid-2020. █ thought that it would be timely to publish the ONR research fracking paper after this date and suggested summer 2020.

█ continued █ presentation and explained that sections 1-6 had been fully drafted and reviewed both internally and externally. █ summarised the content of each section and highlighted updates that were needed following the feedback and comments █ had received.

Following a question relating to what would be the largest possible event, █ said that it is not possible to answer this question without conducting more extensive work. █ suggested including a geology map in the paper and █ volunteered to send it to █

█ to send geology map to █ for incorporating into the research fracking paper (Action 7/11).

█ highlighted the BEIS statement in relation to the Springfields Fuels Ltd site and █ agreed to look into the evidence to support this statement and send it to █

█ to send, to █ the evidence to support the BEIS statement in relation to the Springfields Fuels Ltd site (Action 8/11).

Following discussion, it was agreed that █ would enquire about the underlying foundation geology of the Heysham 1 and 2 AGRs and communicate this to █ for inclusion in the paper.

█ to enquire about the underlying geology of Heysham 1 and 2 AGRs and send to █ for inclusion in the fracking paper (Action 9/11).

█ took notes during the discussion and noted the following additional points to be

considered and included in the update to the fracking paper. They are listed here:

- [REDACTED] commented very positively on the usefulness of the reference list as a valuable resource; this reinforces the decision not to include references from very grey literature that the reader could not easily access from journals or the Internet.
- Chapter 2 to become 'Earthquakes and Hydraulic Fracturing', with new Section 2.1 providing an introduction to the fundamentals of earthquake genesis and characterisation.
- Move current Sections 3.2 and 3.3 to become new Sections 2.4 and 2.5
- Chapter 3 to become 'Fracking-Induced Earthquakes in the UK', with new Section 3.1 on natural (tectonic) seismicity in the UK and Section 3.2 on induced seismicity in the UK.
- Discussion of Mmax in the UK to bring in additional aspects of depth including typical depths of fracking injections, depth of the basement, the possibility of large downward propagating ruptures, the likelihood of large undetected ruptures near the surface, etc.
- Discussions on Mmax to also note the nature of random samples from small sets of observations and how these can easily exceed predictions from a Poisson distribution (use [REDACTED] plots of recurrence data from PNR1z).
- In relation to Mmax, the ONR criterion of 10^{-7} AFE for exclusion of hazards may be noted.
- Add references to Empirical Green's Functions to discussion of ground-motion predictions in Section 4.5 for cases of induced seismicity (require mainstream references)
- In Section 5.2 important to discuss that TLS 'red' lights lead to different responses in different environments (e.g., 18-hour suspension in UK, closure in Alberta).
- In Section 5.3 it should be noted most prohibitions of fracking have been related to concerns regarding water quality and climate change rather than seismicity.
- At the end of Section 5.4, it needs to be noted that the 500m buffer zone proposed in Yorkshire was related to noise, air pollution, etc., and not seismicity.
- In Section 6.1, useful to obtain more information on recent fracking-related earthquakes in China and, if available, some details on the damage caused.
- Liaise with [REDACTED] to update Figure 6.7 and note specifics of normalisations with respect to space and time (and the sensitivity of the curves to these choices).
- Include geological maps showing shale gas bearing deposits (see example below); note that it is forbidden to frack in deposits shallower than 1 km in the UK.
- In Section 6.3, it would be useful to expand on the discussion of Springfields using all of the available information.
- In Section 6.3, it should be possible to establish the ground conditions at Heysham ([REDACTED] to seek out available information).
- In Section 6.3, expand discussion of rationale for the earthquake scenarios.
- In Section 6.3, consider adding some text about margin between seismic design levels and seismic capacity (as proven at North Anna, Fukushima, etc.).
- In Section 6.3 we could add citation of the response formulated by ONR to an FOI request regarding fracking and HPC.
- Clarify and substantiate the statements regarding fracking operations being low-volume, short-duration processes compared with other anthropogenic activities

causing seismicity (report hours/stage and weeks/frack, and volumes/rates of injection).

After discussion, everyone agreed that, despite the Government announcement, the fracking paper should be progressed to incorporate the comments and feedback received so far, together with the feedback at the meeting. Following the publication of the new studies commissioned by OGA, which are anticipated to be released by mid-2020, the paper will be issued as a full draft. The paper will be reviewed in series by [REDACTED] followed by OGA and ONR.

[REDACTED] and [REDACTED] to update the fracking research paper to include all comments and feedback already received and those discussed at the EP meeting - for summer 2020 (Action 10/11).

7. UK Seismicity and non regulatory work

[REDACTED] invited [REDACTED] to deliver [REDACTED] presentation on the work BGS has been engaged in to update the UK seismic hazard map. [REDACTED] explained that the previous map had been produced in 2007, and following significant advances in the methodology for PSHA and ground motion characterisation, an update was necessary. [REDACTED] concluded that the hazard in the UK region is low to moderate and that the differences in the maps from 2007 to present is more pronounced at long return periods – [REDACTED] thought this may be due to epistemic uncertainties being better captured in the recent model than in the MS07 model. [REDACTED] also reported that the highest hazard was observed in Snowdonia. [REDACTED] added that they had received valuable feedback and many comments from reviewers, and that they are in the process of working through them to produce a final version of the hazard map and report. [REDACTED] reported that most of the extra work following the feedback should be completed by March 2020, and it would be presented at a SECED meeting next year.

Following on from this, [REDACTED] provided an update on the seismicity induced by the Preston New Road (PNR) shale gas operations near Blackpool. [REDACTED] showed a map of the macroseismic intensities collected following the 2.9ML induced event on 26 August and added that this was the largest event to be recorded, so far. [REDACTED] explained that it occurred after the operations had been suspended by OGA on the 24th August. There were over 2000 felt reports with a maximum intensity of 6. [REDACTED] also reported on the seismicity sequence near Newdigate, Surrey which was, at first, thought to be induced by nearby operations but, after installing a network of seismometers last year, they found that the alignment of the earthquake epicentres suggested that they had occurred on a regional fault within the basin which is favourably oriented with respect to the regional stress field. [REDACTED] also appraised the meeting of the United Downs Deep Geothermal Project (UDDGP) in Cornwall. [REDACTED] explained that they were planning to exploit the permeability of the Porthowan Fault Zone and have drilled two wells at 2.5km for injection and 4.5km for production. In total, some 18 seismic stations have been installed to monitor the operations. [REDACTED] also reported that BGS had been involved in work to look at induced seismicity events in relation to a Geological Disposal Facility. In addition, [REDACTED] also reported that, in collaboration with the University of Bristol, BGS was part of a project called Equipt4Risk: Solid Earth. [REDACTED] thanked [REDACTED] for [REDACTED] presentations.

8. Items for Research

No items were raised.

9. FOI Requests

No items were raised. However, [REDACTED] reminded everyone that all communications are subject to FOI requests and that everyone should be aware of this when sending emails.

10. AOB

No issues were raised

[REDACTED] thanked everyone for attending and closed the meeting.

[REDACTED]
30 December 2019

Appendix AGENDA**DATE:** 13-14 November 2019**VENUE:** ONR, Redgrave Court, Merton Road, Bootle, UK**OBJECTIVES**

- TAG13 – Proposed revisions
- Review developments in Relevant Good Practice (RGP) and ideas for future research
- Review and discussion of the Expert Panel Research Paper on Fracking
- Review of generic and site-specific project work

ATTENDEES:

Serial	Timing	Item Description	Introduced
Wednesday 13th November – Room 6.1.31			
	13:00 – 13:30	Lunch	
1	13:30 – 13:40 13:30 – 13:40	Introduction Review of agenda and welcome	■
2	13:40 – 15:30 13:40 – 13:55 13:55 – 14:45 14:45 – 14:55 14:55 – 15:10 15:10 – 15:30	RGP and Guidance: TAG13 and Expert Panel Paper TAG13 – Summary of progress and future revision Proposed revisions for discussion IAEA DS507 – Update RGP developments Open discussion including Capable Faulting	■ ■ ■ ■ ■ ■
	15:30 – 15:45	Tea	
3	15:45 – 17:30 15:45 – 16:05 16:05 – 16:25 16:25 – 16:45 16:45 – 16:55 16:55 – 17:05 17:05 – 17:15 17:15 – 17:20 17:20 – 17:30	Project Work - Seismic Hazard Summary of Bradwell B Progress - Overview and progress - Progress with Capable Faulting - Future Panel work Summary of Sizewell C Progress - Overview and progress - Highlights from the site visit Progress on other projects - EDF Seismic Hazard Work - Sellafield Seismic Hazard Work - Update -Hinkley Point C, Wylfa and GDF	■ ■ ■ ■ ■ ■ ■ ■ ■ ■

4	17:30 – 18:00	General Panel Business	■ All
	17:30 – 17:50	Future Plans – contract extensions and projected work to March 2022	
	17:50 – 18:00	Discussion	
	18:00	Close	

Serial	Timing	Item Description	Introduced
Thursday 14th November – Room 6.1.29			
5	08:45 – 09:00	Introduction	■
	08:45 – 09:00	Review of agenda and welcome	
6	09:00 – 12:30	Expert Panel Research – Fracking	■ All
	09:00 – 10:45	Fracking Paper – Developments [1]	
	11:00 – 12:30	Discussion	
	10:45 – 11:00	Tea	
	12:30 – 13:00	Lunch	
7	13:00 – 14:00	UK Seismicity and non regulatory work	■ ■ ■ All
	13:00 – 13:20	Update on significant events and UK research developments	
	13:20 – 13:40	Eurocode 8 seismic hazard map project update	
	13:40 – 13:50	BGS CG – Customer and Industry feedback	
	13:50 – 14:00	Discussion	
8	14:00 – 14:10	Items for Research	All
9	14:10 – 14:20	FOI Requests	■
10	14:20 – 14:30	AOB	All
	14:30	Close – Please note this may be extended owing to item 6, and travel plans should be flexible to allow for this	

PAPERS

[1] Expert Panel Research – Fracking Paper