**To:** [redacted].[[redacted]@provinciegroningen.nl]; [redacted]@noorderzijlvest.nl'[[redacted]@noorderzijlvest.nl]; [redacted].[[redacted]@provinciegroningen.nl]; [redacted]@slochteren.nl'[[redacted]@slochteren.nl]; [redacted]@delfzijl.nl'[[redacted]@delfzijl.nl]; [redacted]'[[redacted]@provinciegroningen.nl]; [redacted]@groningen.nl'[[redacted]@groningen.nl]; [redacted]@vrgroningen.nl'[[redacted]@vrgroningen.nl]; [redacted]@gemeente-oldambt.nl'[[redacted]@gemeente-oldambt.nl]; [redacted] ([redacted]@vrgroningen.nl)'[[redacted]@vrgroningen.nl]
**From:** [redacted]
**Sent:** Fri 4/13/2018 1:04:55 PM
**Subject:** RE: NAM rapport aanvulling HRA nov. 2017

Ook te groot.
Dan graag via de site downloaden als je het wilt lezen.
[redacted].

**Van:** [redacted]
**Verzonden:** vrijdag 13 april 2018 15:04
**Aan:** [redacted].; [redacted]@noorderzijlvest.nl' ; [redacted].; [redacted]@slochteren.nl; [redacted]@delfzijl.nl; [redacted].; [redacted]@groningen.nl; [redacted]@vrgroningen.nl' ; [redacted]@gemeente-oldambt.nl; [redacted] ([redacted]@vrgroningen.nl)
**Onderwerp:** NAM rapport aanvulling HRA nov. 2017

Beste mensen,
Zojuist ontdekt op de NAM-site. Op het "nieuws" op de NAM-site staat nog niets over deze rapporten. En ik vermoed dat ze ook nog t.b.v. het aanstaande instemmingsbesluit mogelijk aangepast gaan/moeten worden.
Die van maart heb ik niet meegezonden (extreem groot).
https://www.nam.nl/feiten-en-cijfers/onderzoeksrapporten.html#iframe=L2VtYmVkL2NvbXBvbmVudC8/aWQ9b25kZXJ6b2Vrc3JhcHBvcnRlbg==

## april 2018

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**Seismic risk assessment for a selection of seismic risk production scenarios for the Groningen field**

Dit is het rapport 'Seismic risk assessment for a selection of seismic risk production scenarios for … Lees meer

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## maart 2018

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**V5 Ground-Motion Model (GMM) for the Groningen Field - Re-issue with Assurance Letter**

The update of the Ground Motion Predion method in 2017. This report also contains the assurance letter.

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<u>Samenvatting van aanvulling HRA:</u>

**Summary**
In the Hazard, Building Damage and Risk Assessment of November 2017 (Ref. 1), the seismic risk for a 24 Bcm/year production scenario was presented. In the current document, using the same workflow and models, the seismic risk for a larger set of theoretical and feasible production scenarios is assessed. This study started in December 2017 and was finalised in the last week of March 2018.
The feasible production scenarios are based on the Regeerakkoord (Ref. 2) and studies performed by Gasunie Transport Services (GTS) (Ref.3 and 4) and therefore also address security of supply. Starting with the production scenario of the Regeerakkoord, seismic risk for subsequently lower production scenarios is assessed. The production scenario directly impacts on the Local Personal Risk (LPR) people in Groningen experience. The lower the production from the Groningen field, the lower the number of buildings that do not meet the Meijdam-norm (Ref. 5, 6 and 7).
In addition, a number of theoretical production scenarios were analysed to gain basic insights into the seismic risk impact of

sudden production reductions. These scenarios show that an immediate cessation of the gas production reduces the seismic risk such that no or only a minimal number of buildings are expected not to meet the safety norm.

Security of supply considerations require production to continue (Ref. 3 and 4), albeit with a gradual reduction in the gas production. The scenario prepared by GTS whereby imported high calorific gas is blended with nitrogen to Groningen gas quality is called the "Max Import scenario". A lower demand for Groningen gas can be achieved by a higher utilisation of the existing nitrogen blending plant (from 85% to 100%), addition of a new gas blending plant or a more ambitious transition away from Groningen gas to other energy sources.

For each of these scenarios, the seismic risk impact was assessed. In the Max. Import scenario, the decline in production starts in 2021. The decline gradually reduces production until production is ceased in 2030. The reduction in risk is therefore not felt in the coming five years. An additional nitrogen blending plant can be on-stream in 2022 (Ref. 3) and allows production of Groningen gas to be reduced by 7 Bcm/year in one step. Combined with a more ambitious phasing out of Groningen production, local personal risk is for almost all buildings reduced to within the Meijdam-norm.

In this report NAM has not looked at the impact a reduction in production from the field has on Security of Supply as the decision-making, balancing these options to improve seismic risk for the Groningen community with impact on Security of Supply, is the responsibility of the Minister of Economic Affairs and Climate (EZK).

<u>De door NAM nu gebruikte referenties:</u>

**References**

1 Induced Seismicity in Groningen Assessment of Hazard, Building Damage and Risk – November 2017, NAM (Jan van Elk and Dirk Doornhof), November 2017.

2 Vertrouwen in de toekomst, Regeerakkoord 2017 – 2021 VVD, CDA, D66 en ChristenUnie, Section 3.3 Gaswinning, 10th October 2017.

3 Advies Groningen-gasveld n.a.v. aardbeving Zeerijp van 8 januari 2018, Staatstoezicht op de Mijnen, 1st February 2018.

4 Optimisation of the distribution of production over the Groningen field to reduce Seismicity, Leendert Geurtsen and Per Valvatne, December 2017.

<u>Inleiding 2de rapport:</u>

**1. Introduction**

Following the magnitude ML 3.6 Huizinge earthquake in August 2012, NAM has engaged in a major endeavour of data acquisition and model development to quantify the risk due to induced earthquakes in the Groningen field. A core component of the model for risk estimation is a ground-motion model (GMM) for the prediction of parameters characterising the shaking at the surface due to each earthquake scenario considered. The Groningen GMM has been developed in successive stages, with the work beginning in the first half of 2013 when a very preliminary model was produced for the 2013 Winningsplan. Subsequently, over a period of four years, a much more sophisticated model has been developed in five successive and iterative stages, culminating in the V5 model presented in this report. The derivation of the previous four versions of the model were all documented in great detail in reports that collectively have a total length of 1,845 pages, supported by numerous other documents of even greater length presenting the underlying data collection activities to characterise the near-surface soil profiles across the Groningen field and the database of ground-motion recordings that have underpinned the model development. Additionally, several papers on different aspects of the model development process have been published in peer-reviewed journals. In view of the extensive documentation already available, this report presents a more succinct overview of the V5 model, presenting a summary of the model and brief narration of the modifications with respect to the V4 model, referencing earlier reports and published papers to guide the reader who seeks more detailed information. Chapter 2 presents an overview of the evolution of the GMM for Groningen, including the incremental differences at each stage of development and most specifically the modifications of the V4 model included in the V5 model. The key features of the model are then explained in three sequential chapters: Chapter 3 presents the model for spectral accelerations and peak ground velocity (PGV) at the NS_B reference rock horizon; Chapter 4 presents the site amplification factors that transfer the rock motions to the ground surface; and Chapter 5 presents the model for durations. Chapter 6 summarises the complete guidance for implementing the GMM in terms of the logic-tree structure and the sampling of the variance components; for the user looking for a concise summary of the model without explanation of its derivation, this is fully self-contained in the sixth chapter. The report concludes with a brief discussion of the applicability of the current model and potential future developments. In order to keep the main body of the report to an accessible length, additional information and plots are presented in 10 appendices. The first of these presents the credentials of the members of the international review panel and also includes the closing letter issued by this panel at the conclusion of their review of the V5 model as presented in the first version of this report. Appendix II presents the recordings obtained during the Slochteren earthquake of May 2017, which were added to the database for the V5 model development. Appendix III provides more detail of the final model for component-to-component variability. This is presented as an Appendix because while it represents a substantial advance with respect to how this component of variability was represented in earlier versions of the model, it is a fairly minor component of the model. Moreover, this appendix includes analyses conducted in response to the review panel comments on the V4 model regarding the potential influence of the instrument orientation on the component-to-component variability. In order to keep the main body of the V5 report as succinct as possible, this material is included in an appendix. The following three appendices contain diagnostic plots to illustrate the performance of the V5 model: Appendix IV presents plots of median predictions in terms of response spectral accelerations at the NS_B horizon; Appendix V compares the NS_B to surface amplification factors calculated for the recording stations with the linear factors assigned to the zones in which they are located; and Appendix VI presents the residuals of the surface recordings with respect to the model predictions. Appendix VIII presents the recordings from a significant earthquake—the third largest in the history of the Groningen field and the largest since the Huizinge earthquake of 2012—that occurred after the V5 model was completed and implemented. Simple comparisons are made between the V5 model predictions and the motions recorded during this earthquake. Finally, Appendices IX and X present the full suite of review comments from the international expert panel on the V4 and V5 models, respectively, together with the complete set of responses from the GMM development team. In this way, there is full disclosure of the detailed review process that the model has undergone.

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