

Delibera n. 36/2021 02 Marzo 2021 Allegato P al Verbale n. 01/2021

Oggetto: Amendment to Cooperation Contract no. 3000-5920053348 by EDF and by INGV.

IL CONSIGLIO DI AMMINISTRAZIONE

VISTO il Decreto legislativo 29 settembre 1999, n. 381, concernente la costituzione dell'Istituto Nazionale di Geofisica e Vulcanologia (INGV);

VISTO il Decreto Leg.vo 25/11/2016, n. 218, concernente "Semplificazione delle attività degli Enti Pubblici di Ricerca ai sensi dell'art. 13 della Legge 7/08/2015, n. 124";

VISTO lo Statuto dell'INGV, approvato con Delibera del Consiglio di Amministrazione n. 114/2020 del 19 giugno 2020, emanato con Decreto del Presidente n. 78/2020 del 27/10/2020, pubblicato sul Sito WEB istituzionale – Avviso di emanazione di cui al Comunicato su Gazzetta Ufficiale della Repubblica Italiana - Serie generale - n. 264 del 24 ottobre 2020, in particolare, l'art. 8, comma 6, lettera f), il quale prevede che il CdA "omissis....delibera la partecipazione a società, fondazione e consorzi, nonché la stipulazione di accordi con organismi nazionali, europei e internazionali";

VISTO il Regolamento di Organizzazione e Funzionamento dell'INGV, emanato con Decreto del Presidente n. 36/2020 del 22/04/2020, pubblicato sul Sito WEB istituzionale e in particolare, l'art. 29 il quale disciplina le *Collaborazioni con soggetti esterni*, stabilendo al primo comma che: "I rapporti di collaborazione nell'attività di ricerca tra l'Ente e soggetti pubblici e privati, italiani e stranieri sono regolati attraverso contratti aventi come riferimento di massima la seguente tipologia: protocolli d'intesa, accordi di programma quadro, convenzioni operative";

VISTO il Regolamento del Personale emanato con Decreto del Presidente n. 118/2018 del 14/5/2018, pubblicato sul Sito WEB istituzionale;

VISTO il Regolamento di Amministrazione, Contabilità e Finanza, adottato con Delibera del Consiglio di Amministrazione n. 145/2020 del 22 luglio 2020, ed emanato con Decreto del Presidente n. 75/2020 del 21 ottobre 2020;

VISTO lo schema dell'Amendment to Cooperation Contract no. 3000-5920053348 by EDF and by INGV;

RITENUTO opportuno per l'INGV procedere alla sottoscrizione del predetto Amendment, che intende regolare le nuove esigenze di ricerca congiunta emerse nell'ambito del Progetto europeo SIGMA2;

CONSIDERATO che tale accordo intende proseguire gli studi sui modelli di ground motion utilizzabili nel contesto italiano e francese, focalizzando le



attività**n** sulle componenti verticali e su parametri energetici di scuotimento da correlare al danneggiamento;

VALUTATA, dunque, l'opportunità di procedere alla sottoscrizione del sopra citato Amendment to Cooperation Contract, che ha l'obiettivo di garantire il diritto di accesso e di utilizzo dei beni e servizi informatici;

VISTO il parere favorevole del Direttore di Sezione e del Direttore di Dipartimento;

su proposta del Presidente,

DELIBERA

L'approvazione dello schema dell'Amendment to Cooperation Contract no. 3000-5920053348 by EDF and by INGV, allegato alla presente quale parte integrante e sostanziale (all.1).

Viene dato mandato al Presidente dell'INGV alla sottoscrizione definitiva dell'atto in questione.

Firmato il 15/03/2021 Depositato presso la Segreteria del Consiglio in data 15/03/2021

La segretaria verbalizzante (Dott.ssa Maria Valeria INTINI)

IL PRESIDENTE (Prof. Carlo DOGLIONI)

AMENDMENT TO COOPERATION CONTRACT NO. **3000-5920053348**

For a research programme carried out jointly by EDF and by INGV

As stated in Article 3 of the cooperation contract no. 3000-5920053348, due to new requirements which emerged during the development of the Research Programme, the Parties jointly agree to modify the Research Programme by adding a new research task. The present AMENDMENT to the COOPERATION CONTRACT NO 3000-5920053348., entering as effective as of February 28, 2021, is made between EDF and the INGV.

It concerns the technical content of the cooperation, the duration and the overall cost of the research Programme. As a consequence new deliverables are planned accordingly to a new schedule.

All the other terms and conditions of the original cooperation contract apply.

- 1. **TECHNICAL CONTENT**. Due to new requirements which emerged during the development of the Research Programme, the Parties jointly agree to modify the Research Programme by adding a new research task, with the purpose of performing research and development on the following topic: "Characterization of the ground motion in the near-source condition for moderate-to-large magnitudes", related to the initial scope. The attached technical appendix describes in detail the scope of the work and the additional tasks to be performed.
- 2. **DURATION OF THE RESEARCH PROGRAMME**. The Modification of the Research Programme induces a modification in its duration. The initial Term for the Cooperation Contract was December 31, 2020. The Modification of the Research Programme need to extend this Term of 38 months. The new Term for the Cooperation Contract becomes February 28, 2024.
- 3. **COST OF THE RESEARCH PROGRAMME**. The cost of the modification of the Research Programme is modified such that EDF additional financial contribution is of 95 000 € ex VAT. For the whole Research Programme (including the amendment), EDF will pay INGV a fixed financial contribution of 170 000€ ex VAT. EDF's total contribution becomes therefore 194 000€ ex VAT (including EDF man-power contribution), as summarized in the Financial appendix.
- 4. **LOGISTICS, DELIVERABLES AND PLANNING**. Details on the deliverables and planning are attached in the financial Appendix.
- 5. **REMUNERATION TERMS**. The payment of EDF's financial contributions will be made in 4 additional instalments at the end of the Research Programme. The new schedule for the coming instalments is the following:

30 000 € on February, 2021 (at the moment the amendment enters as effective)

25 000 €, on January 2022 (after the receipt by EDF of the corresponding deliverable, as defined in the technical appendix)

25 000 € on February 2023 (after the receipt by EDF of the corresponding deliverable, as defined in the technical appendix)

15 000 \in , on February 2024 (after the receipt by EDF of the corresponding deliverable, as defined in the technical appendix)

	Yves BOUTTIER Head Manager of DI-TEGG Department (EDF – DIPNN – DI – TEGG)	
INGV		
Date :	Date :	
Date :		

Technical and Financial Appendices

Technical appendix

Characterization of the ground motion in the near-source condition for moderate-to-large magnitude earthquakes

1. SCIENTIFIC MOTIVATION AND GOALS

In modern seismic codes (e.g. EC8 for Europe, NTC18 for Italy), seismic actions for design of conventional buildings are prescribed in terms of the horizontal components of ground motion and represented by response spectra. For design and verification of nuclear facilities in France, nuclear regulation also prescribes to define seismic actions as response spectra for vertical components of ground motion.

The vertical seismic action is usually derived from the horizontal one, applying a scaling factor, known as the vertical-to-horizontal spectral ratio. In the seismic codes, this factor is assumed equal to 2/3 regardless of the period and the considered seismic scenario.

To predict the horizontal response spectra, the most common approach is to adopt empirical Ground Motion Models (GMMs) that provide the probability distribution of expected shaking, as a function of a small number of explanatory variables, such as magnitude, distance, focal mechanism, and site conditions. However, available empirical GMMs are calibrated using regional or global ground motion data sets, usually dominated by far-field recordings. Then, given the complexity of the phenomena occurring close to the seismic source, the predicted response spectra may not be suitable for representing the characteristics of ground motion in epicentral areas; this deficiency may be particularly critical with respect to the vertical component of ground motion. As a consequence, median predictions from classic GMMs are often unable to reproduce such near-source effects, which go instead to the aleatory uncertainties of the models. Moreover, the damaging potential of near-field ground motions on buildings and critical facilities is still poorly understood.

The overall objective of the Research Programme is to improve the understanding and the characterization of the ground motion in the near-source condition for moderate-to-large magnitudes. The characterization of appropriate ground motion parameters will allow to investigate the damaging potential of these ground motions on buildings and critical facility structures.

To achieve these goals, in addition to the classical ground motion parameters used in earthquake engineering, i.e. peak values and spectral ordinates, the study will be extended to describe other intensity measures, such as Fourier spectra and integral parameters related to the energy content of seismic signals, i.e. Housner intensity (Housner, 1952) Arias intensity (Arias, 1970), significant-duration (Trifunac and Brady, 1975), CAV (Reed and Kassawara, 1988). Complementary to the classical horizontal components, particular attention will also be given to the vertical component of ground motion, which has regained only recently the interest of the earthquake engineering community.

The research activity will make use of both, recorded and simulated waveforms from epicentral areas. Real records are provided by worldwide and regional strong motion datasets, such as NESS (http://ness.mi.ingv.it/) and NGA-WEST2 (peer.berkeley.edu/ngawest2) for global events and ESM, ITACA and RESIF (Traversa et al., 2020) for Italy and France. In collaboration with Politecnico of Milano (Prof.

Smerzini) the simulated waveforms are based on archives of 3D physics-based broadband simulations developed using the code SPEED (<u>http://speed.mox.polimi.it/</u>) for specific regions in Italy and France.

Different strategies will then be explored in order to address the prediction of epicentral seismic shaking. The first strategy consists in introducing corrective factors in available GMMs, applicable for the specific region under study. Several examples can be found in the literature, such as Sgobba et al. 2020 for pulse-like motions and references therein. In particular, to provide more accurate estimates of the expected ground motion in Italy and France, such correctives should take into account for the seismotectonic peculiarities, as well as seismic wave attenuation and local response of the regions under study.

The second consists in developing novel empirical ground motion models (GMM) based on near-source ground motion data, obtained from real and simulated events.

2. MAIN SCIENTIFIC TASKS

- Developing novel empirical ground motion models (GMM) for the Vertical-to-Horizontal (V/H) ratio of various intensity measures, such as acceleration response (5% damping) and Fourier ordinates, Peak Ground Acceleration and Velocity, usable for Italy and France regions;
- 2. Calibrating horizontal median corrective factors (and associated standard deviations) of existing empirical GMMs for near-fault conditions and various intensity measures, also for moderate earthquakes, employing the dataset of task #1;
- 3. Developing novel empirical ground motion models (GMM) for the horizontal and Vertical-to-Horizontal (V/H) ratio of integral parameters (Arias, Housner, CAV) and duration, usable for Italy and France regions;
- 4. Collection of simulated broadband accelerograms fully compatible with the seismic observations in collaboration with Politecnico di Milano;
- 5. Developing hybrid ground-motion models for various ground motion parameters, using both, observed and synthetic waveforms, representative of the peak parameters and the energetic content of the ground motion, with particular focus onto Italian and French regions;
- 6. Conditioned on the results of other ongoing research actions, aimed at developing new ground motion parameters representative of the damaging potential of the shaking on critical facilities structures, estimate of such new parameters, allowing to assess the effective damage potential of near-source ground motions on critical facilities.

3. WORKING PROGRAM

3.1 V/H model (first year)

Recent approaches to assess vertical component of ground motion propose the calibration of ground motion models for the spectral ratio between the vertical and the horizontal components of the motion, named V/H. However, existing state-of-the-art on V/H models neglect the issues related to near-source effects.

In the first year, we plan the following activities:

- Development of a new V/H GMM for spectral ordinates, using Italian and French strong motion data of crustal shallow events. In the development of the model, we will investigate the scaling of the V/H ratio for spectral acceleration, with respect to the explanatory variables and, in particular, to the site condition;
- Comparison of the calibrated model with some worldwide models and the European technical norms;

- Extension of the V/H model for near-source condition, evaluating the residuals (observation minus predictions) with respect to a near source strong ground motion dataset and estimating a corrective factor for Italy and France;
- Application of the model plus the corrective terms to reproduce observed records of given scenarios in Italy and France;
- **3.3 GMM** models for Peak and permanent displacement, FAS, Housner, Arias, duration parameters (second year)
- Development of a V/H GMM for Fourier Amplitude Spectra (FAS) ordinates, Housner, Arias and duration, consistent with those predicted for spectral acceleration (Year 1); if the GMMs for the horizontal components are not available, these models will be calibrated consistently with the V/H component;
- Comparison of the calibrated model with some worldwide models;
- Extension of the horizontal and V/H GMM models for near-source conditions for the additional intensity measures following the approach of the first year of the project;

3.4 Hybrid GMM for IMs (third year)

- Construction of a dataset of synthetic accelerograms in a format consistent with that of earthquake recordings, using stochastic and 3D physics-based simulations developed using the code SPEED (http://speed.mox.polimi.it/) for specific regions in Italy and France.
- Preparation of a hybrid flat-file composed by of recorded and synthetic waveforms;
- Calibration of a hybrid GMM for horizontal and V/H components for France and Italy, considering the same set of intensity measures investigated in first and second years;
- Comparison between empirical and hybrid models in terms of predictions and standard deviations;

Financial appendix

1. LOGISTICS, DELIVERABLES AND PLANNING

The work will be carried out in cooperation among INGV-Milan and EDF. The main manpower will be provided by a PhD student.

The total duration of the Amendment to the Cooperation Contract is 36 months. The additional financial contribution by EDF is 95 000 €.

The work produced within the Research Programme will make the object of scientific publications. Two publications will be founded by EDF in addition to the total cost.

The following table summarizes the main tasks and deliverables specifically related to this amendment, which are added after the instalments planned in the original cooperation contract:

Type of deliverable*	Submission date of the deliverable	Value of the corresponding payment (Euros)
Starting meeting (deliverable : MoM)	February 28, 2021	30 000
Deliverable: report and V/H model for near- source condition.	January 30, 2022	25 000
Deliverable : Ground motion models for different ground motion parameters for near-source condition	February 28, 2023	25 000
Deliverable : Hybrid ground motion models for different ground motion parameters for near-source condition – final report	February 28, 2024	15 000

Table 1 Schedule and payments

The following table summarizes the overall expenditure for the Cooperation Contract, including the present Amendment.

Item of expenditure or income	Cost prices in euros (ex VAT)
Expenditure specific to EDF	
Labour	21 000
Purchases	
Taxes	
Depreciation	
Test resources	
Transport and travel	3 000
Other	
Payments from EDF> INGV	170 000
TOTAL expenditure (D1)	194 000
Income	
Payments from INGV> EDF	0
TOTAL income (R1)	0
TOTAL contribution EDF F1=D1-R1	194 000
Expenditure specific to INGV	
Labour	132 000
Indirect costs	22 000
Transport and travel	12 000
Hardware	4 000
Co-financing (INGV staff labour and overheads)	70 000
Payments from INGV>EDF	0
TOTAL expenditure (D2)	240 000
Income	
Payments from EDF> INGV	170 000
TOTAL income (R2)	170 000
TOTAL contribution INGV F2=D2-R2	70 000
Overall cost of the programme C=F1+F2	264 000
Percentage of financing paid for by EDF P1=F1/C	73 %
Percentage of financing paid for by INGV P2=F2/C	27 %

Table 2 Overall cost of the Research Programme, including the amendment