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Multi-risk assessment of L'Aquila gas distribution network

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This study focuses on the assessment of seismic risk for gas distribution networks. The basic function of a gas system is to deliver gas from sources to costumers and it is essentially composed of pipelines, reduction stations, and demand nodes, which are connected to end users to which the lifeline delivers gas. Because most of the components are spatially distributed and buried, seismic hazard has to account for both spatial correlation of ground motion intensity measures and effects induced by permanent ground deformation such as liquefaction and landslide, which determine localized ground failure. Different performance measures are considered in the study for the network, in terms of connectivity and flow reduction. Part of the gas distribution network operating in L'Aquila (central Italy), operated by ENEL Rete Gas spa has been chosen as case study. The whole network is distributed via a 621 km pipeline network: 234 km of pipes operating at medium pressure and the remaining 387 km with gas flowing at low pressure; it also consists of Metering/Pressure reduction stations, Reduction Groups and demand nodes.

The framework presented makes use of probabilistic seismic hazard analysis, both in terms of ground motion and permanent ground deformation, empirical relations to estimate pipeline response, fragility curves for the evaluation of reduction cabins vulnerability, performance indicators to characterize the functionality of the gas network. The analysis were performed through a computer code specific for risk assessment of distributed systems developed by the authors. Probabilistic hazard scenarios have been simulated for the region covering the case study considering the Paganica fault on which L'Aquila 2009 earthquake was originated as source. The strong motion has been evaluated using an European ground motion prediction equation and an associated spatial correlation model. Regarding geotechnical hazards the landslide potential of L'Aquila region, according to HAZUS procedure has been performed. System's vulnerability has been performed through fragility curves available in literature, the use of which was validated via the analysis of damages following the 2009 L'Aquila earthquake. In order to study the effects of different components on risk assessment, different combinations have been identified. In particular the importance of modelling spatial correlations of ground motion and geotechnical hazard on risk assessment evaluation has been investigated. Results indicate that the system loss may be underestimated when spatial correlation and ground failure effects are ignored.