
***URBAN AND REGIONAL SEISMIC RISK STUDIES. APPLICATION
TO LIFELINES (NATURAL GAS SYSTEM AND OIL SYSTEM)***

Author: Carlos Alberto Utrillo Sentís

Tutors: Nieves Lantada Zarzosa and Lluís G. Pujades Benet

ABSTRACT

This study is a seismic risk analysis of gas, oil and ethylen systems in Catalonia and the gas system in Barcelona municipality using a method based on the HAZUS'99 program, by the Federal Emergency Management, FEMA. This method has an easy application and is convenient to evaluate seismic risk in three basic aspects like expected damage, post-earthquake operativity and reposition cost.

A geographic information system is used to manage data. It allows a quick and easy information management and a good data and results representation.

Catalonia is a moderate to low seismic hazard region. The seismic scenario used, for a 500 year return period, incorporates soil amplification effects and the maximum intensity expected is VIII MSK. Furthermore, possible liquefaction phenomena, assigning a liquefaction susceptibility to each one of the litologies from the catalonian geologic map, and the effects of active faults have been considered as well. Barcelona city also is considered a moderate to low seismic hazard region, with VII-VIII MSK maximum expected intensities and also liquefaction phenomena.

Damage in catalonian gas, oil and ethylen systems is none or minor. The most affected pipelines, with 15 repairs, are 12-16 MPB transport system gas pipelines. Barcelona, La Roca, Sant Celoni, Caldes de Malavella, Manlleu, Torelló, Ripoll, Besalú i Argelaguer are the most probable municipalitites where a leak or a break can take place. There is no damage in the ethylen system due to the fact that the pipeline goes along a low seismic hazard region. 3 leaks take place in the oil system, 2 in TA-BA-GE pipeline and one in TA-LE-ZA pipeline. There won't be breaks due to fault movements because the recurrence periods are much larger than the considered scenario recurrence period (500 years).

One day after the earthquake, the damaged pipelines' funcionality will be of 15% and it will increase 10 days later to 100%.

Analysis results applied to the stations of the 3 studied systems show none to minor damages. Girona and Barcelona tank farms and Santa Perpètua pumping plant are the most damaged, even with light damage. Banyeres and Tivissa compressor stations, Pallejà pumping plant and the 4 stations located in La Pobla de Mafumet are almost not affected because of their location, in the lowest seismic activity zones. The stations' funcionality 1 day after the earthquake is high because damage is light.

Due to the moderate seismic hazard region where Barcelona is located, damages expected on the natural gas distribution system are not important, supposing arc welded joints. 35 repairs in the whole city are expected. The situation becomes worrying if gas pipelines are made with gas welded joints, with 111 expected repairs. The major number of repairs takes place in Sant Martí and Sants districts, sited in delta deposits, where the seismic intensity is amplified and liquefaction incidents can occur. In the other hand, the less affected districts are those that are sited in minor seismic hazard zones and with few kilometers of gas pipelines: Gràcia, Horta-Guinardó, Les Corts and Nou Barris.

In the event of an earthquake two intensity degrees over the expected for a 500 year return period with the soil amplification effect, would increase 6 times the number of repairs, causing a catastrophic scenario, with 231 repairs in the city (case of having arc welded joints) and nearly 800 (if having gas welded joints).