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REDUCED-SCALE HIGH EXPLOSIVE TESTS: METHODOLOGY FOR TNT EQUIVALENCY DETERMINATION IN FREE-FIELD

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Abstract: Interaction between large blast and targets (infrastructure, vehicles, etc.) can only be rarely directly studied, due to cost and practicality considerations. Blast tests using reduced-scale high explosive (HE) charges represent an attractive alternative to understand the phenomena governing blast propagation. The first necessary step consists in studying blast propagation in free-field at the considered reduced-scales. The second step focuses on the determination of the blast load around various types of reference obstacles, in order to provide a critical input for numerical simulation tools of structure resistance. This approach also aims at building simplified models allowing faster design process for security and safety government agencies.

Since 2017, the French Institute for Radiological Protection and Nuclear Safety (IRSN) and the French-German Research Institute of Saint Louis (ISL) have been studying blast propagation in free-field at two different reduced scales using Hexomax® charges. IRSN developed a significant experience on hemispherical blast effects assessment using 42g reference Hexomax® charges detonated in contact to a planar surface equipped with pressure sensors including two types of technologies: piezoelectric and piezoresistive. Based on this experience, ISL developed an outdoor blast-pad located at its own explosive range: 333g Hexomax® charges can be detonated in a factor two up-scaled version of IRSN test configuration. Similar sensors are flush-mounted inside a metallic rail integrated below the concrete pad surface. In addition, ISL manufactured cast hemispherical TNT charges (400g) to provide a local direct reference for the Hexomax® tests.

Two series of Hexomax® charges (at IRSN and ISL) and one series of TNT charges (at ISL) were detonated at distances between 0.6 and 3.5 $m/kg^{1/3}$. Peak overpressure values were extracted for both types of charges. Two different correlations describing peak overpressure versus scaled distance are proposed for TNT: a classic power fit and a more precise segmented in scaled distances fit. These correlations provided two TNT equivalency evolutions with distance for Hexomax® at both scales. Moreover, another parameter to determine TNT equivalency was evaluated: time of arrival of the blast wave. All Hexomax® TNT equivalencies are finally compared and discussed.

These results represent a critical input to assess blast effects on a potential surrounding structure, especially in close range, where its survival may be misinterpreted, if the resulting effects are lower than predicted.