Determining emission products to which personnel may be exposed, when firing ammunition

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The requirements set for selecting ammunition to be procured are based on e.g. the functioning, lifetime, cost and a more difficult parameter to determine: the potential burden on the environment and human health.

Legislation such as the European REACH is demanding the elimination of chemicals which are toxic to the environment and human health. Unfortunately, personnel is not exposed to the pure ingredients when firing ammunition, but to the combustion products of the mixture of ingredients. From the combustion of materials it is known that this process is influenced to a great extent by the environmental conditions such as temperature, humidity and access to oxygen. This makes it complex to predict the composition of combustion products with the currently available computational models. Also, the influence of the frequency of firing, number of rounds and the setup has a major influence on the final emission when firing ammunition. So the only way to determine at this point in time the composition of emission products that personnel will be exposed to when firing ammunition, is via measurement.

At TNO we have over the years performed various experiments for measuring the combustion products of small caliber ammunition and screening as well colored smokes using a variety of experimental setups. Every sampling and analysis approach and every experimental setup has it pros and cons. This makes it difficult/near impossible to find a “one-experimental-setup- fits-all” setup. Our advice is to adjust the setup to the question to be answered. For example: if one would like to identify the exposure of personnel it is important to measure under real-life conditions with a real-life training protocol. However, if one wants to compare weapon-ammunition combinations it might be better to use an setup where the conditions are controlled, so no influence of ventilation, constant measuring volume, humidity and temperature, same measuring setup and position and same number of rounds and frequency of firing. Keep in mind that the chamber volume might not always contain sufficient oxygen and the final concentrations may not be usable to extrapolate to obtain information regarding exposures of personnel.

It is almost impossible to identify and quantify all components, so the question is which components to focus on. It would be helpful to compose a list of components that are essential to measure, but that is difficult if not all formed components are identified to choose from in order to compile such a list. The gases and inorganic elements are relatively easy to predict, the organic components are very difficult to predict.

Even when the measuring setup is suitable to determine the emitted products, the translation into a real exposure and the health hazards from such an exposure is difficult. A complicating factor is that exposure limits are mostly defined for other exposure conditions and are therefore not applicable as such for military personnel firing ammunition. Another complicating factor is that exposure occurs to mixtures and combinations of chemicals, which is still a rather underdeveloped area in toxicology. These are some of the questions that need to be answered and the potential solutions need to be supported by the military community.