1. **Process Technology of NTO**

Globally, Insensitive Munitions (IMs) class of formulations is being developed over the conventional munitions. Insensitive munitions (IMs) are defined as munitions which fulfill their performance requirement on demand but minimize the probability of unintended initiation and severity of subsequent collateral damage to weapon platforms, logistic systems and personnel when subjected to different types of combat threats. Among the various aspects, development of insensitive explosive compositions is one of the most important requirements for the realization of IM. Munitions based on conventional RDX / HMX based compositions in general do not quantify for IM due to their sensitive nature.

In search of insensitive ingredient for insensitive explosive compositions, NTO has been emerged as best suitable candidate. Its performance is close to RDX and insensitivity is comparable to TATB. Further, it has very good self binding property. The development of IM class of formulations containing NTO as a potential bomb fill in admixture with TNT is being explored world-wide. Different types of melt-cast formulations based on NTO such as PAX, OSX, IMX-101 and IMX-104 etc., have been reported.

Considering the potential scope of NTO in replacing existing nitramine based compositions towards IM applications, High Energy Materials Research Laboratory (HEMRL) has established a cost effective, viable synthesis route for NTO from semicarbazide hydrochloride by a two step process. Though the process has been established in good yield and purity, the morphology of NTO obtained from above process is jagged rods in shape which is not desirable for explosive application. This leads to poor processibility and reduced explosive loading. These morphology issues associated with NTO did not allow its use at full scale in formulations which further necessitated to develop a process for the conversion of non-spherical to its spherical form. To overcome all these hurdles associated with morphology, HEMRL has established a large scale preparation process for spherical-NTO by cooling crystallization. The developed crystallization process has also the capability to prepare specific particle size for deemed applications.

Non-Spherical NTO Spherical NTO