GUDN - A New Ingredient in Insensitive War Heads and Boosters

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The most dominant IM solution for war heads since IM become an agenda more than 30 years ago has been cast cured PBX:es. The idea has been to dilute explosive ingredient in an inert plastic binder, predominantly polyurethanes. The concept has been quit successful in terms of improved insensitivity for the munitions. If we compare with conventional melt cast formulation which where widely used earlier the improvement is drastic. The disadvantage with cast cure has been capacity at least in a global perspective. The melt cast equipment can not be used for cast curing and the investments are high in an industry that has limitations in capital for investments. It is still the case that melts cast equipment exists much more widely than cast cured capacities. It is therefore a surge for melt cast formulations with IM properties.

Another aspect making melt casting more attractive is the problem in the future when cast cured ammunition is to be decommissioned and demilitarized. A melt cast war head is easy to demilitarize. It can heated above the melting point and just poured out in the same fashion it once was filled. The demilitarization is not so easy for a cast cured fill. Since the curing reaction is not reversible such as freezing and melting is. More expensive techniques are therefore needed for PBX filled war heads.

GUDN, Guanylurea dinitramide, synonymous with FOX 12, has been demonstrated to be an extremely insensitive energetic molecule. It does not react in fall hammer and friction tests. So far it has been used as a gas generation component in compositions for air bags due to its excellent burning characteristics. A second reason but equally important is the fact that GUDN already is a scaled up explosive. It is produced in industrial scale and there should therefore be no doubts of its affordability. This is certainly not always true for many new energetic substances.

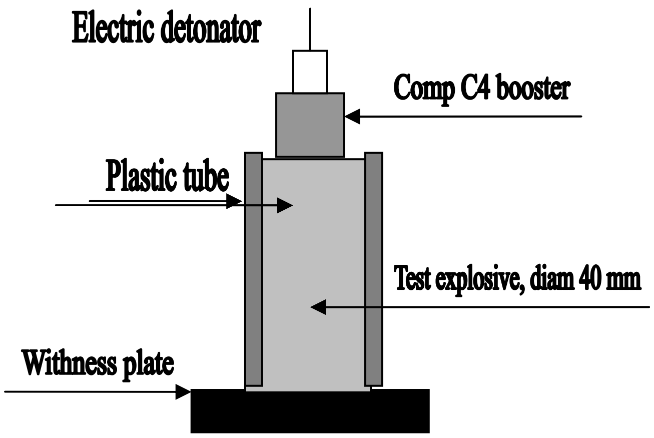
GUDN in TNT

GUDN is a crystalline product. The first approach to introduce GUDN in warheads has been to substitute RDX in hexotol with GUDN. What you get then is a melt cast formulation that could be filled to ammunition in the same way as Composition B. The advantage with this approach is the availability of casting facilities since Composition B has been one of the most widely used war head fills the last fifty years. With the particle sizes we can obtain today we can use up to 60% of GUDN and obtain a good cast. We do believe that we soon will be able to offer GUDN that would allow conventional casting with higher loads of GUDN. The compatibility was confirmed with vacuum stability according to **STANAG 4147.**

155 mm HEER

A composition with 45% GUDN in TNT has been filled into 155 mm HEER shells with the same melt cast technique as is used for composition B. The shells where treated with the same paint as is used for TNT and composition B on the inside to obtain a good adhesion with the fill. The Notch and Drop test (se picture to the right) showed 100 % adhesion compared to TNT fills. This is expected since the adhesion is between the treaded inner wall and TNT in both cases. No Gaps where seen between the wall and the fill and X-Ray also showed that there where no voids in the fill. The density of the fill is 1.XX as compared to 1.xx for composition B. A Burst Yard Test was performed on a 155 mm HEER shell. The result showed a similar or better fragmentation than conventional shells filled with TNT.

Sensitivity tests
A fall hammer (ERL) test was performed on a granulated product with the same composition as was tested in the Bust Yard test. The point of 50% initiation was found to be 25 Joule.
A Minimal Booster Test was made on three different compositions between GUDN and TNT. In this test a booster of C4 with the height the same as the diameter is placed above a cylindrical test charge. The result is the first GO as the weight of the booster is doubled. The picture and the table below shows the experimental configuration and the results we obtained.



45 % GUDN	16 gram GO	(8 gram NO GO)
55	16 gram GO	(4 gram NO GO)
62	64 gram GO	(32 gram NO GO)

As a comparison the value for NO GO for TATB is 4 grams and for a HMX based PBX it is less than 1 gram. In this type of stimuli it is obvious that these compositions are extremely insensitive compared to anything else.

Future work
The composition tested so far has the performance of TNT. By adding aluminum we hope to increase the fragmentation to a level comparable with composition B. Tests will be performed in a near future.
GUDN can also be used in pressable compositions where it is mixed with HMX and a binder.