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IDENTIFICATION OF EXPLOSIVES IN SOVIET WEAPONS

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ABSTRACT

The explosives in the boosters and main charges of 3 Russian ground-air missiles, SA-3, SA-6 and SA-7, were identified.

The techniques used in the identification of the explosives, were commonly known methods such as: TLC (Thin Layer Chromatography), I.R. (Infra Red) Spectroscopy, Chemical Solubility.

Some general data of the identified explosives is given.

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INTRODUCTION

This paper describes the work we did to identify the explosives in some Russian missiles. We will not deal with the structure of the missiles nor with their detonation system. Only their sizes will be given.

The missiles in which we tried to identify the explosives were: SA-3, SA-6, SA-7.

All these 3 missiles are ground-air missiles. SA-7 is a personal weapon and is used by infantery against airplanes. Its size is much smaller than the sizes of the other two and therefore the quantity of explosives in SA-7 warhead is much smaller than in SA-3 and SA-6 warheads.

Generally, the techniques we used in the identification of the explosives, were commonly methods of identification of chemical compounds such as:

1) TLC (Thin Layer Chromatography)
2) I.R. (Infra Red) Spectroscopy
3) Chemical Solubility.

Using those techniques, we were able to identify the various kinds of explosives in the 3 Russian missiles.

SA-3 Warhead

In SA-3 warhead, we found 2 types of explosives:

1. Orange explosive as booster
2. Yellow-brown explosive as main charge.

The orange explosive was a cylinder with the following sizes:

Diameter - 93 mm.

Height - 30 mm.

Weight - 330 gr.

Density - 1.63 gr./cm^3

The explosive looked like a pressed explosive.

The weight of the yellow-brown explosive was 42 kg. and its density - 1.69 gr./cm^3. The explosive looked like a cast explosive.

SA-6 Warhead

The SA-6 warhead contained 4 types of explosives:
In the booster we found 3 types of explosives: a yellow, an orange and a white explosive.

The total weight of the booster explosives was 375 gr. The main charge explosive was a yellow-brown explosive having a weight of 20.3 kg.

The yellow explosive in the booster was a cylinder with the following general data:

O.D. (Outside Diameter)	- 55.5	mm.
I.D. (Inside Diameter)	- 13	mm.
Height	- 35	mm.
Weight	- 120	gr.
Density	- 1.583	gr/cm^3

The orange explosive was found in 2 cylinders having the same sizes as follows:

O.D. (Outside Diameter)	- 55.5	mm.
I.D. (Inside Diameter)	- 27	mm.
Height	- 86	mm.
Weight	- 250	gr.
Density	- 1.609-1.612	gr/cm^3

The white explosive was a powder having a weight of 5 gr.

The weight of the yellow-brown explosive in the main charge was 20.3 kg. and its density was 1.63-1.65 gr./cm^3.

SA-7 Warhead

The booster in SA-7 warhead was a yellow explosive with a weight of 30 gr. The explosive looked like a pressed explosive.

The main charge in SA-7 warhead contained 350 gr. of an orange explosive. This explosive looked also like a pressed explosive.

The yellow explosive in the booster was a cylinder with the following general data:

O.D. (Outside Diameter)	- 62.5	mm.
I.D. (Inside Diameter)	- 6	mm.
Height	- 9	mm.
Weight	- 30	gr.
Density	- 1.613	gr/cm^3

The orange explosive in the main charge was a cylinder with the following general data:

O.D. (Outside Diameter)	- 62.5	mm.
I.D. (Inside Diameter)	- 6	mm.
Height	- 61	mm.
Weight	- 350	gr.
Density	- 1.760	gr/cm^3

SA-3 Warhead

First we tried to identify the orange explosive in the booster. TLC of this material carried out on a plate coated with Silica Gel using as eluent a mixture of Petrol Ether/Acetone - 5/3, showed after spraying with Diphenylamine and U.V. radiation, one violet spot with R_f = 0.38. The conclusion is that the explosive is RDX (in the literature[1]: violet spot - R_f=0.39).

The orange explosive looked like a pressed explosive. Therefore we guessed that it has to contain a binder together with the filler (RDX). We had therefore to identify the binder and also to find the quantitative composition of the orange explosive.

We dissolved a weighted sample in a solution of CCl_4 saturated with RDX. 3% of the sample dissolved. The I.R. spectrum of the residue from the filtrate was identical to the I.R. spectrum of Polyethylene. The undissolved 97% of the sample dissolved completely in acetone. The I.R. spectrum of the residue from the filtrate proved that the material was RDX. Therefore, the composition of the orange explosive is: 97% RDX; 3% Polyethylene; Orange Dye.

To identify the yellow-brown explosive, we performed a TLC analysis. The conditions were the same as mentioned above: a plate coated with Silica Gel and the eluent a mixture of Petrol Ether/Acetone - 5/3. First we obtained one orange spot with R_f = 0.71. After spraying with Diphenylamine and U.V. radiation we obtained one violet spot with R_f = 0.38. The conclusion is that the yellow-brown explosive is a mixture of TNT and RDX (in the literature[1]: TNT - orange spot - R_f = 0.73; RDX - violet spot - R_f = 0.39).

The quantitative composition of the explosive was determined by chemical solubility technique.

A weighted sample of the explosive was dissolved in a solution of CCl_4 saturated with RDX.

20.45% of the sample dissolved. The I.R. spectrum of the residue from the filtrate was identical to the I.R. spectrum of TNT.

The undissolved 79.55% of the sample dissolved completely in acetone. The I.R. spectrum of the residue from the filtrate showed to be an I.R. spectrum of RDX.

Therefore, the composition of the yellow-brown explosive is: 80% RDX; 20% TNT.

This ratio between RDX and TNT in a cast explosive (high amount of RDX) indicating that the explosive was manufactured by an improved casting technique.

SA-6 Warhead

The yellow explosive in the booster was identified by TLC and I.R. spectroscopy. TLC of the material, carried out at the same conditions as for the explosives in SA-3 warhead, showed one yellow spot with R_f = 0.62. The conclusion is that the explosive is Tetryl (in the literature[1]: Tetryl - yellow spot - R_f = 0.62). The I.R. spectrum of the material was identical to the I.R. spectrum of Tetryl.
The yellow explosive is therefore Tetryl.

The orange explosive was identified by TLC, chemical solubility and I.R. spectroscopy, carried out similiarly as for the orange explosive in the booster of SA-3 warhead. The results were found to be identical to the SA-3 booster explosive. The composition of the orange explosive in the booster of SA-6 warhead is therefore:
97% RDX; 3% Polyethylene; Orange Dye.

The white explosive was identified by TLC and I.R. spectroscopy. TLC of the material, carried out at the same conditions mentioned above, showed after spraying with Diphenylamine and U.V radiation one green spot with R_f = 0.77. The explosive is therefore PETN (in the literature[1]: PETN -green spot - R_f=0.72). The I.R. spectrum of the explosive was identical to the I.R. spectrum of PETN.
The white explosive is therefore PETN.

TLC, chemical solubility and I.R. spectroscopy carried out similiarly as for the yellow-brown explosive in the main charge of SA-3 warhead, showed that the composition of the yellow-brown explosive in SA-6 warhead was:

60% RDX; 40% TNT.

The explosive was a cast explosive.

SA-7 Warhead

The yellow explosive in the booster of SA-7 warhead was identified as Tetryl using TLC and I.R. spectroscopy.

The orange explosive in main charge explosive of SA-7 warhead was found to have the same composition as the orange explosives in SA-3 and SA-6 warheads. The techniques used to identify the material were: TLC, chemical solubility and I.R. spectroscopy.

Therefore the composition of the orange explosive is:

97% RDX; 3% Polyethylene; Orange Dye.

The explosive was pressed and because its density was higher comparing with the same compounds in SA-3 and SA-6 warheads, we think that the pressure was much higher in the manufacturing process.

CONCLUSIONS

The explosives identified in the booster and main charges of 3 Russian ground-air missiles, were commonly known explosives like: PETN, Tetryl, Cyclotols (RDX/TNT) and PBX (Plastic Bonded Explosive) (RDX/Polyethylene). TLC, I.R. spectroscopy and chemical solubility proved to be sufficient for doubtless identification of the explosives.

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