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**CONFIDENTIAL**

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## MOLOK EXPLOSION TESTS

Artillery Brigade's test firing establishment conducted an explosion test for MOLOK containers in Niinisalo 9.12.2009. The purpose of the test was to determine the behavior of the container, spreading of pieces to the surrounding areas, and the influences of pressure wave when a charge was exploded inside the container. The test was done with three container models; CityScape, Basic container 3000l and MolokDomino.

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### 1. Test preparation and testing conditions

The containers were installed to even range in Niinisalo Brigade, about 700 meters from the strong points. The containers were installed to sandy soil according to installation instructions. Inside the lifting bags, there were sufficient amount of 5-6 kg sand bags to make the bag adjust in a correct position.

The containers were charged with 500 g charge made from TNT powder. An electronic exploder was used in discharging. The charge was situated on the bottom of the lifting bag, and placed on the centre.

At the time of the test, the weather was calm and cloudy. Temperature was approximately 0 °C. There was no ground frost surrounding the containers.

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## 2. Conducted tests, their purposes and estimated success

**Measuring air pressure** outside the containers did not succeed as planned. One of the detectors was destroyed in the first explosion and therefore the test failed. It was decided to leave the air pressure measurements out of the test, as it was not one of the major tests demanded by the customer.

The system used in the measuring was not adaptable to the test.

The **proof panels** were used to illustrate the power of spreading pieces. The proof panels were made from two adjacent 2 mm aluminium panels attached to a steel body. The joint area of the panels was 2 x 2 m. The proof panels were situated 2 meters from the containers. The bottoms of the plates were on ground level. The steel body was not fastened to the ground, it stands on its own support.

The proof panels gave a clear indication of the amount and power of the spreading pieces. The findings on the proof panels have been stated in part 3 of the report.

The purpose of **quick filming** was to indicate the direction of the pressure wave, and the breaking mechanism in the construction of the containers. The used documentation technique was 1000 pictures/ second. The usability of the film is limited because of the bright fireball formed in the explosion.

The quick film shows discharging of pressure immediately after the explosion, before the fireball is formed and right after the fireball has extinguished. The explosion is best seen on the video of basic container and MolokDomino.

The quick films (DVD) are attached as an appendix 1. Efficient use of the DVD requires the program to enable picture by picture view.

The purpose of the **regular video** is to give a general idea of the explosions. The filming was done with three DV cameras; two situated about 60 m from the containers and one about 700 m from the containers. The usability of the films is limited because of the bright fireball formed in the explosion.

Details of the explosion are hard to detect in the normal video, but when the film is in slow-motion, the impact of the explosion can be seen relatively good.

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The footage from the two cameras situated 60 m from the containers and the footage from the thermo camera has been saved to a DVD. One clip shows the film in slow-motion (appendix 2). The original video clips will be saved at least for six months by the Test fire establishment.

The black and white footage from the camera situated 700 meters from the container is displayed in the appendix 3.

The footage from the **thermo camera** indicates the direction of the explosion gas. There were only limited amount of user experience of filming such explosions with the thermo camera. Therefore filming the explosion was also a test for the camera. Due to limited experience and falling of the program, the footage from the first explosion was not saved.

The footage from the thermo camera is mostly informative, but with accurate analysis, it is possible to gain information of direction and progress of the gas. The footage can be found on appendix 2.

The **photos** indicate the impact that the explosion had on the containers. Photos can be found on appendix 4.

The **chart of spreading of pieces** indicates the amount of pieces spreading to the surrounding areas and length of the flight paths. The distance of the light pieces is affected by their flying characteristics.

Only pieces that flew more than 10 meters have been observed in the chart. Apart from the heavier pieces from the lifting bag of 3000l container and pieces from the lid's metal constructions, the pieces were small in size.

The chart can be found on part 4 of this report.

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### 3. Test results and other observations

#### 3.1 CityScape

CityScape was the smallest container in terms of capacity and installation depth. The construction was mostly made of plastic.

- The parts above ground were broken and they flew to surroundings due to the pressure
- The explosion caused a 25 cm in depth and 1,5 m wide hole to the place of the container
- The parts underground broke in to several pieces, but they stayed at the same place.
- An article separated from the side of the container and flew through the proof panel, bending the panel loose from its framing.
- The footage from the thermo camera was not saved due to an error in the program.



Pictures of CityScape

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### 3.2 Basic container 3000l

Basic container is the mostly used container, mainly made of plastic.

- The parts above ground were broken and they flew to surroundings due to the pressure
- An article separated from the side of the container and flew to the proof panel causing a 1 cm deep trace to the area of 50 cm x 5 cm
- No hole to the ground
- The parts situated underground broke slightly but stayed at the same place



Pictures of Molok 3000l

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### 3.3 MolokDomino

The well of MolokDomino is made from 50mm casted concrete, and is constructionally the strongest of all the tested containers.

- The concrete parts on ground level broke in to four separate parts falling on the edges of the pit and partly in to the pit.
- The parts underground broke in to few large parts, which stayed in the pit.
- The metal frame from the top of the container remained in form and flew straight upwards falling partly on the pit
- There were no detectable marks on the proof panel; however the proof panel fell down probably because of the pressure.
- No hole to the ground



Pictures of MolokDomino



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4. Chart of spreading of pieces

<b>CityScape</b>	<b>Basic container 3000 l</b>	<b>MolokDomino</b>
<i>distance m and type</i>	<i>distance m and type</i>	<i>distance m and type</i>
52 part of the side, metal	30 lid, plastic (almost intact)	32 part of lid, plastic
38 part of the side, metal	17 part of the side, plastic	26 part of lid, plastic
34 filling lid, plastic	16 logo on metal sheet	24 bundle of rope
30 hinge, metal	13 metal band	16 part of lid, plastic
27 logo on metal sheet	12 part of lid, metal	15 metal part
19 part of the side, plastic	11 filling lid, plastic	
17 part of the side, metal	10 lifting bag and metal construction (heavy)	

Manager of the establishment  
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Enclosure    Appendix 1    Quick video  
                 Appendix 2    Video clips + thermo camera footage  
                 Appendix 3    Surveillance video  
                 Appendix 4    Photos

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