BOFORS TEST CENTER

MSIAC L-150
Self-Audit Procedure Report
Edition 1

Bofors Test Center
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BOFORS TEST CENTER

Information about the test organization

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Date of the report

This report was approved for release the 12th of November 2012.

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Objective of the audit

The objective of this work was to follow the self-audit procedure stated in Reference 1 and audit Bofors Test Center's competences and capabilities as an IM test organization.

Overview of Bofors Test Center

General information

In 1886, Bofors established a firing range in order to test ammunition and weapon systems. More than a century later, Bofors Test Center is a state-of-the-art testing facility for both military and civilian products. At our extensive proving ground in Sweden our dedicated engineers perform tests for a large number of defence materiel companies from all over the world.

We are an independent private company with the experience and resources required to establish a complete and fully accurate IM signature on competitive terms. We can evaluate which tests are necessary and how they should be performed. We perform them and measure, film and record every event in detail. In the end we assess the results and provide complete reports. If there is a safety hazard hidden inside a product, we will find it.

Bofors Test Center provides a wide and flexible range of services from testing and product development support to destruction, including:

- Performance and qualification testing
- IM testing
- HC testing
- Lifetime extension testing
- Environmental testing
- Testing of Unmanned Aircraft Systems
- Wind tunnel testing
- Destruction of explosives
- Demilitarization

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Our present proving ground was established in 1913 and is situated in Karlskoga midway between Stockholm and Oslo in close proximity to airports and hotels.

Bofors Test Center has an approximate maximum firing range of 25 km and an approximate width of 4 km. Together with our neighbour Villingsberg, a Swedish Armed Forces training area, we provide a total restricted operation area of approximately 200 km^2. At our proving ground we could detonate charges with Net Explosive Quantity (NEQ) of up to 250 kg TNT equivalent and we have a restricted airspace of 30,000 feet which could be temporarily extended if required.

Bofors Test Center and Villingsberg

We have well equipped mechanical workshops for gun systems as well as for products containing explosives. We could also provide helicopter service for surveillance, tracking and transport.

If a longer firing range and detonation of larger charges are required we have access to Älvdalen which is a 540 km^2 Swedish Armed Forces training area situated 300 km north of Bofors Test Center. At Älvdalen we could fire heavy artillery up to distances of 50 km and detonate charges with an NEQ of up to approximately 5 metric tons. This gives our customers the opportunity to test the most extreme of conventional weapon systems.

At Bofors Test Center we perform all six IM tests as they are described in each STANAG.

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- Bullet Impact tests are performed in accordance with STANAG 4241 using three single shot .50 cal guns remotely controlled with a system which enables a variable rate of fire. We can also perform Bullet Impact tests in a tailor-made way using other guns with various calibres.

- Fragment Impact tests are performed in accordance with STANAG 4496 using a specially designed 40 mm gun able to fire the 14.30 mm Standard Fragment with high accuracy at impact velocities of 2530 m/s. Our Fragment Impact gun can also fire other types of fragments with different dimensions up to a calibre of 40 mm.

- Shaped Charge Jet Impact tests are performed in accordance with STANAG 4526 or tailor-made using warheads provided by us or by the customer. Normally we use warheads from the RPG-7 system. Except from our PG-7M and PG-7L warheads which are specially made for static firings we could also offer other warheads from e.g. the 84 mm Carl-Gustaf system.

Bullet Impact guns

Fragment Impact gun

Warheads for Shaped Charge Jet Impact tests

- Sympathetic Reaction tests are performed in accordance with STANAG 4396 or in a tailor-made way depending on customer's requirements. If needed different systems for initiation could be provided. For Sympathetic Reaction tests we use a flat levelled and unobstructed area of 300 x 300 m covered with gravel. The perfect ground for fragment mapping.

- Fast Cook Off tests are performed in accordance with STANAG 4240 using liquid hydrocarbon fuel or in accordance with AOP-39 with our Liquefied Propane Gas system. We also perform external fire tests in accordance with UN Transport of Dangerous Goods Manual of Test and Criteria using wood as fuel. Our Liquefied Propane Gas system has been presented at several international symposiums and is recognized worldwide as a very cost-efficient and environmentally friendly alternative to liquid hydrocarbon fuel.

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Sympathetic Reaction test

Fast Cook Off test with liquid hydrocarbon fuel

Bofors Test Center's Liquefied Propane Gas system

- Slow Cook Off tests are performed in accordance with STANAG 4382 using specially designed ovens tailor-made for each type of test item. The ovens are built of a very brittle material with relatively low density in order to provide the least possible confinement. They are also equipped with windows which permit video coverage of the events inside of the oven during the test.

Slow Cook Off oven

Slow Cook Off oven with extra insulation and video cameras

HC testing in accordance with Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, is also performed at Bofors Test Center.

Test facilities

At Bofors Test Center we have six permanent test sites and several temporary test sites for different purposes. We also have special test facilities like our environmental test laboratory, our open jet wind tunnel and our flash X-ray facility.

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Permanent test sites

All of our permanent test sites are equipped with bunkers for protection of personnel and equipment, thermal treatment chambers with a temperature range from -54°C to +76°C and target butts like stone walls and concrete bunkers.

The test sites Övre, Nedre and Roten have a maximum firing range of approximately 25 km for indirect firing and 600 m for direct firing.

Övre

Nedre

Test site Björnen has a maximum firing range of approximately 25 km for indirect firing and 1000 m for direct firing.

Roten

Björnen

The test sites Abborrtjärn and Lillen have maximum firing ranges of 500 m and 600 m respectively for direct firing. At Abborrtjärn we also have special infrastructure e.g. a 395 m long rail track, rocket motor test facilities and a test area for illumination charges.

Abborrtjärn
rail track test facility

Abborrtjärn
illumination test area

Lillen

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Temporary test sites

Since most of our equipment is mobile we could easily adapt to new situations and use our temporary test sites built for special purposes. We have also during the years performed tests in other parts of the world and that is something that still could be done if required. We are always trying to defeat the impossible.

At our largest target butt Brotorp which was built to catch tank ammunition we could provide direct firing ranges from 1,000 – 2,700 m. The height of this target butt is 18 m from ground to ceiling. At Älgsimmen, our proximity fuze test area, we have firing ranges from 600 – 1,600 m and we provide different target solutions like cylindrical, spherical and missile targets.

Brotorp

Älgsimmen

We have two test sites for missile testing; Beteshult for anti-tank missiles and Bredtjärnstorp for anti-aircraft missiles.

At Beteshult we have firing ranges from 1,000 – 1,840 m and different target solutions like T-72, BMP-1 and moving tank targets. We could also build temporary drop towers for large test items at Beteshult.

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Beteshult

Moving tank target

12 m drop tower for large test items

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The firing ranges at Bredtjärnstorp are from 1,500 – 4,500 m and we could provide fixed targets like hovering helicopter and also towed targets and UAV targets.

Bredtjärnstorp

Our test site Bonusplan is a 300 x 300 m flat levelled and unobstructed area covered with gravel. Bonusplan was built for recovery of artillery sub-munitions but is also used for e.g. sympathetic reaction tests and testing of unmanned aircraft systems (UAS). The maximum firing range to Bonusplan is 19 km. Our other recovery area 22,000 is a 500 x 800 m open soil and gravel surface impact area for indirect fired ammunition and the maximum firing range to this recovery area is 22 km.

Bonusplan

22,000

When we have requirements for large detonations of up to NEQ 250 kg TNT equivalent we use our destruction site Rösimmen situated in the centre of our restricted operation area.

Rösimmen

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Special test facilities

Some examples of our special test facilities are our environmental test laboratory, our open jet wind tunnel and our flash X-ray facility.

At our environmental test laboratory we have the experience, knowledge and resources to help our customers with everything from writing specifications to perform the tests and assess the results. With our advanced equipment we could test most mechanical and climatic environments also on test items containing explosives. Tests we perform include:

- Vibration
- Shock
- Drop
- Bump
- Bounce
- Acceleration
- Climate
- Thermal shock
- Sand and dust
- Salt spray
- Solar radiation
- Rain
- Pressure

Bofors Test Center's environmental test laboratory

Since our environmental test laboratory is situated at our proving ground we can perform environmental tests like artificial ageing on e.g. ammunition and then transport the ammunition to other test sites at Bofors Test Center for performance tests without driving at public roads.

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In Bofors Test Center's open jet wind tunnel we could simulate wind speeds from 10 m/s to Mach 3.6 and test items and scale models up to a length of approximately 40 cm. The open exhaust allows parts from the test object to separate during testing and air could be pre-heated to maximum 600°C.

Open jet wind tunnel

Our flash X-ray facility could be used for both static and dynamic firings and are widely used for evaluation of shaped charge jets.

Flash X-ray test facility

Our latest special test facility is our indoor firing range where we can fully control the environment from gun position to target, and have exactly the same conditions during every test. We can provide a huge amount of guns in various calibres and also fire different kinds of fragments up to a distance of 50 m. In our indoor firing range we could fire at test items containing explosives like reactive armour also with systems that create a back blast.

Instrumentation

At Bofors Test Center we use modern instrumentation to capture all kinds of data needed to assess the performance from a certain type of test. As an example we use LDS Nicolet high speed data acquisition system to capture physical data from different kinds of sensors. Our pressure transducers are made by Kistler or PCB.

We use high speed colour video cameras from Photron for optimal imaging performance. HD-video cameras from Sony are used for video coverage of tests.

Our radar systems are from Weibel and our meteorological systems are from Vaisala.

We also have witness plates in different thickness and sizes suitable for all kinds of IM tests.

Staff knowledge and expertise

At Bofors Test Center, IM tests have been conducted on a regular basis since the mid 1980's and IM testing is a part of our daily work. The staff has through the years gathered a huge amount of experience in IM testing from a wide range of different products that has gone through IM qualification programs. The key staff participates regularly in e.g. the IMEM technology symposium and other IM related conferences and meetings in order to be updated within the field of IM testing and development.

The experiences include all aspects of measuring, recording and filming as well as planning the tests, establish test protocols and creating comprehensive, evaluated technical reports. All measuring are carried out by employees with applicable academic knowledge.

Bofors Test Center have a dedicated IM specialist who has the specific task of evaluation of IM test results and to assist the test officers as well as the rest of the staff in all IM related issues. The specialist is also responsible for all the IM standards such as STANAGs, MIL-STDs and AOPs at our company and to make sure that all of the staff involved in IM testing is updated when new issues of IM standards are published.

We have developed equipment for IM tests that is designed and manufactured at Bofors Test Center's workshop. One example is our Fragment Impact gun which meets the high speed requirement stated in STANAG 4496 with good accuracy. Another example is our internationally recognized system for Fast Cook-Off testing with Liquefied Propane Gas.

Several persons are approved superintendents in accordance to Swedish Law. The superintendents must undergo a certain education and be approved by the Swedish Civil Contingencies Agency. All personnel involved with the handling and transport of dangerous goods are certified by the Swedish Transport Administration.

We have the capability to participate in trial planning groups. Bofors Test Center's contribution in these groups is our experience of performing IM tests which during the years have created a great knowledge of how the tests should be performed to meet all different kinds of requirements.

Limitations associated with safety, environment and environmental impact

Since we are situated outside the dwellings of the city, almost no environmental limitations are impeding our IM activities. We are on our own account and in close dialogue with the supervising authority continuously decreasing our environmental impact. The only possible restriction due to environmental restrictions is the noise levels in connection with very large detonations.

We have adopted the safety regulations that apply for the Swedish Armed Forces and modified them to suit our own operations. Together with the safety procedures required to comply with the Seveso rules and the vast expanse of land we are disposing ensures that all types of IM testing can be performed.

Environment protection plans and emergency plans

Bofors Test Center have been certified according to ISO 14001 since 1997. We do not have any specific procedures dedicated to IM or HC testing. Since Bofors Test Center is a private enterprise regulations specific for government agencies do not apply.

Preventive actions and impacts associated with IM and HC testing are integrated in our overall environmental management system and our Internal Rescue Plan. In these documents we point out how to act as to avoid environmental impact or what to do if an emergency situation appears.

IM and HC test sites

IM and HC tests could be performed at most of our test sites but they are often performed at Abborrtjärn. Sympathetic reaction tests are an exception since they are more or less always performed at Bonusplan which is a perfect environment for fragment mapping.

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For test items with large NEQs (up to NEQ 250 kg TNT equivalent) we use our destruction site Rösimmen or our anti-tank missiles test site Beteshult.

References

[1] MSIAC Audit Procedure of IM Test Organizations' Competences and Capabilities, L-150, Edition 3, Pierre Archambault, November 2010

Appendixes

General technical reports describing typical IM tests and how they are performed, assessed and reported at Bofors Test Center are enclosed in Appendixes A-F. Except for technical reports, if ordered, the customers will receive all data, films and pictures etc from the tests digitally in requested formats.

A: General technical report, Fast Cook Off Test

A general technical report describing a typical Fast Cook Off Test and how it is performed, assessed and reported at Bofors Test Center is enclosed in Appendix A.

B: General technical report, Slow Cook Off Test

A general technical report describing a typical Slow Cook Off Test and how it is performed, assessed and reported at Bofors Test Center is enclosed in Appendix B.

C: General technical report, Fragment Impact Test

A general technical report describing a typical Fragment Impact Test and how it is performed, assessed and reported at Bofors Test Center is enclosed in Appendix C.

D: General technical report, Bullet Impact Test

A general technical report describing a typical Bullet Impact Test and how it is performed, assessed and reported at Bofors Test Center is enclosed in Appendix D.

E: General technical report, Sympathetic Reaction Test

A general technical report describing a typical Sympathetic Reaction Test and how it is performed, assessed and reported at Bofors Test Center is enclosed in Appendix E.

F: General technical report, Shaped Charge Jet Test

A general technical report describing a typical Shaped Charge Jet Test and how it is performed, assessed and reported at Bofors Test Center is enclosed in Appendix F.

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Fast Cook Off Test performed on NNNN 155 HEIM

Abstract

N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Fast Cook Off Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

The purpose of these tests was to determine the sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation, when subjected to a liquid fuel fire environment.

Two tests were performed. Test No. 1 was a calibration test. In Test No. 2 one unpackaged 155 mm artillery projectile NNNN 155 HEIM was subjected to a liquid fuel fire environment.

The fast heating sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the type of response in the fast cook off test performed.

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N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Fast Cook Off Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

1 Introduction

1.1 Background

The purpose of these tests was to determine the sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation, when subjected to a liquid fuel fire environment.

The tests were performed in accordance with Reference 1; STANAG 4240 “Liquid Fuel / External Fire, Munition Test Procedures”, Edition 2. The results of the tests were assessed in accordance with Reference 2; AOP-39 “Guidance on the Assessment and Development of Insensitive Munitions (IM)”, Edition 3.

The tests were sponsored by NNNN Corporation, Department NNN.

1.2 Aim and objectives of the tests

Two tests were performed.

Test No. 1 was a calibration test. The purpose of performing this test was to obtain knowledge about the air blast pressure levels, the fragmentation and fragment distribution when one live projectile was initiated to detonation using a blasting cap i.e. the possible worst case reaction.

Test No. 2 was a Fast Cook Off Test performed in accordance with Reference 1, Annex A.

1.3 Place and date

The tests were performed at Bofors Test Center in Karlskoga, Sweden at test site Abborrtjärn, see Figure 1, the NNth and the NNth of Nnn 20NN.

Figure 1: Test site Abborrtjärn.

1.4 Test procedure

The tests were performed in accordance with Reference 3; Test Procedure "Fast Cook Off Test, NNNN 155 HEIM", Edition 1, published by NNNN Corporation the NNth of Nnn 20NN. The test procedure is also briefly described in Chapter 3.

1.5 Test officials

From Bofors Test Center following personnel worked at the test site with these tests:

Name, Title
Name, Title
Name, Title
Name, Title
Name, Title

1.6 Participating personnel

From NNNN Corporation following personnel worked at the test site with these tests:

Name, Title
Name, Title

2 Test equipment

2.1 Test site equipment

The test equipment provided by Bofors Test Center is described in Table 1.

Table 1: Test equipment provided by Bofors Test Center.

Type of equipment	Name	Bofors Test Center No.
Steel tub Y x Y m (x4)	NNN	Not Applicable
Fuel (nnnn l)	NNN	Not Applicable
Transient Recorder	NNN	B NNNN-NNNN
Amplifier	NNN	B NNNN-NNNN
Transient Recorder	NNN	B NNNN-NNNN
Amplifier	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Thermocouple (x8)	NNN	Not Applicable
HD video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
Weather Transmitter	NNN	B NNNN-NNNN
Initiation/Ignition System	NNN	B NNNN-NNNN
Electrical resistance measurement device	NNN	B NNNN-NNNN
Blasting cap (x1)	NNN	Not Applicable
Igniter (x16)	NNN	Not Applicable

2.2 Customer provided equipment

The test equipment provided by NNNN Corporation is described in Table 2.

Table 2: Test equipment provided by NNNN Corporation.

Type of equipment	Name	Drawing No.	Test ID No.
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-1
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-2
Live Booster	NNNN, Live Booster	NNN-3	YYYY-11
Live Booster	NNNN, Live Booster	NNN-3	YYYY-12
Modified Fuze	NNNN, Modified Fuze	NNN-5	YYYY-21
Lifting Plug	NNNN, Lifting Plug	NNN-8	YYYY-22

The NNNN 155 HEIM is a 155 mm artillery projectile with following specifications:

Weight, with lifting plug: NN.NNN kg
Filling, ACIMEX44B: N.NN kg
Booster Charge, ACIMEX32D: N.NN kg
Length, with lifting plug: NNN mm

2.3 Test items

2.3.1 Test No. 1 (calibration test)

The test item in Test No. 1 was one live projectile NNNN 155 HEIM, Live (YYYY-1) equipped with one live booster NNNN, Live Booster (YYYY-11) and one modified fuze NNNN, Modified Fuze (YYYY-21) as shown in Figure 2. The modified fuze was made in order to assemble a blasting cap and by the blasting cap initiate the test item to detonation.

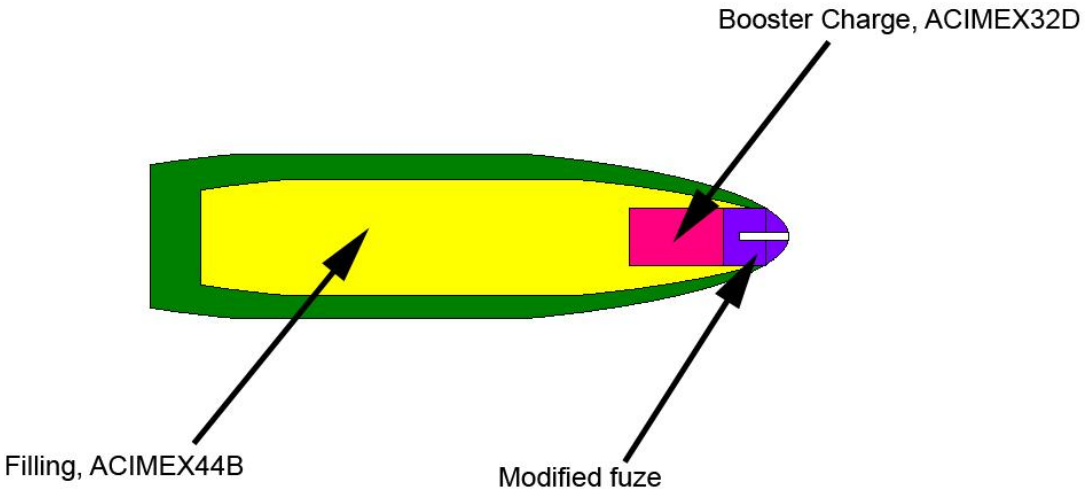


Figure 2: The test item in Test No. 1.

The parts in the test item in Test No. 1 are summarized in Table 3.

Table 3: The parts in the test item in Test No. 1.

Part	Test ID No.	Colour
Live Projectile	YYYY-1	Green
Live Booster	YYYY-11	Not Applicable
Modified Fuze	YYYY-21	Not Applicable

2.3.2 Test No. 2

The test item in Test No. 2 was one live projectile NNNN 155 HEIM, Live (YYYY-2) equipped with one live booster NNNN, Live Booster (YYYY-12) and one lifting plug NNNN, Lifting Plug (YYYY-22) as shown in Figure 3.

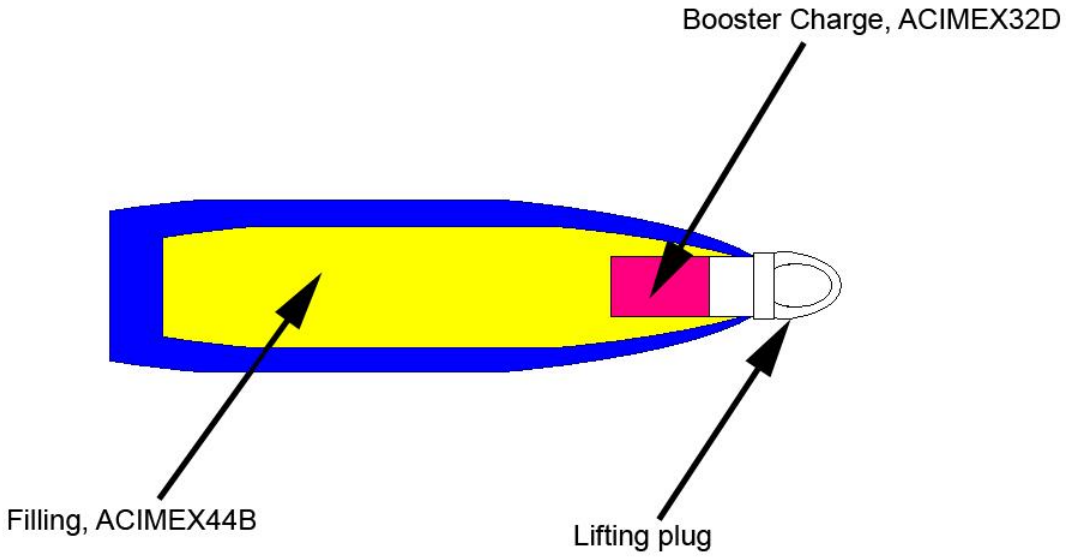


Figure 3: The test item in Test No. 2.

The parts in the test item in Test No. 2 are summarized in Table 4.

Table 4: The parts in the test item in Test No. 2.

Part	Test ID No.	Colour
Live Projectile	YYYY-2	Blue
Live Booster	YYYY-12	Not Applicable
Lifting Plug	YYYY-22	Not Applicable

3 Test procedure

The tests were performed in accordance with Reference 3.

Test No. 1 was the first test to be performed followed by Test No. 2.

Test No. 1 was performed as follows:

1. The test item was positioned correctly.
2. All personnel except for the Test Technicians took cover.
3. Electrical resistance in the open initiation chain (firing cable) was measured.
4. The initiation chain (firing cable) was short-circuited.
5. Electrical resistance in the short-circuited initiation chain (firing cable) was measured.
6. The blasting cap was connected to the short-circuited initiation chain.
7. Electrical resistance in the initiation chain (firing cable and blasting cap) was measured.
8. The blasting cap was installed into the modified fuze system on the test item.
9. The Test Technicians took cover.
10. The test item was initiated to detonation.
11. Waiting time as decided by the Test Officer.
12. Preliminary inspection of the test site performed by the Test Officer.
13. Inspection of the test site and assessment of the result.

Test No. 2 was performed as follows:

1. The test item was positioned correctly.
2. The test personnel took cover.
3. The fuel was ignited.
4. The test was running until all munition reactions were completed and the fuel was consumed.
5. Waiting time as decided by the Test Officer.
6. Preliminary inspection of the test site performed by the Test Officer.
7. Inspection of the test site and assessment of the result.

After completion of all tests the explosives remains were collected and disposed as further described in Chapter 8.

4 Test configuration

4.1 Test setups

4.1.1 Test No. 1

The test setup for Test No. 1 is shown in Figure 4.

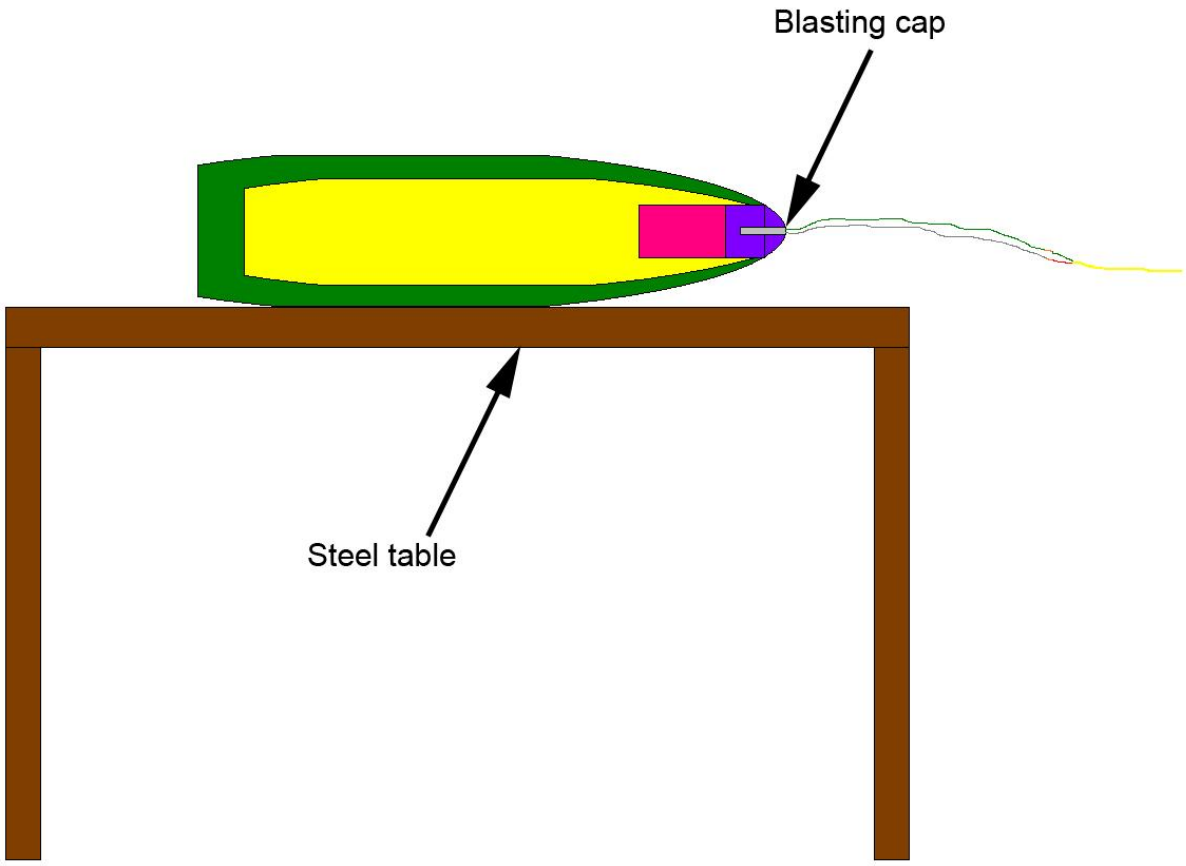


Figure 4: The test setup for Test No. 1 (calibration test).

4.1.2 Test No. 2

The test setup in Test No. 2 is shown in Figures 5-6. Eight thermocouples were used to record temperature as a function of time during the test. The position of each thermocouple is also shown in Figures 5-6. In Figure 5 is also the height of the test item above the fuel surface shown.

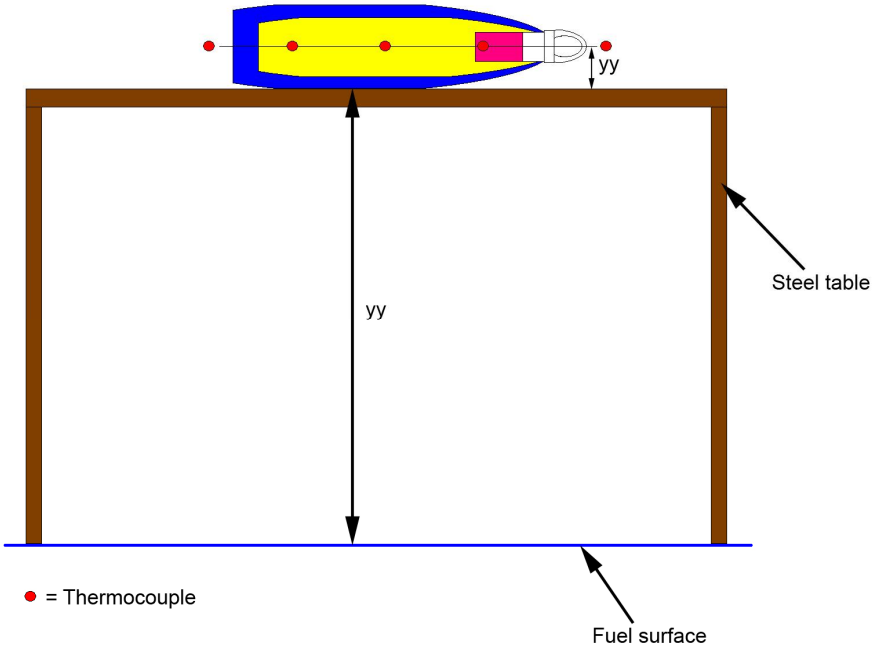
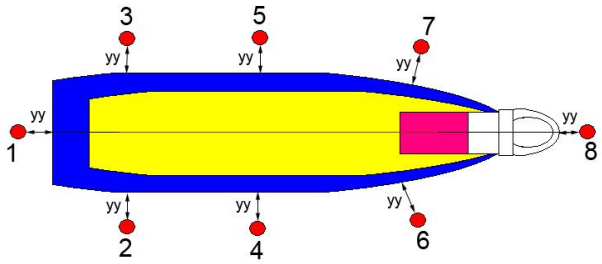


Figure 5: The test setup with the position of each thermocouple and the height of the test item above the fuel surface (side view).



= Thermocouple

Figure 6: The test setup with the position of each thermocouple (top view).

4.2 Test layout

A schematic view, not to scale, of the test layout is shown in Figure 7. The distance in meters from the centre point of the test item to each piece of equipment is described in Table 5.

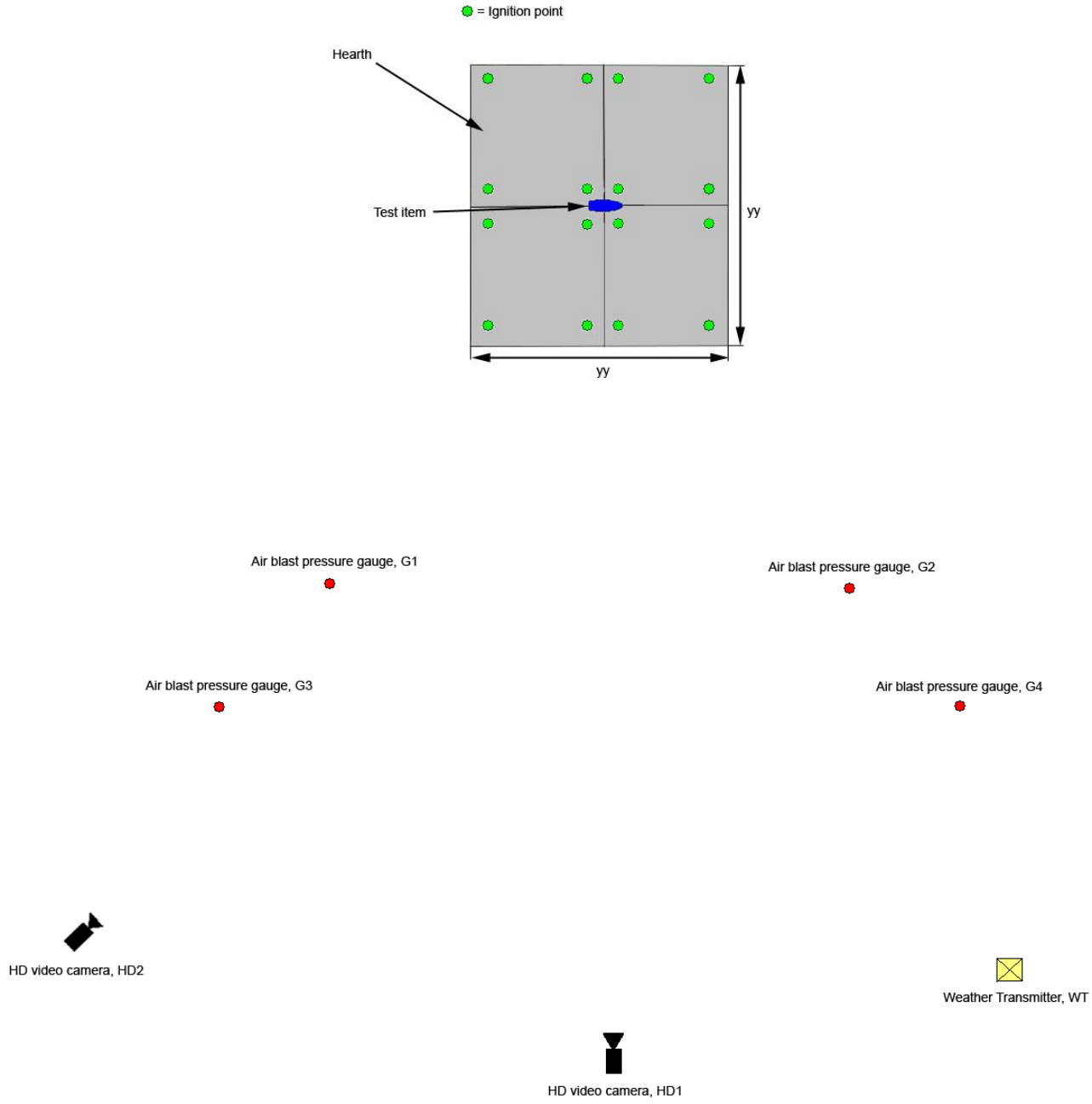


Figure 7: A schematic view, not to scale, of the test layout.

Table 5: The distance from the centre point of the test item to each piece of equipment.

Piece of equipment	**Distance from the centre point of the test item (m)**
HD1	NN
HD2	NN
G1	NN
G2	NN
G3	NN
G4	NN
WT	NN

5 Safety measures

The tests were performed in accordance with Bofors Test Center's Safety and Security Plan.

6 Meteorological conditions

The meteorological conditions during the tests are described in Table 6.

Table 6: The meteorological conditions during the tests.

Test No.	Date and time	Barometric pressure (hPa)	Relative humidity (%RH)	Liquid Precipitation (mm)	Wind speed (m/s)	Wind direction (º)	Air temperature (ºC)
1	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n

(At nn times during the tests the wind speed exceeded 10 km/h.)

7 Results

N.B. Following Chapters (7.1-7.2) do not contain any pictures since the tests, as stated earlier, never have been performed.

7.1 Test No. 1 (calibration test)

Pictures from the HD video cameras are shown in Figures 8-11.

No picture available

Figure 8: The test item when initiated (picture from HD1).

No picture available

Figure 9: The test item after initiation (picture from HD1).

No picture available

Figure 10: The test item when initiated (picture from HD2).

No picture available

Figure 11: The test item after initiation (picture from HD2).

The registered air blast pressure values are shown in Table 7. These values were used in Test No. 2 as reference values.

Table 7: The registered air blast pressure values in Test No. 1.

Registered air blast pressures values (kPa)			
G1, NN m	**G2, NN m**	**G3, NN m**	**G4, NN m**
nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 12, fragments from the test item were found, see Figure 13. These fragments were used in Test No. 2 as references.

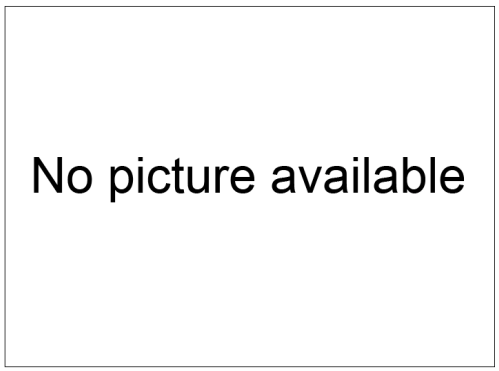


Figure 12: The test area after Test No. 1.

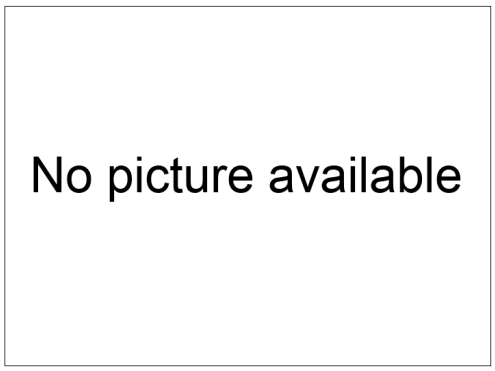


Figure 13: All collected fragments from the test item in Test No. 1.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 8 and are mapped in the sketch (not to scale) in Figure 14. These values were used in Test No. 2 as reference values of how far fragments could travel when the test item was initiated to detonation i.e. the possible worst case reaction.

Table 8: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

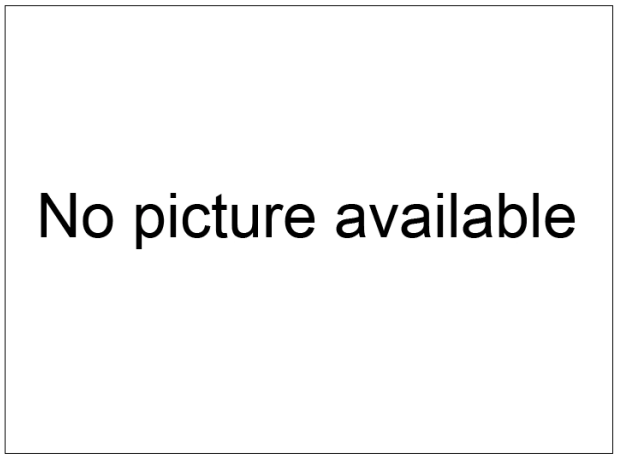


Figure 14: A sketch, not to scale, of the test area after Test No. 1.

7.2 Test No. 2

When the fuel was ignited the temperature measured by each thermocouple was as shown in Table 9.

Table 9: The temperature measured by each thermocouple when the fuel was ignited.

Thermocouple No.	Temperature (ºC)
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn
7	nn
8	nn

The time to reach 550ºC measured by two thermocouples (in this test Thermocouple No. n and Thermocouple No. n) was nn s. This is hereafter referred to as T_0.

Nn minutes and nn seconds after T_0 nnn occurred… The temperature measured by each thermocouple at that time is shown in Table 10.

Table 10: The temperature measured by each thermocouple when nnn occurred.

Thermocouple No.	Temperature (ºC)
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn
7	nn
8	nn

Pictures from the HD video cameras when nnn occurred are shown in Figures 15-16.

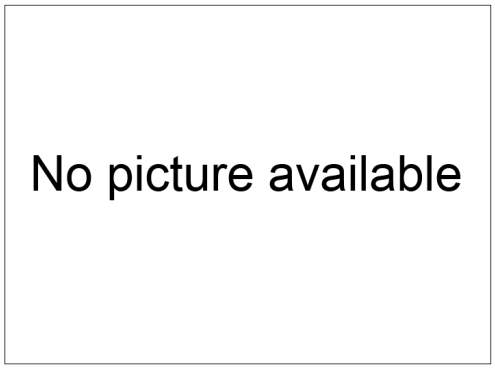


Figure 15: Nnn occurs (picture from HD1).

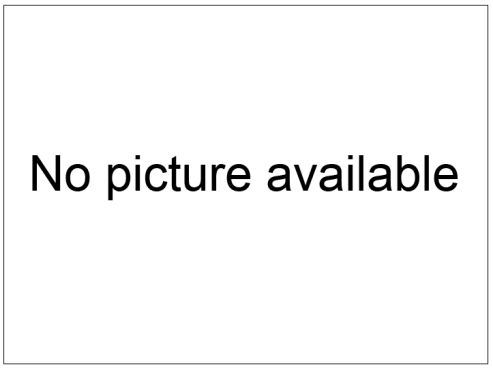


Figure 16: Nnn occurs (picture from HD2).

When nnn occurred there where no registered air blast pressure values differing from normal conditions.

Nnn minutes and nnn seconds after T_0 nnnn occurred and fragments were thrown out of the flames. The temperature measured by each thermocouple at that time is shown in Table 11.

Table 11: The temperature measured by each thermocouple when nnnn occurred.

Thermocouple No.	**Temperature (ºC)**
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn
7	nn
8	nn

Pictures from the HD video cameras when nnnn occurred are shown in Figures 17-18.

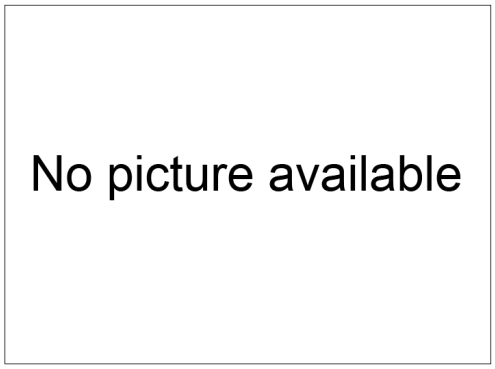


Figure 17: Nnnn occurs (picture from HD1).

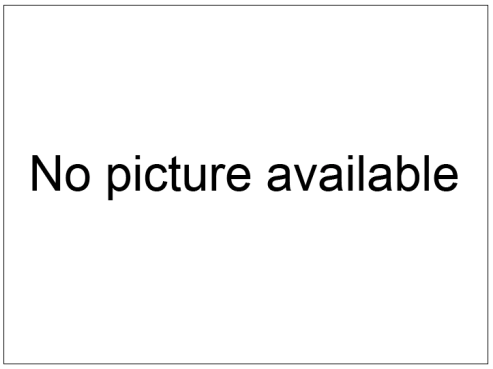


Figure 18: Nnnn occurs (picture from HD2).

The registered air blast pressure values are shown in Table 12.

Table 12: The registered air blast pressure when nnnn occurred.

Registered air blast pressures values (kPa)			
G1, NN m	**G2, NN m**	**G3, NN m**	**G4, NN m**
nn.nn	nn.nn	nn.nn	nn.nn

After nnnn occurred there were no more reactions observed and when the fire had burnt out the test was terminated.

The temperature as a function of time during Test No. 2 is shown in Figure 19.

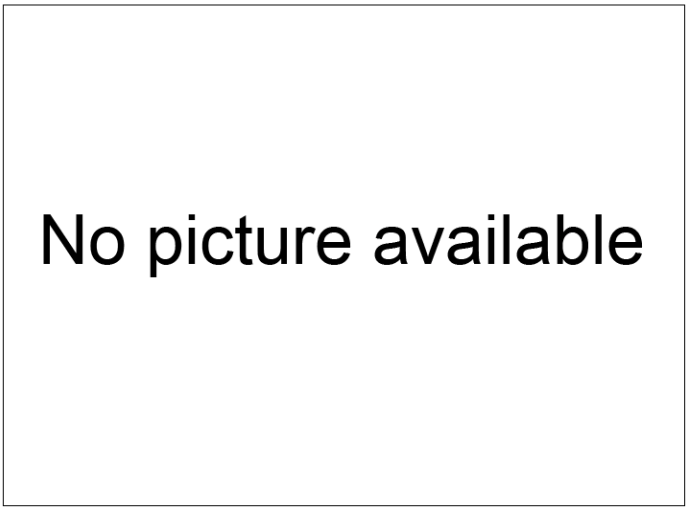


Figure 19: The temperature as a function of time during Test No. 2.

The average flame temperature from the time the flames reached 550ºC (T_0) until all munition reactions were completed (nnn minutes and nnn seconds) was nnn ºC. Values from Thermocouples No. n,n,n,n and n were used in this calculation.

When the test area was searched after the test, see Figure 20, fragments from the test item were found, see Figure 21.

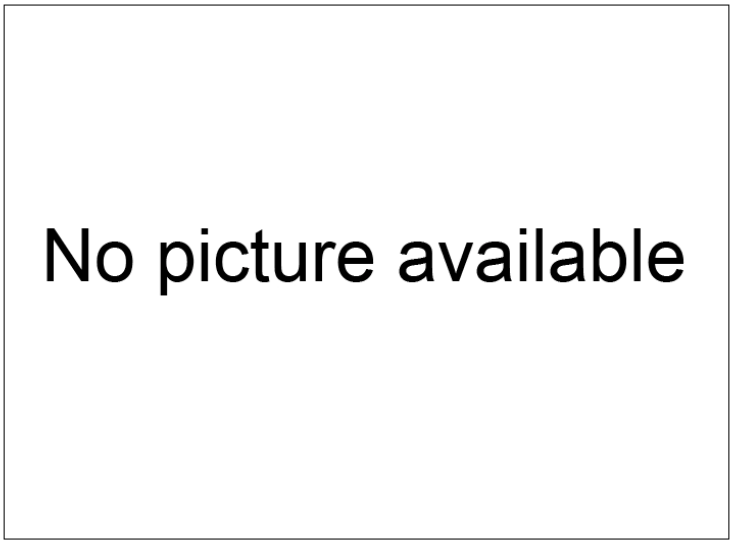


Figure 20: The test area after Test No. 2.

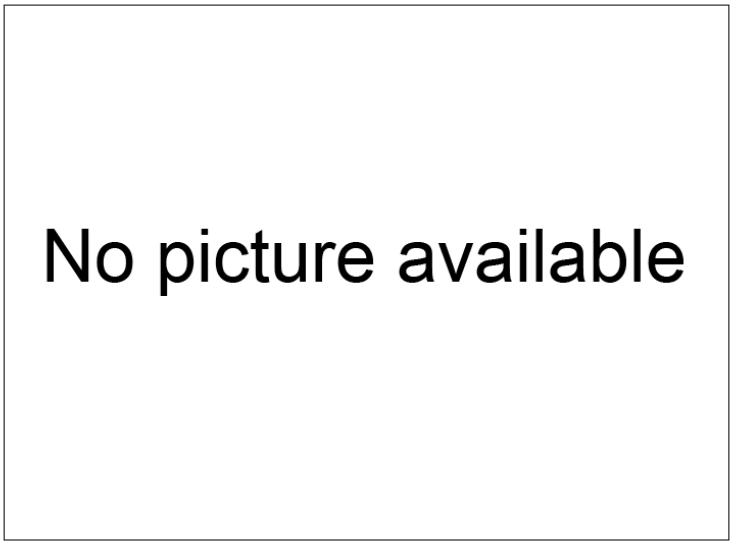


Figure 21: All collected fragments from the test item in Test No. 2.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 13 and are mapped in the sketch (not to scale) in Figure 22.

Table 13: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

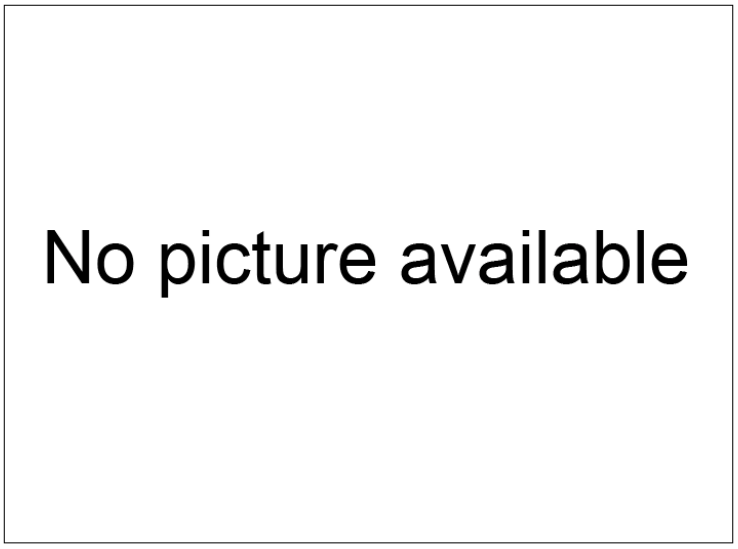


Figure 22: A sketch, not to scale, of the test area after Test No. 2.

Based on the information given in Chapters 7.1, 7.2 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

8 Disposal of explosive items

After completion of all tests the explosives remains were collected and disposed in one detonation using PETN based plastic explosives and one blasting cap, see Figures 23-24.

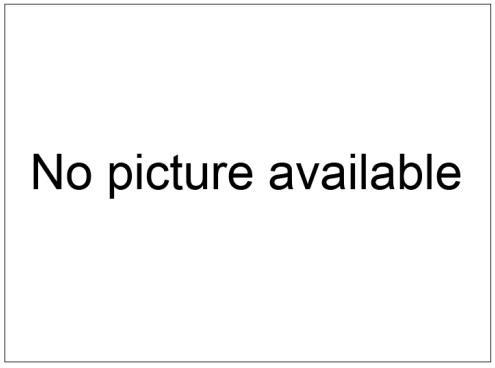


Figure 23: All collected explosives remains before disposal.

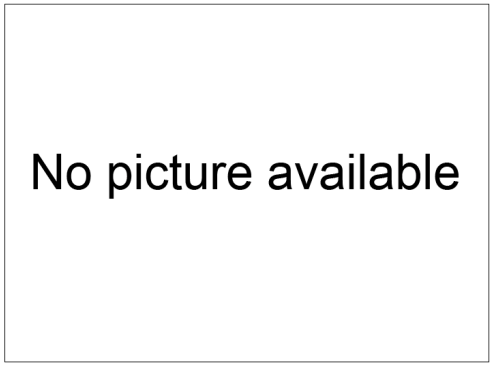


Figure 24: The site after disposal.

9 Conclusions

The fast heating sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the type of response in the fast cook off test performed.

10 References

[1.] STANAG 4240 "Liquid Fuel / External Fire, Munition Test Procedures", Edition 2, 15th of April 2003

[2.] AOP-39 "Guidance on the Assessment and Development of Insensitive Munitions (IM)", Edition 3, March 2010

[3.] Test Procedure "Fast Cook Off Test, NNNN 155 HEIM", Edition 1, NNNN Corporation, NNth of Nnn 20NN

MSIAC L-150, Self-Audit Procedure Report, Edition 1, Appendix B

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Slow Cook Off Tests performed on NNNN 155 HEIM

Abstract

N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Slow Cook Off Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

The purpose of these tests was to determine the sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation, when subjected to a gradually increasing thermal environment.

Two identical tests were performed as described in STANAG 4382, Edition 2.

The slow heating sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two slow cook off tests performed.

Distribution list

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NNNN Corporation

Authorisation

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N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Slow Cook Off Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

1 Introduction

1.1 Background

The purpose of these tests was to determine the sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation, when subjected to a gradually increasing thermal environment.

The tests were performed in accordance with Reference 1; STANAG 4382 “Slow Heating, Munitions Test Procedures”, Edition 2. The results of the tests were assessed in accordance with Reference 2; AOP-39 “Guidance on the Assessment and Development of Insensitive Munitions (IM)”, Edition 3.

The tests were sponsored by NNNN Corporation, Department NNN.

1.2 Aim and objectives of the tests

Two identical tests were performed.

Test No. 1 and Test No. 2 was performed in accordance with Reference 1 “Procedure 1 (Standard Test)”.

1.3 Place and date

The tests were performed simultaneously at Bofors Test Center in Karlskoga, Sweden at test site Abborrtjärn, see Figure 1, the NNth and the NNth of Nnn 20NN.

Figure 1: Test site Abborrtjärn.

1.4 Test procedure

The tests were performed in accordance with Reference 3; Test Procedure "Slow Cook Off Tests, NNNN 155 HEIM", Edition 1, published by NNNN Corporation the NNth of Nnn 20NN. The test procedure is also briefly described in Chapter 3.

1.5 Test officials

From Bofors Test Center following personnel worked at the test site with these tests:

Name, Title
Name, Title
Name, Title
Name, Title
Name, Title

1.6 Participating personnel

From NNNN Corporation following personnel worked at the test site with these tests:

Name, Title
Name, Title

2 Test equipment

2.1 Test site equipment

The test equipment provided by Bofors Test Center is described in Table 1.

Table 1: Test equipment provided by Bofors Test Center.

Type of equipment	Name	Bofors Test Center No.
Slow Cook Off oven (x2)	NNN	Not Applicable
Heating control system	NNN	Not Applicable
Transient Recorder	NNN	B NNNN-NNNN
Amplifier	NNN	B NNNN-NNNN
Transient Recorder	NNN	B NNNN-NNNN
Amplifier	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Thermocouple (x7)	NNN	Not Applicable
Video camera	NNN	Not Applicable
HD video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
Witness plate (x2)	NNN	Not Applicable
Weather Transmitter	NNN	B NNNN-NNNN

2.2 Customer provided equipment

The test equipment provided by NNNN Corporation is described in Table 2.

Table 2: Test equipment provided by NNNN Corporation.

Type of equipment	Name	Drawing No.	Test ID No.
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-1
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-2
Live Booster	NNNN, Live Booster	NNN-3	YYYY-11
Live Booster	NNNN, Live Booster	NNN-3	YYYY-12
Lifting Plug	NNNN, Lifting Plug	NNN-8	YYYY-21
Lifting Plug	NNNN, Lifting Plug	NNN-8	YYYY-22

The NNNN 155 HEIM is a 155 mm artillery projectile with following specifications:

Weight, with lifting plug: NN.NNN kg
Filling, ACIMEX44B: N.NN kg
Booster Charge, ACIMEX32D: N.NN kg
Length, with lifting plug: NNN mm

2.3 Test items

2.3.1 Test No. 1

The test item in Test No. 1 was one live projectile NNNN 155 HEIM, Live (YYYY-1) equipped with one live booster NNNN, Live Booster (YYYY-11) and one lifting plug NNNN, Lifting Plug (YYYY-21) as shown in Figure 2.

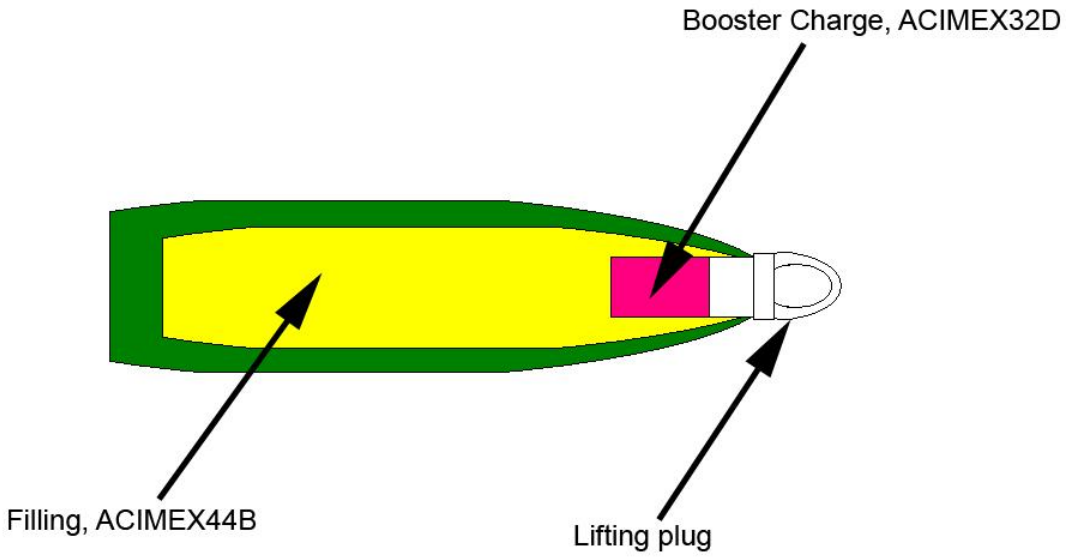

Figure 2: The test item in Test No. 1.

The parts in the test item in Test No. 1 are summarized in Table 3.

Table 3: The parts in the test item in Test No. 1.

Part	Test ID No.	Colour
Live Projectile	YYYY-1	Green
Live Booster	YYYY-11	Not Applicable
Lifting Plug	YYYY-21	Not Applicable

2.3.2 Test No. 2

The test item in Test No. 2 was one live projectile NNNN 155 HEIM, Live (YYYY-2) equipped with one live booster NNNN, Live Booster (YYYY-12) and one lifting plug NNNN, Lifting Plug (YYYY-22) as shown in Figure 3.

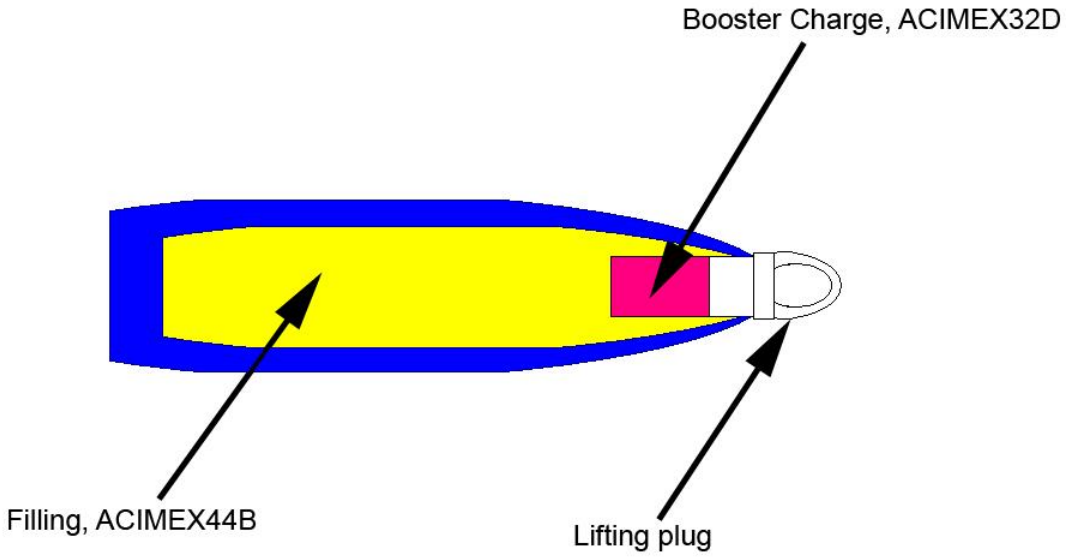

Figure 3: The test item in Test No. 2.

The parts in the test item in Test No. 2 are summarized in Table 4.

Table 4: The parts in the test item in Test No. 2.

Part	Test ID No.	Colour
Live Projectile	YYYY-2	Blue
Live Booster	YYYY-12	Not Applicable
Lifting Plug	YYYY-22	Not Applicable

3 Test procedure

The tests were performed in accordance with Reference 3.

Test No. 1 and Test No. 2 were performed at the simultaneously on two different places at test site Abborrtjärn. Three test technicians from Bofors Test Center working in shift were responsible for the full time surveillance of the tests.

The tests were performed as follows:

1. The test item was positioned correctly in the oven.
2. The test personnel took cover.
3. The heating was started in accordance with Reference 1 “Procedure 1 (Standard Test)”.
4. The test was running until reaction occurred.
5. After reaction: waiting time as decided by the Test Officer.
6. Preliminary inspection of the test site performed by the Test Officer.
7. Inspection of the test site and assessment of the result.

After completion of all tests the explosives remains were collected and disposed as further described in Chapter 8.

4 Test configuration

4.1 Test setups

4.1.1 Test No. 1

The test setup in Test No. 1 is shown in Figure 4. The oven was made in accordance with the guidelines given in Reference 1. The heating system consisted of nn electric heater(s), (each) with an effect of nn W, and the air was circulated in the oven using nn electric fan(s). Six thermocouples were used to record temperature as a function of time during the test and one thermocouple (No. 7) was used to guide the temperature in the oven. The position of each thermocouple is shown in Figure 5 as well as the position of the test item. NN mm beneath the test item one witness plate was mounted. The dimensions of the witness plate were (Width x Length x Thickness) yyyy mm x yyyy mm x yy mm.

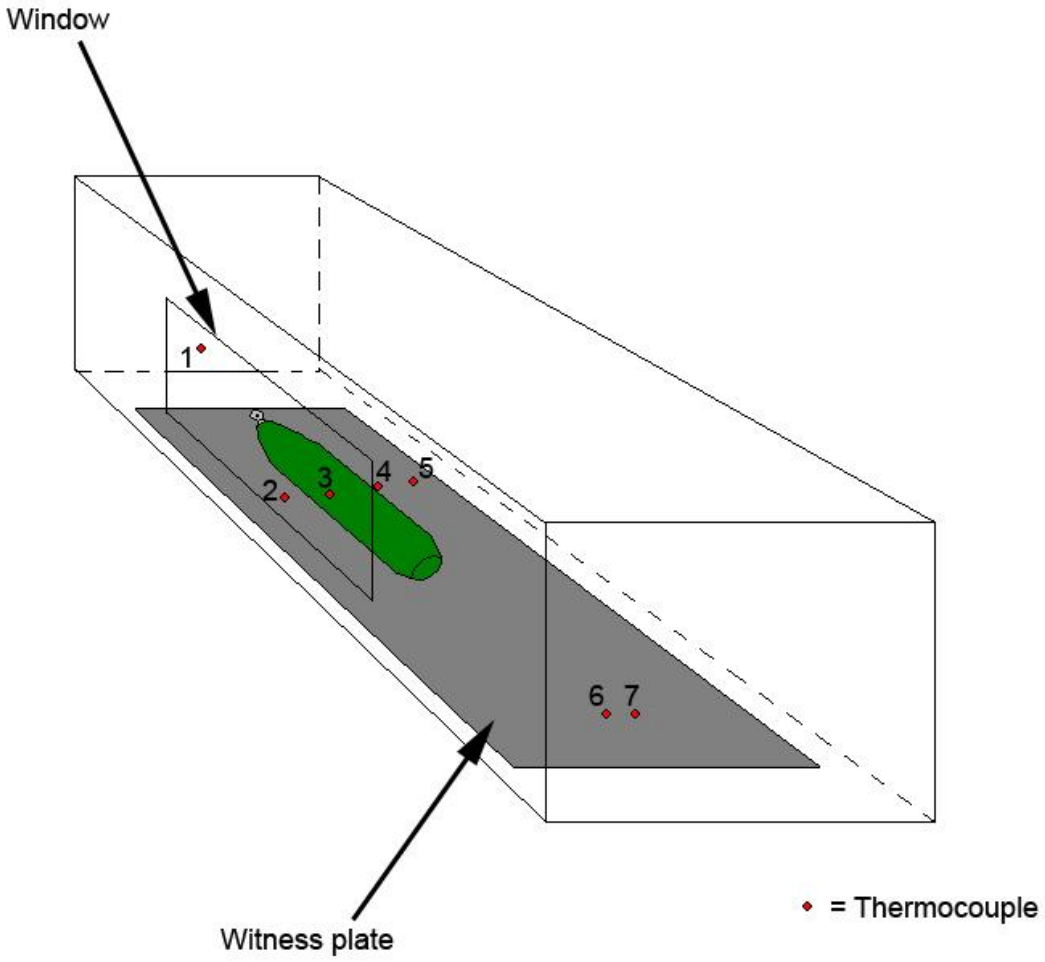

Figure 4: The test setup in Test No. 1.

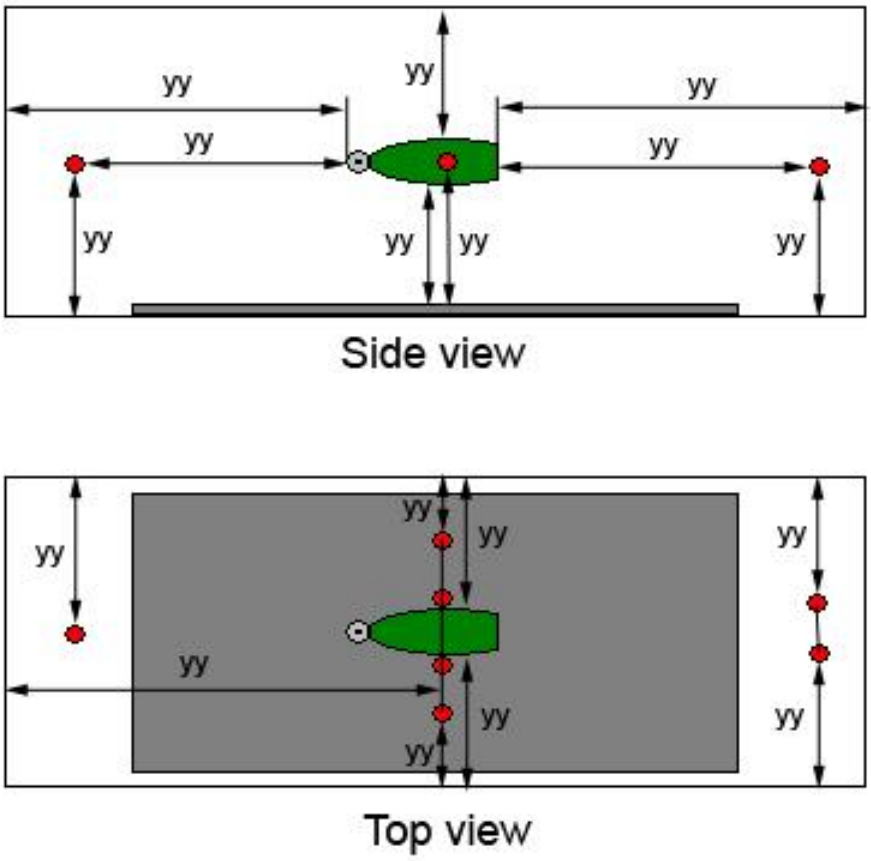

Figure 5: The position of each thermocouple and the position of the test item.

4.1.2 Test No. 2

The test setup in Test No. 2 (identical with the test setup in Test No. 1) is shown in Figure 6. The oven was made in accordance with the guidelines given in Reference 1. The heating system consisted of nn electric heater(s), (each) with an effect of nn W, and the air was circulated in the oven using nn electric fan(s). Six thermocouples were used to record temperature as a function of time during the test and one thermocouple (No. 7) was used to guide the temperature in the oven. The position of each thermocouple is shown in Figure 7 as well as the position of the test item. NN mm beneath the test item one witness plate was mounted. The dimensions of the witness plate were (Width x Length x Thickness) yyyy mm x yyyy mm x yy mm.

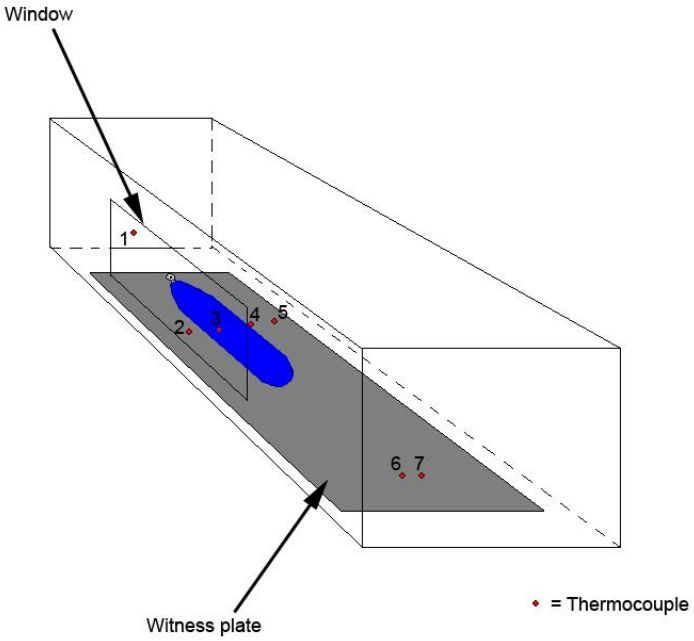

Figure 6: The test setup in Test No. 2.

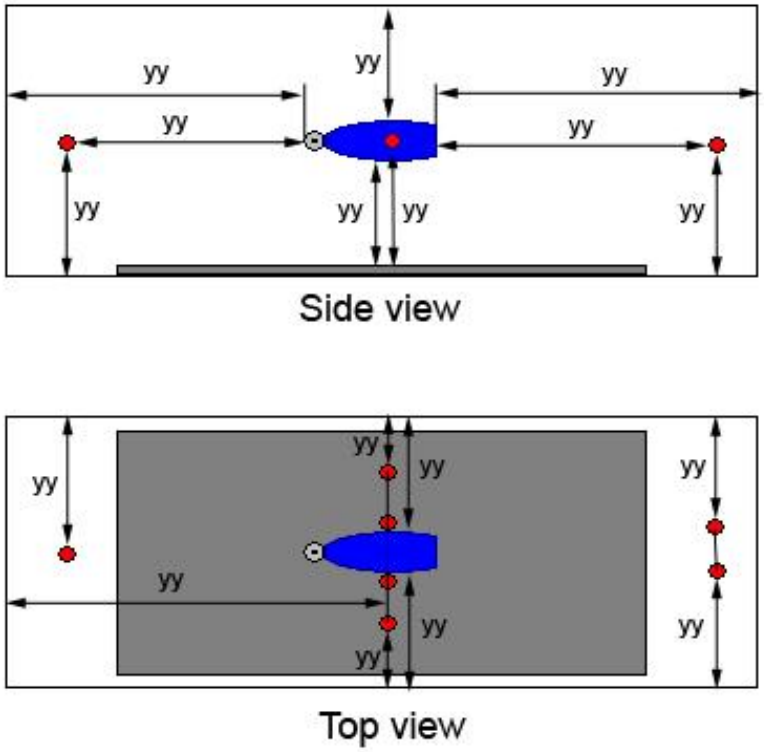

Figure 7: The position of each thermocouple and the position of the test item.

4.2 Test layout

A schematic view, not to scale, of the test layout is shown in Figure 8. The distance in meters from the centre point of the test item to each piece of equipment is described in Table 5.

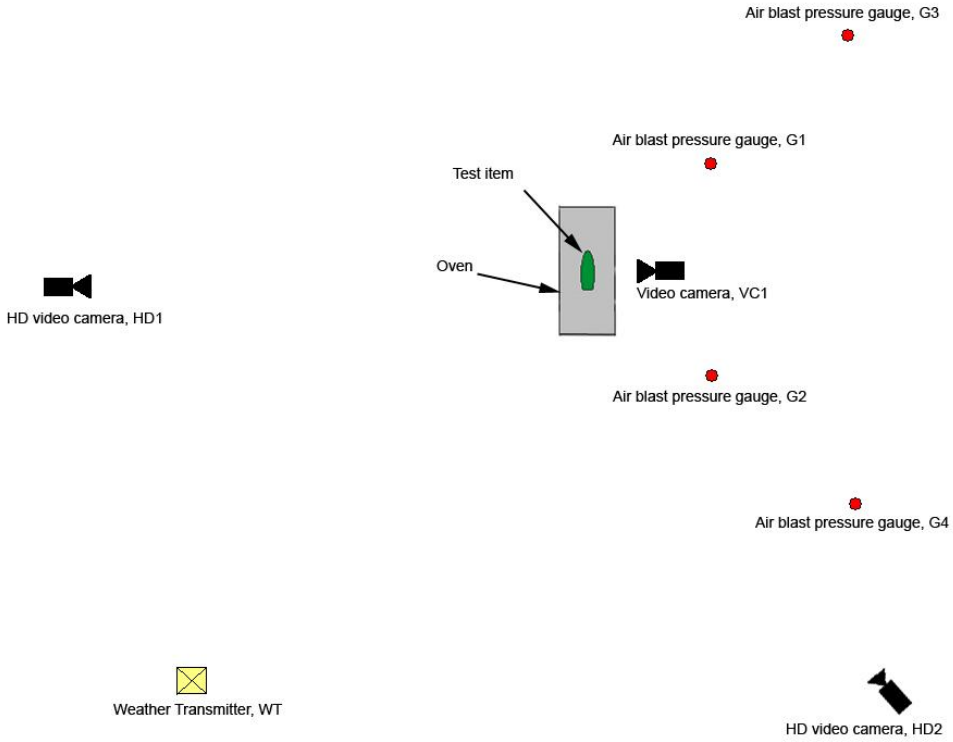

Figure 8: A schematic view, not to scale, of the test layout.

Table 5: The distance from the centre point of the test item to each piece of equipment.

Piece of equipment	Distance from the centre point of the test item (m)
VC1	N
HD1	NN
HD2	NN
G1	N
G2	N
G3	NN
G4	NN
WT	NN

5 Safety measures

The tests were performed in accordance with Bofors Test Center's Safety and Security Plan.

6 Meteorological conditions

The meteorological conditions during the tests are described in Table 6.

Table 6: The meteorological conditions during the tests.

Test No.	Date and time	Barometric pressure (hPa)	Relative humidity (%RH)	Liquid Precipitation (mm)	Wind speed (m/s)	Wind direction (º)	Air temperature (ºC)
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
1, 2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n

7 Results

N.B. Following Chapters (7.1-7.2) do not contain any pictures since the tests, as stated earlier, never have been performed.

7.1 Test No. 1

When the slow heating started the temperature inside of the oven at each thermocouple was as shown in Table 7.

Table 7: The temperature inside of the oven at each thermocouple when the slow heating started.

Thermocouple No.	Temperature (ºC)
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn

After nn hours and nn minutes nnn occurred… The temperatures inside of the oven at that time are shown in Table 8.

Table 8: The temperature inside of the oven at each thermocouple when nnn occurred.

Thermocouple No.	Temperature (ºC)
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn

Pictures from the video camera, VC1, when nnn occurred are shown in Figures 9-10.

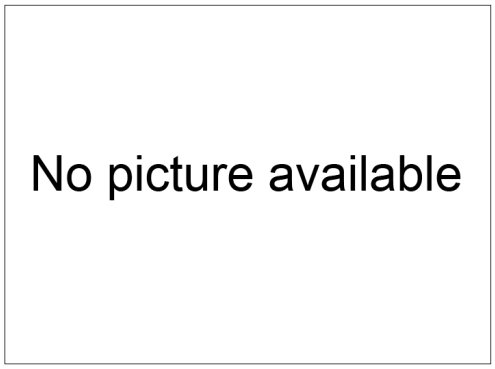

Figure 9: Nnn occurs (picture from VC1).

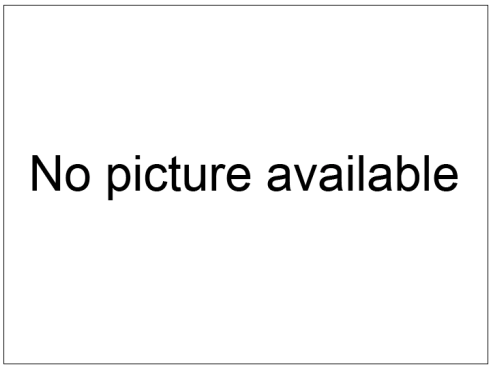

Figure 10: Nnn occurs (picture from VC1).

When nnn occurred there where no registered air blast pressure values differing from normal conditions.

After nnn hours and nnn minutes nnnn occurred, the oven was smashed and consequently the test was terminated. The temperatures inside of the oven at that time are shown in Table 9.

Table 9: The temperature inside of the oven at each thermocouple when nnnn occurred.

Thermocouple No.	**Temperature (ºC)**
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn

Pictures from the video camera, VC1, when nnnn occurred are shown in Figures 11-12.

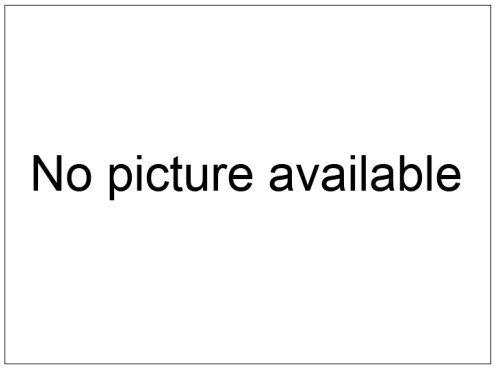

Figure 11: Nnnn occurs (picture from VC1).

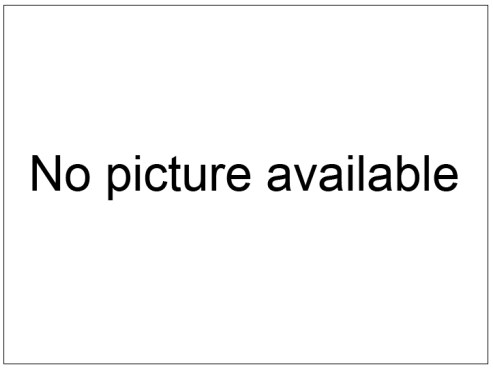

Figure 12: Nnnn occurs (picture from VC1).

The registered air blast pressure values are shown in Table 10.

Table 10: The registered air blast pressure when nnnn occurred.

Registered air blast pressures values (kPa)			
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**
nn.nn	nn.nn	nn.nn	nn.nn

The temperature as a function of time during Test No. 1 is shown in Figure 13.

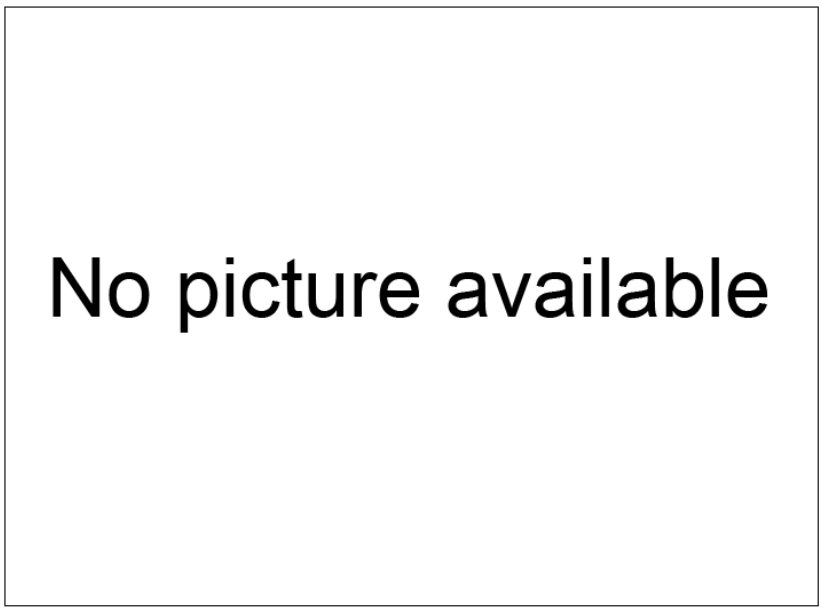

Figure 13: The temperature as a function of time during Test No. 1.

When the test area was searched after the test, see Figure 14, the oven was found smashed and fragments from the test item were found, see Figure 15.

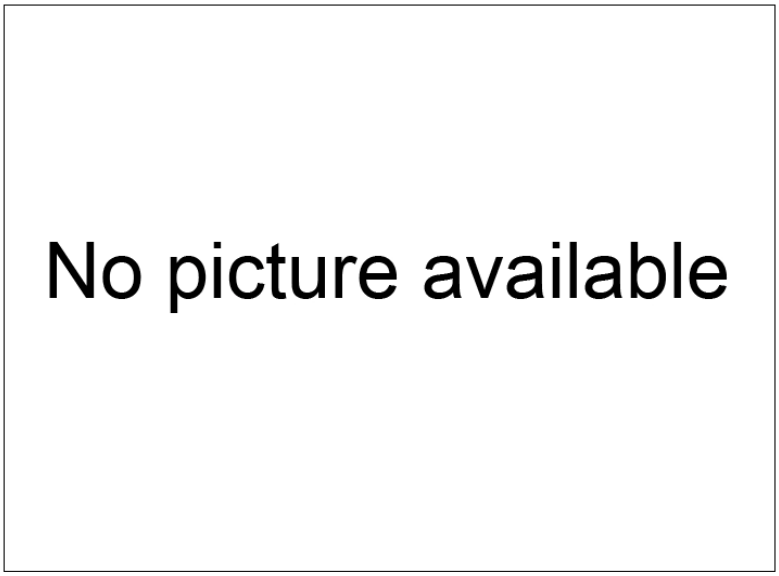

Figure 14: The test area after Test No. 1.

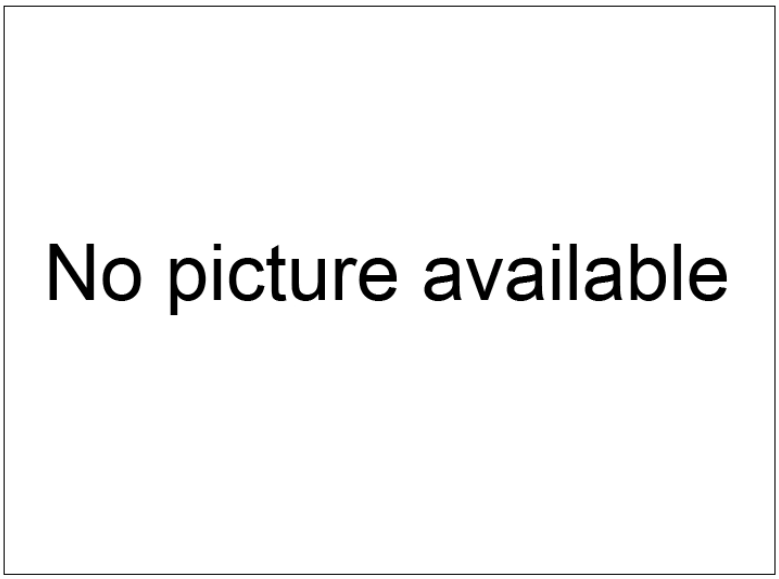

Figure 15: All collected fragments from the test item in Test No. 1.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 11 and are mapped in the sketch (not to scale) in Figure 16.

Table 11: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

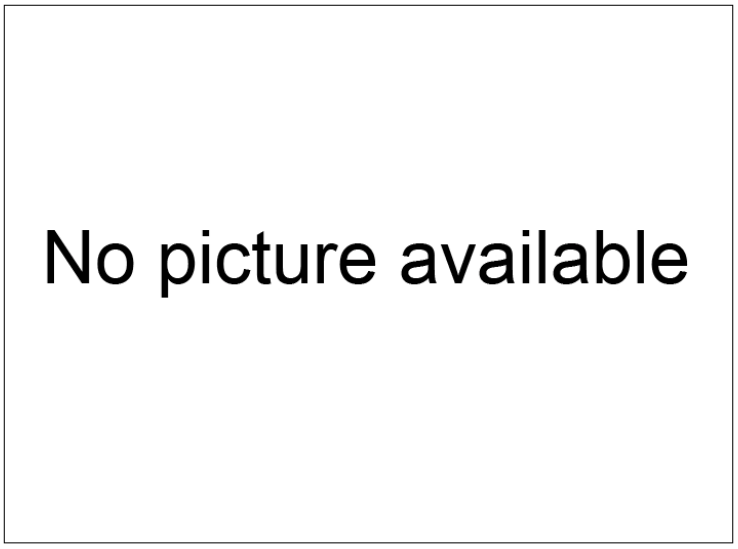

Figure 16: A sketch, not to scale, of the test area after Test No. 1.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 17.

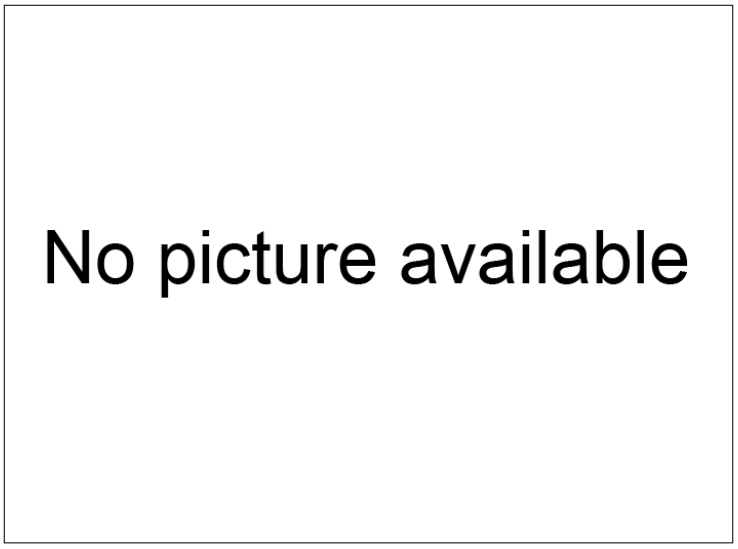

Figure 17: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapter 7.1 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

7.2 Test No. 2

When the slow heating started the temperature inside of the oven at each thermocouple was as shown in Table 12.

Table 12: The temperature inside of the oven at each thermocouple when the slow heating started.

Thermocouple No.	Temperature (ºC)
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn

After nn hours and nn minutes nnn occurred… The temperatures inside of the oven at that time are shown in Table 13.

Table 13: The temperature inside of the oven at each thermocouple when nnn occurred.

Thermocouple No.	Temperature (ºC)
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn

Pictures from the video camera, VC1, when nnn occurred are shown in Figures 18-19.

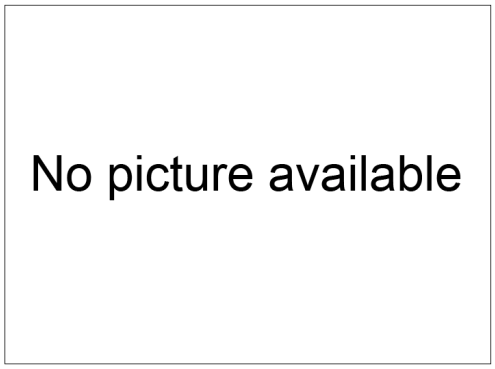

Figure 18: Nnn occurs (picture from VC1).

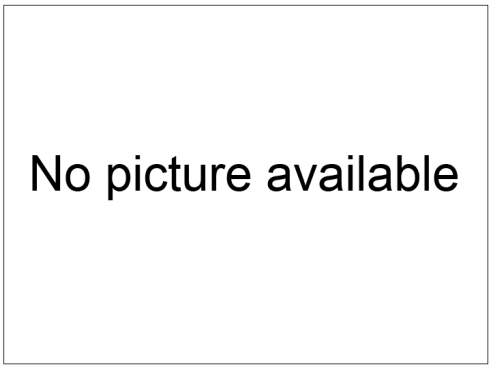

Figure 19: Nnn occurs (picture from VC1).

When nnn occurred there where no registered air blast pressure values differing from normal conditions.

After nnn hours and nnn minutes nnnn occurred, the oven was smashed and consequently the test was terminated. The temperatures inside of the oven at that time are shown in Table 14.

Table 14: The temperature inside of the oven at each thermocouple when nnnn occurred.

Thermocouple No.	**Temperature (ºC)**
1	nn
2	nn
3	nn
4	nn
5	nn
6	nn

Pictures from the video camera, VC1, when nnnn occurred are shown in Figures 20-21.

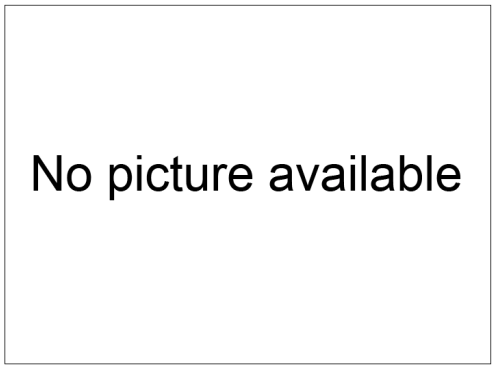

Figure 20: Nnnn occurs (picture from VC1).

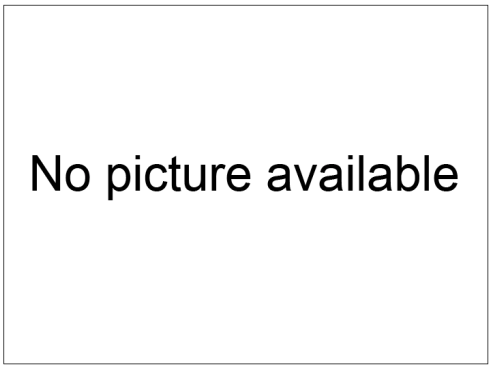

Figure 21: Nnnn occurs (picture from VC1).

The registered air blast pressure values are shown in Table 15.

Table 15: The registered air blast pressure when nnnn occurred.

Registered air blast pressures values (kPa)			
G2, N m	**G2, N m**	**G3, NN m**	**G4, NN m**
nn.nn	nn.nn	nn.nn	nn.nn

The temperature as a function of time during Test No. 2 is shown in Figure 22.

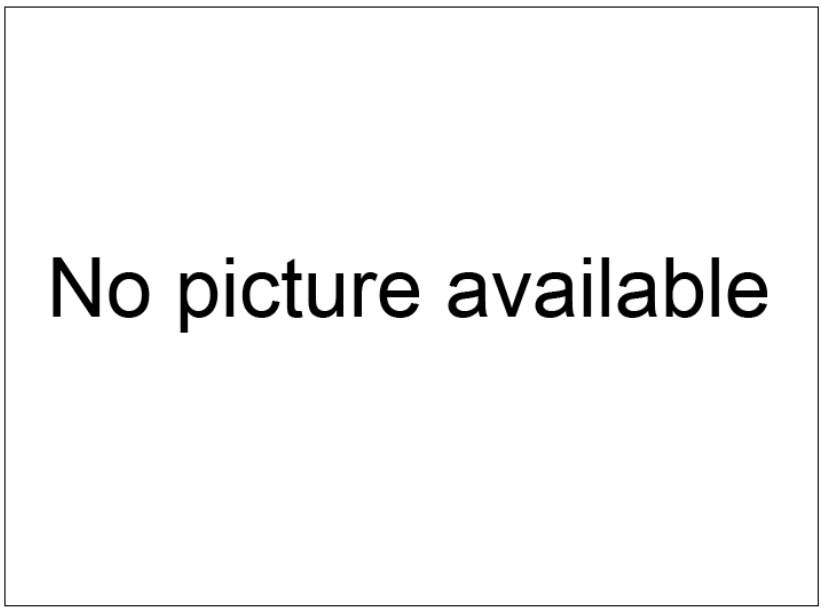

Figure 22: The temperature as a function of time during Test No. 2.

When the test area was searched after the test, see Figure 23, the oven was found smashed and fragments from the test item were found, see Figure 24.

No picture available

Figure 23: The test area after Test No. 2.

No picture available

Figure 24: All collected fragments from the test item in Test No. 2.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 16 and are mapped in the sketch (not to scale) in Figure 25.

Table 16: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

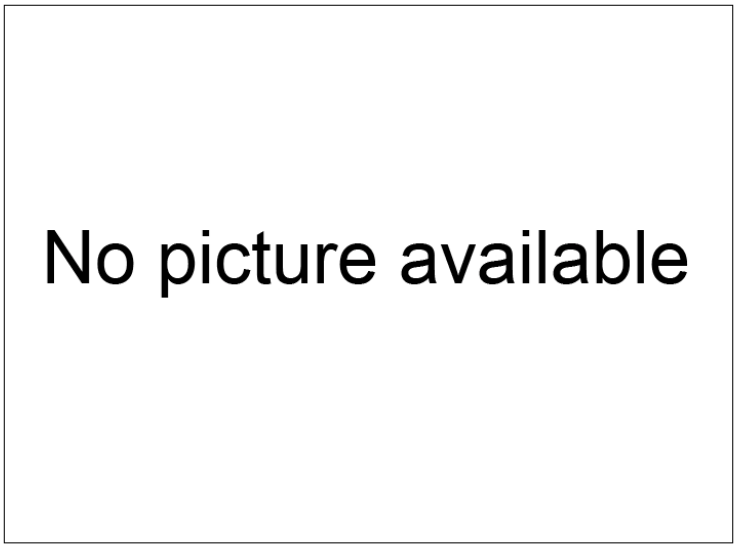

Figure 25: A sketch, not to scale, of the test area after Test No. 2.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 26.

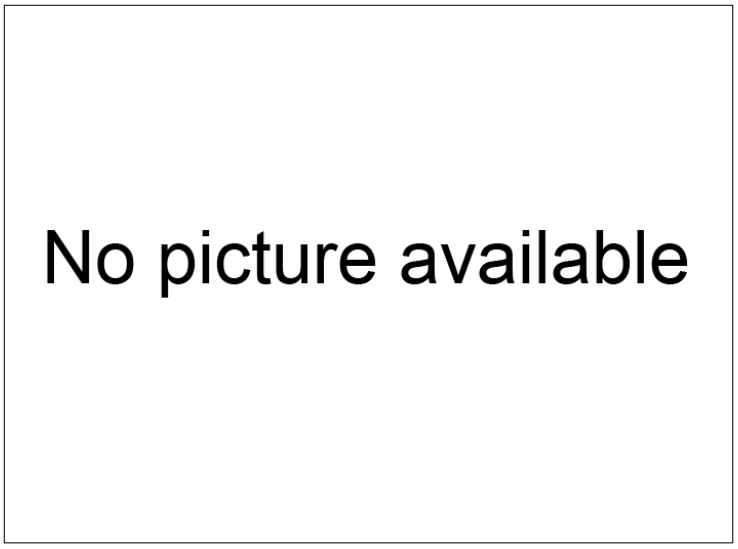

Figure 26: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapter 7.2 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

8 Disposal of explosive items

After completion of all tests the explosives remains were collected and disposed in one detonation using PETN based plastic explosives and one blasting cap, see Figures 27-28.

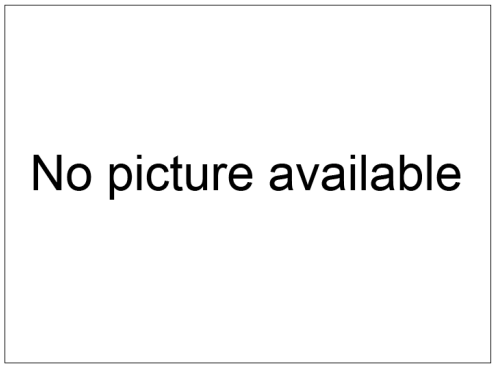

Figure 27: All collected explosives remains before disposal.

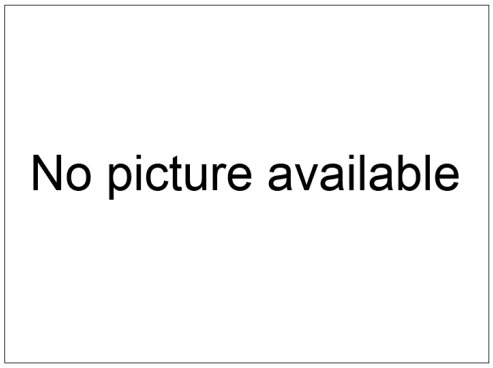

Figure 28: The site after disposal.

9 Conclusions

The slow heating sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two slow cook off tests performed.

10 References

[1.] STANAG 4382 “Slow Heating, Munitions Test Procedures”, Edition 2, 15th of April 2003

[2.] AOP-39 “Guidance on the Assessment and Development of Insensitive Munitions (IM)”, Edition 3, March 2010

[3.] Test Procedure “Slow Cook Off Tests, NNNN 155 HEIM”, Edition 1, NNNN Corporation, NNth of Nnn 20NN

MSIAC L-150, Self-Audit Procedure Report, Edition 1, Appendix C

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Fragment Impact Tests performed on NNNN 155 HEIM

Abstract

N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Fragment Impact Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

The purpose of these tests was to determine the fragment impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation.

Four tests were performed. Test No. 1 and Test No. 2 were calibration tests. In Test No. 3 one STANAG 4496 Standard Fragment was fired at the largest explosive component and in Test No. 4 one STANAG 4496 Standard Fragment was fired at the booster.

The fragment impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two fragment impact tests performed.

Distribution list

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N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Fragment Impact Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

1 Introduction

1.1 Background

The purpose of these tests was to determine the fragment impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation.

The tests were performed in accordance with Reference 1; STANAG 4496 "Fragment Impact, Munitions Test Procedures", Edition 1. The results of the tests were assessed in accordance with Reference 2; AOP-39 "Guidance on the Assessment and Development of Insensitive Munitions (IM)", Edition 3.

The tests were sponsored by NNNN Corporation, Department NNN.

1.2 Aim and objectives of the tests

Four tests were performed.

Test No. 1 was a calibration test. The purpose of performing this test was to obtain knowledge about the air blast pressure levels, the fragmentation, fragment distribution and witness plate damage when one live projectile was initiated to detonation using a blasting cap i.e. the possible worst case reaction.

Test No. 2 was also a calibration test. The purpose of performing this test was to obtain knowledge about the air blast pressure levels, the fragmentation, fragment distribution and witness plate damage when one inert projectile was hit by one STANAG 4496 Standard Fragment. I.e. to study the damage caused to the projectile only by the kinetic energy from the STANAG 4496 Standard Fragment.

In Test No. 3, one STANAG 4496 Standard Fragment was fired at the largest explosive component.

In Test No. 4, one STANAG 4496 Standard Fragment was fired at the booster.

1.3 Place and date

The tests were performed at Bofors Test Center in Karlskoga, Sweden at test site Abborrtjärn, see Figure 1, the NNth and the NNth of Nnn 20NN.

Figure 1: Test site Abborrtjärn.

1.4 Test procedure

The tests were performed in accordance with Reference 3; Test Procedure "Fragment Impact Tests, NNNN 155 HEIM", Edition 1, published by NNNN Corporation the NNth of Nnn 20NN. The test procedure is also briefly described in Chapter 3.

1.5 Test officials

From Bofors Test Center following personnel worked at the test site with these tests:

Name, Title
Name, Title
Name, Title
Name, Title
Name, Title

1.6 Participating personnel

From NNNN Corporation following personnel worked at the test site with these tests:

Name, Title
Name, Title

2 Test equipment

2.1 Test site equipment

The test equipment provided by Bofors Test Center is described in Table 1.

Table 1: Test equipment provided by Bofors Test Center.

Type of equipment	Name	Bofors Test Center No.
Fragment Impact Gun	NNN	B NNNN-NNNN
Firing control system	NNN	B NNNN-NNNN
FI Ammunition	NNN	Not Applicable
Transient Recorder	NNN	B NNNN-NNNN
Amplifier	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Measurement rod	NNN	B NNNN-NNNN
High speed video camera	NNN	B NNNN-NNNN
High speed video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
Witness plates (x4)	NNN	Not Applicable
Sabot catcher plate	NNN	Not Applicable
Weather Transmitter	NNN	B NNNN-NNNN
Initiation System	NNN	B NNNN-NNNN
Electrical resistance measurement device	NNN	B NNNN-NNNN
Blasting cap (x1)	NNN	Not Applicable

The fragments used in Test No. 2, Test No. 3 and Test No. 4 were all made in accordance with Reference 1, Annex A. They were manufactured of NNN with a Brinell Hardness of HB NNN.

2.2 Customer provided equipment

The test equipment provided by NNNN Corporation is described in Table 2.

Table 2: Test equipment provided by NNNN Corporation.

Type of equipment	Name	Drawing No.	Test ID No.
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-1
Inert Projectile	NNNN 155 HEIM, Inert	NNN-2	YYYY-2
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-3
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-4
Live Booster	NNNN, Live Booster	NNN-3	YYYY-11
Inert Booster	NNNN, Inert Booster	NNN-4	YYYY-12
Live Booster	NNNN, Live Booster	NNN-3	YYYY-13
Live Booster	NNNN, Live Booster	NNN-3	YYYY-14
Modified Fuze	NNNN, Modified Fuze	NNN-5	YYYY-21
Inert Fuze	NNNN, Inert Fuze	NNN-6	YYYY-22
Live Fuze	NNNN, Live Fuze	NNN-7	YYYY-23
Live Fuze	NNNN, Live Fuze	NNN-7	YYYY-24

The NNNN 155 HEIM is a 155 mm artillery projectile with following specifications:

Weight, with live fuze: NN.NNN kg
Filling, ACIMEX44B: N.NN kg
Booster Charge, ACIMEX32D: N.NN kg
Length, with live fuze: NNN mm

2.3 Test items

2.3.1 Test No. 1 (calibration test)

The test item in Test No. 1 was one live projectile NNNN 155 HEIM, Live (YYYY-1) equipped with one live booster NNNN, Live Booster (YYYY-11) and one modified fuze NNNN, Modified Fuze (YYYY-21) as shown in Figure 2. The modified fuze was made in order to assemble a blasting cap and by the blasting cap initiate the test item to detonation.

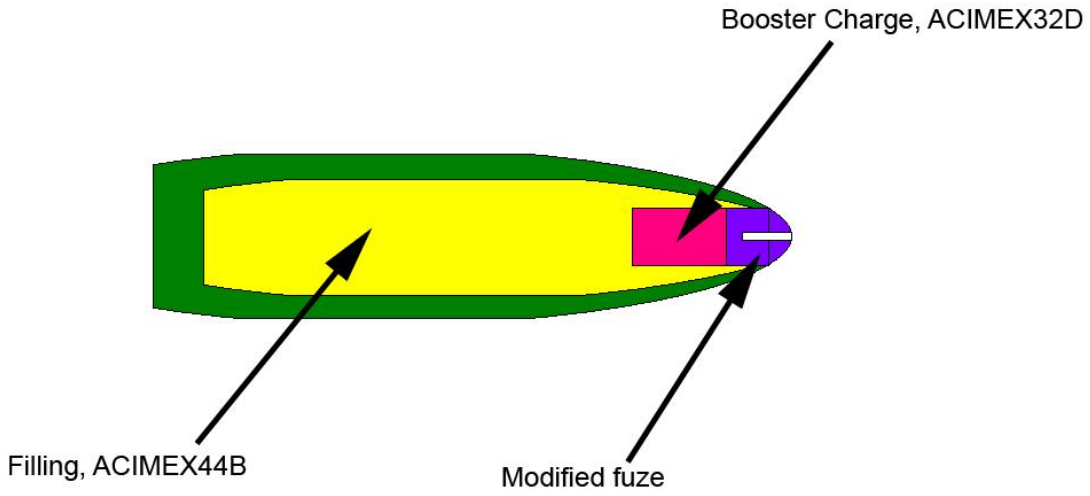

Figure 2: The test item in Test No. 1.

The parts in the test item in Test No. 1 are summarized in Table 3.

Table 3: The parts in the test item in Test No. 1.

Part	Test ID No.	Colour
Live Projectile	YYYY-1	Green
Live Booster	YYYY-11	Not Applicable
Modified Fuze	YYYY-21	Not Applicable

2.3.2 Test No. 2 (calibration test)

The test item in Test No. 2 was one inert projectile NNNN 155 HEIM, Inert (YYYY-2) equipped with one inert booster NNNN, Inert Booster (YYYY-12) and one inert fuze NNNN, Inert Fuze (YYYY-22) as shown in Figure 3.

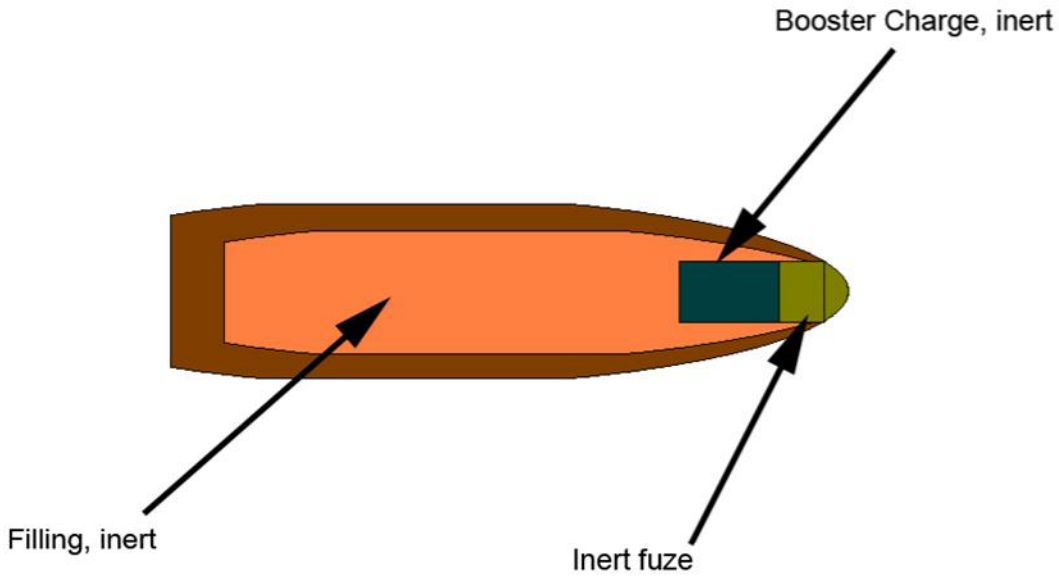

Figure 3: The test item in Test No. 2.

The parts in the test item in Test No. 2 are summarized in Table 4.

Table 4: The parts in the test item in Test No. 2.

Part	Test ID No.	Colour
Inert Projectile	YYYY-2	Brown
Inert Booster	YYYY-12	Not Applicable
Inert Fuze	YYYY-22	Not Applicable

2.3.3 Test No. 3

The test item in Test No. 3 was one live projectile NNNN 155 HEIM, Live (YYYY-3) equipped with one live booster NNNN, Live Booster (YYYY-13) and one live fuze NNNN, Live Fuze (YYYY-23) as shown in Figure 4.

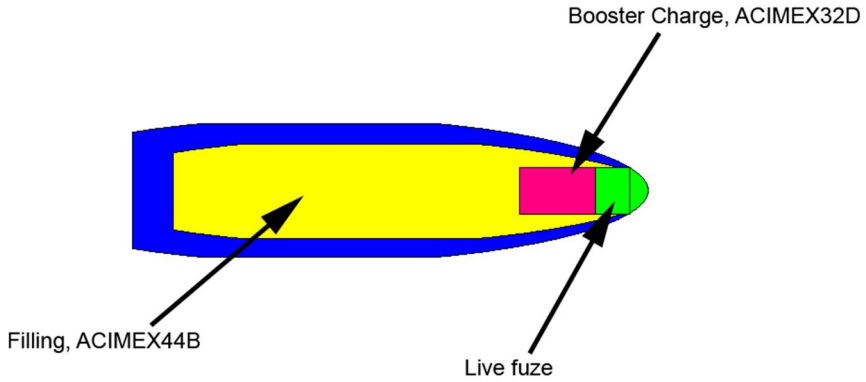

Figure 4: The test item in Test No. 3.

The parts in the test item in Test No. 3 are summarized in Table 5.

Table 5: The parts in the test item in Test No. 3.

Part	Test ID No.	Colour
Live Projectile	YYYY-3	Blue
Live Booster	YYYY-13	Not Applicable
Live Fuze	YYYY-23	Not Applicable

The point of impact in Test No. 3 is shown in Figure 5.

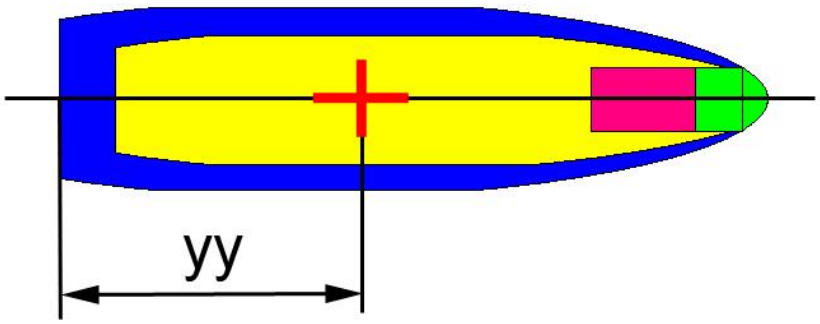

Figure 5: The point of impact in Test No. 3.

2.3.4 Test No. 4

The test item in Test No. 4 was one live projectile NNNN 155 HEIM, Live (YYYY-4) equipped with one live booster NNNN, Live Booster (YYYY-14) and one live fuze NNNN, Live Fuze (YYYY-24) as shown in Figure 6.

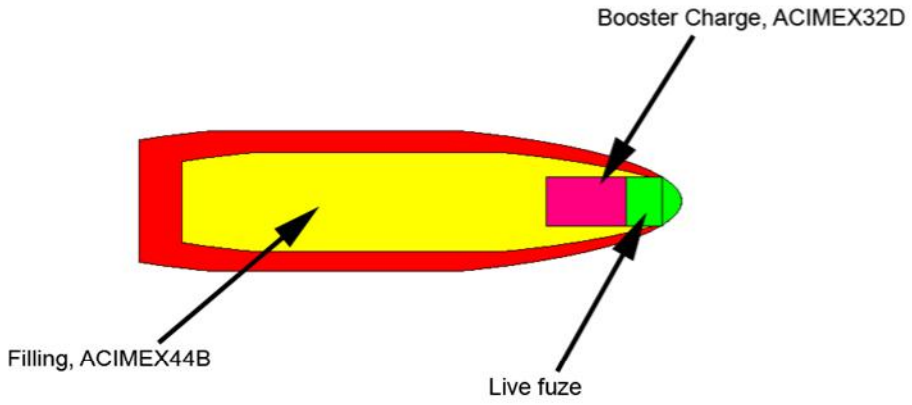

Figure 6: The test item in Test No. 4.

The parts in the test item in Test No. 4 are summarized in Table 6.

Table 6: The parts in the test item in Test No. 4.

Part	Test ID No.	Colour
Live Projectile	YYYY-4	Red
Live Booster	YYYY-14	Not Applicable
Live Fuze	YYYY-24	Not Applicable

The point of impact in Test No. 4 is shown in Figure 7.

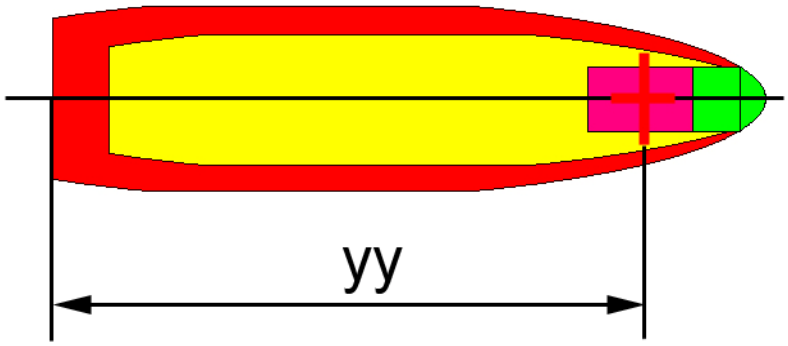

Figure 7: The point of impact in Test No. 4.

3 Test procedure

The tests were performed in accordance with Reference 3.

Test No. 1 was the first test to be performed followed by Test No. 2, Test No. 3 and finally Test No. 4.

Test No. 1 was performed as follows:

1. The test item was positioned correctly.
2. All personnel except for the Test Technicians took cover.
3. Electrical resistance in the open initiation chain (firing cable) was measured.
4. The initiation chain (firing cable) was short-circuited.
5. Electrical resistance in the short-circuited initiation chain (firing cable) was measured.
6. The blasting cap was connected to the short-circuited initiation chain.
7. Electrical resistance in the initiation chain (firing cable and blasting cap) was measured.
8. The blasting cap was installed into the modified fuze system on the test item.
9. The Test Technicians took cover.
10. The test item was initiated to detonation.
11. Waiting time as decided by the Test Officer.
12. Preliminary inspection of the test site performed by the Test Officer.
13. Inspection of the test site and assessment of the result.

Test No. 2, Test No. 3 and Test No. 4 was performed as follows:

1. The test item was positioned correctly.
2. All personnel except for the Test Technicians took cover.
3. The gun was loaded.
4. The Test Technicians took cover.
5. The gun was fired.
6. Waiting time as decided by the Test Officer.
7. Preliminary inspection of the test site performed by the Test Officer.
8. Inspection of the test site and assessment of the result.

Prior to Test No. 2 nn number of rounds were fired in order to measure the impact velocity and check the accuracy.

After completion of all tests the explosives remains were collected and disposed as further described in Chapter 8.

4 Test configuration

4.1 Test setups

4.1.1 Test No. 1 (calibration test)

The test setup for Test No. 1 is shown in Figure 8. The dimensions of the witness plate were (Width x Length x Thickness) yyyy mm x yyyy mm x yy mm. The depth of the sand bed was yy mm.

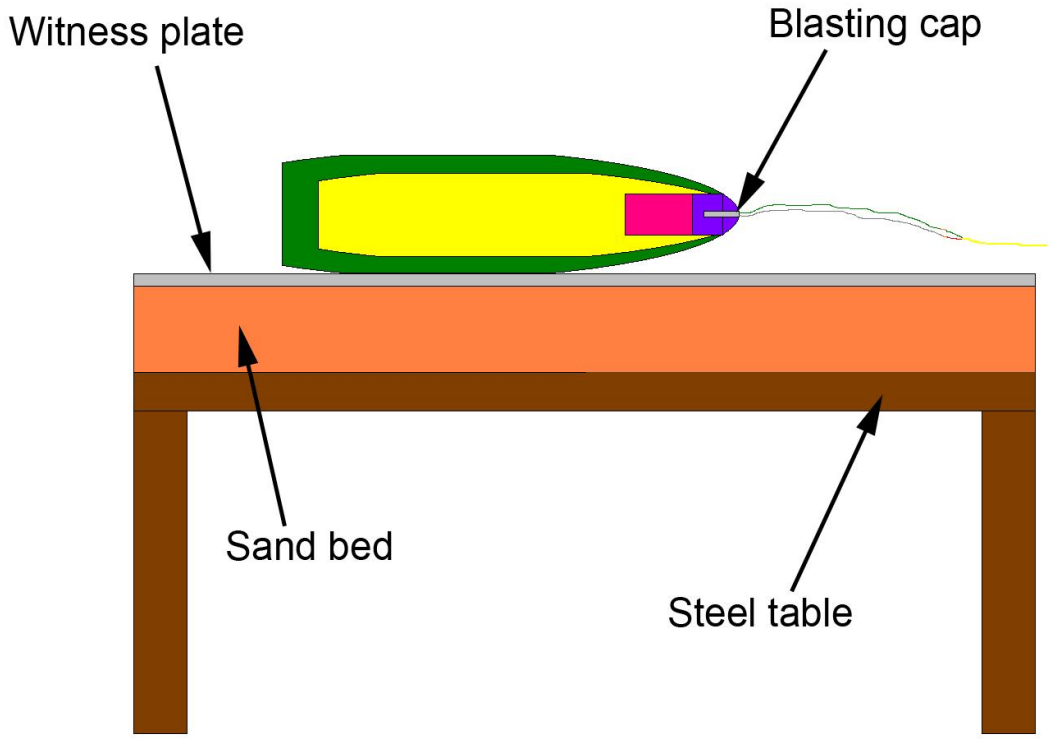

Figure 8: The test setup for Test No. 1 (calibration test).

4.1.2 Test No. 2 (calibration test), Test No. 3 and Test No. 4

The test setup for Test No. 2, Test No. 3 and Test No. 4 is shown in Figure 9. The dimensions of the witness plate were (Width x Length x Thickness)
yyyy mm x yyyy mm x yy mm. The depth of the sand bed was yy mm.

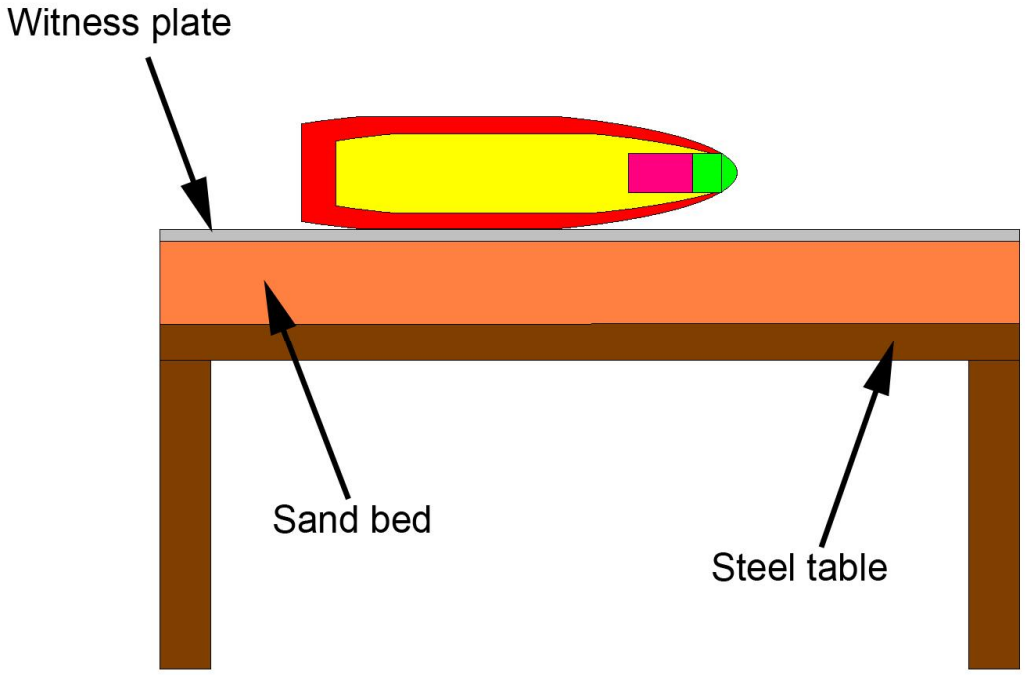

Figure 9: The test setup for Test No. 2, Test No. 3 and Test No. 4 (picture from Test No. 4).

4.2 Test layout

A schematic view, not to scale, of the test layout is shown in Figure 10. The air blast pressure gauges were placed in orthogonal directions from the centre point of the test item. The distance in meters from the centre point of the test item to each piece of equipment is described in Table 7.

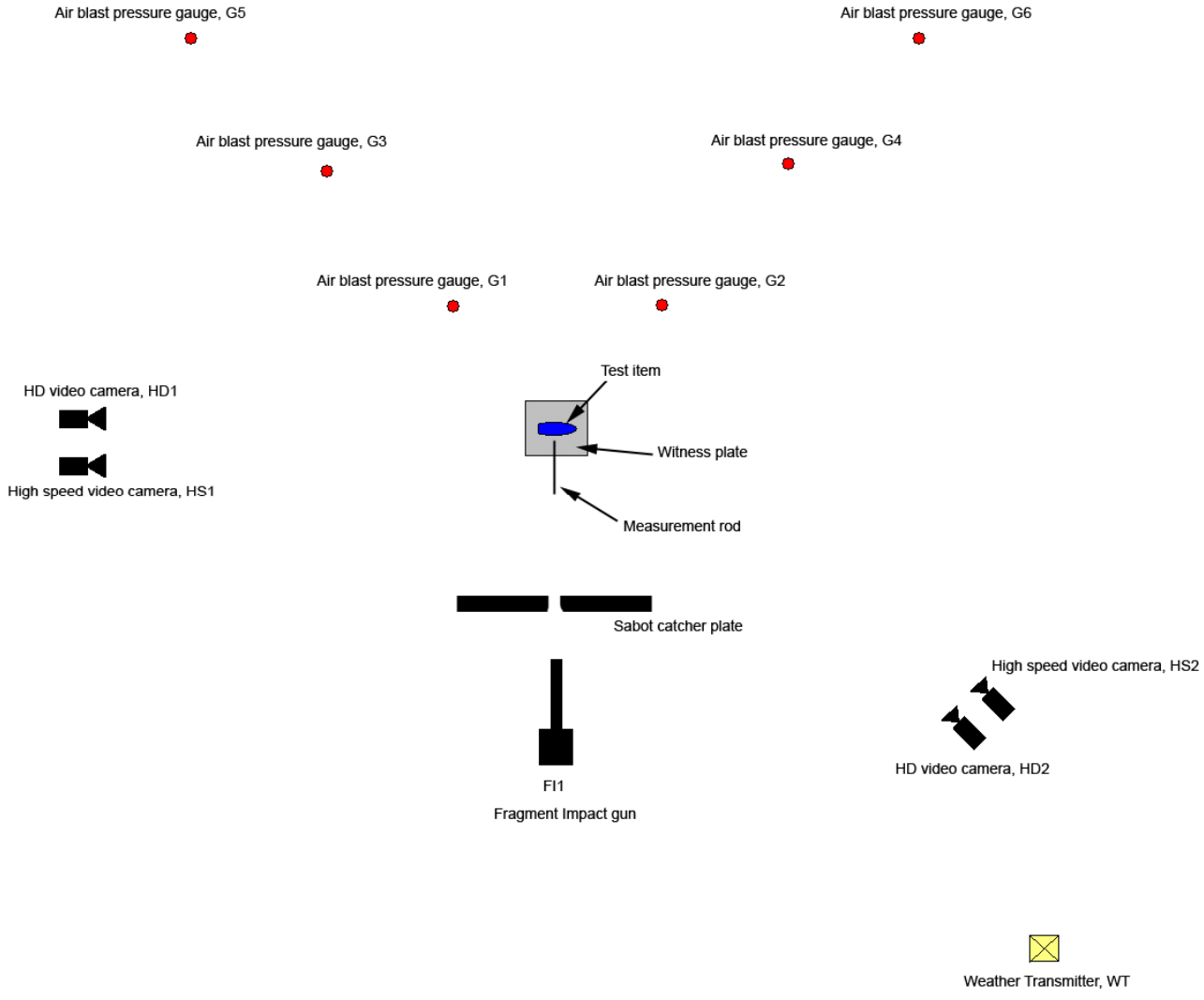

Figure 10: A schematic view, not to scale, of the test layout.

Table 7: The distance from the centre point of the test item to each piece of equipment.

Piece of equipment	Distance from the centre point of the test item (m)
HS1	NN
HD1	NN
HS2	NN
HD2	NN
G1	N
G2	N
G3	NN
G4	NN
G5	NN
G6	NN
FI1	NN
WT	NN

5 Safety measures

The tests were performed in accordance with Bofors Test Center's Safety and Security Plan.

6 Meteorological conditions

The meteorological conditions at the time of each test are described in Table 8.

Table 8: The meteorological conditions at the time of each test.

Test No.	Date and time	Barometric pressure (hPa)	Relative humidity (%RH)	Liquid Precipitation (mm)	Wind speed (m/s)	Wind direction (º)	Air temperature (ºC)
1	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
3	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
4	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n

7 Results

N.B. Following Chapters (7.1-7.4) do not contain any pictures since the tests, as stated earlier, never have been performed.

7.1 Test No. 1 (calibration test)

Pictures from the high speed video cameras are shown in Figures 11-14.

No picture available

Figure 11: The test item when initiated (picture from HS1).

No picture available

Figure 12: The test item nn ms after initiation (picture from HS1).

No picture available

Figure 13: The test item when initiated (picture from HS2).

No picture available

Figure 14: The test item nn ms after initiation (picture from HS2).

The registered air blast pressure values are shown in Table 9. These values were used in Test No. 3 and Test No. 4 as reference values.

Table 9: The registered air blast pressure values in Test No. 1.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 15, fragments from the test item were found, see Figure 16. These fragments were used in Test No. 3 and Test No. 4 as references.

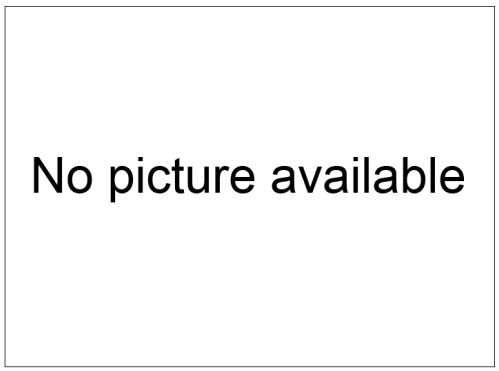

Figure 15: The test area after Test No. 1.

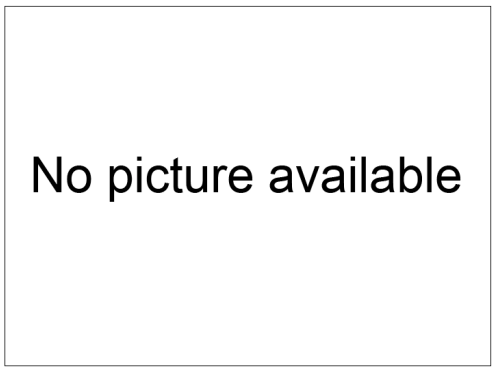

Figure 16: All collected fragments from the test item in Test No. 1.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 10 and are mapped in the sketch (not to scale) in Figure 17. These values were used in Test No. 3 and Test No. 4 as reference values of how far fragments could travel when the test item was initiated to detonation i.e. the possible worst case reaction.

Table 10: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

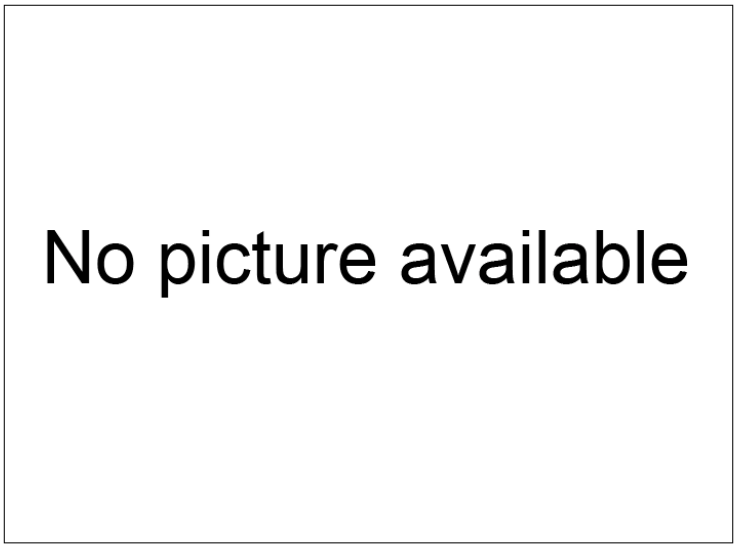

Figure 17: A sketch, not to scale, of the test area after Test No. 1.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 18. These values were used in Test No. 3 and Test No. 4 as reference values of the indent(s) and penetration(s) of one test item initiated to detonation.

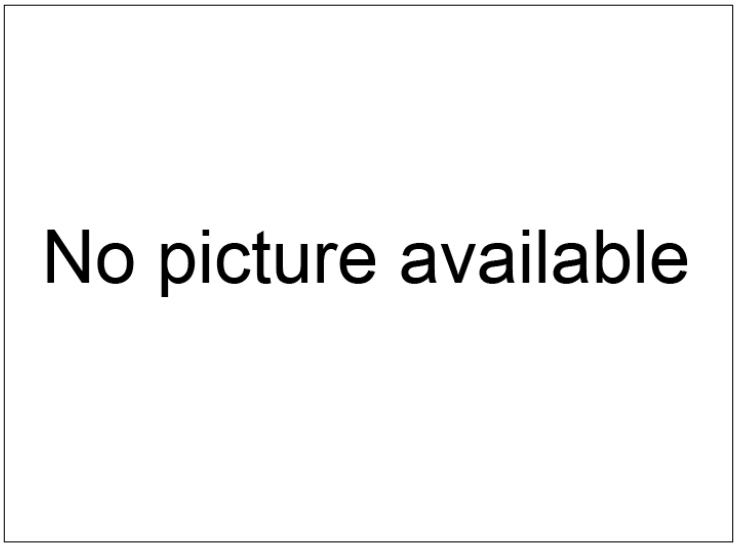

Figure 18: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

7.2 Test No. 2 (calibration test)

Pictures from the high speed video cameras are shown in Figures 19-24.

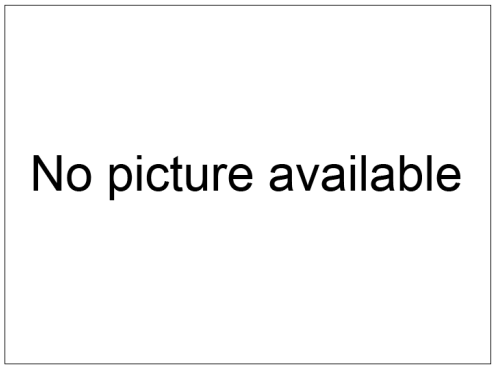

Figure 19: The fragment hits the test item (picture from HS1).

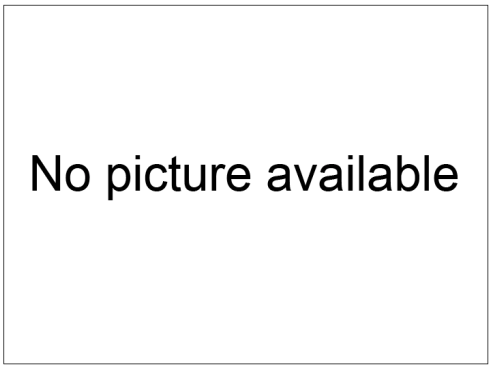

Figure 20: The fragment hits the test item (picture from HS2).

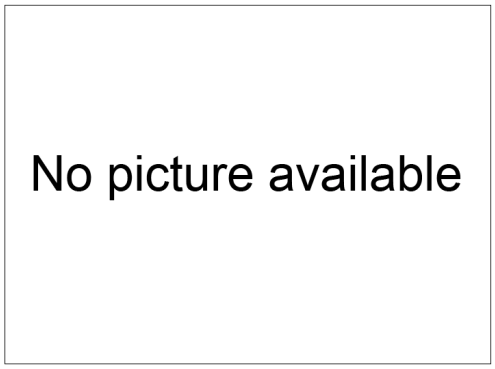

Figure 21: The test item nn ms after it was hit (picture from HS1).

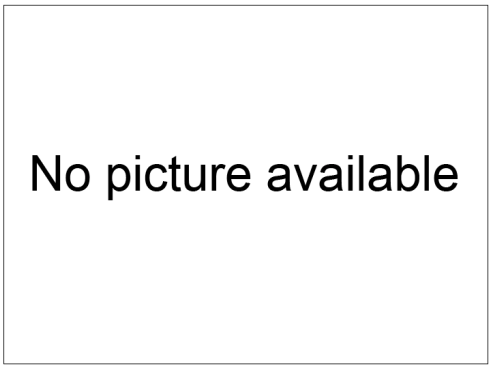

Figure 22: The test item nn ms after it was hit (picture from HS2).

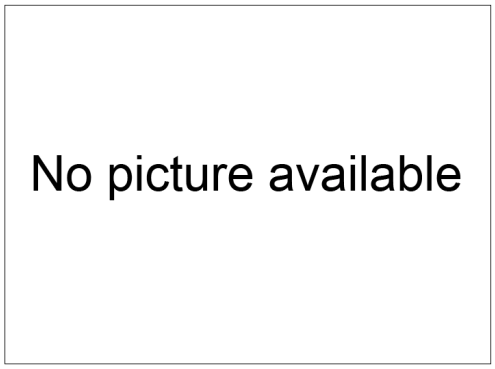

Figure 23: The test item nnn ms after it was hit (picture from HS1).

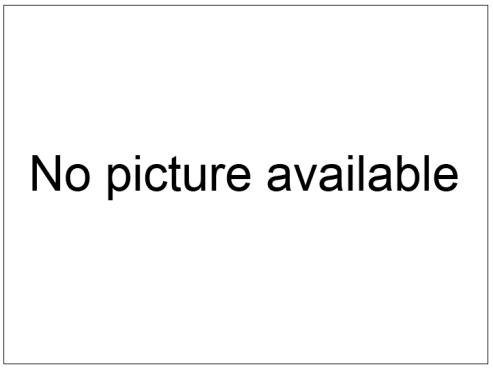

Figure 24: The test item nnn ms after it was hit (picture from HS2).

The fragment impact velocity was nnnn m/s.

The registered air blast pressure values are shown in Table 11. These values were used in Test No. 3 and Test No. 4 as reference values.

Table 11: The registered air blast pressure values in Test No. 2.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 25, fragments from the test item were found, see Figure 26. These fragments were used in Test No. 3 and Test No. 4 as references.

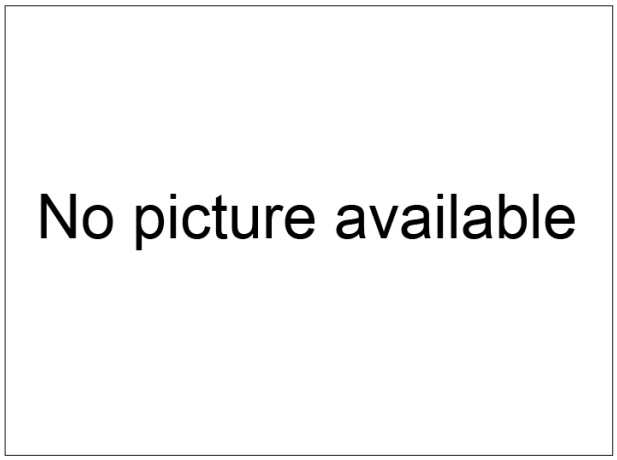

Figure 25: The test area after Test No. 2.

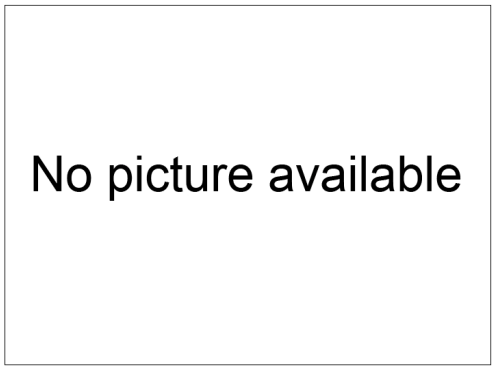

Figure 26: All collected fragments from the test item in Test No. 2.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 12 and are mapped in the sketch (not to scale) in Figure 27. These values were used in Test No. 3 and Test No. 4 as reference values of how far fragments from an inert test item could travel only due to the kinetic energy provided by the STANAG 4496 Standard Fragment.

Table 12: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

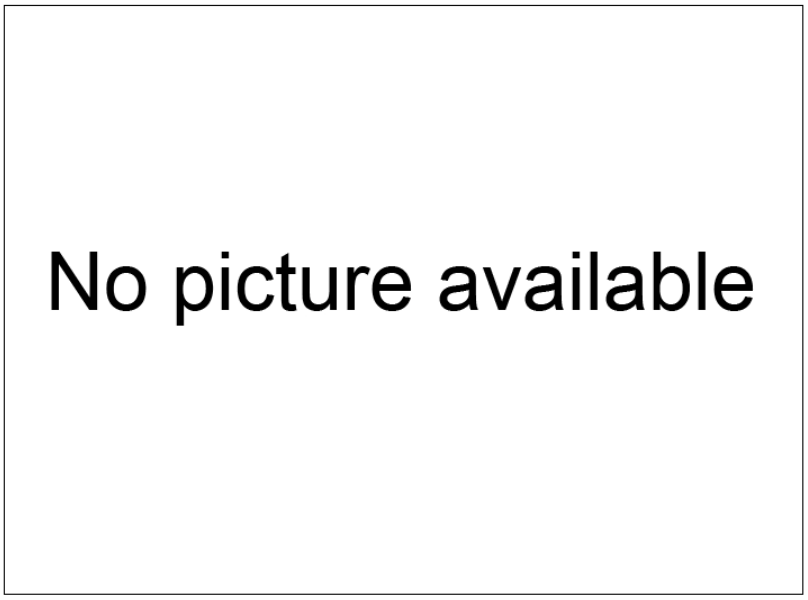

Figure 27: A sketch, not to scale, of the test area after Test No. 2.

The witness plate had no indents and was not penetrated, see Figure 28.

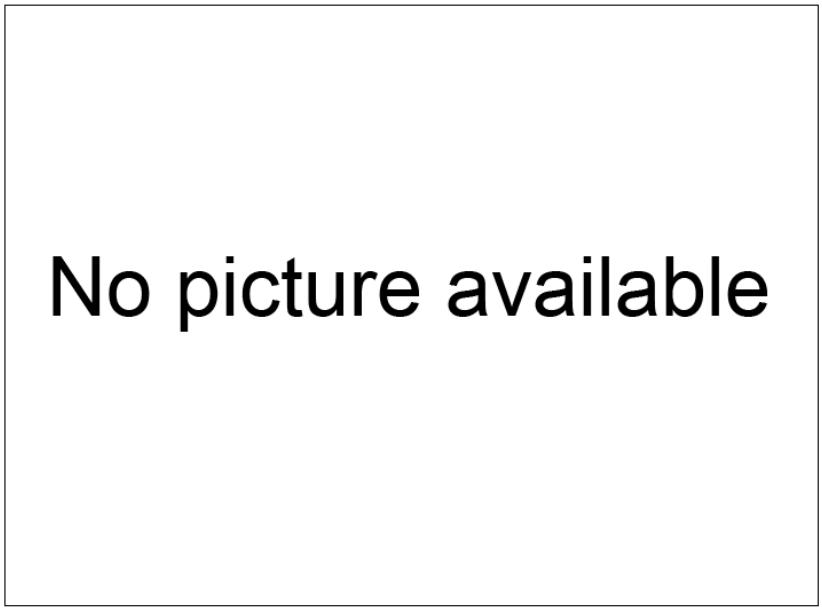

Figure 28: The witness plate had no indents and was not penetrated.

7.3 Test No. 3

Pictures from the high speed video cameras are shown in Figures 29-34.

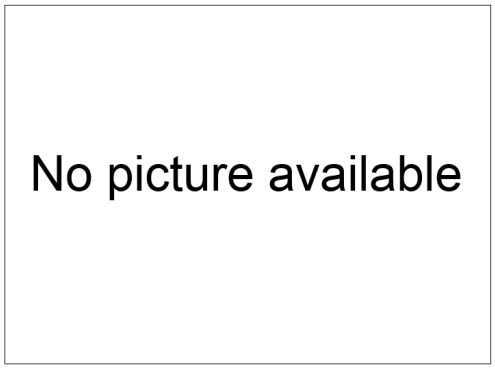

Figure 29: The fragment hits the test item (picture from HS1).

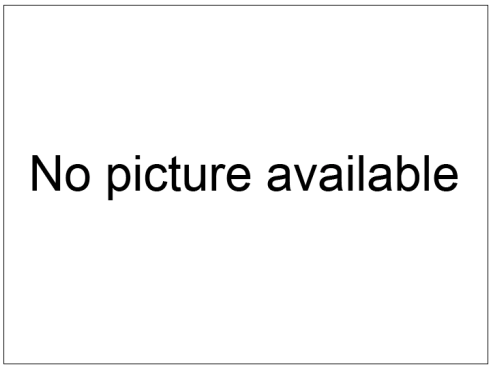

Figure 30: The fragment hits the test item (picture from HS2).

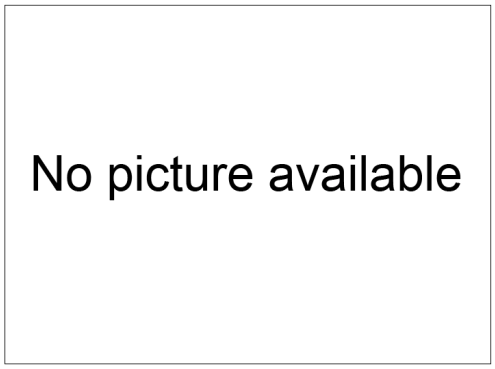

Figure 31: The test item nn ms after it was hit (picture from HS1).

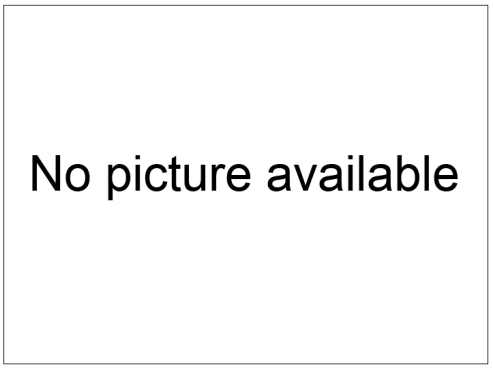

Figure 32: The test item nn ms after it was hit (picture from HS2).

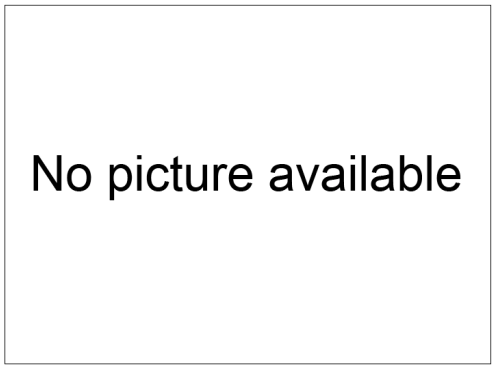

Figure 33: The test item nnn ms after it was hit (picture from HS1).

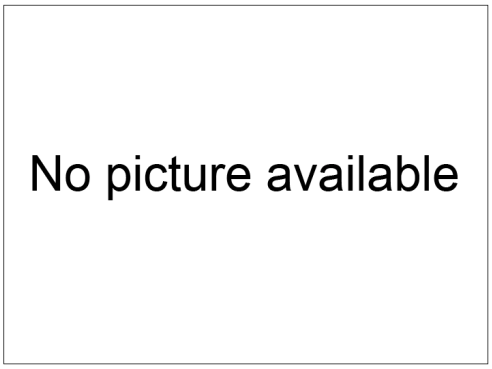

Figure 34: The test item nnn ms after it was hit (picture from HS2).

The fragment impact velocity was nnnn m/s.

The registered air blast pressure values are shown in Table 13.

Table 13: The registered air blast pressure values in Test No. 3.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 35, fragments from the test item were found, see Figure 36.

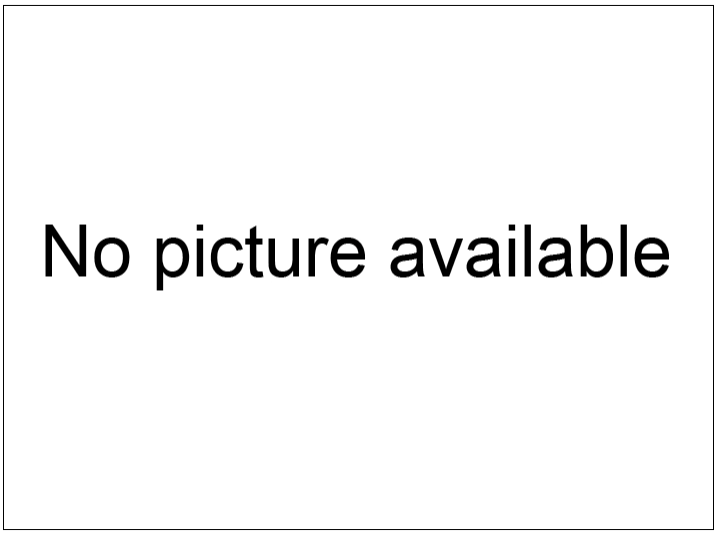

Figure 35: The test area after Test No. 3.

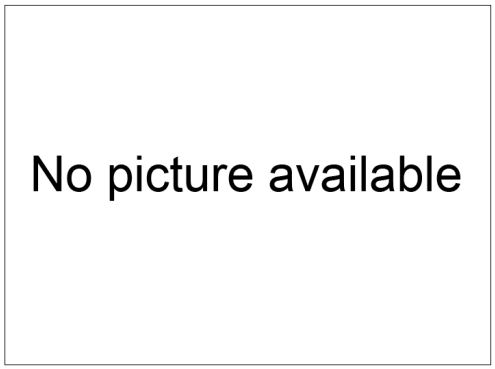

Figure 36: All collected fragments from the test item in Test No. 3.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 14 and are mapped in the sketch (not to scale) in Figure 37.

Table 14: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

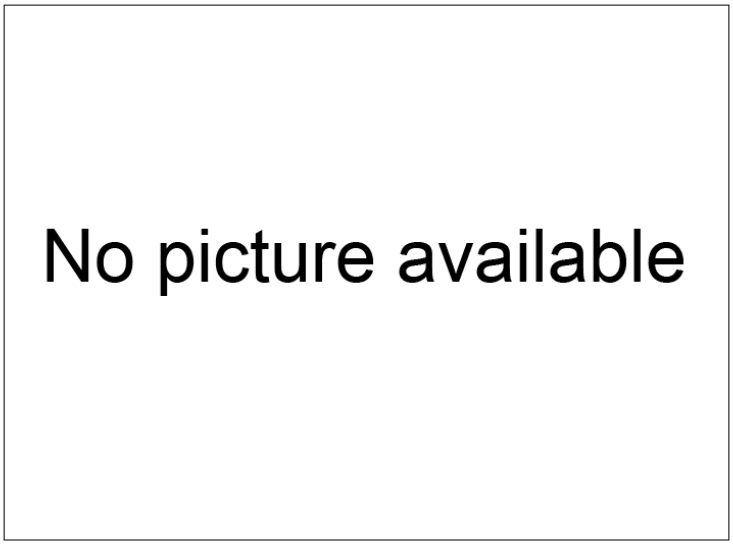

Figure 37: A sketch, not to scale, of the test area after Test No. 3.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 38.

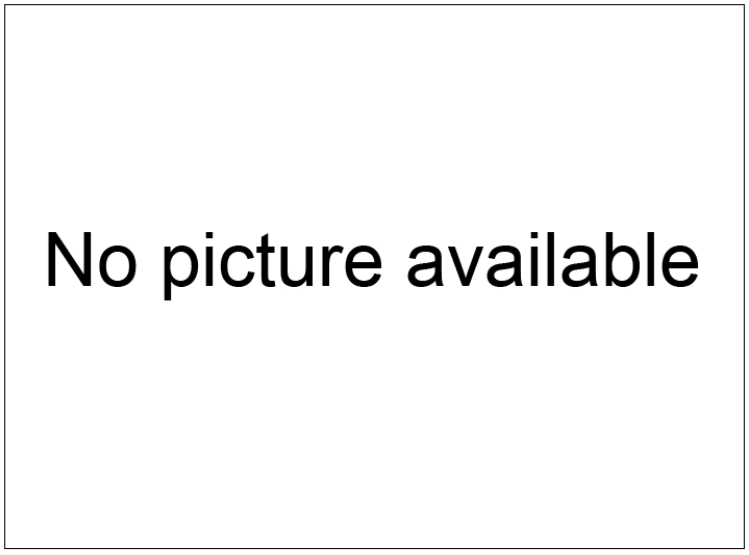

Figure 38: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapters 7.1, 7.2, 7.3 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

7.4 Test No. 4

Pictures from the high speed video cameras are shown in Figures 39-44.

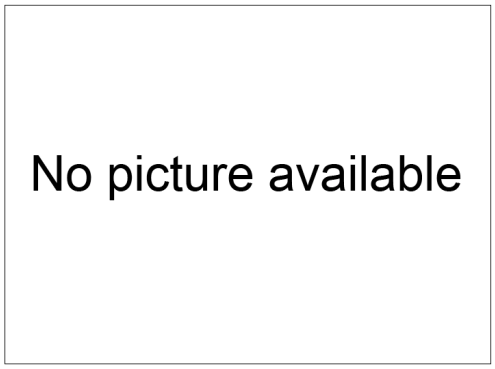

Figure 39: The fragment hits the test item (picture from HS1).

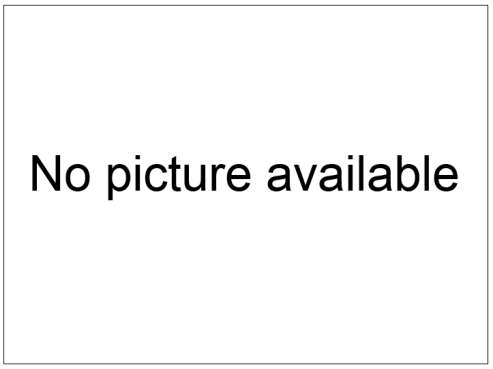

Figure 40: The fragment hits the test item (picture from HS2).

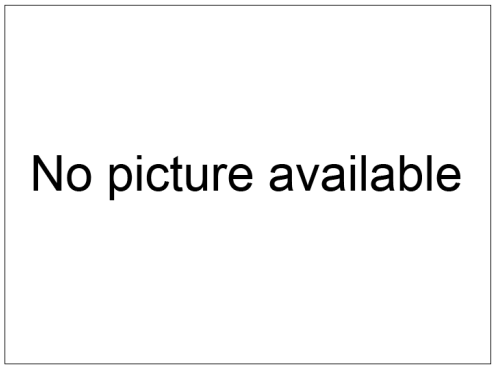

Figure 41: The test item nn ms after it was hit (picture from HS1).

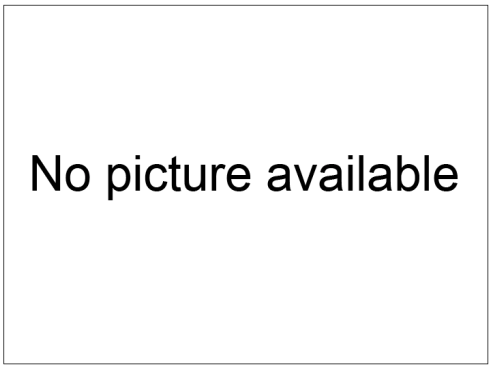

Figure 42: The test item nn ms after it was hit (picture from HS2).

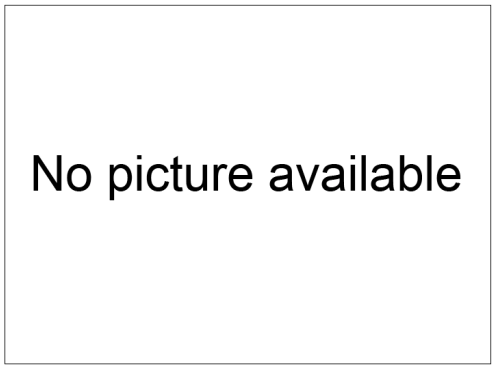

Figure 43: The test item nnn ms after it was hit (picture from HS1).

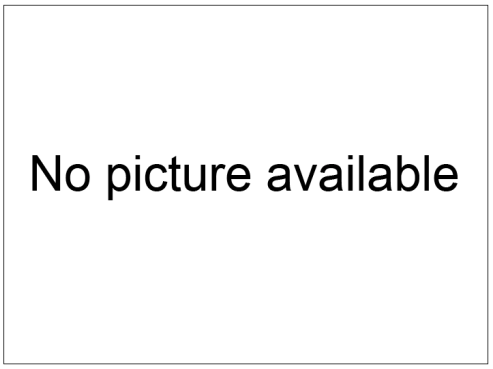

Figure 44: The test item nnn ms after it was hit (picture from HS2).

The fragment impact velocity was nnnn m/s.

The registered air blast pressure values are shown in Table 15.

Table 15: The registered air blast pressure values in Test No. 4.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 45, fragments from the test item were found, see Figure 46.

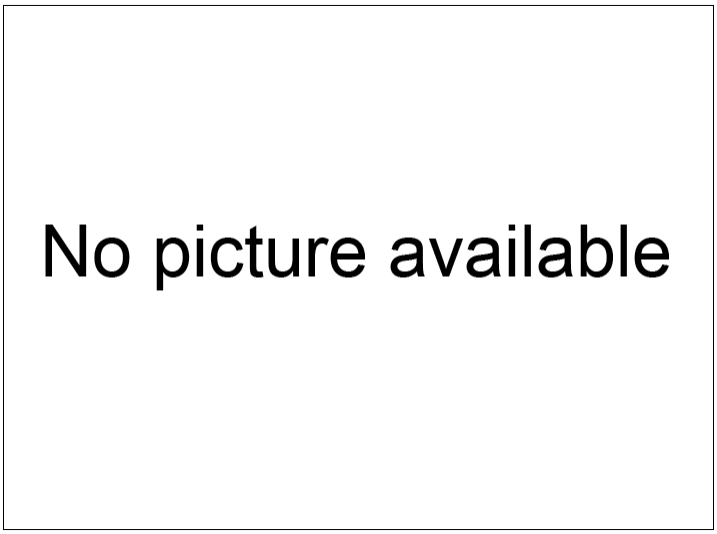

Figure 45: The test area after Test No. 4.

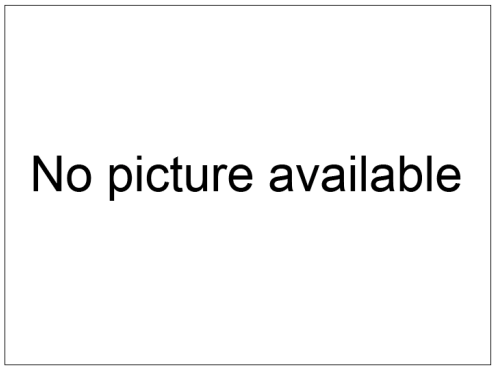

Figure 46: All collected fragments from the test item in Test No. 4.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 16 and are mapped in the sketch (not to scale) in Figure 47.

Table 16: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

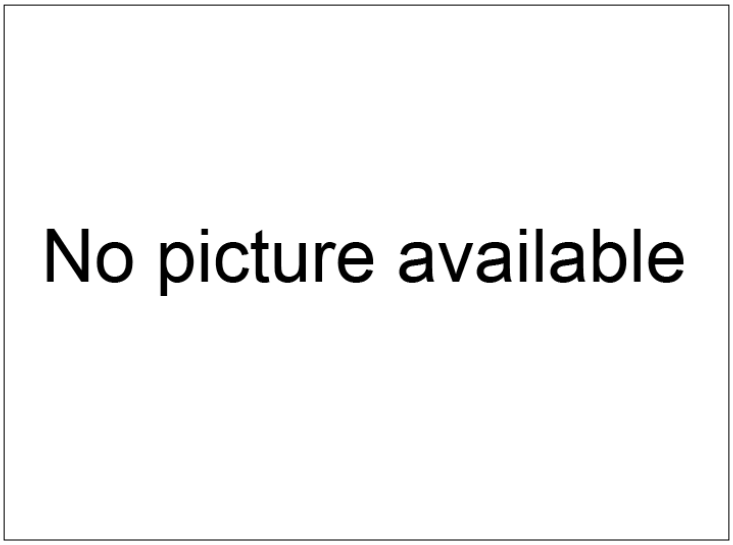

Figure 47: A sketch, not to scale, of the test area after Test No. 4.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 48.

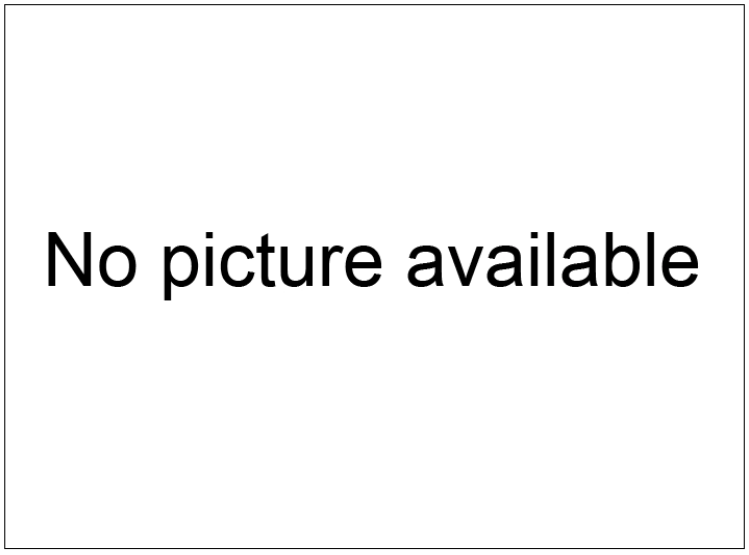

Figure 48: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapters 7.1, 7.2, 7.4 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

8 Disposal of explosive items

After completion of all tests the explosives remains were collected and disposed in one detonation using PETN based plastic explosives and one blasting cap, see Figures 49-50.

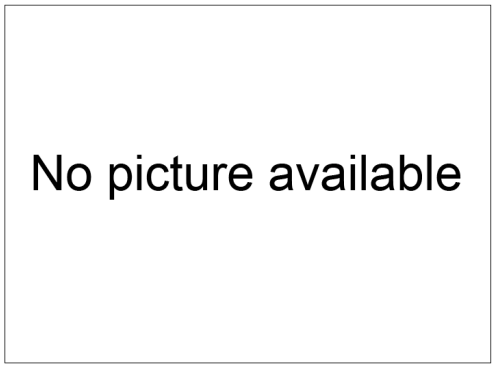

Figure 49: All collected explosives remains before disposal.

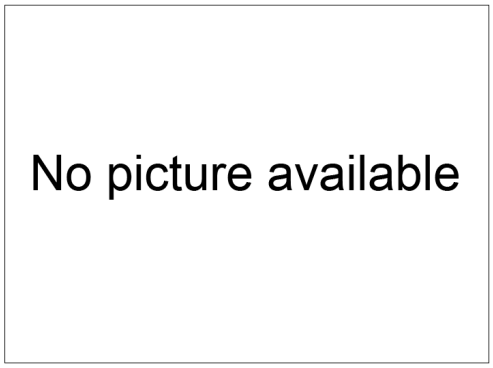

Figure 50: The site after disposal.

9 Conclusions

The fragment impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two fragment impact tests performed.

10 References

[1.] STANAG 4496 “Fragment Impact, Munitions Test Procedures”, Edition 1, 13th of December 2006

[2.] AOP-39 “Guidance on the Assessment and Development of Insensitive Munitions (IM)”, Edition 3, March 2010

[3.] Test Procedure “Fragment Impact Tests, NNNN 155 HEIM”, Edition 1, NNNN Corporation, NNth of Nnn 20NN

Bullet Impact Tests performed on NNNN 155 HEIM

Abstract

N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Bullet Impact Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

The purpose of these tests was to determine the bullet impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation.

Four tests were performed. Test No. 1 and Test No. 2 were calibration tests. In Test No. 3 three cal 0.50 AP M2 bullets were fired at the largest explosive component and in Test No. 4 three cal 0.50 AP M2 bullets were fired at the booster.

The bullet impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two bullet impact tests performed.

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N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Bullet Impact Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

1 Introduction

1.1 Background

The purpose of these tests was to determine the bullet impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation.

The tests were performed in accordance with Reference 1; STANAG 4241 “Bullet Impact, Munition Test Procedures”, Edition 2. The results of the tests were assessed in accordance with Reference 2; AOP-39 “Guidance on the Assessment and Development of Insensitive Munitions (IM)”, Edition 3.

The tests were sponsored by NNNN Corporation, Department NNN.

1.2 Aim and objectives of the tests

Four tests were performed.

Test No. 1 was a calibration test. The purpose of performing this test was to obtain knowledge about the air blast pressure levels, the fragmentation, fragment distribution and witness plate damage when one live projectile was initiated to detonation using a blasting cap i.e. the possible worst case reaction.

Test No. 2 was also a calibration test. The purpose of performing this test was to obtain knowledge about the air blast pressure levels, the fragmentation, fragment distribution and witness plate damage when one inert projectile was hit by three cal 0.50 AP M2 bullets. I.e. to study the damage caused to the projectile only by the kinetic energy from the three cal 0.50 AP M2 bullets.

In Test No. 3, three cal 0.50 AP M2 bullets were fired at the largest explosive component.

In Test No. 4, three cal 0.50 AP M2 bullets were fired at the booster.

1.3 Place and date

The tests were performed at Bofors Test Center in Karlskoga, Sweden at test site Abborrtjärn, see Figure 1, the NNth and the NNth of Nnn 20NN.

Figure 1: Test site Abborrtjärn.

1.4 Test procedure

The tests were performed in accordance with Reference 3; Test Procedure "Bullet Impact Tests, NNNN 155 HEIM", Edition 1, published by NNNN Corporation the NNth of Nnn 20NN. The test procedure is also briefly described in Chapter 3.

1.5 Test officials

From Bofors Test Center following personnel worked at the test site with these tests:

Name, Title
Name, Title
Name, Title
Name, Title
Name, Title

1.6 Participating personnel

From NNNN Corporation following personnel worked at the test site with these tests:

Name, Title
Name, Title
Name, Title

2 Test equipment

2.1 Test site equipment

The test equipment provided by Bofors Test Center is described in Table 1.

Table 1: Test equipment provided by Bofors Test Center.

Type of equipment	Name	Bofors Test Center No.
Bullet Impact Gun	NNN	B NNNN-NNNN
Bullet Impact Gun	NNN	B NNNN-NNNN
Bullet Impact Gun	NNN	B NNNN-NNNN
Firing control system	NNN	B NNNN-NNNN
Cal 0.50 AP M2 rounds	NNN	Not Applicable
Doppler radar	NNN	B NNNN-NNNN
Transient Recorder	NNN	B NNNN-NNNN
Amplifier	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
High speed video camera	NNN	B NNNN-NNNN
High speed video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
Witness plates (x4)	NNN	Not Applicable
Weather Transmitter	NNN	B NNNN-NNNN
Initiation System	NNN	B NNNN-NNNN
Electrical resistance measurement device	NNN	B NNNN-NNNN
Blasting cap (x1)	NNN	Not Applicable

2.2 Customer provided equipment

The test equipment provided by NNNN Corporation is described in Table 2.

Table 2: Test equipment provided by NNNN Corporation.

Type of equipment	Name	Drawing No.	Test ID No.
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-1
Inert Projectile	NNNN 155 HEIM, Inert	NNN-2	YYYY-2
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-3
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-4
Live Booster	NNNN, Live Booster	NNN-3	YYYY-11
Inert Booster	NNNN, Inert Booster	NNN-4	YYYY-12
Live Booster	NNNN, Live Booster	NNN-3	YYYY-13
Live Booster	NNNN, Live Booster	NNN-3	YYYY-14
Modified Fuze	NNNN, Modified Fuze	NNN-5	YYYY-21
Inert Fuze	NNNN, Inert Fuze	NNN-6	YYYY-22
Live Fuze	NNNN, Live Fuze	NNN-7	YYYY-23
Live Fuze	NNNN, Live Fuze	NNN-7	YYYY-24

The NNNN 155 HEIM is a 155 mm artillery projectile with following specifications:

Weight, with live fuze: NN.NNN kg
Filling, ACIMEX44B: N.NN kg
Booster Charge, ACIMEX32D: N.NN kg
Length, with live fuze: NNN mm

2.3 Test items

2.3.1 Test No. 1 (calibration test)

The test item in Test No. 1 was one live projectile NNNN 155 HEIM, Live (YYYY-1) equipped with one live booster NNNN, Live Booster (YYYY-11) and one modified fuze NNNN, Modified Fuze (YYYY-21) as shown in Figure 2. The modified fuze was made in order to assemble a blasting cap and by the blasting cap initiate the test item to detonation.

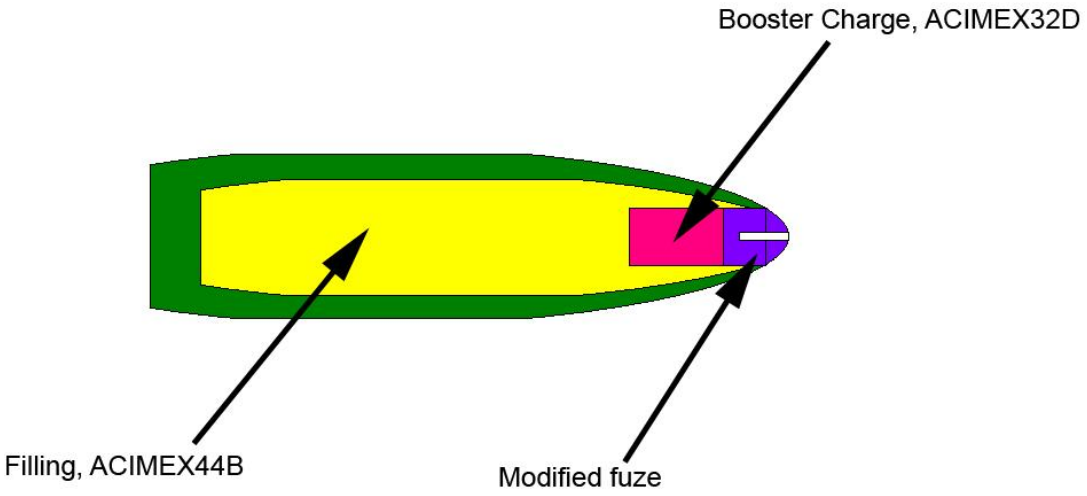

Figure 2: The test item in Test No. 1.

The parts in the test item in Test No. 1 are summarized in Table 3.

Table 3: The parts in the test item in Test No. 1.

Part	Test ID No.	Colour
Live Projectile	YYYY-1	Green
Live Booster	YYYY-11	Not Applicable
Modified Fuze	YYYY-21	Not Applicable

2.3.2 Test No. 2 (calibration test)

The test item in Test No. 2 was one inert projectile NNNN 155 HEIM, Inert (YYYY-2) equipped with one inert booster NNNN, Inert Booster (YYYY-12) and one inert fuze NNNN, Inert Fuze (YYYY-22) as shown in Figure 3.

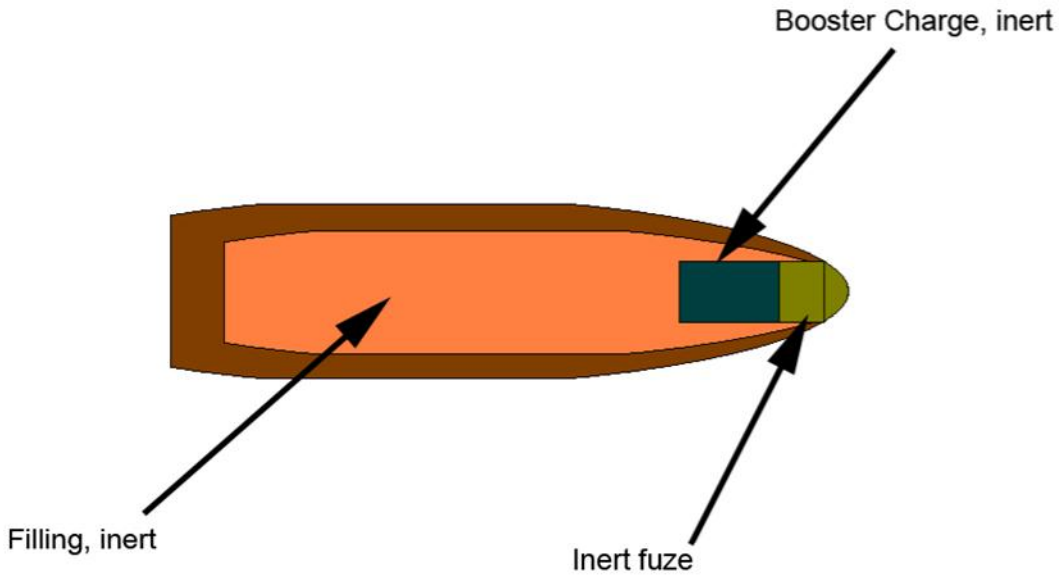

Figure 3: The test item in Test No. 2.

The parts in the test item in Test No. 2 are summarized in Table 4.

Table 4: The parts in the test item in Test No. 2.

Part	Test ID No.	Colour
Inert Projectile	YYYY-2	Brown
Inert Booster	YYYY-12	Not Applicable
Inert Fuze	YYYY-22	Not Applicable

2.3.3 Test No. 3

The test item in Test No. 3 was one live projectile NNNN 155 HEIM, Live (YYYY-3) equipped with one live booster NNNN, Live Booster (YYYY-13) and one live fuze NNNN, Live Fuze (YYYY-23) as shown in Figure 4.

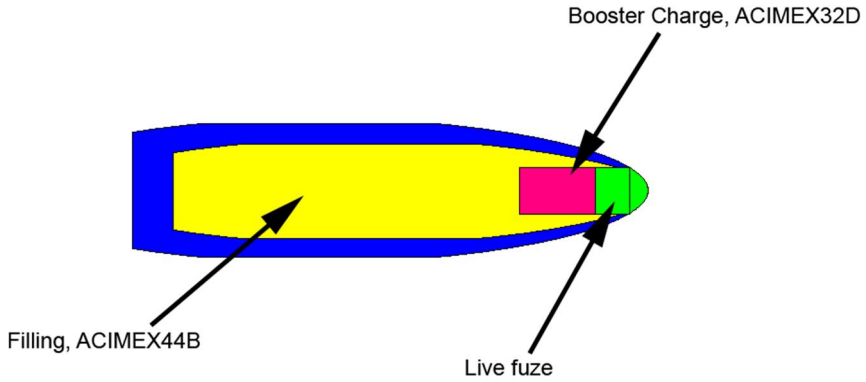

Figure 4: The test item in Test No. 3.

The parts in the test item in Test No. 3 are summarized in Table 5.

Table 5: The parts in the test item in Test No. 3.

Part	Test ID No.	Colour
Live Projectile	YYYY-3	Blue
Live Booster	YYYY-13	Not Applicable
Live Fuze	YYYY-23	Not Applicable

The point of impact in Test No. 3 is shown in Figure 5.

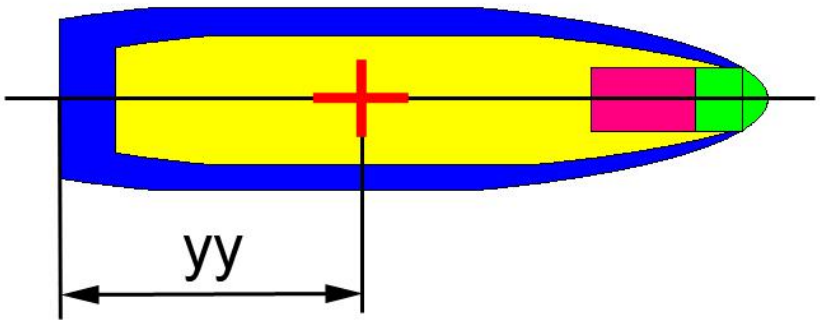

Figure 5: The point of impact in Test No. 3.

2.3.4 Test No. 4

The test item in Test No. 4 was one live projectile NNNN 155 HEIM, Live (YYYY-4) equipped with one live booster NNNN, Live Booster (YYYY-14) and one live fuze NNNN, Live Fuze (YYYY-24) as shown in Figure 6.

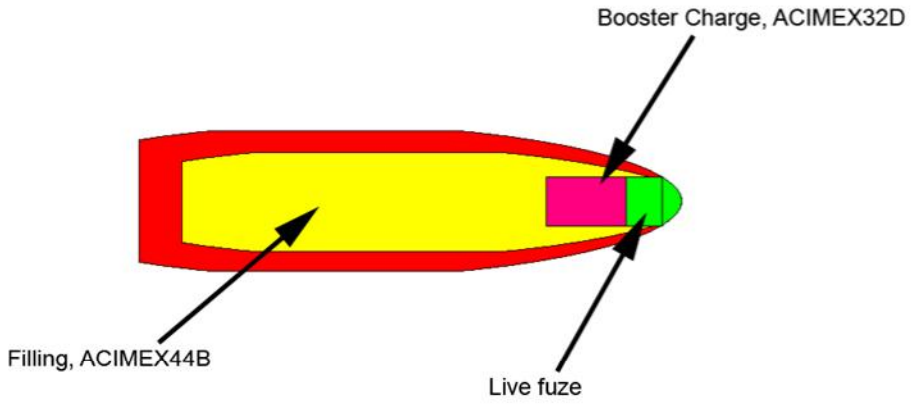

Figure 6: The test item in Test No. 4.

The parts in the test item in Test No. 4 are summarized in Table 6.

Table 6: The parts in the test item in Test No. 4.

Part	Test ID No.	Colour
Live Projectile	YYYY-4	Red
Live Booster	YYYY-14	Not Applicable
Live Fuze	YYYY-24	Not Applicable

The point of impact in Test No. 4 is shown in Figure 7.

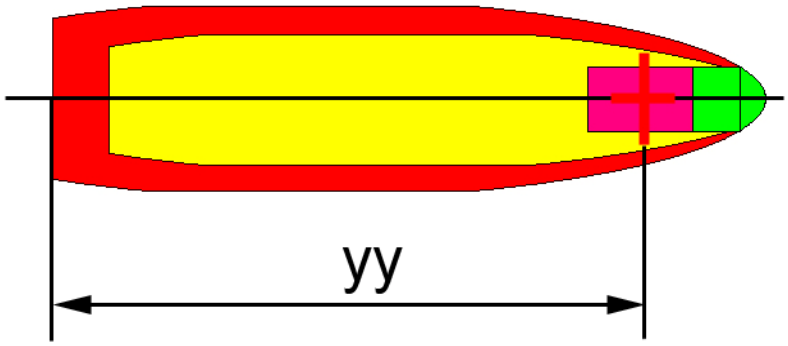

Figure 7: The point of impact in Test No. 4.

3 Test procedure

The tests were performed in accordance with Reference 3.

Test No. 1 was the first test to be performed followed by Test No. 2, Test No. 3 and finally Test No. 4.

Test No. 1 was performed as follows:

1. The test item was positioned correctly.
2. All personnel except for the Test Technicians took cover.
3. Electrical resistance in the open initiation chain (firing cable) was measured.
4. The initiation chain (firing cable) was short-circuited.
5. Electrical resistance in the short-circuited initiation chain (firing cable) was measured.
6. The blasting cap was connected to the short-circuited initiation chain.
7. Electrical resistance in the initiation chain (firing cable and blasting cap) was measured.
8. The blasting cap was installed into the modified fuze system on the test item.
9. The Test Technicians took cover.
10. The test item was initiated to detonation.
11. Waiting time as decided by the Test Officer.
12. Preliminary inspection of the test site performed by the Test Officer.
13. Inspection of the test site and assessment of the result.

Test No. 2, Test No. 3 and Test No. 4 was performed as follows:

1. The test item was positioned correctly.
2. All personnel except for the Test Technicians took cover.
3. The guns were loaded.
4. The Test Technicians took cover.
5. The guns were fired.
6. Waiting time as decided by the Test Officer.
7. Preliminary inspection of the test site performed by the Test Officer.
8. Inspection of the test site and assessment of the result.

Prior to Test No. 2 nn number of rounds were fired with each gun in order to measure the impact velocity and check the accuracy.

After completion of all tests the explosives remains were collected and disposed as further described in Chapter 8.

4 Test configuration

4.1 Test setups

4.1.1 Test No. 1 (calibration test)

The test setup for Test No. 1 is shown in Figure 8. The dimensions of the witness plate were (Width x Length x Thickness) yyyy mm x yyyy mm x yy mm. The depth of the sand bed was yy mm.

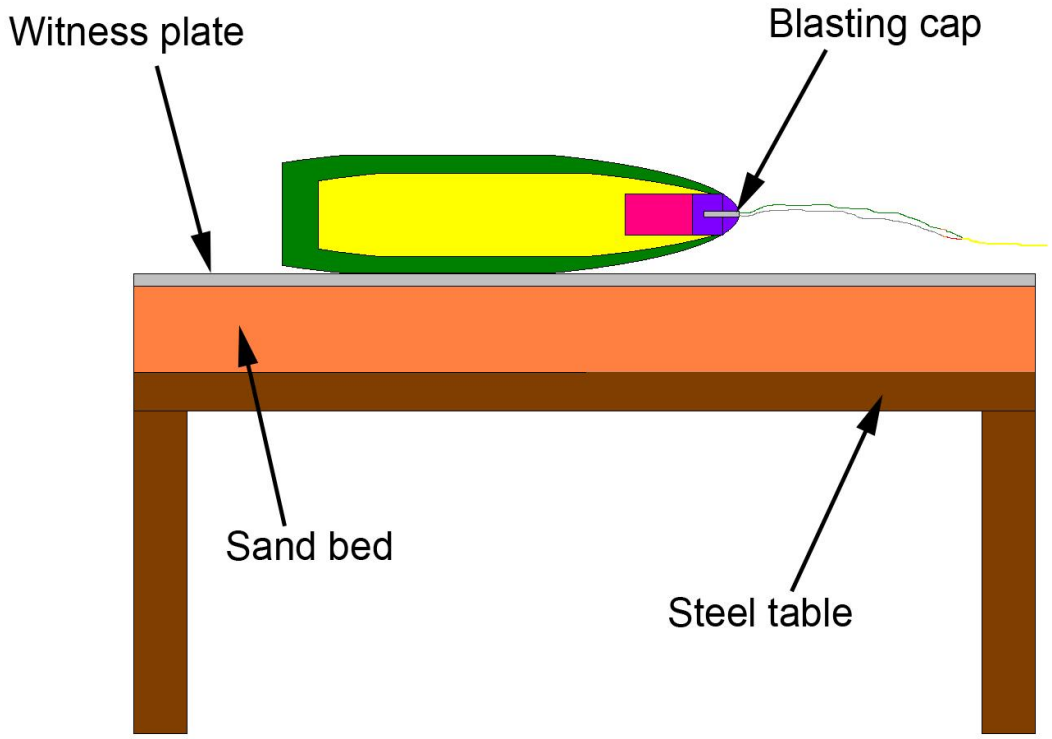

Figure 8: The test setup for Test No. 1 (calibration test).

4.1.2 Test No. 2 (calibration test), Test No. 3 and Test No. 4

The test setup for Test No. 2, Test No. 3 and Test No. 4 is shown in Figure 9. The dimensions of the witness plate were (Width x Length x Thickness)
yyyy mm x yyyy mm x yy mm. The depth of the sand bed was yy mm.

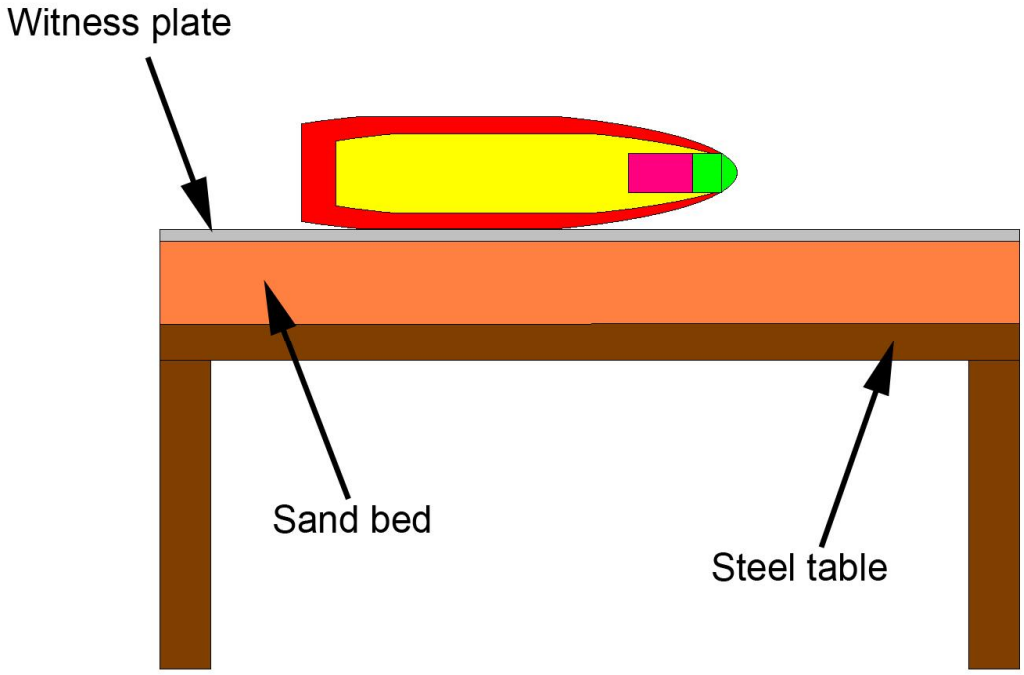

Figure 9: The test setup for Test No. 2, Test No. 3 and Test No. 4 (picture from Test No. 4).

4.2 Test layout

A schematic view, not to scale, of the test layout is shown in Figure 10. The air blast pressure gauges were placed in orthogonal directions from the centre point of the test item. The distance in meters from the centre point of the test item to each piece of equipment is described in Table 7.

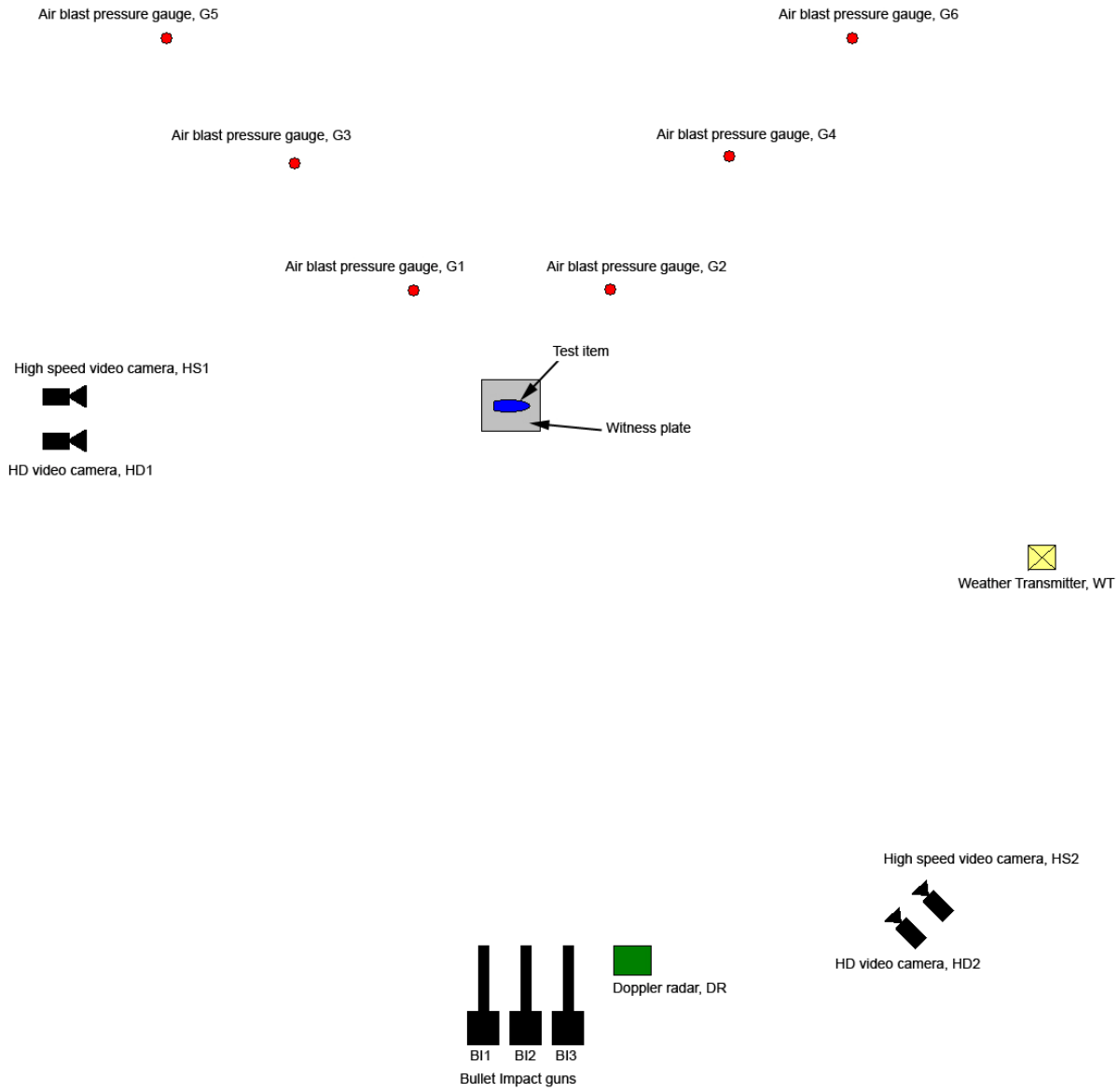

Figure 10: A schematic view, not to scale, of the test layout.

Table 7: The distance from the centre point of the test item to each piece of equipment.

Piece of equipment	**Distance from the centre point of the test item (m)**
HS1	NN
HD1	NN
HS2	NN
HD2	NN
G1	N
G2	N
G3	NN
G4	NN
G5	NN
G6	NN
DR	NN
BI1	NN
BI2	NN
BI3	NN
WT	NN

5 Safety measures

The tests were performed in accordance with Bofors Test Center's Safety and Security Plan.

6 Meteorological conditions

The meteorological conditions at the time of each test are described in Table 8.

Table 8: The meteorological conditions at the time of each test.

Test No.	Date and time	Barometric pressure (hPa)	Relative humidity (%RH)	Liquid Precipitation (mm)	Wind speed (m/s)	Wind direction (º)	Air temperature (ºC)
1	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
3	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
4	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n

7 Results

N.B. Following Chapters (7.1-7.4) do not contain any pictures since the tests, as stated earlier, never have been performed.

7.1 Test No. 1 (calibration test)

Pictures from the high speed video cameras are shown in Figures 11-14.

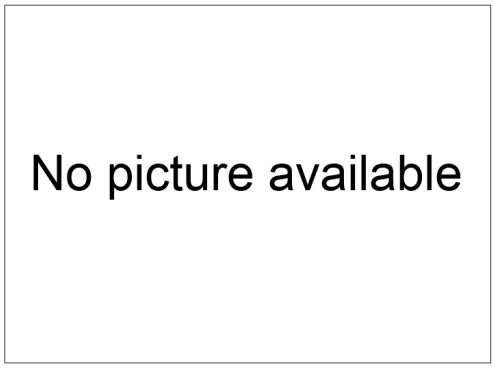

Figure 11: The test item when initiated (picture from HS1).

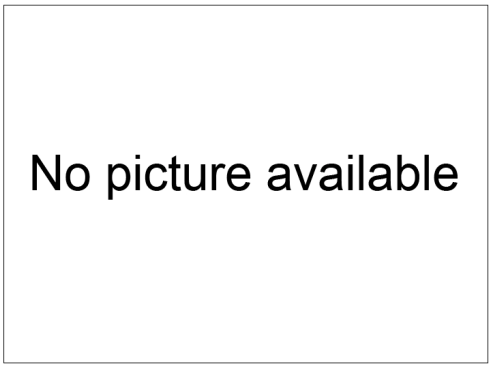

Figure 12: The test item nn ms after initiation (picture from HS1).

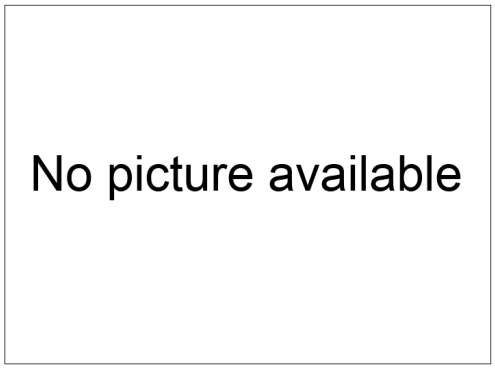

Figure 13: The test item when initiated (picture from HS2).

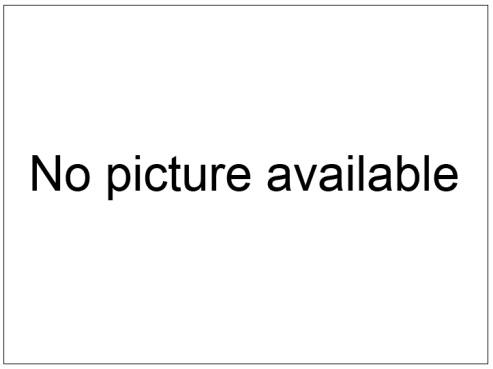

Figure 14: The test item nn ms after initiation (picture from HS2).

The registered air blast pressure values are shown in Table 9. These values were used in Test No. 3 and Test No. 4 as reference values.

Table 9: The registered air blast pressure values in Test No. 1.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 15, fragments from the test item were found, see Figure 16. These fragments were used in Test No. 3 and Test No. 4 as references.

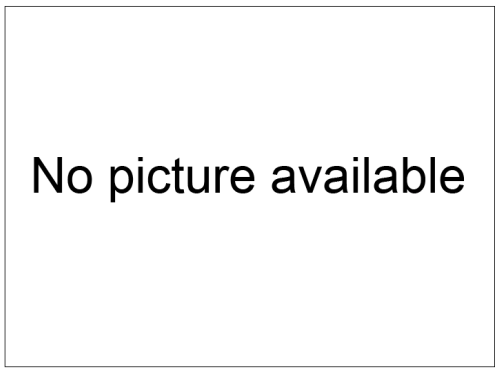

Figure 15: The test area after Test No. 1.

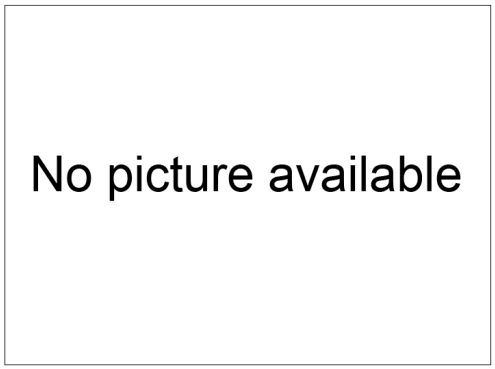

Figure 16: All collected fragments from the test item in Test No. 1.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 10 and are mapped in the sketch (not to scale) in Figure 17. These values were used in Test No. 3 and Test No. 4 as reference values of how far fragments could travel when the test item was initiated to detonation i.e. the possible worst case reaction.

Table 10: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

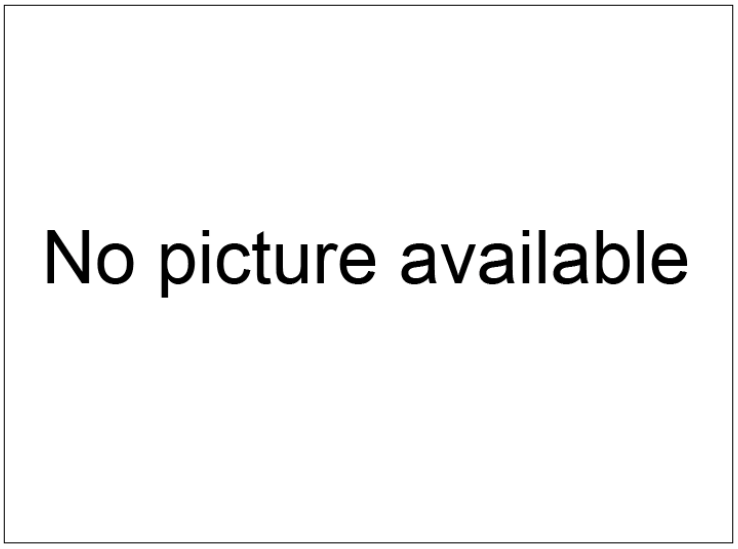

Figure 17: A sketch, not to scale, of the test area after Test No. 1.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 18. These values were used in Test No. 3 and Test No. 4 as reference values of the indent(s) and penetration(s) of one test item initiated to detonation.

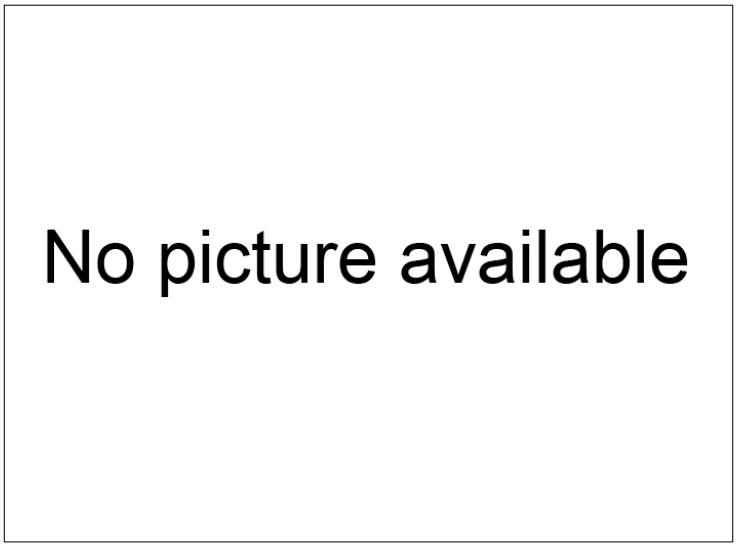

Figure 18: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

7.2 Test No. 2 (calibration test)

Pictures from the high speed video cameras are shown in Figures 19-24.

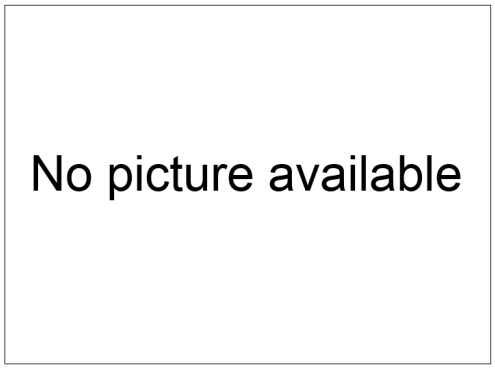

Figure 19: Bullet No. 1 hits the test item (picture from HS1).

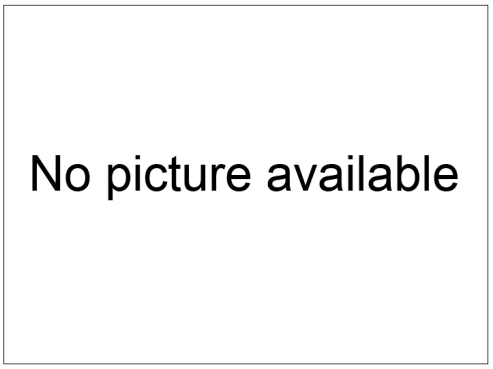

Figure 20: Bullet No. 1 hits the test item (picture from HS2).

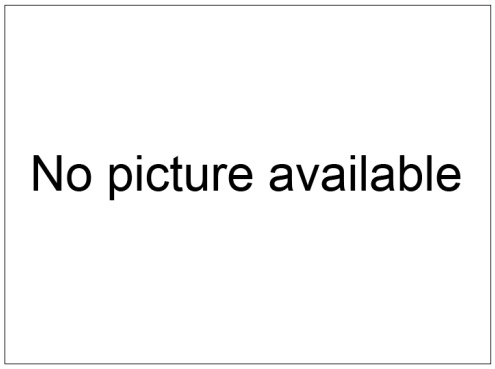

Figure 21: Bullet No. 2 hits the test item (picture from HS1).

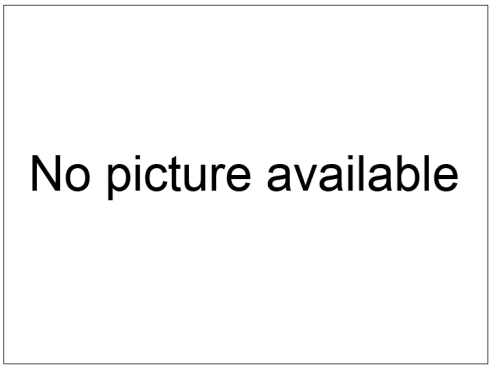

Figure 22: Bullet No. 2 hits the test item (picture from HS2).

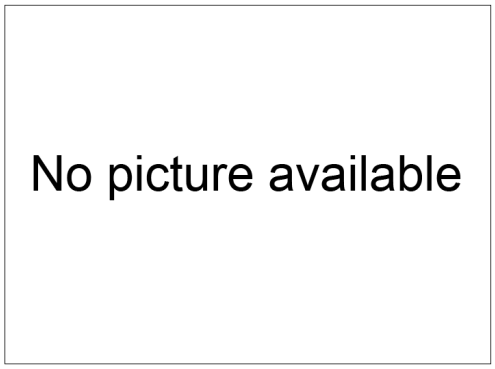

Figure 23: Bullet No. 3 hits the test item (picture from HS1).

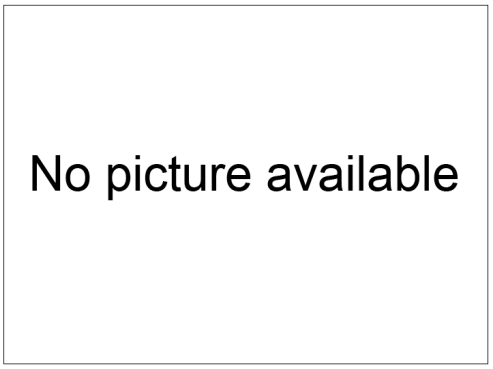

Figure 24: Bullet No. 3 hits the test item (picture from HS2).

The rate of fire was nnn rounds per minute.

The bullet impact velocities for each gun are shown in Table 11:

Table 11: The bullet impact velocities for each gun in Test No. 2.

Bullet impact velocity (m/s)		
Gun BI1	**Gun BI2**	**Gun BI3**
nnn	nnn	nnn

The registered air blast pressure values are shown in Table 12. These values were used in Test No. 3 and Test No. 4 as reference values.

Table 12: The registered air blast pressure values in Test No. 2.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 25, fragments from the test item were found, see Figure 26. These fragments were used in Test No. 3 and Test No. 4 as references.

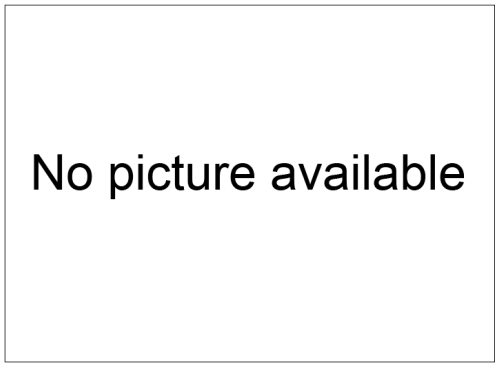

Figure 25: The test area after Test No. 2.

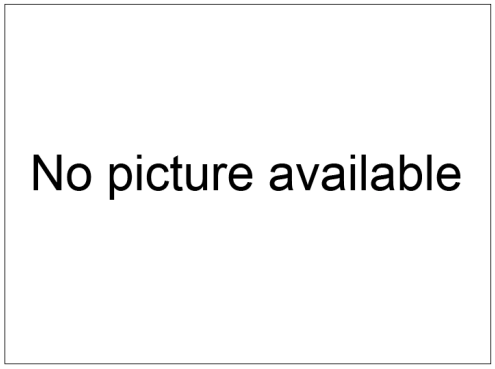

Figure 26: All collected fragments from the test item in Test No. 2.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 13 and are mapped in the sketch (not to scale) in Figure 27. These values were used in Test No. 3 and Test No. 4 as reference values of how far fragments from an inert test item could travel only due to the kinetic energy provided by the three hitting bullets.

Table 13: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

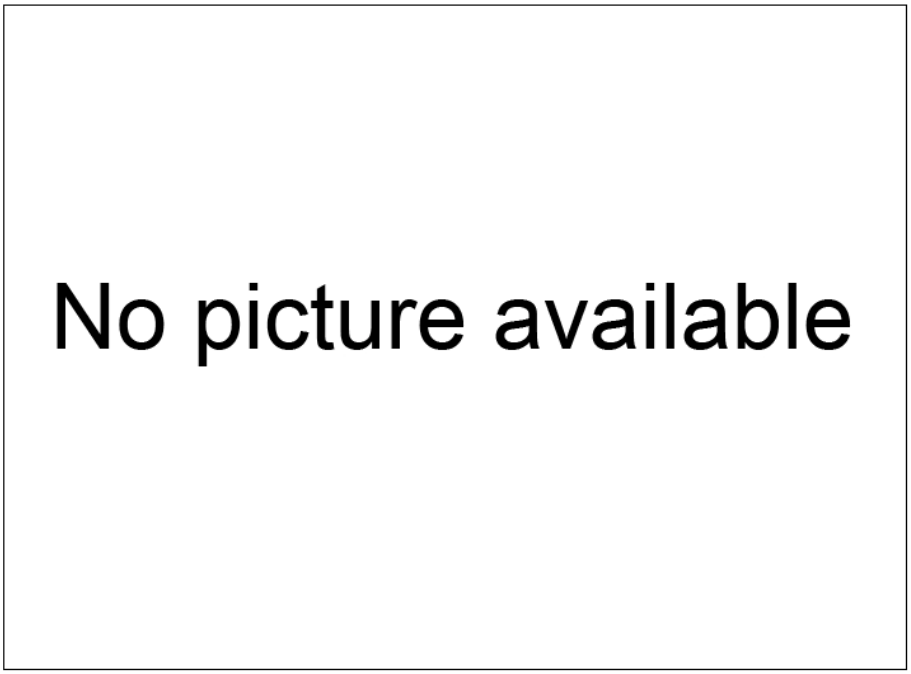

Figure 27: A sketch, not to scale, of the test area after Test No. 2.

The witness plate had no indents and was not penetrated, see Figure 28.

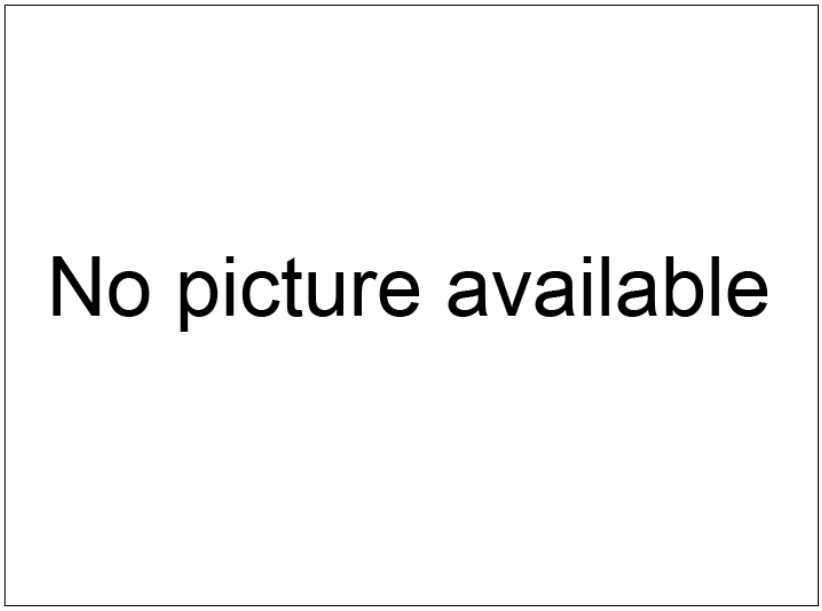

Figure 28: The witness plate had no indents and was not penetrated.

7.3 Test No. 3

Pictures from the high speed video cameras are shown in Figures 29-34.

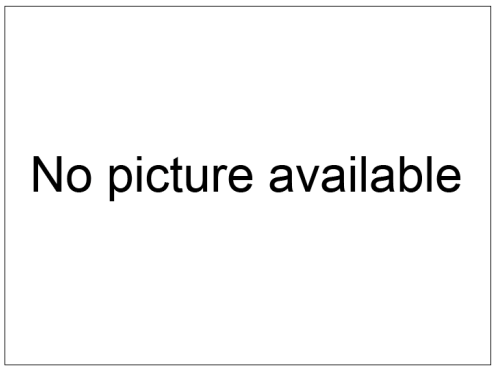

Figure 29: Bullet No. 1 hits the test item (picture from HS1).

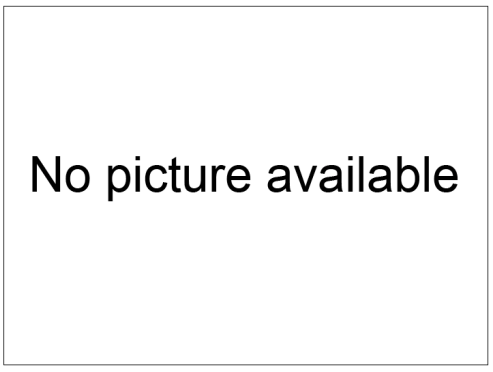

Figure 30: Bullet No. 1 hits the test item (picture from HS2).

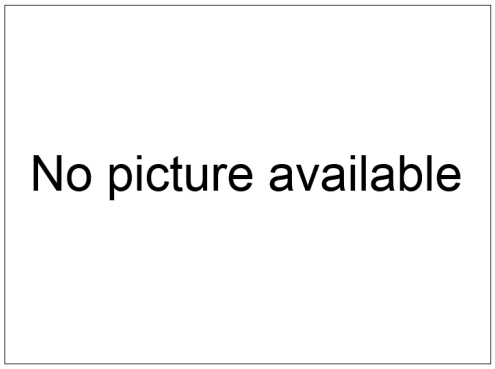

Figure 31: Bullet No. 2 hits the test item (picture from HS1).

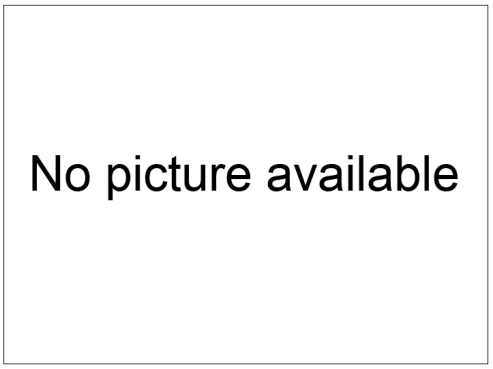

Figure 32: Bullet No. 2 hits the test item (picture from HS2).

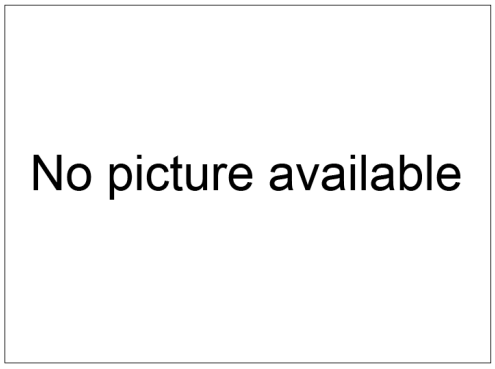

Figure 33: Bullet No. 3 hits the test item (picture from HS1).

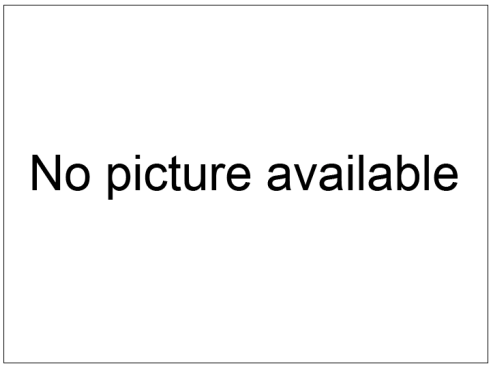

Figure 34: Bullet No. 3 hits the test item (picture from HS2).

The rate of fire was nnn rounds per minute.

The bullet impact velocities for each gun are shown in Table 14:

Table 14: The bullet impact velocities for each gun in Test No. 3.

Bullet impact velocity (m/s)		
Gun BI1	**Gun BI2**	**Gun BI3**
nnn	nnn	nnn

The registered air blast pressure values are shown in Table 15.

Table 15: The registered air blast pressure values in Test No. 3.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 35, fragments from the test item were found, see Figure 36.

Figure 35: The test area after Test No. 3.

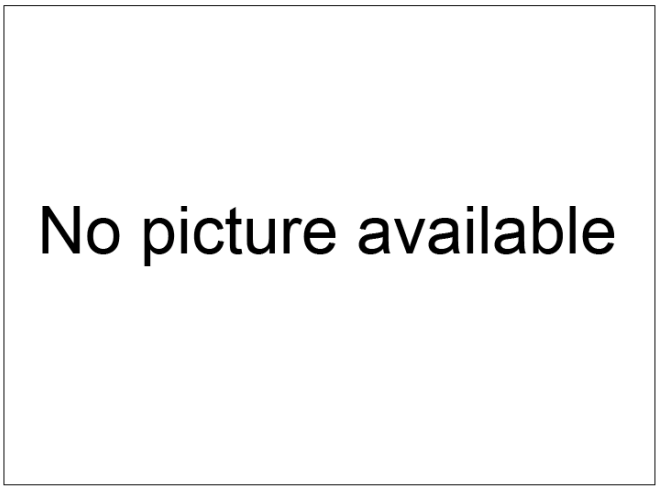

Figure 36: All collected fragments from the test item in Test No. 3.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 16 and are mapped in the sketch (not to scale) in Figure 37.

Table 16: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

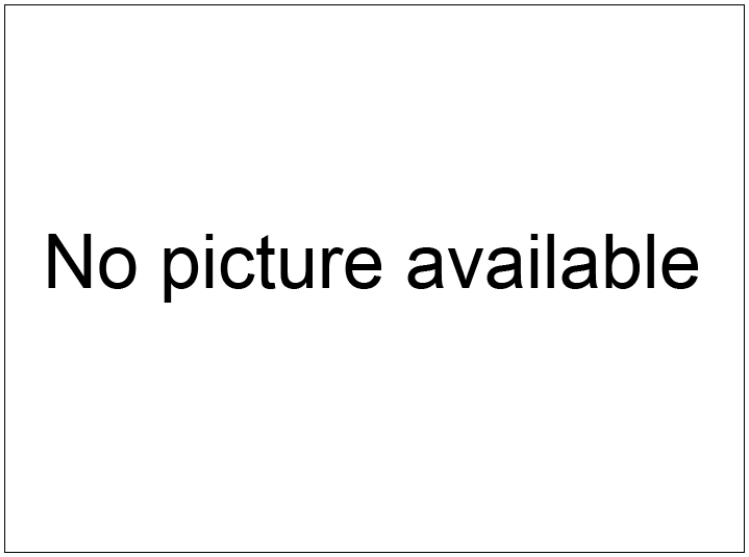

Figure 37: A sketch, not to scale, of the test area after Test No. 3.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 38.

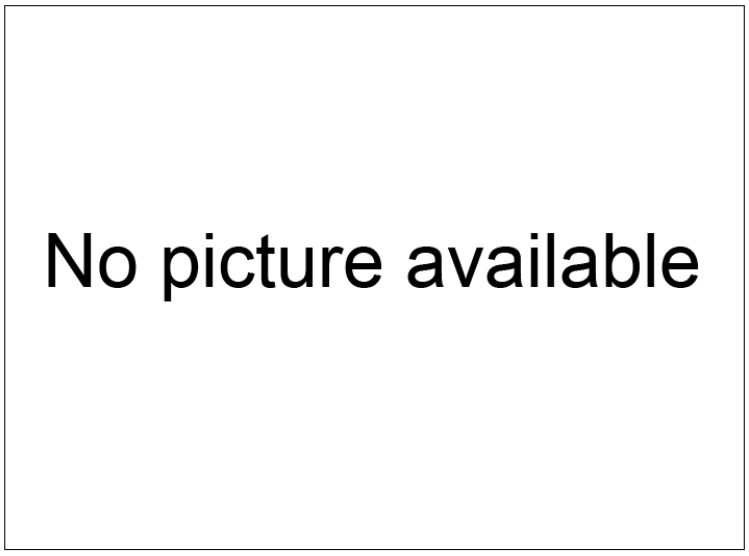

Figure 38: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapters 7.1, 7.2, 7.3 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

7.4 Test No. 4

Pictures from the high speed video cameras are shown in Figures 39-44.

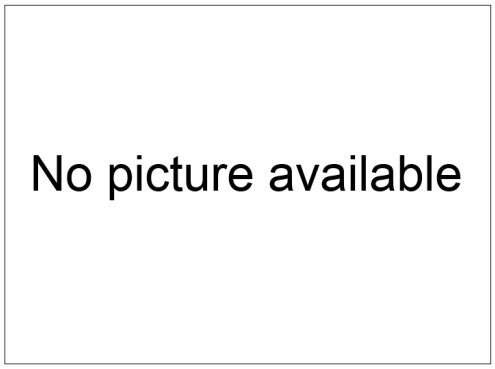

Figure 39: Bullet No. 1 hits the test item (picture from HS1).

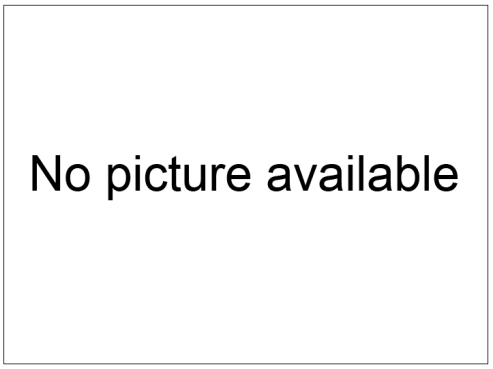

Figure 40: Bullet No. 1 hits the test item (picture from HS2).

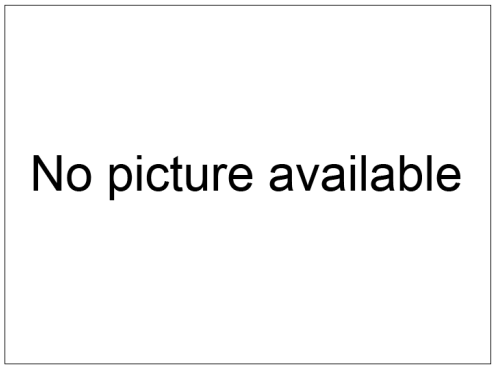

Figure 41: Bullet No. 2 hits the test item (picture from HS1).

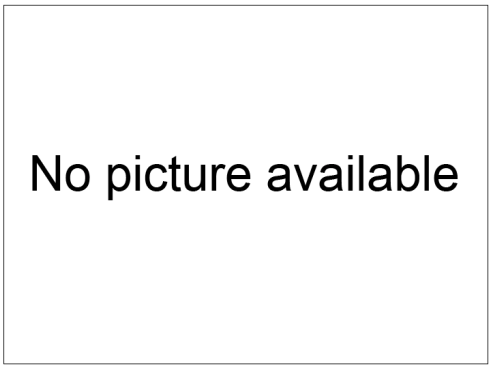

Figure 42: Bullet No. 2 hits the test item (picture from HS2).

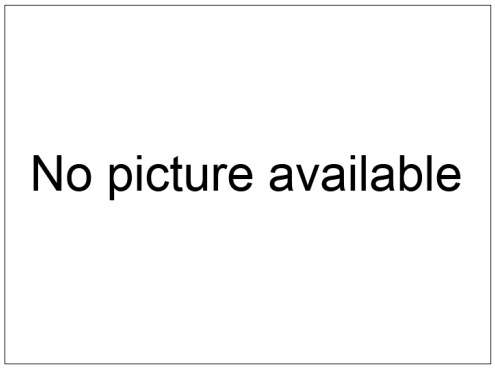

Figure 43: Bullet No. 3 hits the test item (picture from HS1).

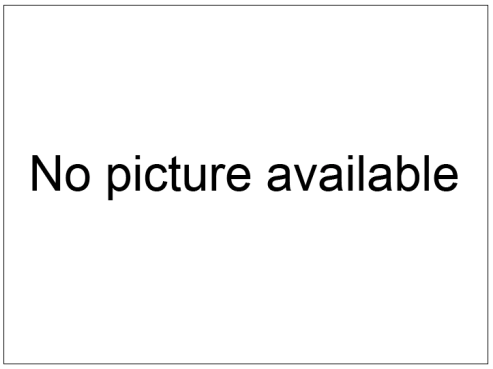

Figure 44: Bullet No. 3 hits the test item (picture from HS2).

The rate of fire was nnn rounds per minute.

The bullet impact velocities for each gun are shown in Table 17:

Table 17: The bullet impact velocities for each gun in Test No. 4.

Bullet impact velocity (m/s)		
Gun BI1	**Gun BI2**	**Gun BI3**
nnn	nnn	nnn

The registered air blast pressure values are shown in Table 18.

Table 18: The registered air blast pressure values in Test No. 4.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 45, fragments from the test item were found, see Figure 46.

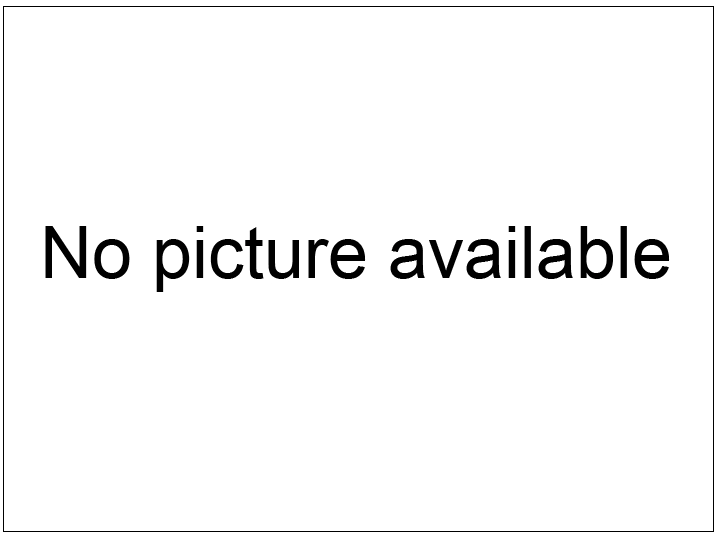

Figure 45: The test area after Test No. 4.

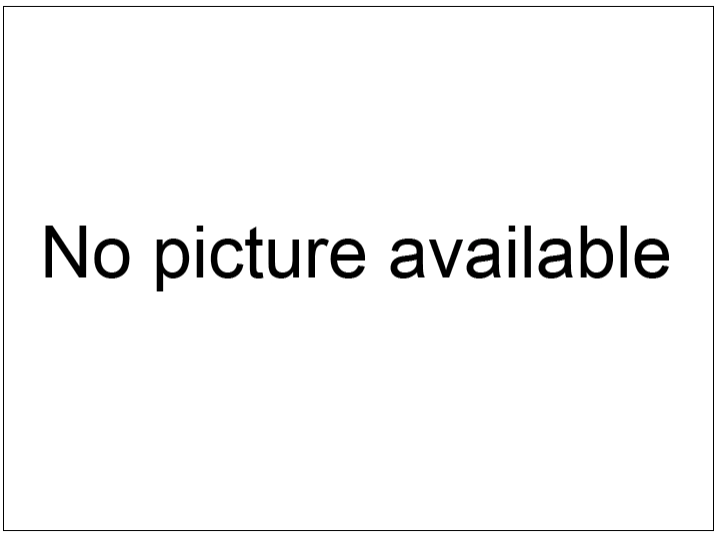

Figure 46: All collected fragments from the test item in Test No. 4.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 19 and are mapped in the sketch (not to scale) in Figure 47.

Table 19: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	Weight (g)	Projection distance (m)
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

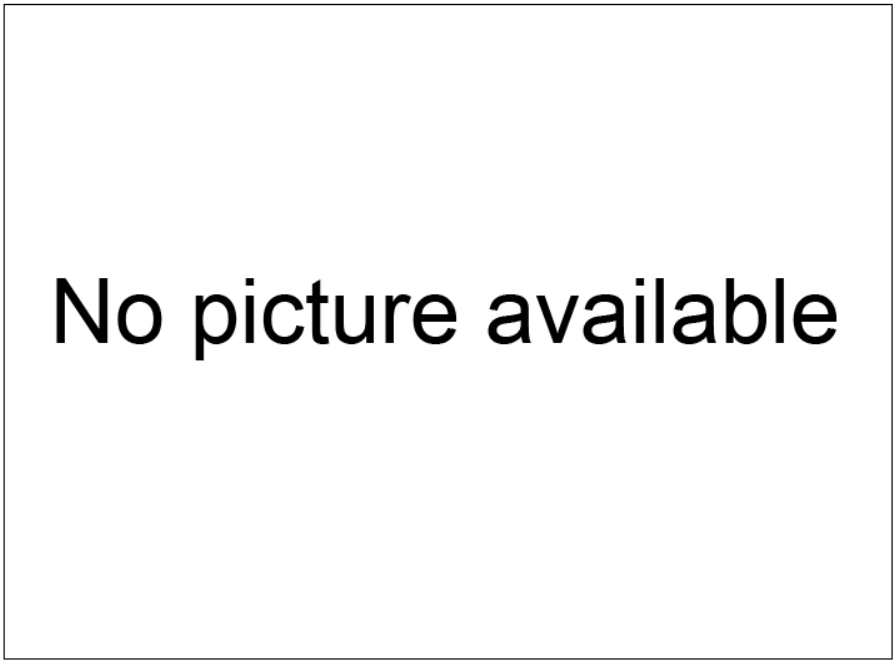

Figure 47: A sketch, not to scale, of the test area after Test No. 4.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 48.

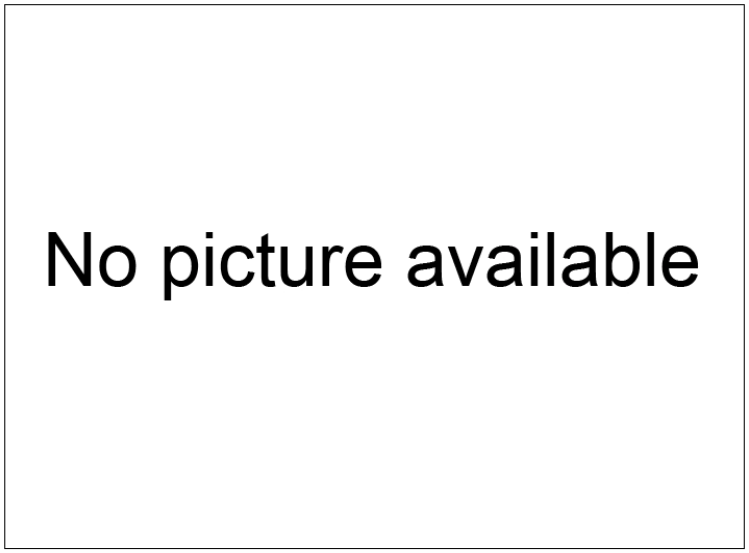

Figure 48: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapters 7.1, 7.2, 7.4 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

8 Disposal of explosive items

After completion of all tests the explosives remains were collected and disposed in one detonation using PETN based plastic explosives and one blasting cap, see Figures 49-50.

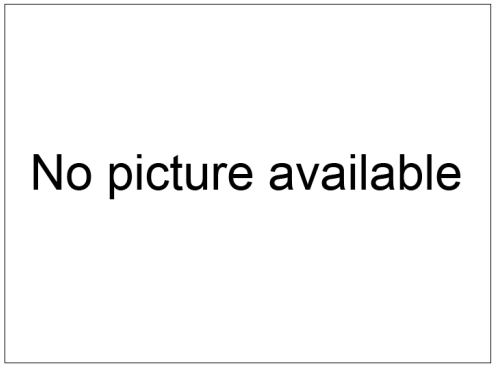

Figure 49: All collected explosives remains before disposal.

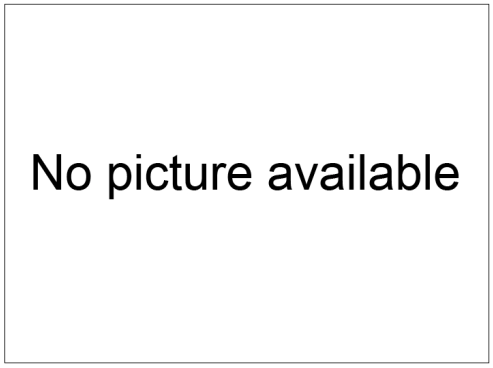

Figure 50: The site after disposal.

9 Conclusions

The bullet impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two bullet impact tests performed.

10 References

[1.] STANAG 4241 "Bullet Impact, Munition Test Procedures", Edition 2, 15th of April 2003

[2.] AOP-39 "Guidance on the Assessment and Development of Insensitive Munitions (IM)", Edition 3, March 2010

[3.] Test Procedure "Bullet Impact Tests, NNNN 155 HEIM", Edition 1, NNNN Corporation, NNth of Nnn 20NN

Sympathetic Reaction Tests performed on NNNN 155 HEIM

Abstract

N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Sympathetic Reaction Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

The purpose of these tests was to determine the sympathetic reaction sensitivity of the 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation, in its logistical configuration.

Three tests were performed. Test No. 1 was a calibration test, Test No. 2 was an unconfined test and Test No. 3 was a confined test.

The sympathetic reaction sensitivity of the 155 mm artillery projectile NNNN 155 HEIM in its logistical configuration is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two sympathetic reaction tests (unconfined and confined) performed.

Distribution list

Recipient
NNNN Corporation

Authorisation

Approved by	Date	Authorised by	Date
Nnnn Nnnn	nnnn-nn-nn	Nnnn Nnnn	nnnn-nn-nn

Record of Changes

Issue	Date	Changed By	Change Description

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N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Sympathetic Reaction Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

1 Introduction

1.1 Background

The purpose of these tests was to determine the sympathetic reaction sensitivity of the 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation, in its logistical configuration.

The tests were performed in accordance with Reference 1; STANAG 4396 "Sympathetic Reaction, Munition Test Procedures", Edition 2. The results of the tests were assessed in accordance with Reference 2; AOP-39 "Guidance on the Assessment and Development of Insensitive Munitions (IM)", Edition 3.

The tests were sponsored by NNNN Corporation, Department NNN.

1.2 Aim and objectives of the tests

Three tests were performed.

Test No. 1 was a calibration test. The purpose of performing this test was to obtain knowledge about the air blast pressure levels, the fragmentation, fragment distribution and witness plate damage when only one live projectile was initiated to detonation.

Test No. 2 was an unconfined test.

Test No. 3 was a confined test.

1.3 Place and date

The tests were performed at Bofors Test Center in Karlskoga, Sweden at test site Bonusplan, see Figure 1, the NNth and the NNth of Nnn 20NN.

Figure 1: Test site Bonusplan.

1.4 Test procedure

The tests were performed in accordance with Reference 3; Test Procedure "Sympathetic Reaction Tests, NNNN 155 HEIM", Edition 1, published by NNNN Corporation the NNth of Nnn 20NN. The test procedure is also briefly described in Chapter 3.

1.5 Test officials

From Bofors Test Center following personnel worked at the test site with these tests:

Name, Title
Name, Title
Name, Title
Name, Title
Name, Title
Name, Title

1.6 Participating personnel

From NNNN Corporation following personnel worked at the test site with these tests:

Name, Title
Name, Title
Name, Title

2 Test equipment

2.1 Test site equipment

The test equipment provided by Bofors Test Center is described in Table 1.

Table 1: Test equipment provided by Bofors Test Center.

Type of equipment	Name	Bofors Test Center No.
Transient Recorder	NNN	B NNNN-NNNN
Amplifier	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
High speed video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
Witness plate	NNN	Not Applicable
Weather Transmitter	NNN	B NNNN-NNNN
Initiation System	NNN	B NNNN-NNNN
Electrical resistance measurement device	NNN	B NNNN-NNNN
Blasting caps (x3)	NNN	Not Applicable

2.2 Customer provided equipment

The test equipment provided by NNNN Corporation is described in Table 2.

Table 2: Test equipment provided by NNNN Corporation.

Type of equipment	Name	Drawing No.	Test ID No.
Live Donor Projectile	NNNN 155 HEIM, Donor	NNN-1	YYYY-1
Live Donor Projectile	NNNN 155 HEIM, Donor	NNN-1	YYYY-2
Live Donor Projectile	NNNN 155 HEIM, Donor	NNN-1	YYYY-3
Inert Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-2	YYYY-11
Inert Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-2	YYYY-12
Inert Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-2	YYYY-13
Live Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-3	YYYY-21
Live Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-3	YYYY-22
Live Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-3	YYYY-23
Live Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-3	YYYY-31
Live Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-3	YYYY-32
Live Acceptor Projectile	NNNN 155 HEIM, Acceptor	NNN-3	YYYY-33
Pallet (x3)	Logistic Pallet Configuration	NNN-4	YYYY-1P

The NNNN 155 HEIM is a 155 mm artillery projectile with following specifications:

Weight, with lifting plug: NN.NNN kg
Filling, ACIMEX44B: N.NN kg
Booster Charge, ACIMEX32D: N.NN kg
Length, with lifting plug: NNN mm

The donor projectiles (NNN-1) are standard projectiles with a modified fuze, see Figure 2.

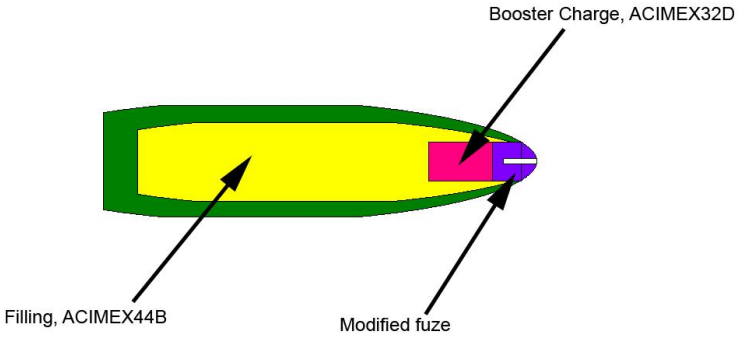

Figure 2: The donor projectiles (NNN-1).

The inert acceptor projectiles (NNN-2), see Figure 3, are standard projectiles with inert filling of sand, granule size N/N, to achieve the correct weight. A lifting plug was assembled instead of a fuze as the tests represented the logistical configuration of the projectiles.

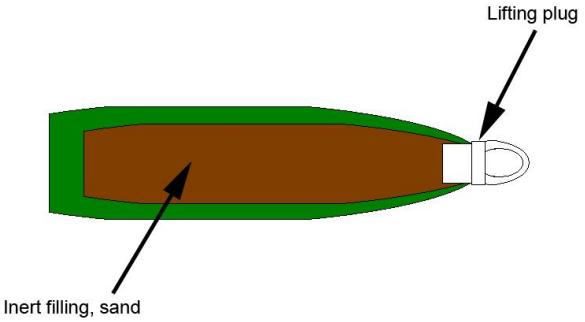

Figure 3: The inert acceptor projectiles (NNN-2).

The live acceptor projectiles (NNN-3), see Figure 4, are standard projectiles. A lifting plug was assembled instead of a fuze as the tests represented the logistical configuration of the projectiles.

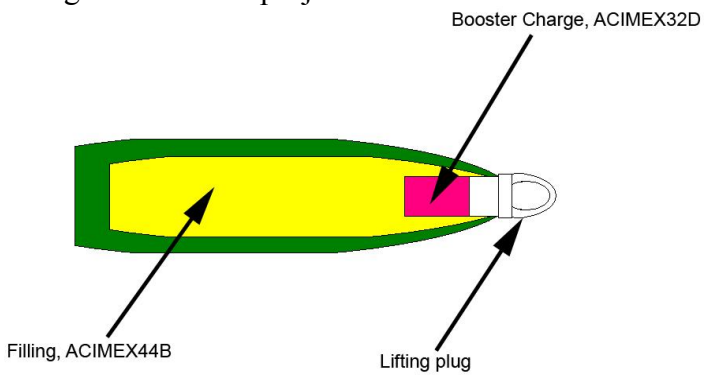

Figure 4: The live acceptor projectiles (NNN-3).

2.3 Test items

2.3.1 Test No. 1 (calibration test)

The test item in Test No. 1 was one Logistic Pallet Configuration (YYYY-1P) packed with one live donor projectile NNNN 155 HEIM, Donor (YYYY-1) and three inert acceptor projectiles (YYYY-11, YYYY-12 and YYYY-13) as shown in Figure 5.

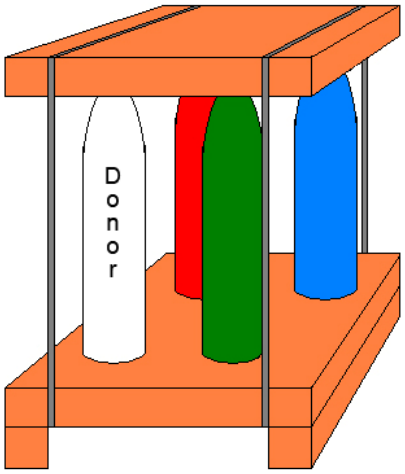

Figure 5: The test item in Test No. 1.

The projectiles were painted prior to the test as described in Table 3.

Table 3: Colours of the projectiles in Test No. 1.

Type of equipment	Test ID No.	Colour
Live Donor Projectile	YYYY-1	White
Inert Acceptor Projectile	YYYY-11	Dark green
Inert Acceptor Projectile	YYYY-12	Red
Inert Acceptor Projectile	YYYY-13	Blue

2.3.2 Test No. 2

The test item in Test No. 2 was one Logistic Pallet Configuration (YYYY-1P) packed with one live donor projectile NNNN 155 HEIM, Donor (YYYY-2) and three live acceptor projectiles (YYYY-21, YYYY-22 and YYYY-23) as shown in Figure 6.

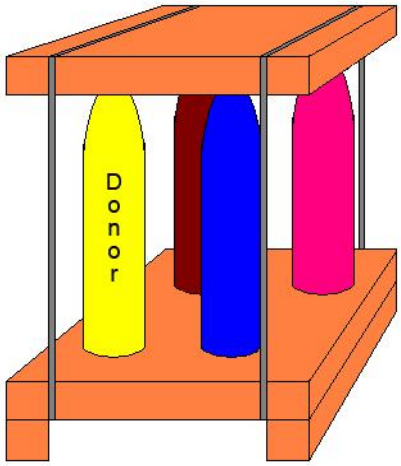

Figure 6: The test item in Test No. 2.

The projectiles were painted prior to the test as described in Table 4.

Table 4: Colours of the projectiles in Test No. 2.

Type of equipment	Test ID No.	Colour
Live Donor Projectile	YYYY-2	Yellow
Live Acceptor Projectile	YYYY-21	Dark blue
Live Acceptor Projectile	YYYY-22	Brown
Live Acceptor Projectile	YYYY-23	Pink

2.3.3 Test No. 3

The test item in Test No. 3 was one Logistic Pallet Configuration (YYYY-1P) packed with one live donor projectile NNNN 155 HEIM, Donor (YYYY-3) and three live acceptor projectiles (YYYY-31, YYYY-32 and YYYY-33) as shown in Figure 7.

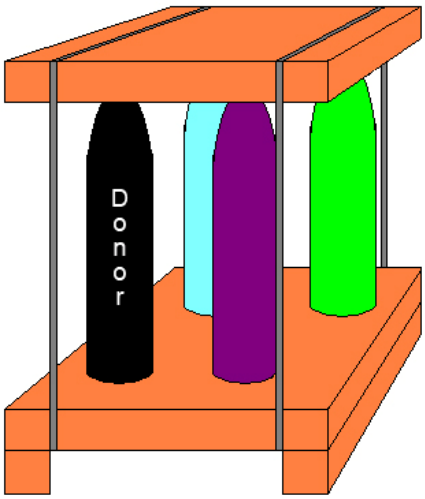

Figure 7: The test item in Test No. 3.

The projectiles were painted prior to the test as described in Table 5.

Table 5: Colours of the projectiles in Test No. 3.

Type of equipment	Test ID No.	Colour
Live Donor Projectile	YYYY-3	Black
Live Acceptor Projectile	YYYY-31	Purple
Live Acceptor Projectile	YYYY-32	Light blue
Live Acceptor Projectile	YYYY-33	Light green

3 Test procedure

The tests were performed in accordance with Reference 3.

Test No. 1 was the first test to be performed followed by Test No. 2 and finally Test No. 3.

Each test was performed as follows:

1. The test item was placed on top of the witness plate and positioned correctly.
2. All personnel except for the Test Technicians took cover.
3. Electrical resistance in the open initiation chain (firing cable) was measured.
4. The initiation chain (firing cable) was short-circuited.
5. Electrical resistance in the short-circuited initiation chain (firing cable) was measured.
6. The blasting cap was connected to the short-circuited initiation chain.
7. Electrical resistance in the initiation chain (firing cable and blasting cap) was measured.
8. The blasting cap was installed into the fuze system on the donor round.
9. The Test Technicians took cover.
10. The donor projectile was initiated to detonation.
11. Waiting time as decided by the Test Officer.
12. Preliminary inspection of the test site performed by the Test Officer.
13. Inspection of the test site and assessment of the result.

After completion of all tests the explosives remains were collected and disposed as further described in Chapter 8.

4 Test configuration

4.1 Test setups

4.1.1 Test No. 1 (calibration test) and Test No. 2

The test setup for Test No. 1 and Test No. 2 is shown in Figure 8. The dimensions of the witness plate were (Width x Length x Thickness) yyyy mm x yyyy mm x yy mm.

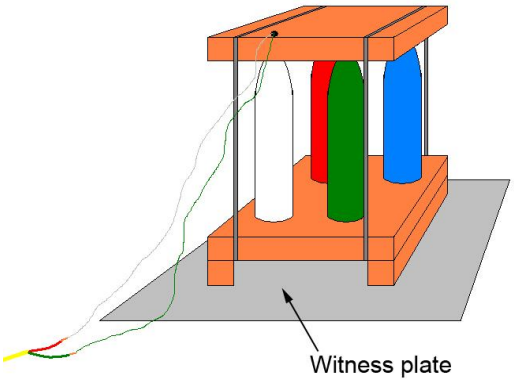

Figure 8: The test setup for Test No. 1 and Test No. 2 (picture from Test No. 1).

4.1.2 Test No. 3

The test setup for Test No. 3 was the same as for Test No. 1 and Test No. 2 except for that the test item in Test No. 3 was confined using sandbags (granule size of the sand was N/N). The sandbags were stacked around the test item 1 m from the outer surfaces of the test item in all directions as shown in Figure 9.

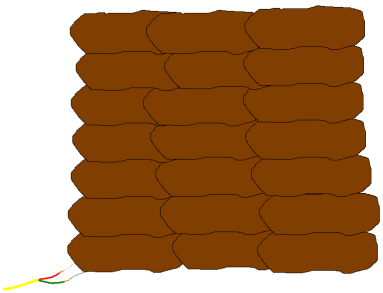

Figure 9: The test setup for Test No. 3.

4.2 Test layout

A schematic view, not to scale, of the test layout in each test is shown in Figure 10. The air blast pressure gauges were placed in orthogonal directions from the centre point of the test item. The distance in meters from the centre point of the test item to each piece of equipment is described in Table 6.

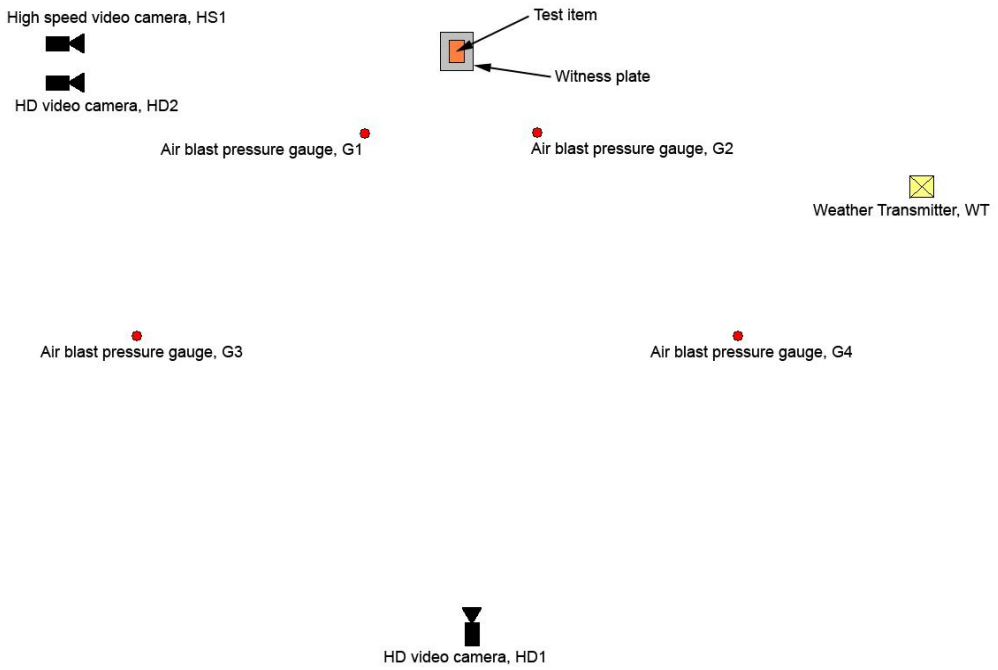

Figure 10: A schematic view, not to scale, of the test layout.

Table 6: The distance from the centre point of the test item to each piece of equipment.

Piece of equipment	Distance from the centre point of the test item (m)
HS1	NN
HD2	NN
HD1	NNN
G1	N
G2	N
G3	NN
G4	NN
WT	NNN

5 Safety measures

The tests were performed in accordance with Bofors Test Center's Safety and Security Plan.

6 Meteorological conditions

The meteorological conditions at the time of each test are described in Table 7.

Table 7: The meteorological conditions at the time of each test.

Test No.	Date and time	Barometric pressure (hPa)	Relative humidity (%RH)	Liquid Precipitation (mm)	Wind speed (m/s)	Wind direction (º)	Air temperature (ºC)
1	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
3	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n

7 Results

N.B. Following Chapters (7.1-7.3) do not contain any pictures since the tests, as stated earlier, never have been performed.

7.1 Test No. 1 (calibration test)

Pictures from the HD video cameras and the high speed video camera are shown in Figures 11-14.

No picture available

Figure 11: The test item when initiated (picture from HD1).

No picture available

Figure 12: The test item when initiated (picture from HD2).

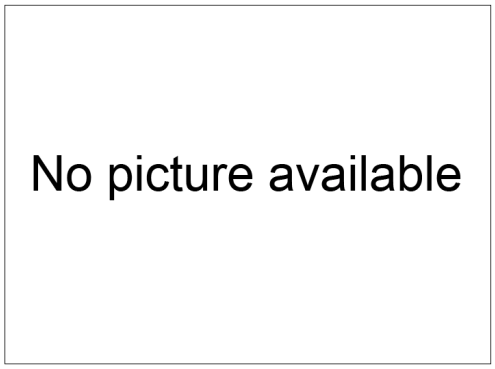

Figure 13: The test item when initiated (picture from HS1).

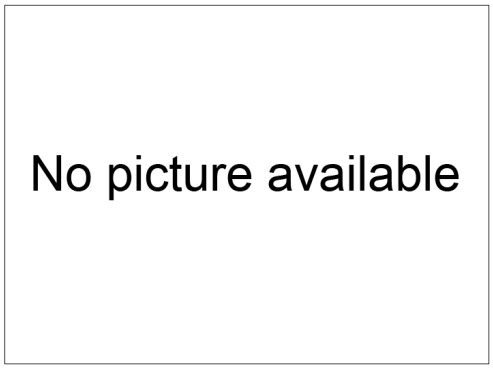

Figure 14: The test item nn ms after initiation (picture from HS1).

The registered air blast pressure values are shown in Table 8. These values were used in Test No. 2 and Test No. 3 as reference values.

Table 8: The registered air blast pressure values in Test No. 1.

Registered air blast pressure values (kPa)			
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**
nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 15, pieces from the donor projectile (YYYY-1) were found, see Figure 16, as well as pieces from the three inert acceptor projectiles (YYYY-11, YYYY-12 and YYYY-13), see Figures 17-19, and the Logistic Pallet Configuration (YYYY-1P), see Figure 20. These pieces were used in Test No. 2 and Test No. 3 as references.

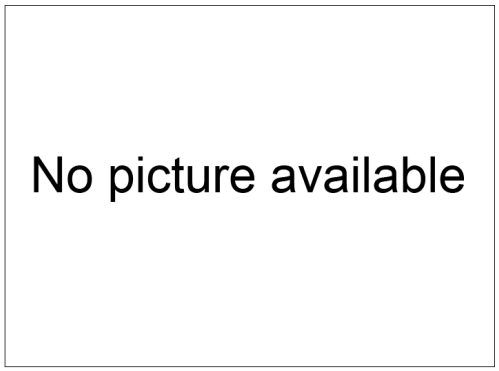

Figure 15: The test area after Test No. 1.

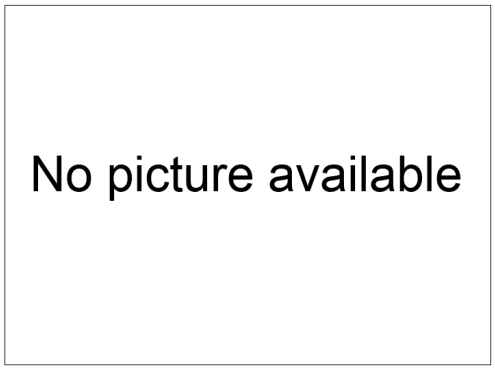

Figure 16: All collected pieces from the donor projectile YYYY-1.

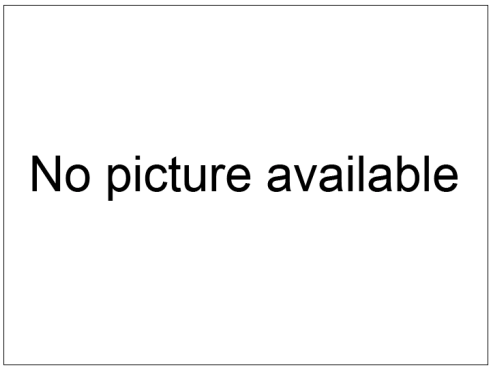

Figure 17: All collected pieces from the inert acceptor projectile YYYY-11.

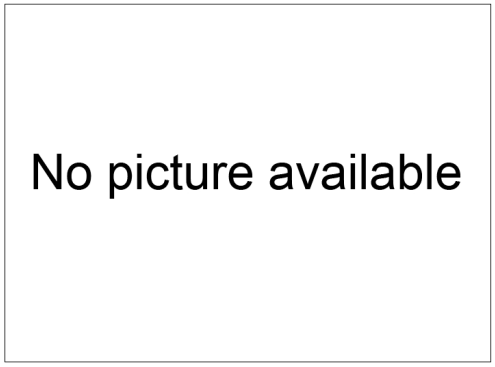

Figure 18: All collected pieces from the inert acceptor projectile YYYY-12.

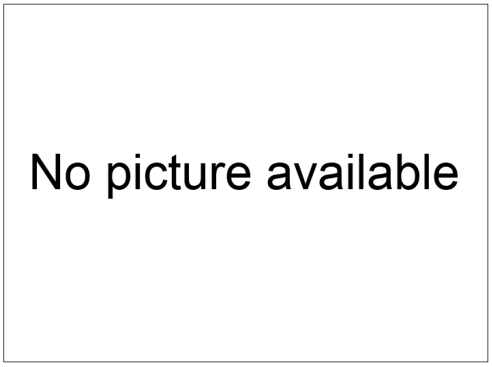

Figure 19: All collected pieces from the inert acceptor projectile YYYY-13.

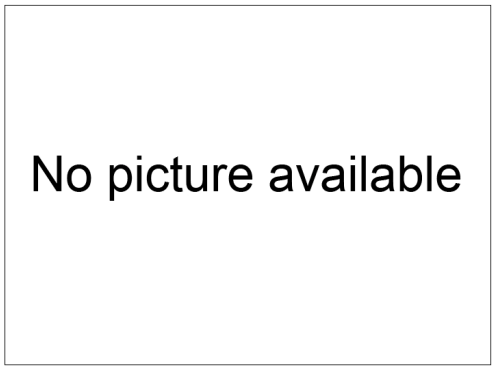

Figure 20: All collected pieces from the Logistic Pallet Configuration YYYY-1P.

All pieces which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 9 and are mapped in the sketch (not to scale) in Figure 21. These values were used in Test No. 2 and Test No. 3 as reference values of how far inert material could travel only due to the kinetic energy provided by the detonated donor projectile.

Table 9: All pieces which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Piece No.	**Identified from Test ID No.**	**Weight (g)**	**Projection distance (m)**
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n

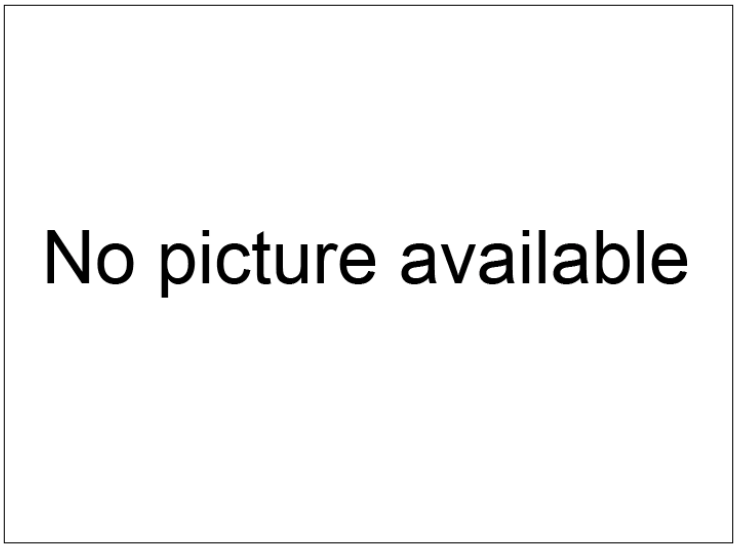

Figure 21: A sketch, not to scale, of the test area after Test No. 1.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 22. These values were used in Test No. 2 and Test No. 3 as reference values of the indent(s) and penetration(s) of one detonated projectile.

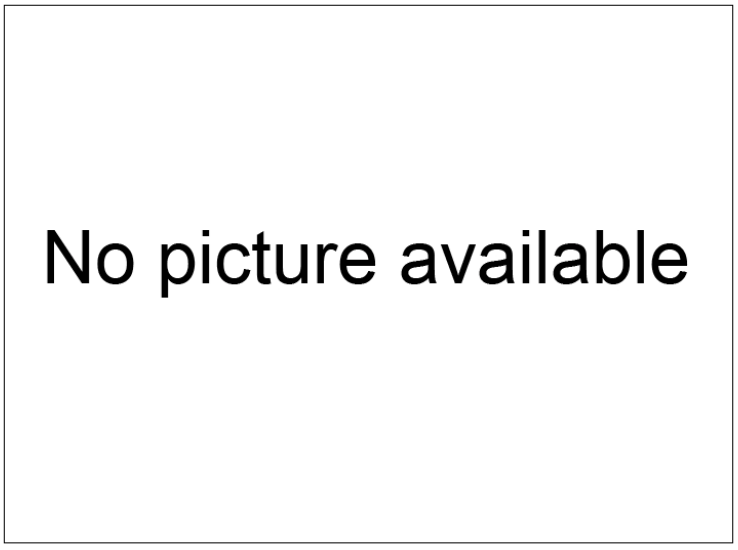

Figure 22: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

7.2 Test No. 2

Pictures from the HD video cameras and the high speed video camera are shown in Figures 23-26.

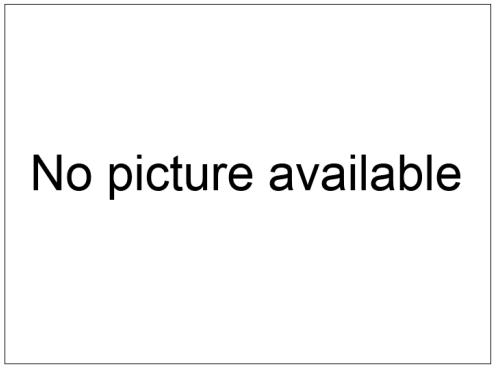

Figure 23: The test item when initiated (picture from HD1).

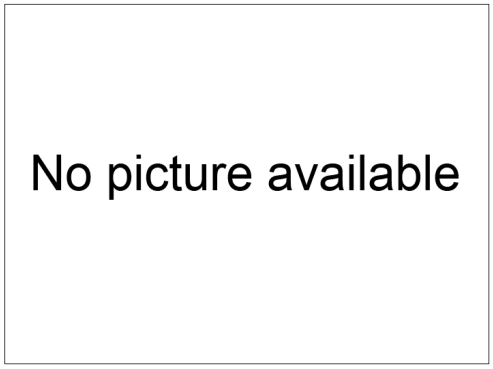

Figure 24: The test item when initiated (picture from HD2).

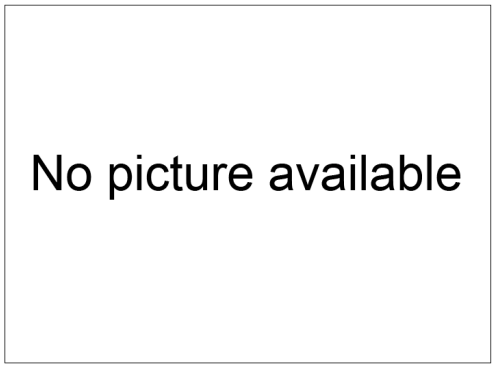

Figure 25: The test item when initiated (picture from HS1).

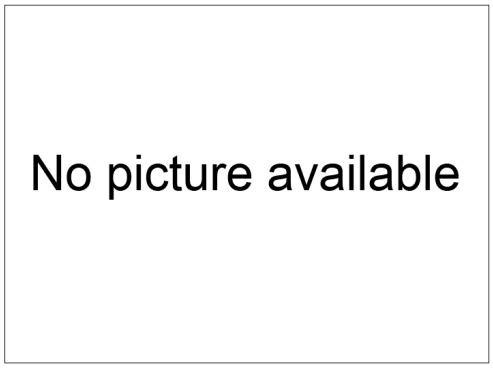

Figure 26: The test item nn ms after initiation (picture from HS1).

The registered air blast pressure values are shown in Table 10.

Table 10: The registered air blast pressure values in Test No. 2.

Registered air blast pressure values (kPa)			
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**
nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 27, pieces from the donor projectile (YYYY-2) were found, see Figure 28, as well as pieces from the three live acceptor projectiles (YYYY-21, YYYY-22 and YYYY-23), see Figures 29-31, and the Logistic Pallet Configuration (YYYY-1P), see Figure 32.

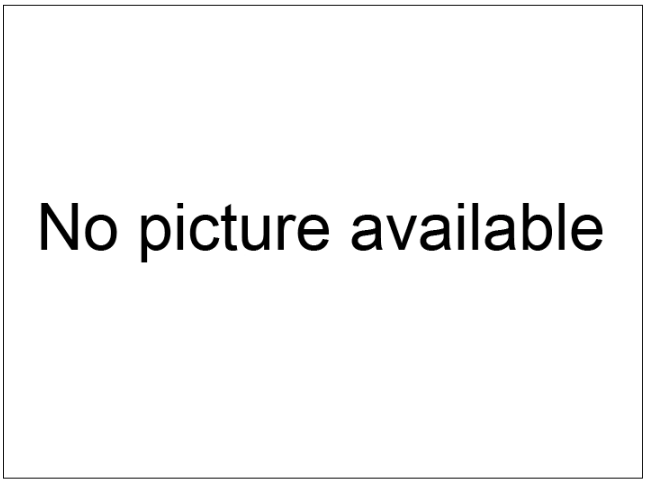

Figure 27: The test area after Test No. 2.

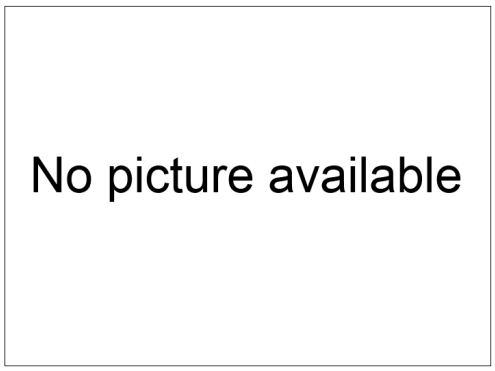

Figure 28: All collected pieces from the donor projectile YYYY-2.

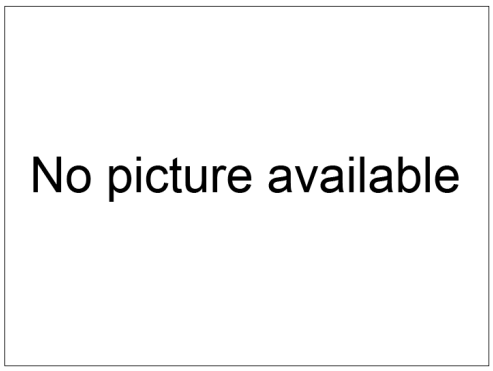

Figure 29: All collected pieces from the live acceptor projectile YYYY-21.

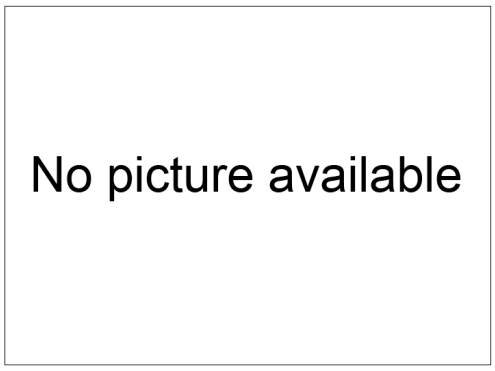

Figure 30: All collected pieces from the live acceptor projectile YYYY-22.

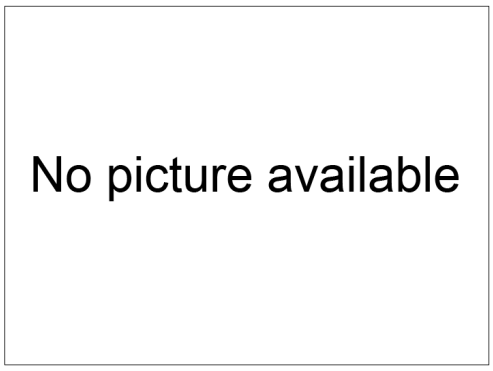

Figure 31: All collected pieces from the live acceptor projectile YYYY-23.

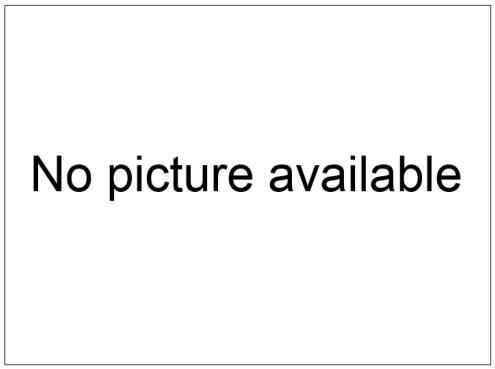

Figure 32: All collected pieces from the Logistic Pallet Configuration YYYY-1P.

All pieces which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 11 and are mapped in the sketch (not to scale) in Figure 33.

Table 11: All pieces which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Piece No.	**Identified from Test ID No.**	**Weight (g)**	**Projection distance (m)**
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n

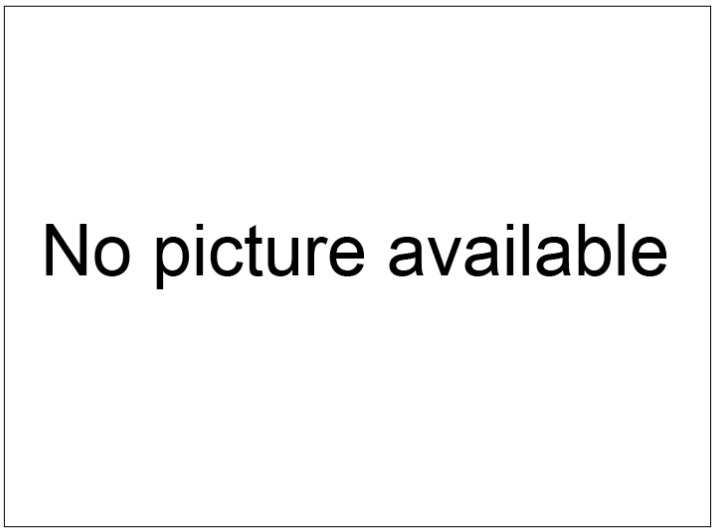

Figure 33: A sketch, not to scale, of the test area after Test No. 2.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 34.

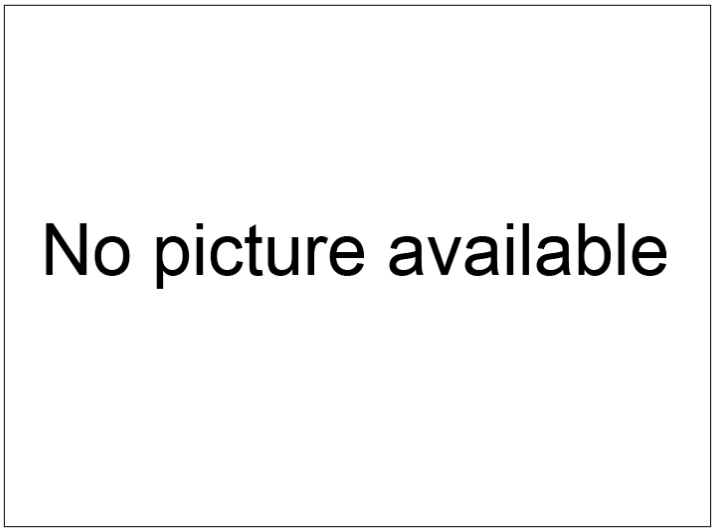

Figure 34: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapter 7.1 and Chapter 7.2 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

7.3 Test No. 3

Pictures from the HD video cameras and the high speed video camera are shown in Figures 35-38.

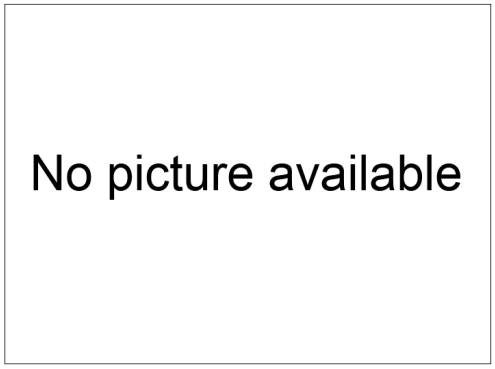

Figure 35: The test item when initiated (picture from HD1).

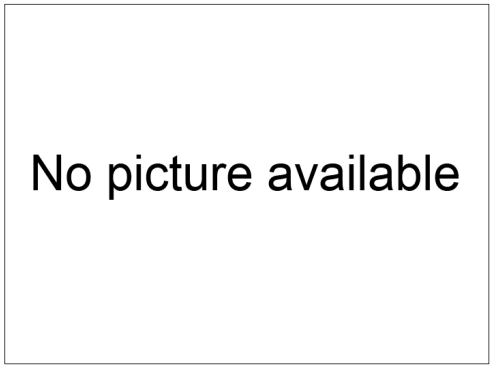

Figure 36: The test item when initiated (picture from HD2).

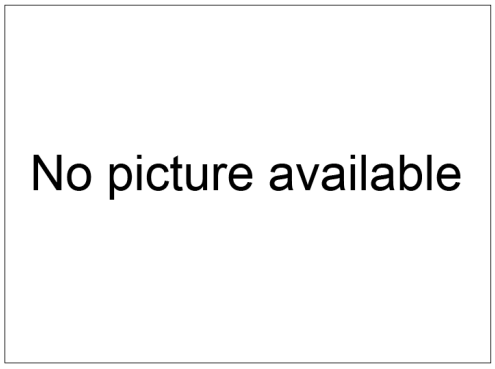

Figure 37: The test item when initiated (picture from HS1).

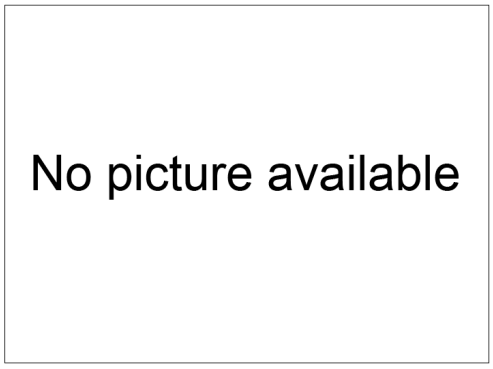

Figure 38: The test item nn ms after initiation (picture from HS1).

The registered air blast pressure values are shown in Table 12.

Table 12: The registered air blast pressure values in Test No. 3.

Registered air blast pressure values (kPa)			
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**
nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 39, pieces from the donor projectile (YYYY-3) were found, see Figure 40, as well as pieces from the three live acceptor projectiles (YYYY-31, YYYY-32 and YYYY-33), see Figures 41-43, and the Logistic Pallet Configuration (YYYY-1P), see Figure 44.

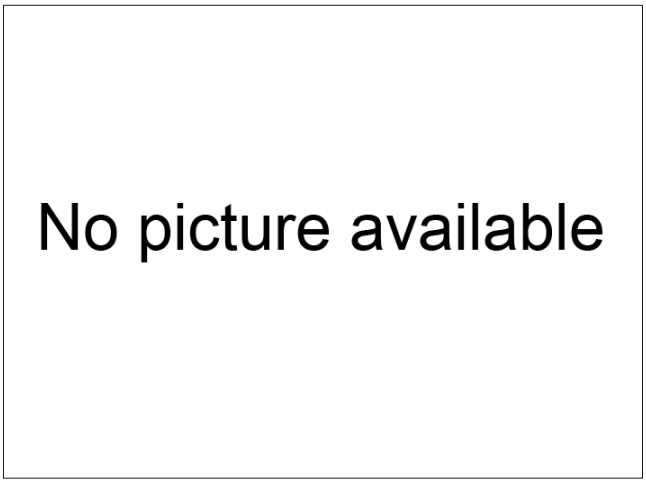

Figure 39: The test area after Test No. 3.

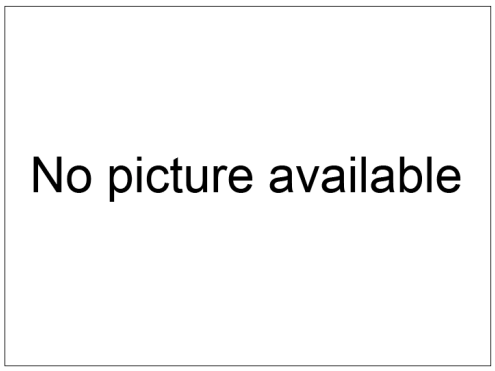

Figure 40: All collected pieces from the donor projectile YYYY-3.

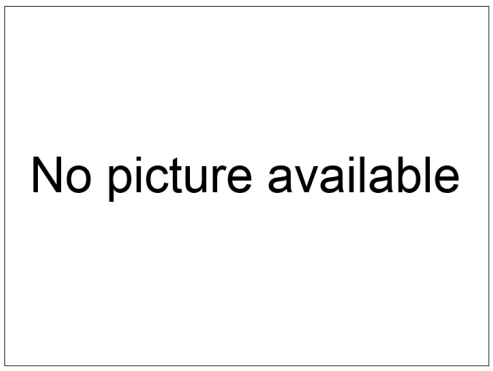

Figure 41: All collected pieces from the live acceptor projectile YYYY-31.

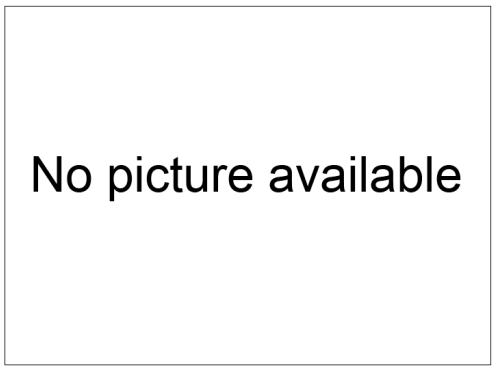

Figure 42: All collected pieces from the live acceptor projectile YYYY-32.

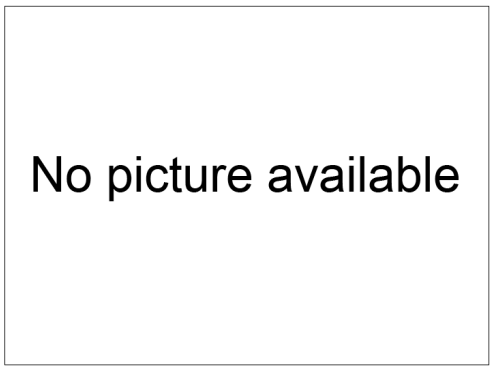

Figure 43: All collected pieces from the live acceptor projectile YYYY-33.

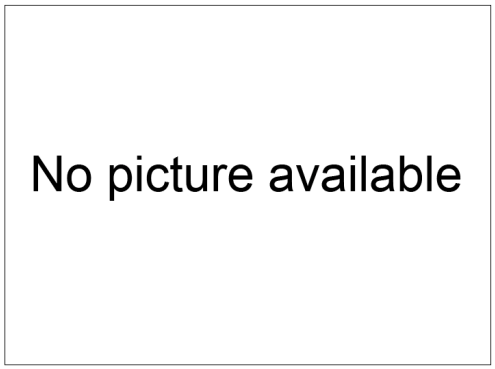

Figure 44: All collected pieces from the Logistic Pallet Configuration YYYY-1P.

All pieces which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 13 and are mapped in the sketch (not to scale) in Figure 45.

Table 13: All pieces which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Piece No.	**Identified from Test ID No.**	**Weight (g)**	**Projection distance (m)**
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n
n	YYYY-nn	nn	nn.n

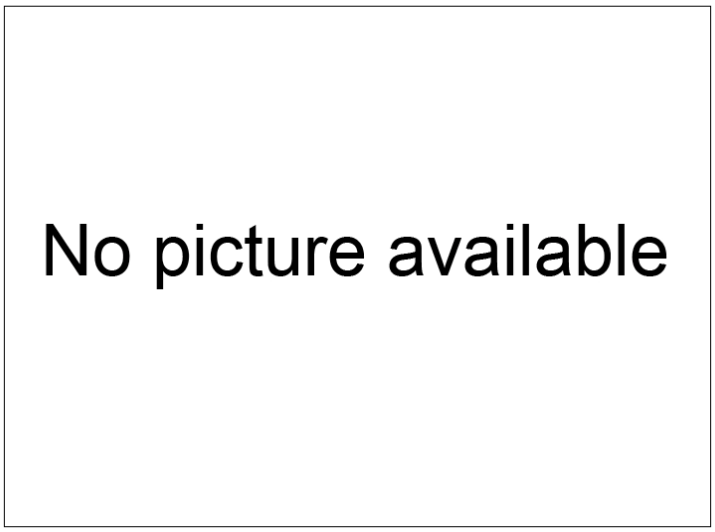

Figure 45: A sketch, not to scale, of the test area after Test No. 3.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 46.

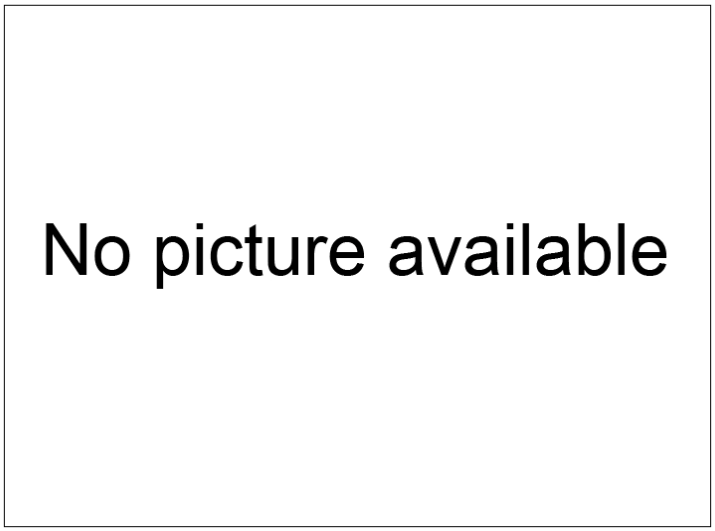

Figure 46: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapter 7.1 and Chapter 7.3 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

8 Disposal of explosive items

After completion of all tests the explosives remains were collected and disposed in one detonation using PETN based plastic explosives and one blasting cap, see Figures 47-48.

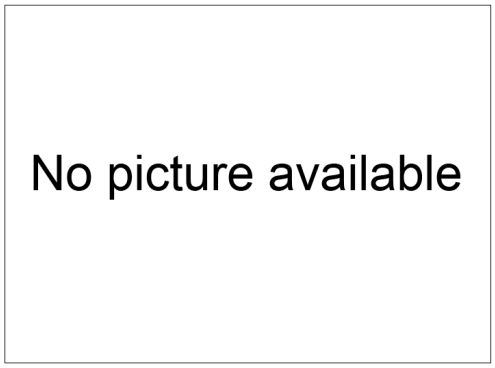

Figure 47: All collected explosives remains before disposal.

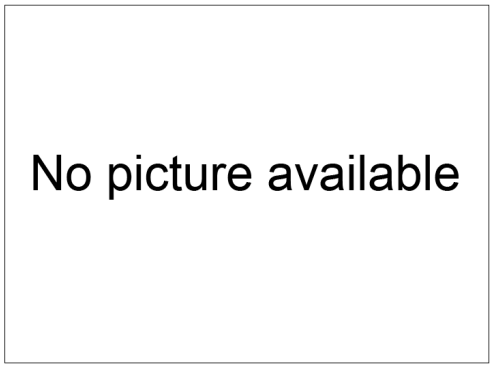

Figure 48: The site after disposal.

9 Conclusions

The sympathetic reaction sensitivity of the 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation, in its logistical configuration is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two sympathetic reaction tests (unconfined and confined) performed.

10 References

[1.] STANAG 4396 “Sympathetic Reaction, Munition Test Procedures”, Edition 2, 15th of April 2003

[2.] AOP-39 “Guidance on the Assessment and Development of Insensitive Munitions (IM)”, Edition 3, March 2010

[3.] Test Procedure “Sympathetic Reaction Tests, NNNN 155 HEIM”, Edition 1, NNNN Corporation, NNth of Nnn 20NN

Shaped Charge Jet Tests performed on NNNN 155 HEIM

Abstract

N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Shaped Charge Jet Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

The purpose of these tests was to determine the shaped charge jet impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation.

Four tests were performed. Test No. 1 and Test No. 2 were calibration tests. In Test No. 3 one PG-7M warhead was fired at the largest explosive component and in Test No. 4 one PG-7M warhead was fired at the booster.

The shaped charge jet impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two shaped charge jet tests performed.

Distribution list

Recipient
NNNN Corporation

Authorisation

Approved by	Date	Authorised by	Date
Nnnn Nnnn	nnnn-nn-nn	Nnnn Nnnn	nnnn-nn-nn

Record of Changes

Issue	Date	Changed By	Change Description

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N.B. NNNN Corporation, the product NNNN 155 HEIM and the tests described in this technical report are all fictitious. The purpose of this report is to give the customers of Bofors Test Center an impression of our technical reports in the field of IM testing – in this case Shaped Charge Jet Test. Please note that the report format is just an example. The precise format may vary depending upon requirements of the customer.

1 Introduction

1.1 Background

The purpose of these tests was to determine the shaped charge jet impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM, manufactured by NNNN Corporation.

The tests were performed in accordance with Reference 1; STANAG 4526 “Shaped Charge Jet, Munitions Test Procedures”, Edition 2. The results of the tests were assessed in accordance with Reference 2; AOP-39 “Guidance on the Assessment and Development of Insensitive Munitions (IM)”, Edition 3.

The tests were sponsored by NNNN Corporation, Department NNN.

1.2 Aim and objectives of the tests

Four tests were performed.

Test No. 1 was a calibration test. The purpose of performing this test was to obtain knowledge about the air blast pressure levels, the fragmentation, fragment distribution and witness plate damage when one live projectile was initiated to detonation using a blasting cap i.e. the possible worst case reaction.

Test No. 2 was also a calibration test. The purpose of performing this test was to obtain knowledge about the air blast pressure levels, the fragmentation, fragment distribution and witness plate damage when one inert projectile was hit by one shaped charge jet from a PG-7M warhead from the RPG system. I.e. to study the damage caused to the projectile only by the kinetic energy from the shaped charge jet from a PG-7M warhead.

In Test No. 3, one PG-7M warhead was fired at the largest explosive component.

In Test No. 4, one PG-7M warhead was fired at the booster.

1.3 Place and date

The tests were performed at Bofors Test Center in Karlskoga, Sweden at test site Abborrtjärn, see Figure 1, the NNth and the NNth of Nnn 20NN.

Figure 1: Test site Abborrtjärn.

1.4 Test procedure

The tests were performed in accordance with Reference 3; Test Procedure "Shaped Charge Jet Tests, NNNN 155 HEIM", Edition 1, published by NNNN Corporation the NNth of Nnn 20NN. The test procedure is also briefly described in Chapter 3.

1.5 Test officials

From Bofors Test Center following personnel worked at the test site with these tests:

Name, Title
Name, Title
Name, Title
Name, Title
Name, Title

1.6 Participating personnel

From NNNN Corporation following personnel worked at the test site with these tests:

Name, Title
Name, Title

2 Test equipment

2.1 Test site equipment

The test equipment provided by Bofors Test Center is described in Table 1.

Table 1: Test equipment provided by Bofors Test Center.

Type of equipment	Name	Bofors Test Center No.
PG-7M Warhead (x3)	NNN	Not Applicable
Transient Recorder	NNN	B NNNN-NNNN
Amplifier	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
Air blast pressure gauge	NNN	B NNNN-NNNN
High speed video camera	NNN	B NNNN-NNNN
High speed video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
HD video camera	NNN	B NNNN-NNNN
Witness plates (x4)	NNN	Not Applicable
Weather Transmitter	NNN	B NNNN-NNNN
Initiation System	NNN	B NNNN-NNNN
Electrical resistance measurement device	NNN	B NNNN-NNNN
Blasting cap (x4)	NNN	Not Applicable

2.2 Customer provided equipment

The test equipment provided by NNNN Corporation is described in Table 2.

Table 2: Test equipment provided by NNNN Corporation.

Type of equipment	Name	Drawing No.	Test ID No.
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-1
Inert Projectile	NNNN 155 HEIM, Inert	NNN-2	YYYY-2
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-3
Live Projectile	NNNN 155 HEIM, Live	NNN-1	YYYY-4
Live Booster	NNNN, Live Booster	NNN-3	YYYY-11
Inert Booster	NNNN, Inert Booster	NNN-4	YYYY-12
Live Booster	NNNN, Live Booster	NNN-3	YYYY-13
Live Booster	NNNN, Live Booster	NNN-3	YYYY-14
Modified Fuze	NNNN, Modified Fuze	NNN-5	YYYY-21
Inert Fuze	NNNN, Inert Fuze	NNN-6	YYYY-22
Live Fuze	NNNN, Live Fuze	NNN-7	YYYY-23
Live Fuze	NNNN, Live Fuze	NNN-7	YYYY-24

The NNNN 155 HEIM is a 155 mm artillery projectile with following specifications:

Weight, with live fuze: NN.NNN kg
Filling, ACIMEX44B: N.NN kg
Booster Charge, ACIMEX32D: N.NN kg
Length, with live fuze: NNN mm

2.3 Test items

2.3.1 Test No. 1 (calibration test)

The test item in Test No. 1 was one live projectile NNNN 155 HEIM, Live (YYYY-1) equipped with one live booster NNNN, Live Booster (YYYY-11) and one modified fuze NNNN, Modified Fuze (YYYY-21) as shown in Figure 2. The modified fuze was made in order to assemble a blasting cap and by the blasting cap initiate the test item to detonation.

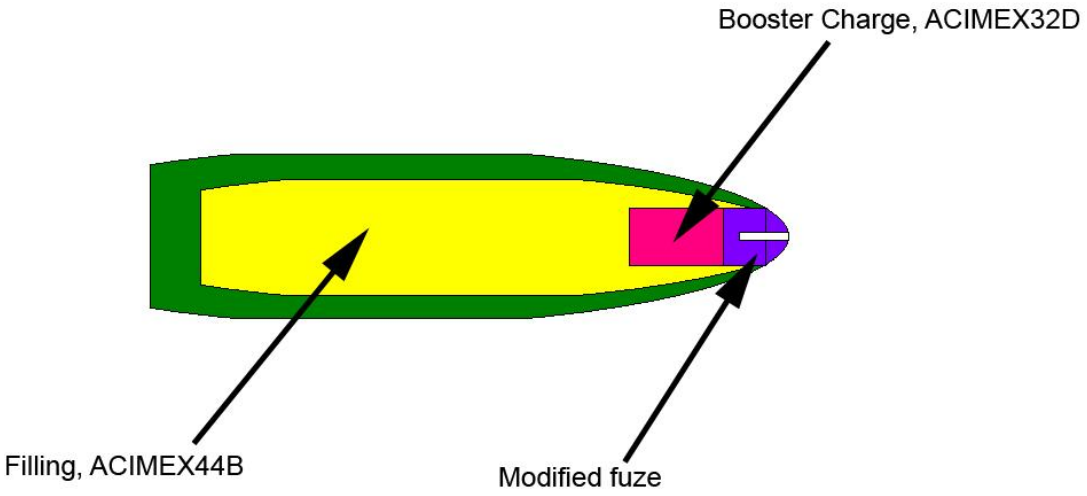

Figure 2: The test item in Test No. 1.

The parts in the test item in Test No. 1 are summarized in Table 3.

Table 3: The parts in the test item in Test No. 1.

Part	Test ID No.	Colour
Live Projectile	YYYY-1	Green
Live Booster	YYYY-11	Not Applicable
Modified Fuze	YYYY-21	Not Applicable

2.3.2 Test No. 2 (calibration test)

The test item in Test No. 2 was one inert projectile NNNN 155 HEIM, Inert (YYYY-2) equipped with one inert booster NNNN, Inert Booster (YYYY-12) and one inert fuze NNNN, Inert Fuze (YYYY-22) as shown in Figure 3.

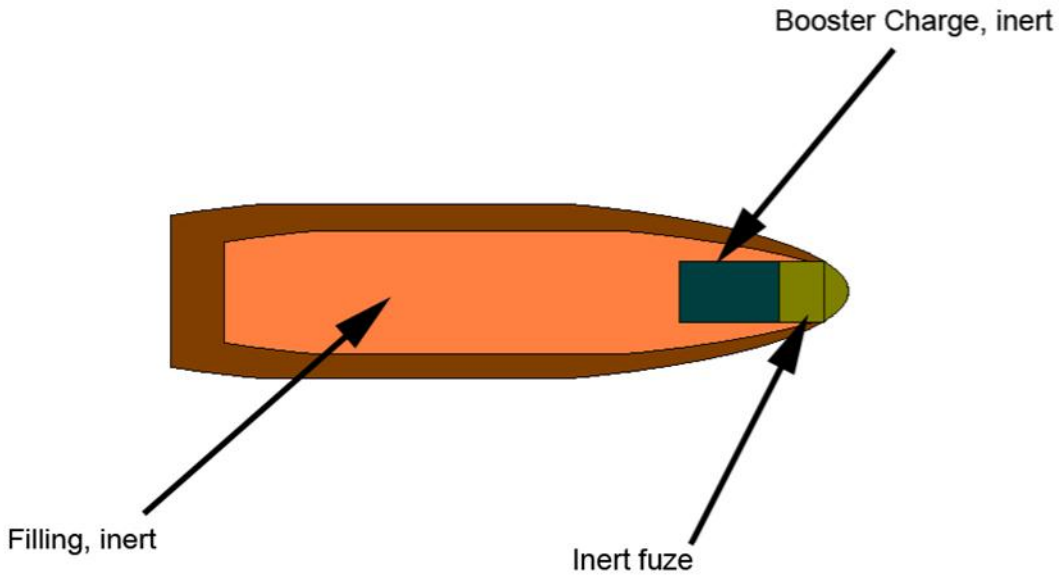

Figure 3: The test item in Test No. 2.

The parts in the test item in Test No. 2 are summarized in Table 4.

Table 4: The parts in the test item in Test No. 2.

Part	Test ID No.	Colour
Inert Projectile	YYYY-2	Brown
Inert Booster	YYYY-12	Not Applicable
Inert Fuze	YYYY-22	Not Applicable

2.3.3 Test No. 3

The test item in Test No. 3 was one live projectile NNNN 155 HEIM, Live (YYYY-3) equipped with one live booster NNNN, Live Booster (YYYY-13) and one live fuze NNNN, Live Fuze (YYYY-23) as shown in Figure 4.

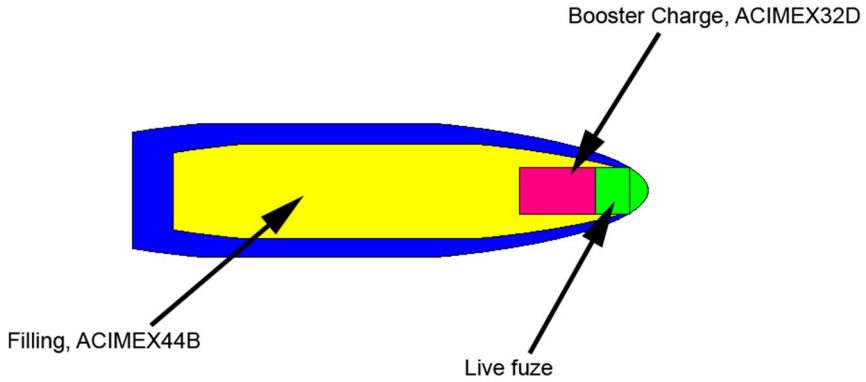

Figure 4: The test item in Test No. 3.

The parts in the test item in Test No. 3 are summarized in Table 5.

Table 5: The parts in the test item in Test No. 3.

Part	Test ID No.	Colour
Live Projectile	YYYY-3	Blue
Live Booster	YYYY-13	Not Applicable
Live Fuze	YYYY-23	Not Applicable

The point of impact in Test No. 3 is shown in Figure 5.

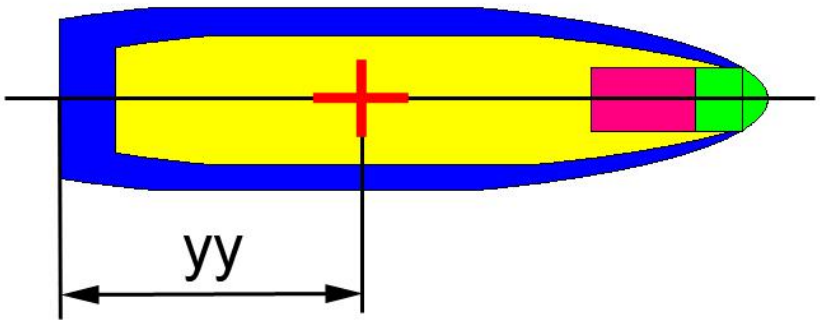

Figure 5: The point of impact in Test No. 3.

2.3.4 Test No. 4

The test item in Test No. 4 was one live projectile NNNN 155 HEIM, Live (YYYY-4) equipped with one live booster NNNN, Live Booster (YYYY-14) and one live fuze NNNN, Live Fuze (YYYY-24) as shown in Figure 6.

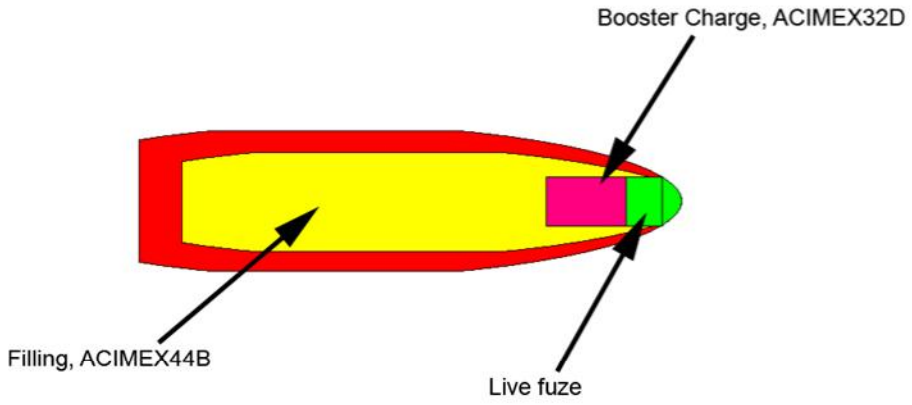

Figure 6: The test item in Test No. 4.

The parts in the test item in Test No. 4 are summarized in Table 6.

Table 6: The parts in the test item in Test No. 4.

Part	Test ID No.	Colour
Live Projectile	YYYY-4	Red
Live Booster	YYYY-14	Not Applicable
Live Fuze	YYYY-24	Not Applicable

The point of impact in Test No. 4 is shown in Figure 7.

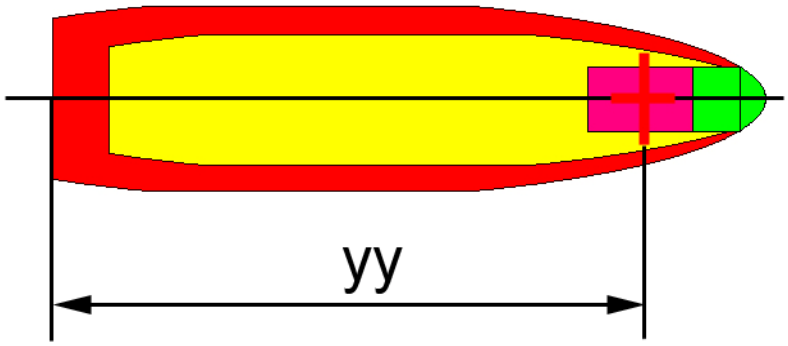

Figure 7: The point of impact in Test No. 4.

3 Test procedure

The tests were performed in accordance with Reference 3.

Test No. 1 was the first test to be performed followed by Test No. 2, Test No. 3 and finally Test No. 4.

Test No. 1 was performed as follows:

1. The test item was positioned correctly.
2. All personnel except for the Test Technicians took cover.
3. Electrical resistance in the open initiation chain (firing cable) was measured.
4. The initiation chain (firing cable) was short-circuited.
5. Electrical resistance in the short-circuited initiation chain (firing cable) was measured.
6. The blasting cap was connected to the short-circuited initiation chain.
7. Electrical resistance in the initiation chain (firing cable and blasting cap) was measured.
8. The blasting cap was installed into the modified fuze system on the test item.
9. The Test Technicians took cover.
10. The test item was initiated to detonation.
11. Waiting time as decided by the Test Officer.
12. Preliminary inspection of the test site performed by the Test Officer.
13. Inspection of the test site and assessment of the result.

Test No. 2, Test No. 3 and Test No. 4 was performed as follows:

1. The test item was positioned correctly.
2. All personnel except for the Test Technicians took cover.
3. Electrical resistance in the open initiation chain (firing cable) was measured.
4. The initiation chain (firing cable) was short-circuited.
5. Electrical resistance in the short-circuited initiation chain (firing cable) was measured.
6. The blasting cap was connected to the short-circuited initiation chain.
7. Electrical resistance in the initiation chain (firing cable and blasting cap) was measured.
8. The blasting cap was installed into the initiation system on the PG-7M warhead.
9. The Test Technicians took cover.
10. The PG-7M warhead was initiated to detonation.
11. Waiting time as decided by the Test Officer.

12. Preliminary inspection of the test site performed by the Test Officer.
13. Inspection of the test site and assessment of the result.

After completion of all tests the explosives remains were collected and disposed as further described in Chapter 8.

4 Test configuration

4.1 Test setups

4.1.1 Test No. 1 (calibration test)

The test setup for Test No. 1 is shown in Figure 8. The dimensions of the witness plate were (Width x Length x Thickness) yyyy mm x yyyy mm x yy mm. The depth of the sand bed was yy mm.

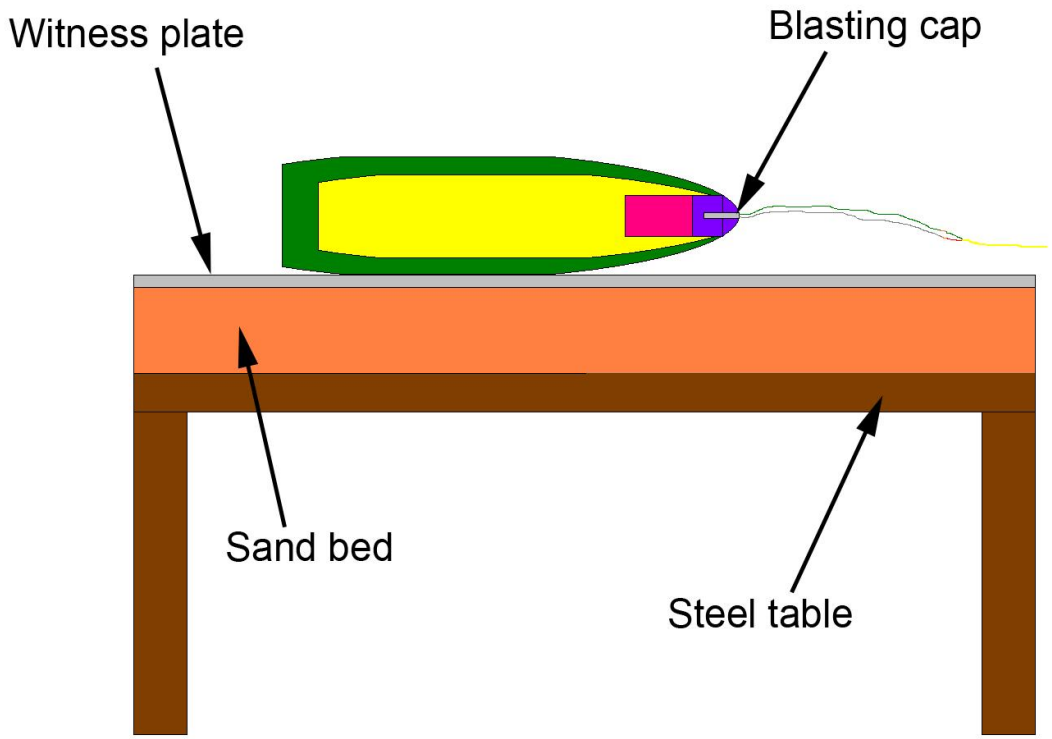

Figure 8: The test setup for Test No. 1 (calibration test).

4.1.2 Test No. 2 (calibration test), Test No. 3 and Test No. 4

The test setup for Test No. 2, Test No. 3 and Test No. 4 is shown in Figure 9. The dimensions of the witness plate were (Width x Length x Thickness)
yyyy mm x yyyy mm x yy mm. The depth of the sand bed was yy mm.

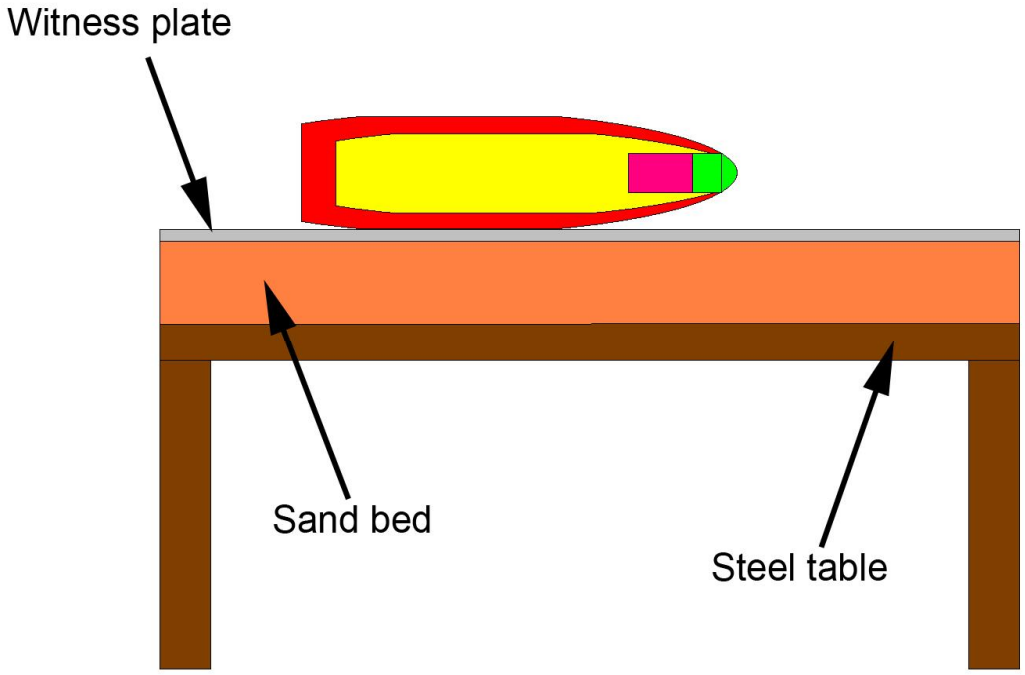

Figure 9: The test setup for Test No. 2, Test No. 3 and Test No. 4 (picture from Test No. 4).

4.2 Test layout

A schematic view, not to scale, of the test layout is shown in Figure 10. The air blast pressure gauges were placed in orthogonal directions from the centre point of the test item. The distance in meters from the centre point of the test item to each piece of equipment is described in Table 7.

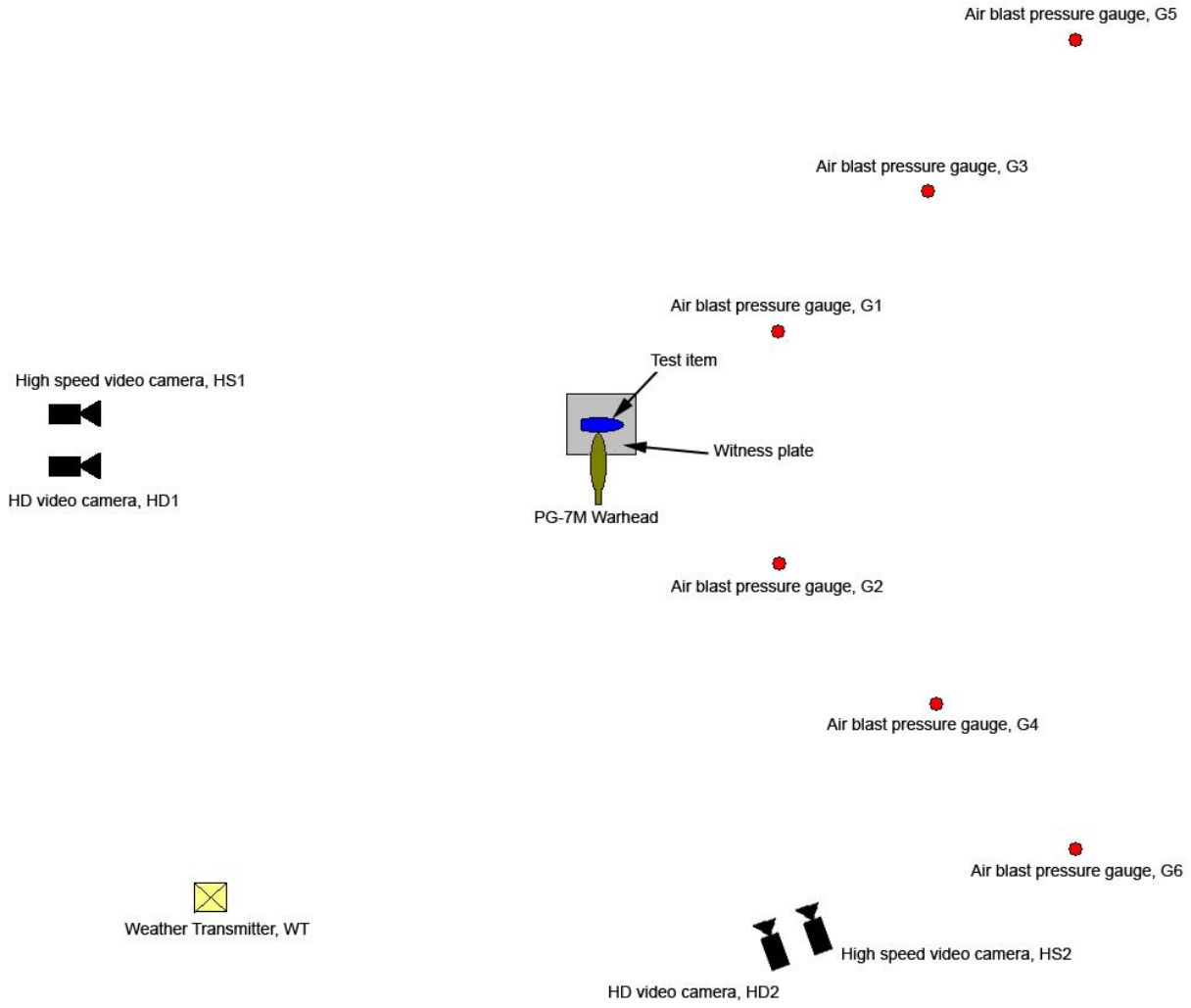

Figure 10: A schematic view, not to scale, of the test layout.

Table 7: The distance from the centre point of the test item to each piece of equipment.

Piece of equipment	Distance from the centre point of the test item (m)
HS1	NN
HD1	NN
HS2	NN
HD2	NN
G1	N
G2	N
G3	NN
G4	NN
G5	NN
G6	NN
WT	NN

5 Safety measures

The tests were performed in accordance with Bofors Test Center's Safety and Security Plan.

6 Meteorological conditions

The meteorological conditions at the time of each test are described in Table 8.

Table 8: The meteorological conditions at the time of each test.

Test No.	Date and time	Barometric pressure (hPa)	Relative humidity (%RH)	Liquid Precipitation (mm)	Wind speed (m/s)	Wind direction (º)	Air temperature (ºC)
1	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
2	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
3	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n
4	20nn-nn-nn nn:nn	nnn.nn	nn.n	n	n.nn	nn	nn.n

7 Results

N.B. Following Chapters (7.1-7.4) do not contain any pictures since the tests, as stated earlier, never have been performed.

7.1 Test No. 1 (calibration test)

Pictures from the high speed video cameras are shown in Figures 11-14.

No picture available

Figure 11: The test item when initiated (picture from HS1).

No picture available

Figure 12: The test item nn ms after initiation (picture from HS1).

No picture available

Figure 13: The test item when initiated (picture from HS2).

No picture available

Figure 14: The test item nn ms after initiation (picture from HS2).

The registered air blast pressure values are shown in Table 9. These values were used in Test No. 3 and Test No. 4 as reference values.

Table 9: The registered air blast pressure values in Test No. 1.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 15, fragments from the test item were found, see Figure 16. These fragments were used in Test No. 3 and Test No. 4 as references.

No picture available

Figure 15: The test area after Test No. 1.

No picture available

Figure 16: All collected fragments from the test item in Test No. 1.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 10 and are mapped in the sketch (not to scale) in Figure 17. These values were used in Test No. 3 and Test No. 4 as reference values of how far fragments could travel when the test item was initiated to detonation i.e. the possible worst case reaction.

Table 10: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

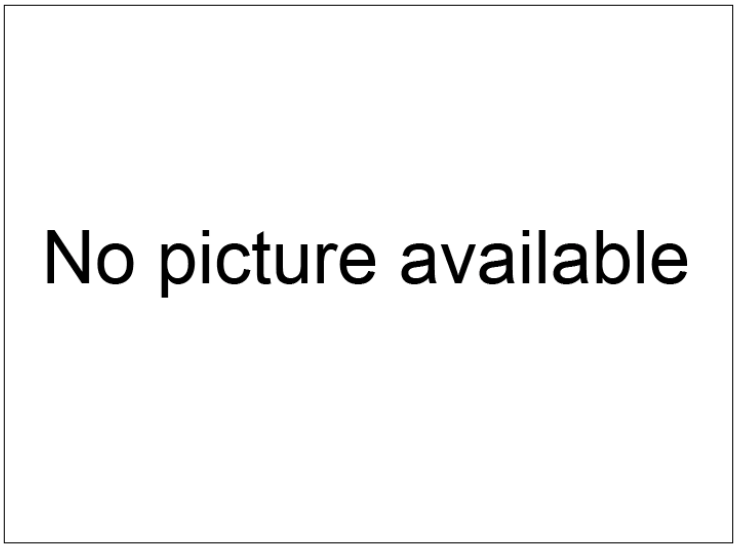

Figure 17: A sketch, not to scale, of the test area after Test No. 1.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 18. These values were used in Test No. 3 and Test No. 4 as reference values of the indent(s) and penetration(s) of one test item initiated to detonation.

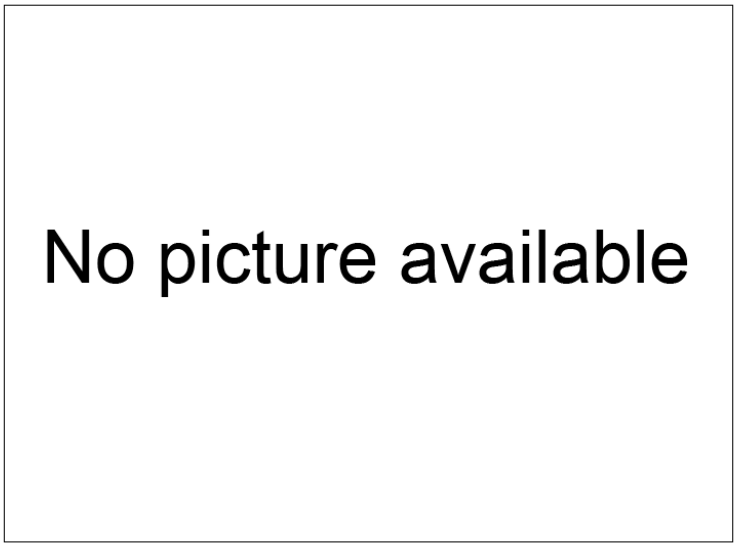

Figure 18: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

7.2 Test No. 2 (calibration test)

Pictures from the high speed video cameras are shown in Figures 19-24.

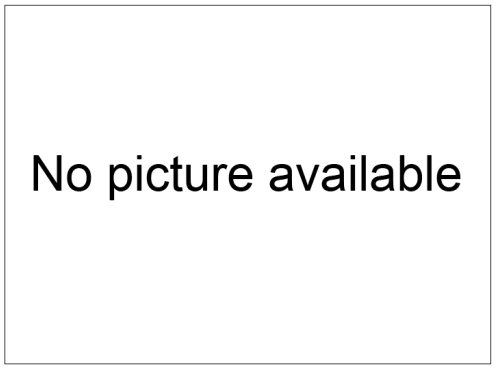

Figure 19: The PG-7M warhead when initiated (picture from HS1).

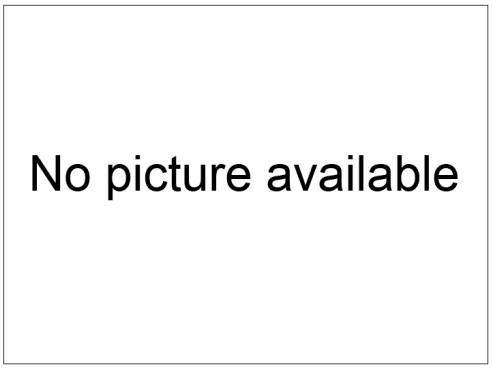

Figure 20: The PG-7M warhead when initiated (picture from HS2).

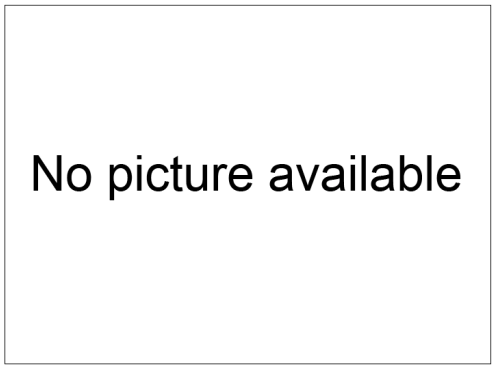

Figure 21: The test item nn ms after the PG-7M warhead was initiated (picture from HS1).

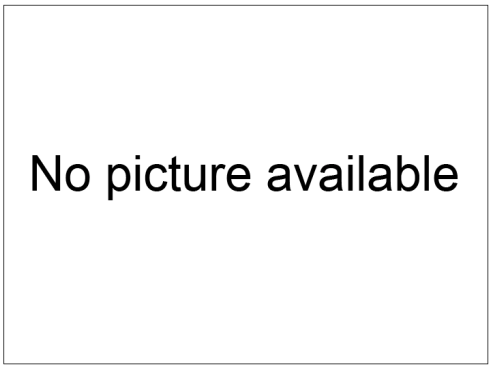

Figure 22: The test item nn ms after the PG-7M warhead was initiated (picture from HS2).

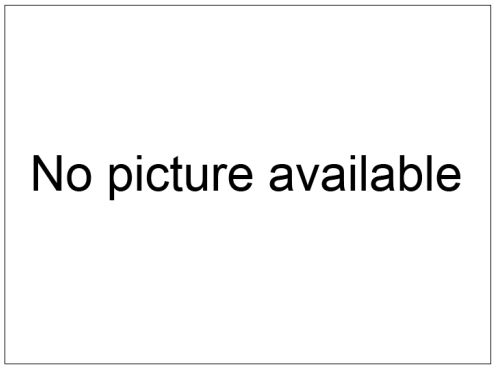

Figure 23: The test item nnn ms after the PG-7M warhead was initiated (picture from HS1).

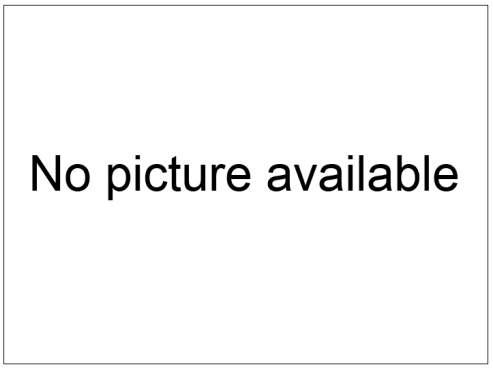

Figure 24: The test item nnn ms after the PG-7M warhead was initiated (picture from HS2).

The registered air blast pressure values are shown in Table 11. These values were used in Test No. 3 and Test No. 4 as reference values.

Table 11: The registered air blast pressure values in Test No. 2.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 25, fragments from the test item were found, see Figure 26. These fragments were used in Test No. 3 and Test No. 4 as references.

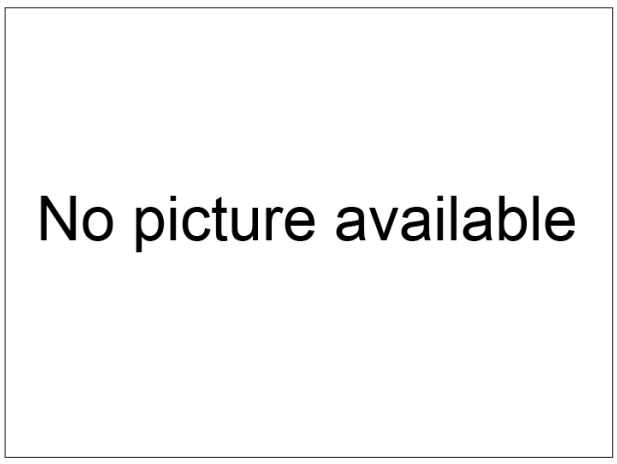

Figure 25: The test area after Test No. 2.

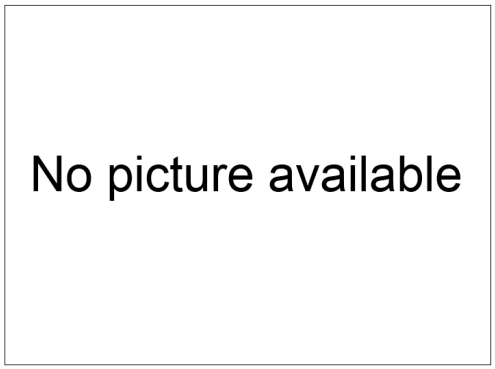

Figure 26: All collected fragments from the test item in Test No. 2.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 12 and are mapped in the sketch (not to scale) in Figure 27. These values were used in Test No. 3 and Test No. 4 as reference values of how far fragments from an inert test item could travel only due to the kinetic energy provided by the shaped charge jet.

Table 12: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

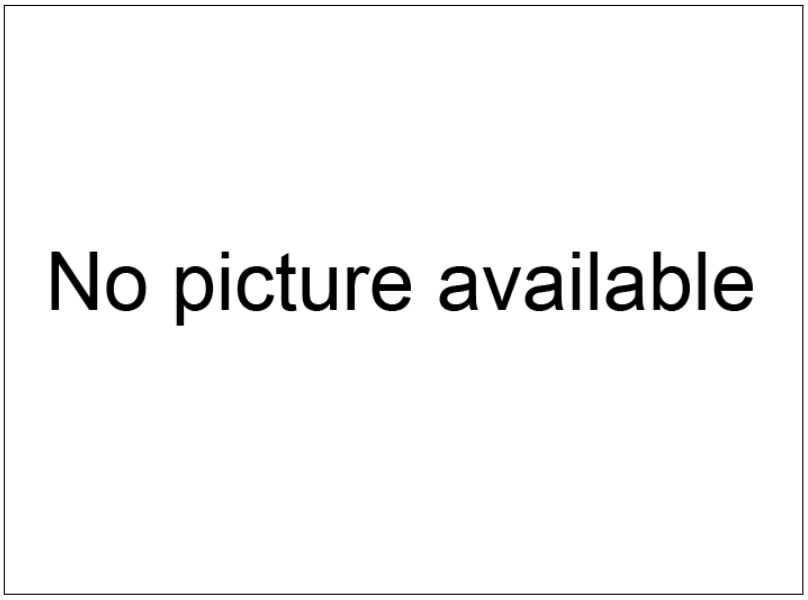

Figure 27: A sketch, not to scale, of the test area after Test No. 2.

The witness plate had no indents and was not penetrated, see Figure 28.

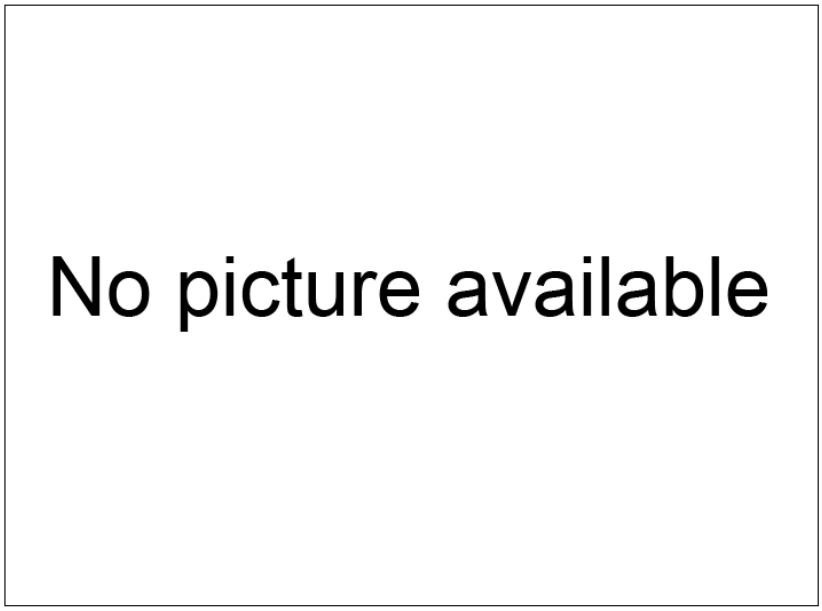

Figure 28: The witness plate had no indents and was not penetrated.

7.3 Test No. 3

Pictures from the high speed video cameras are shown in Figures 29-34.

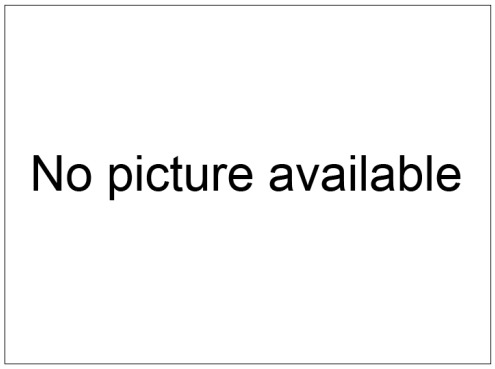

Figure 29: The PG-7M warhead when initiated (picture from HS1).

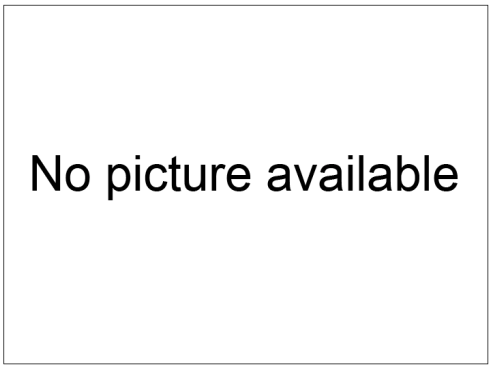

Figure 30: The PG-7M warhead when initiated (picture from HS2).

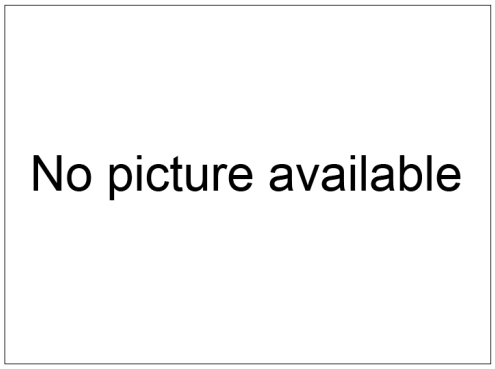

Figure 31: The test item nn ms after the PG-7M warhead was initiated (picture from HS1).

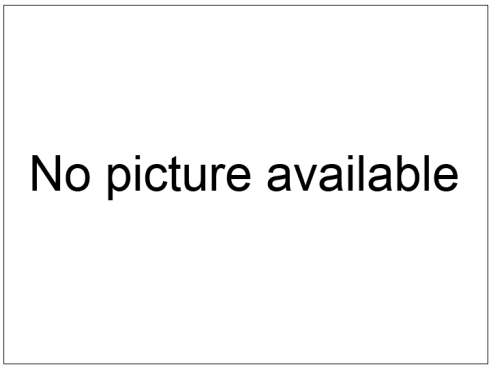

Figure 32: The test item nn ms after the PG-7M warhead was initiated (picture from HS2).

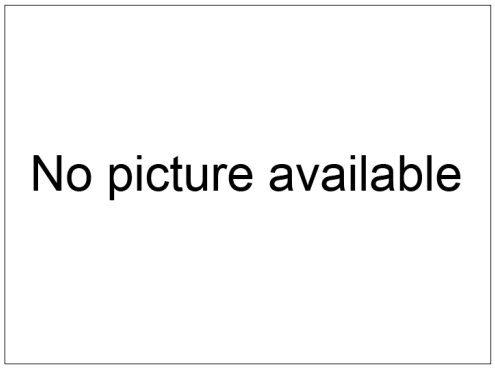

Figure 33: The test item nnn ms after the PG-7M warhead was initiated (picture from HS1).

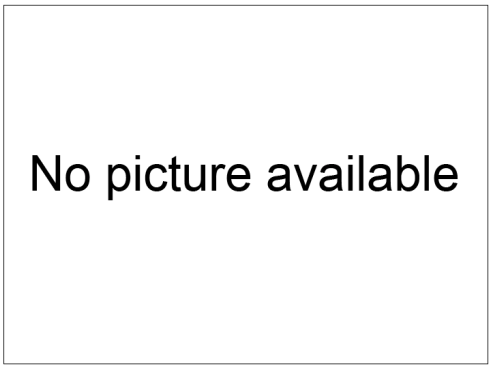

Figure 34: The test item nnn ms after the PG-7M warhead was initiated (picture from HS2).

The registered air blast pressure values are shown in Table 13.

Table 13: The registered air blast pressure values in Test No. 3.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 35, fragments from the test item were found, see Figure 36.

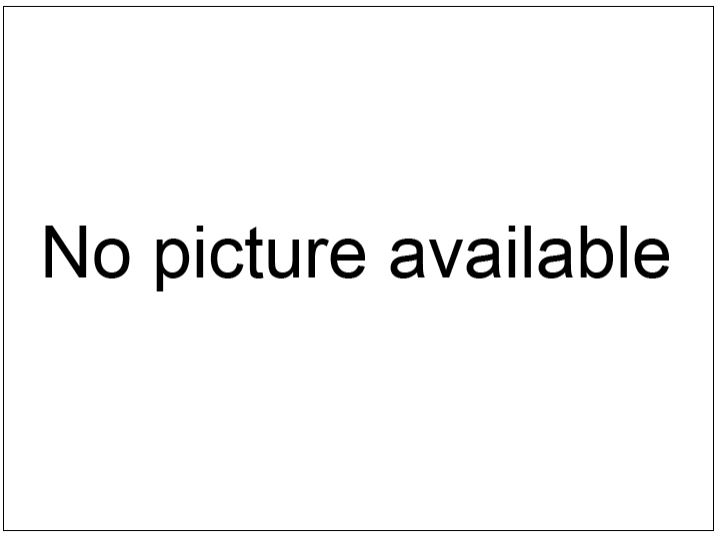

Figure 35: The test area after Test No. 3.

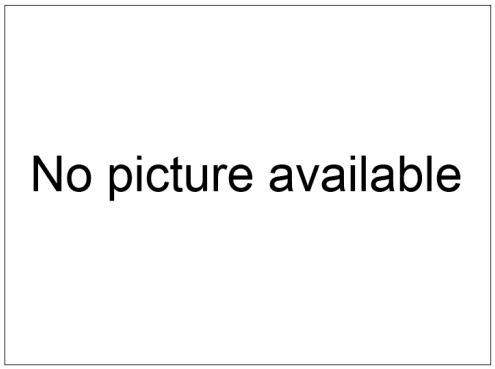

Figure 36: All collected fragments from the test item in Test No. 3.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 14 and are mapped in the sketch (not to scale) in Figure 37.

Table 14: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

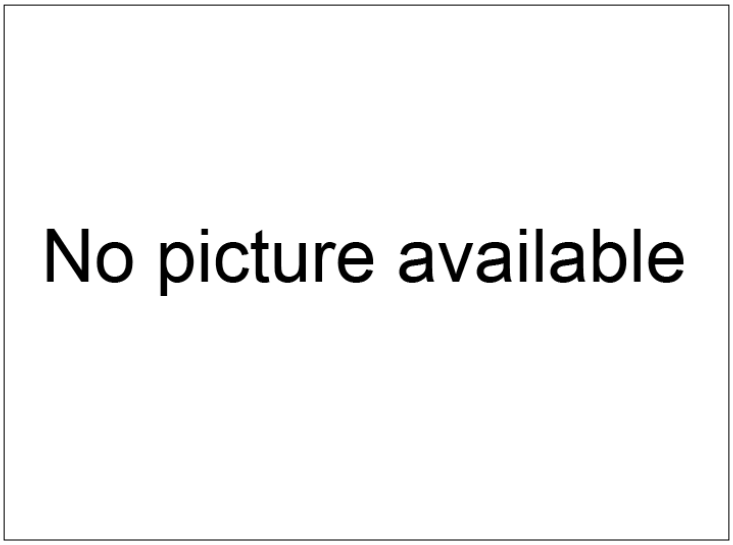

Figure 37: A sketch, not to scale, of the test area after Test No. 3.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 38.

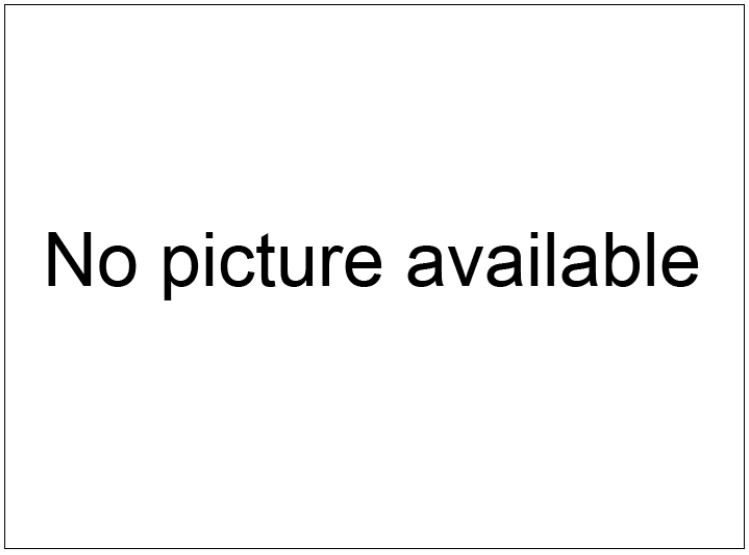

Figure 38: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapters 7.1, 7.2, 7.3 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

7.4 Test No. 4

Pictures from the high speed video cameras are shown in Figures 39-44.

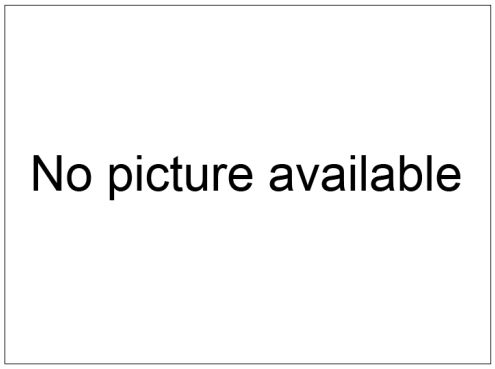

Figure 39: The PG-7M warhead when initiated (picture from HS1).

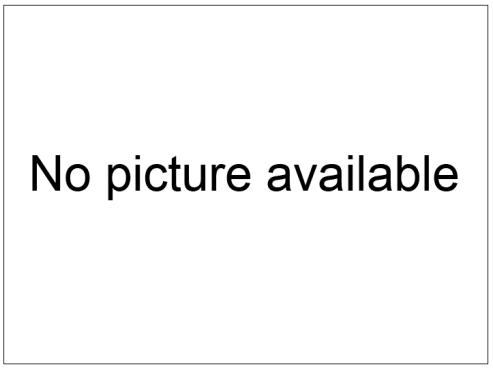

Figure 40: The PG-7M warhead when initiated (picture from HS2).

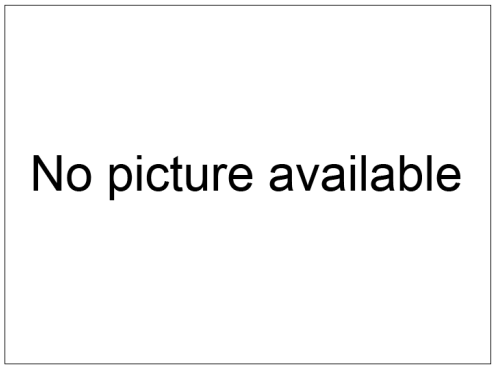

Figure 41: The test item nn ms after the PG-7M warhead was initiated (picture from HS1).

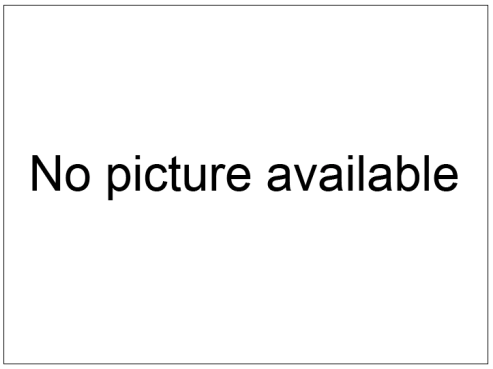

Figure 42: The test item nn ms after the PG-7M warhead was initiated (picture from HS2).

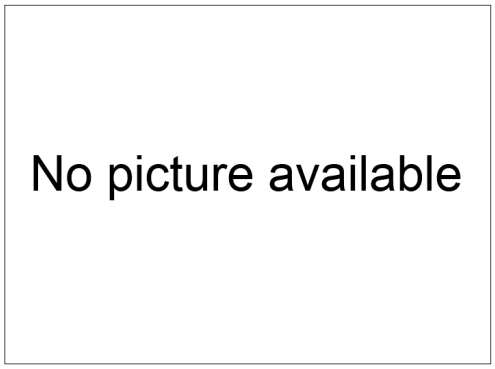

Figure 43: The test item nnn ms after the PG-7M warhead was initiated (picture from HS1).

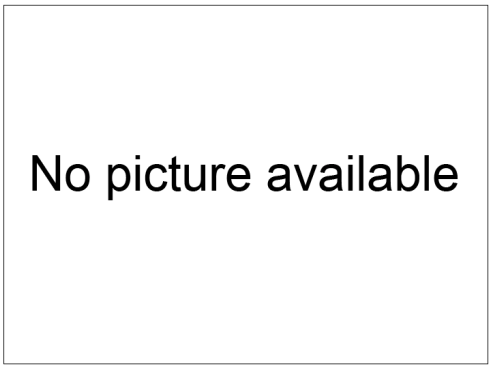

Figure 44: The test item nnn ms after the PG-7M warhead was initiated (picture from HS2).

The registered air blast pressure values are shown in Table 15.

Table 15: The registered air blast pressure values in Test No. 4.

Registered air blast pressures values (kPa)					
G1, N m	**G2, N m**	**G3, NN m**	**G4, NN m**	**G5, NN m**	**G6, NN m**
nn.nn	nn.nn	nn.nn	nn.nn	nn.nn	nn.nn

When the test area was searched after the test, see Figure 45, fragments from the test item were found, see Figure 46.

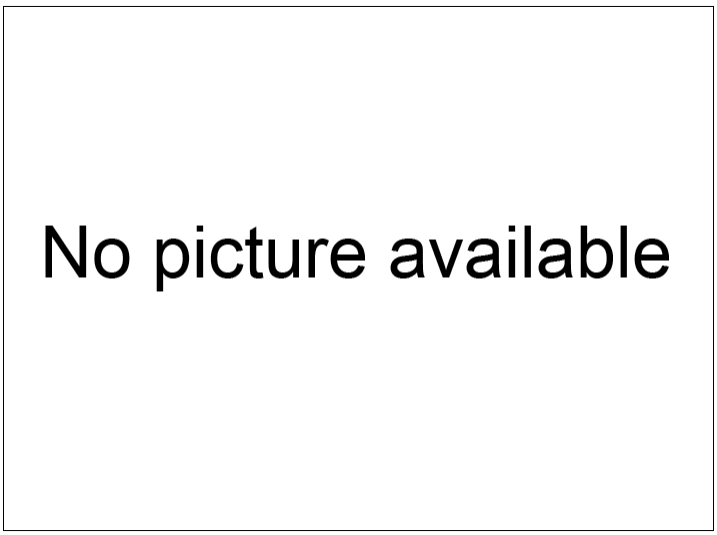

Figure 45: The test area after Test No. 4.

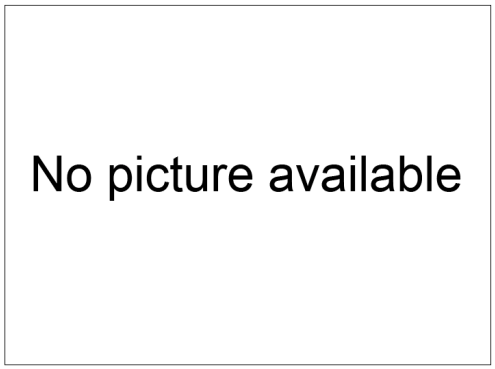

Figure 46: All collected fragments from the test item in Test No. 4.

All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1) are given in Table 16 and are mapped in the sketch (not to scale) in Figure 47.

Table 16: All fragments which had travelled beyond 15 m and with an energy level greater than 20 J based on the distance versus mass relationships given in Reference 2 (Figure B-1).

Fragment No.	**Weight (g)**	**Projection distance (m)**
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n
n	nn	nn.n

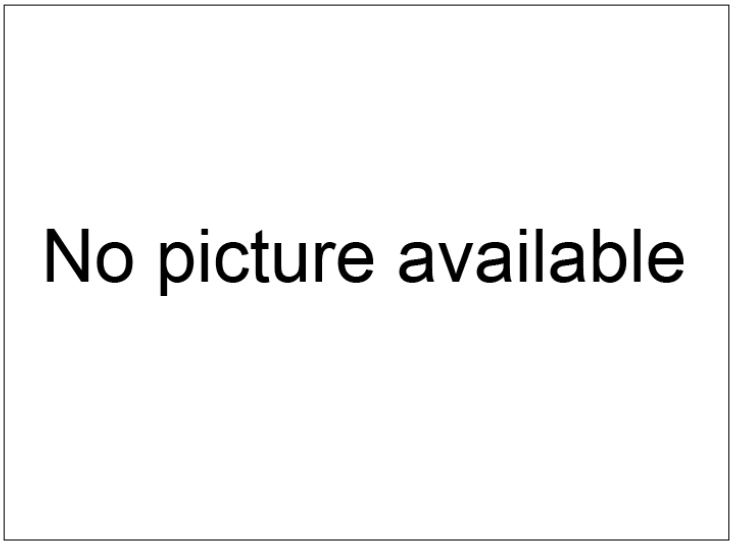

Figure 47: A sketch, not to scale, of the test area after Test No. 4.

The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated, see Figure 48.

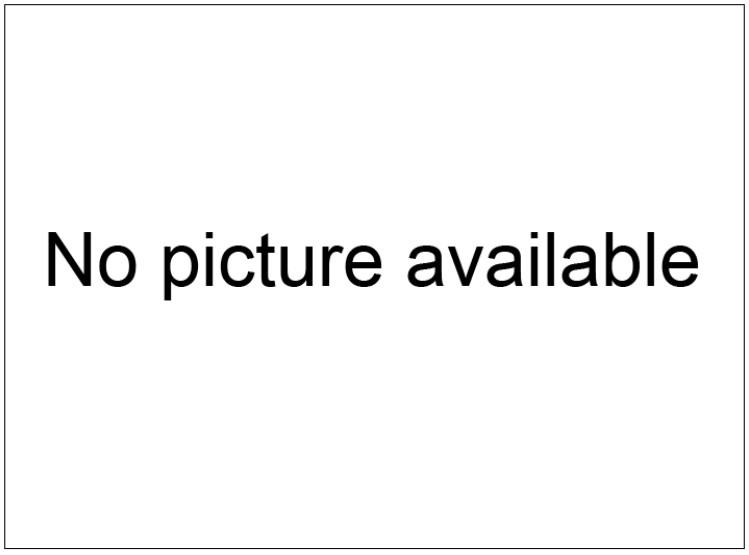

Figure 48: The witness plate had nn approximately nn mm deep indent(s) but was/was not penetrated.

Based on the information given in Chapters 7.1, 7.2, 7.4 and in Reference 2 (Annex I) the type of response is judged as a NNN (Type NN). This since…

8 Disposal of explosive items

After completion of all tests the explosives remains were collected and disposed in one detonation using PETN based plastic explosives and one blasting cap, see Figures 49-50.

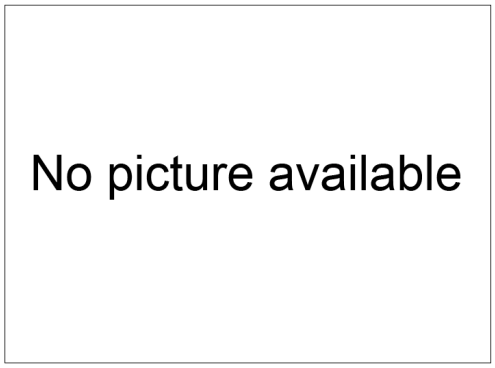

Figure 49: All collected explosives remains before disposal.

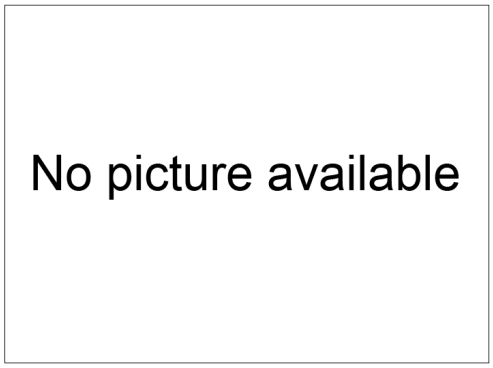

Figure 50: The site after disposal.

9 Conclusions

The shaped charge jet impact sensitivity of the unpackaged 155 mm artillery projectile NNNN 155 HEIM is judged to be a NNN (Type NN) type of response since this was the worst case type of response in the two shaped charge jet tests performed.

10 References

[1.] STANAG 4526 “Shaped Charge Jet, Munitions Test Procedures”, Edition 2, 10th of December 2004

[2.] AOP-39 “Guidance on the Assessment and Development of Insensitive Munitions (IM)”, Edition 3, March 2010

[3.] Test Procedure “Shaped Charge Jet Tests, NNNN 155 HEIM”, Edition 1, NNNN Corporation, NNth of Nnn 20NN