TEST GUIDELINE

Bullet resistant plate materials

Englische Übersetzung, es gilt immer die deutsche Originalfassung!

English translation, however the original German version always prevails!

Editor:

Association of test laboratories for bullet resistant materials and constructions

Edition: 2008-05-08

First edition of VPAM PM 2007: 2007-10-25

Documentation of modifications

Modifications		Modifications were made and numbered as follows
No.	**Date**	
1	2008-05-08	Foreword, introduction (renaming of APR 2006, therefore changes at 2 and 4.1), 5

Foreword

These guideline was worked out by the (VPAM) Association of test laboratories for bullet resistant materials and constructions. Members of the VPAM are:

- Beschussamt Wien (A)
- Ruestungsdirektion, Amt fuer Ruestung und Wehrtechnik, Felixdorf (A)
- Royal Military Academy, Dept. of Weapon Systems & Ballistics (ABAL), Bruessel (B)
- Universitaet Bern, Institut für Rechtsmedizin, Bern (CH)
- armasuisse, Wissenschaft & Technologie, Thun (CH)
- Beschussamt Mellrichstadt (D)
- Beschussamt Muenchen (D)
- Beschussamt Ulm (D)
- Deutsche Hochschule der Polizei, Polizeitechnisches Institut (PTI), Muenster (D)
- vts Politie Nederland, Apeldoorn (NL)
- TNO Defence, Security and Safety, Rijswijk (NL)
- Politiets data - og materiellt jeneste, Oslo (N)

Reference source VPAM - PM 2007:

VPAM
Association of test laboratories for bullet resistant materials and constructions

Office:

Deutsche Hochschule der Polizei
Polizeitechnisches Institut
Postfach 48 03 53
48080 Muenster

Deutschland

Tel.: +49 (0) 25 01 806-259
Fax: +49 (0) 25 01 806-239

E-Mail: pti@dhpol.de
Internet: www.vpam.eu oder www.dhpol.de

Table of contents

Seite

Introduction

The basics for ballistic tests and/or assessment of conformity[1] of materials, constructions and products, which offer protection against attacks with firearms are described in the report „Allgemeine Pruefgrundlagen fuer ballistische Material-, Konstruktions- und Produktpruefungen“ (General basics for ballistic material, construction and product tests), VPAM - APR 2006.

This test guideline describes the specific requirements, classifications and test-methods for „Bullet resistant plate materials“(PM).

[1] To simplify the text the term TEST will be used.

1 Fields of application

Bullet resistant plate materials are supposed to protect people and objects against bullets, fired from small arms and rifles (ballistic protection). These materials should reduce the penetration of bullets or bullet fragments at an impact angle of 90° (perpendicular hit).

2 Normative Reference

The following standardised documents contain modalities that have to be considered as part of this test guideline as they are referred to. A reference with a date does not comprise changes or corrections of this publication.

It is recommended that contractual partners who are using this guideline check the possibility to use the latest version of the following standardised documents.

When using a reference without a date the latest version of the standardised document is valid. Legal regulations apply to the latest valid version.

- **VPAM - APR 2006**, General basis for ballistic material, construction and product tests.
- **EN 10204**, Metal products - Types of test-certificates
- **EN 1063**, Glass for construction engineering - special safety glazing - testing methods and classification of the impact resistance.
- **TDCC**, Dimension sheet of the Permanent International Commission for testing small arms. (C.I.P.)

3 Terms

The definitions of terms are generally defined in the APR 2006. For the appliance of this test guideline the following additional terms are valid:

3.1 Plate materials

Plate materials are made of one or more layers of woven fabrics of organic or non-organic materials in single or multiple layers (examples see attachment 2). The single layers can be connected by gluing, forging, soldering, weaving, screwing or clamping. Each layer must show a continuously unitary cross-section. Materials or constructions tested according to the EN 1522 and 1523 (windows, doors, seals) or EN1063 (glass for construction engineering) do not belong to this definition.

3.2 Test specimen

A sample prepared for testing.

Notice: The structure and the materials of the sample element must match the specifications of the producer or the applicant. It must also represent the standard quality of the product.

Each test specimen must be explicitly designated to identify the product.

Test-reports (e.g. EN10204-3.1 for steel and the batch number), the exact structure, especially the material-composition and the production processes have to be provided with each test specimen.

3.3 Splinter release

Splinters release is evident from the backside of the test specimen, if the splinter indicator is penetrated.

3.4 Multihit

Multihit stands for 3 hits which show an equilateral triangle on the target. The centres of the 3 hits must have a distance to each other of at least 3 times and at most 4 times the calibre.

4 Requirements, classifications and test conditions

4.1 General requirements, classifications and test conditions

Plate materials are classified according to the test steps of VPAM - APR 2006, paragraph 4.1, table 1.

The designation of the classes reads as follows:

Class 7 as specified by VPAM - PM 2007

4.2 Multihit test

The test has to be carried out according to paragraph 6.5.2 of this guideline.

4.3 Calculation of the ballistic limit V_{50}

The ballistic limit value V_{50} has to be carried out according to the method VPAM-KNB paragraph 6.4.3 of the VPAM - APR 2006.

5 Test and measurement equipment

The VPAM - APR 2006, paragraphs 5 und 6, dictate the testing and measuring equipment as well as the test procedure for plate materials.

The determined parameters of VPAM - APR 2006, paragraph 4.1, table 1, have to be ascertained.

The test sequence must match attachment 1 of this guideline.

5.1 Measuring and target setup

Measuring and target setup must match to attachment 1 of this guideline.

5.2 Clamping frame / test specimen fixture

The test specimen has to be fixed as specified in attachment 1, fig. 2, to a rigid back-sided frame. It should be fixed in a way the all sides have a support of 30 mm minimum. The contact face is coated with 4 mm neoprene hardness 40 IRHD to 60 IRHD as specified in ISO 48. The floor space below the plate material must be of neoprene of the same thickness and quality.

Attachment 2 shows how the test sample is fixed with four M12 bolts at the four corners as follows:

Fasten the bolts without washers with a torque of 60 ± 2 N.

Test specimen whose attack-faced side is coated or covered with any kind of material which allows a penetration of the fastening bolts into the material are to be protected by an additional frame, size 500 x 500 mm. It has to be of flats 30 x 30 x 5 mm, positioned between the screws and the surface of the test specimen. The screws are to be fastened with the same torque as mentioned before.

Comply with the test sample sizes and the clamping conditions of EN 1063 when testing glass panels for special protected cars.

5.3 Penetration and splinter indicators

Use the indicators of VPAM - APR 2006, paragraphs 5.4 and 5.5 to determine penetration and splinter release of test specimen.

6 Test procedures

6.1 General

If test procedures and characteristics are not defined here refer to the VPAM - APR 2006.

6.2 Number of test specimen

For any plate material to test at least three identical test specimen have to be submitted at the same time.

6.3 Test specimen size

The size of the test sample is 500 x 500 mm (± 10 mm). Minor variations of the dimensions must be approved by the test centre. These variations have to be mentioned in the test report.

Note: When using inhomogeneous test specimen (e.g. ceramic panels) their arrangement must be marked on the test specimen.

6.4 Test range

For plate materials the

- **Bullet resistance** is carried out according to the defined parameters of VPAM - APR 2006, paragraph 4.1, table 1, together with the triangle impact defined in paragraph 6.5.1.

Can be carried out optionally:

- **Multihit test** according to paragraph 6.5.2 of this guideline (except glass und glass-like materials, e.g. ceramics)
- Calculation of the **ballistic limit** V_{50} according to no. 6.4.3 of VPAM - APR 2006 and paragraph 6.5.3 of this guideline (except glass und glass-like materials, e.g. ceramics)

6.5 Number and distance of impacts (hits)

6.5.1 Triangle shooting

On a test specimen 3 shots have to be fired with a hit distance of 120 mm to each other. Any single impact must not be closer to the inside of the clamping frame than 75 mm.

Note: At the test of inhomogeneous specimen as ceramic panels the hit triangle may be enlarged to hit three single plates in their centres. Furthermore 3 gaps as shown in attachment 2, fig. 4.1 and 4.2, are tested. The test centre defines the high risk areas of other inhomogeneous test specimen.

6.5.2 Multihit test

On the test specimen 3 impacts are defined which have a distance to each other of 3 times the diameter of the calibre (tolerance + 5 mm). The border of the multihit impact group must have a minimum distance of 120 mm to any impact of the triangle shooting.

Any single impact must not be closer to the inside of the clamping frame than 75 mm.

This test can be carried out on a test sample which was already tested according to paragraph 6.5.1.

Note: For inhomogeneous test specimen (e.g. ceramic panels) the multihit test is only carried out for information purposes.

6.5.3 Calculation of the ballistic limit V_{50}

The calculation of the ballistic limit V_{50} should comply with the display of the position of impacts defined the limit like in attachment 4.

Note: For inhomogeneous test specimen (e.g. ceramic panels) the multihit test is only carried out for information purposes.

6.6 Determination of points of impact

The points of impact on the test specimen must be marked and numbered according to attachment 3 of this guideline.

The zero point of the coordinate system is laid into the bottom left corner of the test sample. The ordinate is designated with the letter "Y", the abscissa with the letter "X".

7 Evaluation and documentation of the test, test report

Assessment and documentation of the test complies with VPAM - APR 2006, no. 7.

If the test was carried out according to paragraph 4.2 and/or paragraph 4.3 of this guideline it has to be documented in the test report.

Attachment 1: Measuring and target setup

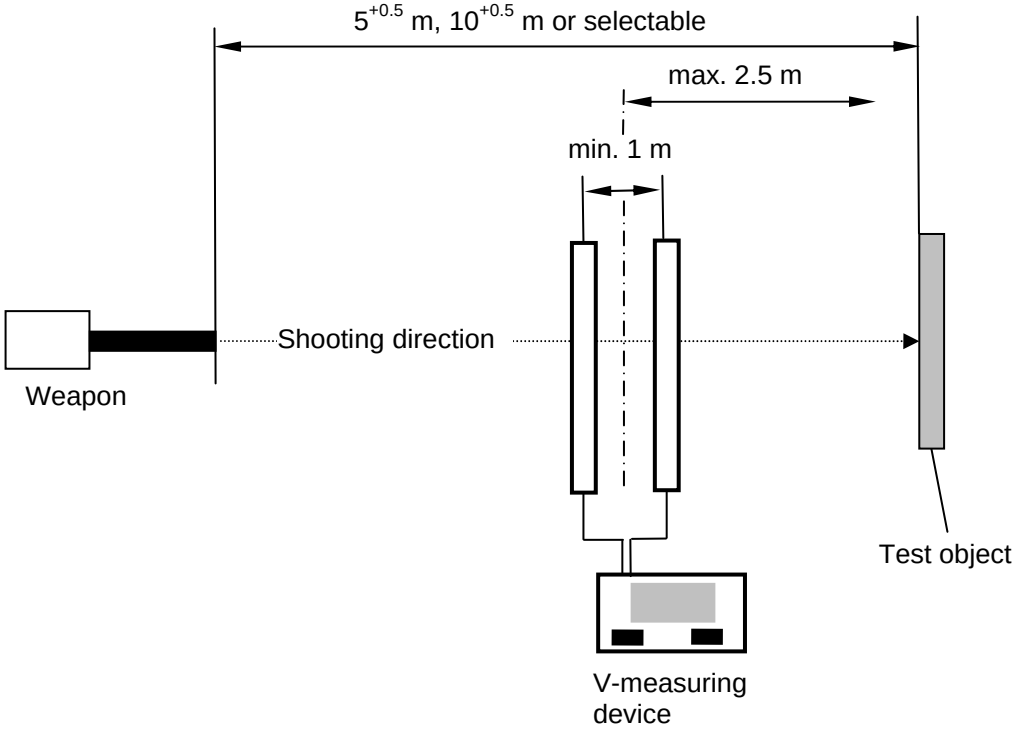


Fig. 1: Clamping frame, test sample fixing

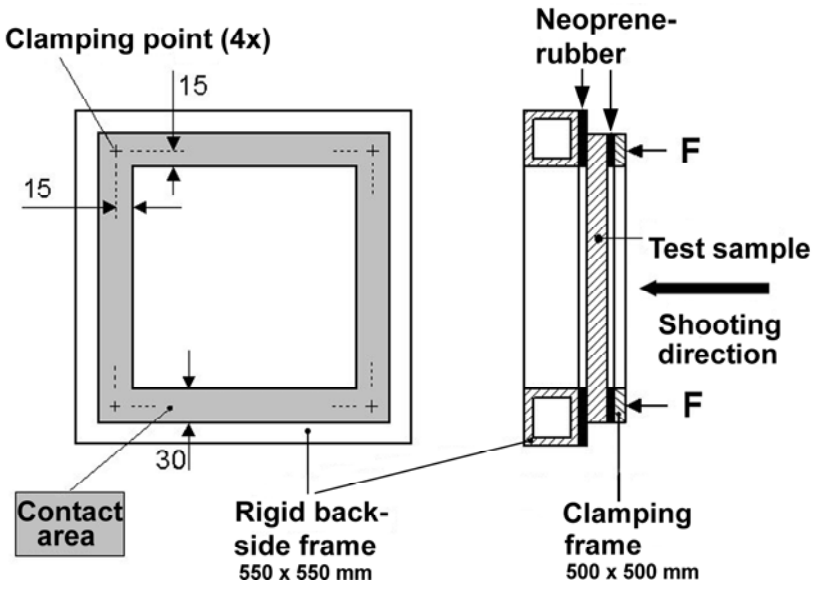
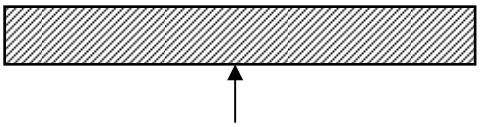


Fig. 2: clamping frame, test sample fixture

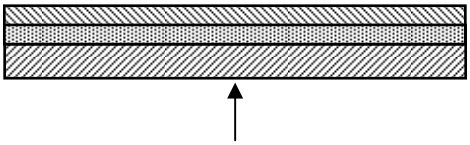
Attachment 2: Plate materials, shooting direction and position of impact points (examples)

Fig. 1



Single, homogenous plate

Fig. 2



Combined panel (also glass)

Fig. 3

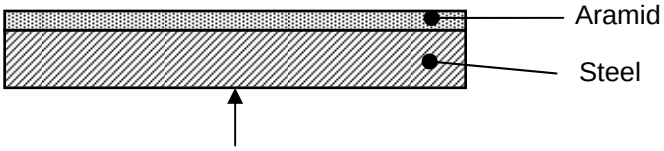


Fig. 4.1

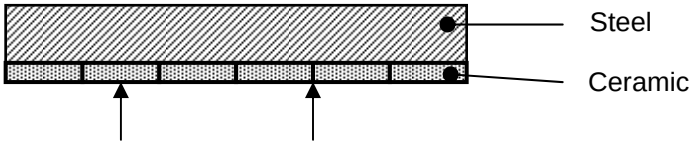
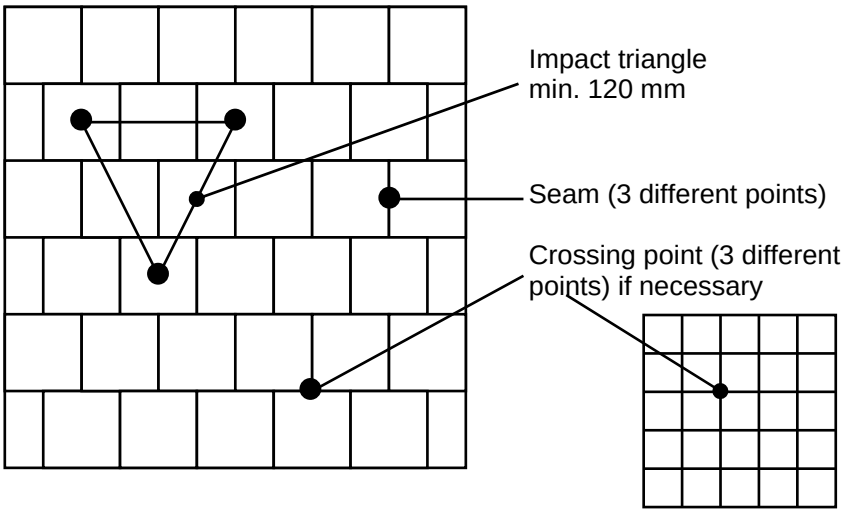
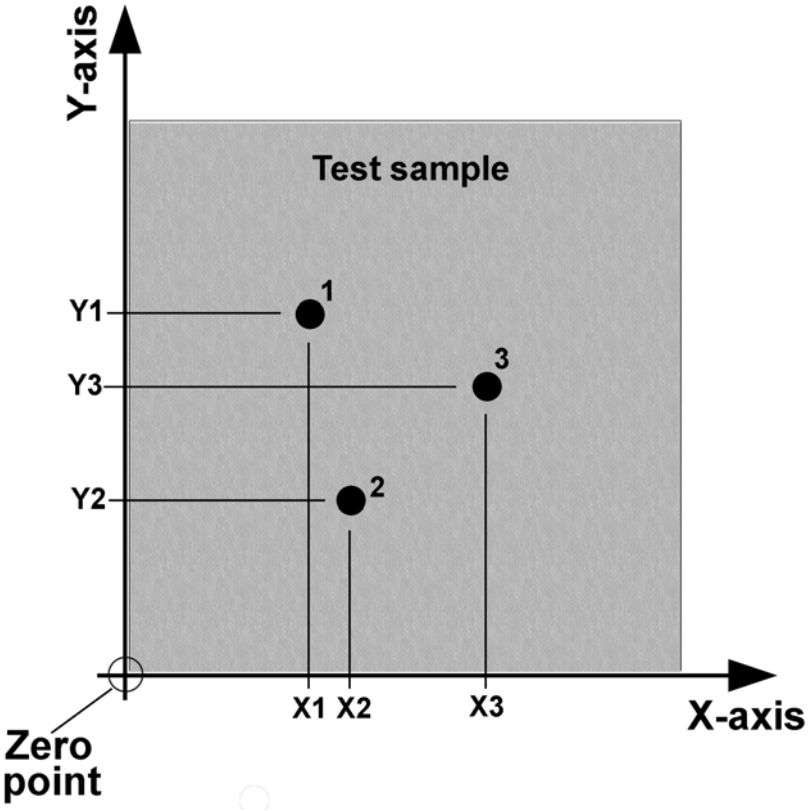


Fig.4.2

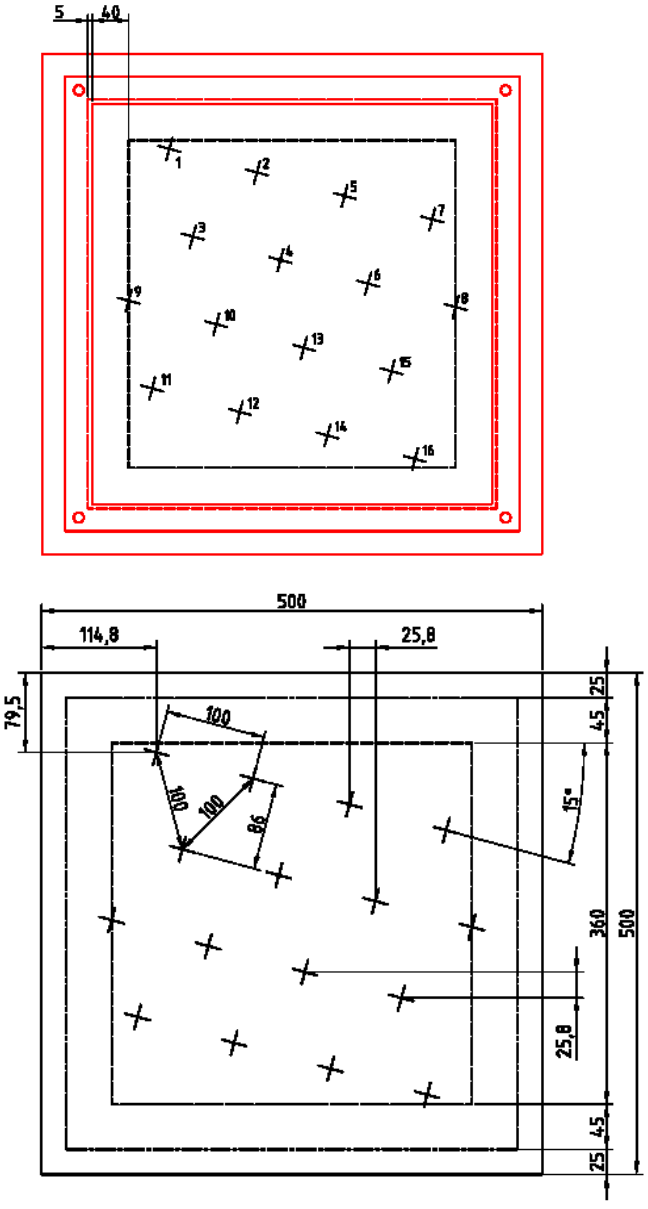


Attachment 3: Coordinate system for determination of impact point position (example)



Attachment 4: Representation of impact points for calculation of the ballistic limit (V_{50}) (example)

Impact location at an impact angle of 90° (unprepared test object)



The shots are released according to the sketch and in the sequence of the numbers (impact distance to each other: min. 100 mm).
As a rule choose the impact distance so that there is no influence of one impact to any other.

Remark: The files for the setup of a pattern to mark the points of impact can be downloaded from the internet presence of the VPAM: www.vpam.eu ⇨ "Zeichnung Schussmuster".