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THE INTERNATIONAL CRIMINAL TRIBUNAL
FOR THE FORMER YUGOSLAVIA

CASE № **IT-01-42-T**

IN THE TRIAL CHAMBER II

BEFORE: **Judge Kevin Parker**, Presiding
Judge Krister Thelin
Judge Christine Van Den Wyngaert

REGISTRAR: **Mr. Hans Holthuis**

DATE FILED: **25th of June 2004**

PROSECUTOR

v.

PAVLE STRUGAR

- C O N F I D E N T I A L -

DEFENCE SUBMISSION:
EXPERT REPORT V

OFFICE OF THE PROSECUTOR:
Ms. Susan Somers
Mr. Philip Weiner
Mr. David Re
Ms. Prashanti Mahindaratne

COUNSEL FOR THE DEFENCE:
Mr. Goran Rodić
Mr. Vladimir Petrović

THE INTERNATIONAL CRIMINAL TRIBUNAL
FOR THE FORMER YUGOSLAVIA

Case № **IT-01-42-T**

PROSECUTOR

v.

PAVLE STRUGAR

- C O N F I D E N T I A L -

DEFENCE SUBMISSION:

EXPERT REPORT V

1. Pursuant to Rule 94*bis* of the Rules of Procedure and Evidence of the International Tribunal for the Prosecution of Persons Responsible for Serious Violations of International Humanitarian Law Committed in the Territory of the Former Yugoslavia since 1991, seated at The Hague (hereinafter "Rules" and "Tribunal" respectively), the Defence of General Pavle STRUGAR (hereinafter "Defence" and "Accused" respectively) hereby submits the expert report written by Mr. Janko VILIČIĆ, Ph.D. engineer (hereinafter "Expert Report V").

Counsel for the Accused:

GORAN RODIĆ
Lead Counsel

VLADIMIR PETROVIĆ
Co-Counsel

Dated this twenty-fifth day of the month of June, the year MMIV
Belgrade
Serbia and Montenegro

JankoVILICIC, Ph.D. Eng.
Milan GAJIC, Mr.Eng.
Lieutenant Colonel Mr.Tugomir KOKELJ

EXPERT ANALYSIS OF THE "SHELLING" OF DUBROVNIK OLD TOWN

2004

/translator's note: page numbers given here refer to the original/

CONTENTS

EXPERT ANALYSIS
of the "shelling" of Dubrovnik Old Town and the firing of weapons of JNA units during operations in the Dubrovnik zone
according to indictment IT-01-42 against:

PAVLE STRUGAR and
VLADIMIR KOVACEVIC

Introductory remarks

The aim of this expert analysis is to utilise, in a precise manner, the available documents submitted to Defence Counsel by the International Tribunal for the Prosecution of Persons Responsible for Serious Violations of International Humanitarian Law Committed in the Territory of the Former Yugoslavia since 1991 (hereinafter "the Tribunal") concerning events on the Dubrovnik battleground, in order to establish the most important facts: the deliberate or accidental striking of the Old Town; prevailing conditions when the Old Town was struck; the types and calibres of pieces operated weapon and projectiles with which the Old Town was struck; the direction of fire; the distance of fire; the influence of meteorological conditions and the possible influence of errors when adopting firing data; and other factors that may have influenced the accuracy of fire against the firing positions (VPs) of the pieces of the Dubrovnik Defence Forces (hereinafter "DOS"), i.e. distance and directional deviations of strikes, so that on the basis of an analysis of all relevant factors, a conclusion can be drawn on what caused Dubrovnik Old Town to be hit.

The basis for the expert analysis comprises official documents submitted by the Tribunal, reports and records of police and judicial organs of the Republic of Croatia, and witness statements given before these official organs and representatives, as well as the testimony of Prosecution witnesses given before the Tribunal.

The expert team did not have complete and original documentation at its disposal.

There was a particular lack of orders issued by the leaders of JNA units operating in the Dubrovnik sector. The most complete data on the disposition and actions of units were the data provided by Tribunal witnesses on the JNA 472nd Trebinje Brigade 3rd Battalion. The actions of this battalion of the 472nd Trebinje Brigade, according to the witness statements, were most intensive on 6 December 1991.

The basis for the initial examination comprised the following documents:

1. Witness statement of Nojko MARINKOVIC given before Tribunal investigators Clint WILLIAMSON and Michael STEPHENS on 2, 3, 4, 6 and 7 August and 20 September 2000 (29 pages in total, in B/C/S);
2. Witness statement of Nojko MARINKOVIC given before the Tribunal while testifying in case IT-02-54-T on 3 April 2003, transcript, pages 18509 to 18599, in English;
3. Witness statement of Zeljko SOLDO given before Tribunal investigator Clint WILLIAMSON on 7 and 8 January 2001, document no. 0108-8991 – 0108-8000-ikr, in B/C/S;

4. Interim report of Major Richard P. O'LEARY, given on 23 January 2001 following the request of the Tribunal, 12 pages, document no. 0208-3002-3012, in B/C/S;

5. Witness statement of Zoran PRIMIC given before Tribunal investigator Michael STEPHENS on 29 September and 2 October 2000, document in B/C/S, pages 03029565 to 03029570;

6. Witness statement of Ivan NEGODIC given before Tribunal investigators Richard PHILIPPS and Azim ARSHAD on 12 and 13 December 2003, document in B/C/S, file no. 0345-9157-0345-9164-BCST/Translation;

7. Witness statement of Miodrag JOKIC given in testimony at the Tribunal from 24 March 2004 to 7 April 2004, transcript;

8. Report on the STRUGAR *et al* case produced by Jozef POJE at the request of the Tribunal in B/C/S, pages 02992787 to 02992819;

9. Report of the Mission for the investigation of war crimes in Dubrovnik, prepared by the United Nations Expert Commission, 4 November 1993, 66 pages, no reference number, in B/C/S;

10. Dubrovnik 1:25000 scale map, published by the JNA Military Geographical Institute, copy in Annex 1;

11. Trebinje 1:50000 scale map, published by the JNA Military Geographical Institute, copy in Annex 2;

12. Dubrovnik 1:7,500, scale map showing the positions of Croatian weapons in the period from December 1991 to March 1992 – data based on testimony of Nojko Marinovic given 03 August 2000, document no 01026552, Annex 3;

13. 1:12,500 map, Decision of the Commander of the Dubrovnik Municipal Defence, received from the Tribunal, no. 03340716;

14. Map with no scale indicated, entitled Plan for the Operation of Artillery in Defence, /issued by/ the leader Captain Ivan NEGODIC, received from the Tribunal, numbered 03340718, and part of the same map numbered 03340719. Annex 4;

1. ANALYSIS OF THE DEPLOYMENT OF PIECES ON THE DUBROVNIK BATTLEGROUND

1.1 JNA pieces

On the basis of the 1:50000 map published by the JNA Military Geographical Institute, the deployment of JNA forces on the Dubrovnik battleground on 6 December 1991 is shown in Figure 1.1 (which also shows the deployment of DOS pieces) and on the copies of the maps in Annexes 1 and 2.

The deployment of JNA forces was as follows:

The JNA 472nd Trebinje Brigade 3rd Battalion was deployed from the north-eastern side towards Dubrovnik from Rijeka Dubrovacka, and from Cajkovici via Strincijera and Bosanka Dubrava to Rt Osti /point/.

The 472nd Trebinje Brigade 3rd Battalion had the following weapons (that were capable of firing on Dubrovnik Old Town):

- 82-mm M69A mortars, platoon with six mortars, in the Strincijera sector;
- 82-mm M69A mortars, platoon with four mortars, in the Rajcevici sector;
- 120-mm M75 mortars, four mortars, close to Ledenica on the road to Ivanica;

- AT Gn 76-mm M42 guns, three, near Vrastice;
- T-55 tanks with a 100-mm gun, four: one three-tank platoon between Zarkovica and Bosanka, and one tank by Rajcevici;
- 82-mm M60A recoilless gun, six: two by Rajcevici and four at Zarkovica;
- *Maljutka* guided anti-tank rockets (two sets) at Zarkovica; intended as support;
- Battalion of 130-mm M46 guns (12 guns) by Volujac close to Bihovo.

From the north-western side towards Lapad, the following JNA unit was deployed:

5th Motorised Brigade 3rd Battalion with the following weapons (which were capable of firing in the direction of Lapad but with their range were not capable of firing on Dubrovnik Old Town):

- 82-mm M69A mortars, platoon with six mortars, in the Pobrezje sector;
- 120-mm M75mortars, four mortars, in the Greblje sector.

1.2 DOS pieces[1]

The Dubrovnik Defence Forces (DOS)[2] had the following weapons:

- 60-mm mortars, two, in Vodovadja;
- M69A 82-mm mortars, 13: two at Brgat, six at Cepikuce, two in Vodovadja, three in Bogisica Park, and two in the motor camp at Babin Kuk;
- 120-mm M75mortars, four: two at Brgat and two at Babin Kuk;
- AT 76-mm M42 guns, two: one at Babin Kuk and one close to the *Neptun* hotel;
- 85-mm M39guns, four: two above Cavtat and two in Resnica near Molunat;
- 20/1mm M75 /single-barrelled 20-mm anti-aircraft gun//, two;
- 20/3 M55 triple-barrelled anti-aircraft guns, ten;
- *Partizanac* 128-mm M71 rocket launchers, two, with a range of 8.6 kilometres.

All these pieces were deployed in Lapad, to the west of Dubrovnik Old Town, with a platoon of three 82-mm M69A mortars deployed close to the Old Town walls in Bogisica Park.

[1] The data on the number and deployment of DOS weapons given by witnesses Nojko MARINOVIC and Ivan NEGODIC differ in terms of both numbers and locations. This expert analysis takes into account only the DOS positions and weapons around the walls of Dubrovnik Old Town.

[2] Testimony of Nojko MARINOVIC, page 03028445, B/C/S translation; testimony of Ivan NEGODIC of 12 and 13 December 2003.

1.3 Topographical coordinates[3] of the deployment of pieces of JNA and DOS forces.

On the basis of a situation map of the combat disposition of JNA units on 6 December 1991, the statements of Zeljko SOLDO and Nojko MARINOVIC given before Tribunal investigators on 3 August 2000 and 3 April 2003 regarding case number IT-54-T, and the testimony of Miodrag JOKIC given before the Tribunal from 24 March to 7 April 2004, the combat elements of the warring sides on 6 December 1991 were plotted onto a topographical 1:25000 scale map (JNA forces are shown in red and DOS forces in blue, in accordance with the then applicable Instructions on Working Maps in the Armed Forces[4]. This map is provided in Annex 1 herein.

In order to provide a broader survey of the deployment of additional units and in particular the firing positions of artillery weapons, a summary of the deployment of mortar and artillery weapons is given on a 1:50000 map in Figures 1.1 and in Annex 1. Figure 1.1 /as printed/ also shows the deployment of an 105-mm M56 howitzer battalion in the Hum sector, and a battalion of 130-mm M46 guns minus a battery in the Volujac sector near Bihovo.

1.31 – Analysis of the JNA's combat disposition of pieces and targets

In order to provide a detailed analysis, in accordance with the testimony of Nojko MARINOVIC, Ivan NEGODIC, Zeljko SOLDO and Miodrag JOKIC, the combat disposition is shown on a 1:50000 map (Annex2). The rectangular coordinates of the combat elements of units and formations hypothetically significant for any firing on Dubrovnik Old Town were established. The rectangular coordinates were established with a 1:25000 scale map and a 1:50000 scale map, and by applying the coordinate scale as prescribed under the then applicable rules in the JNA. During the measuring of the rectangular coordinates, certain errors (Δpk) were made, which equated to 1mm on the map.

The (approximate) rectangular coordinates[5] of the significant combat elements of JNA pieces were as follows:

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[3] Gauss-Kruger rectangular coordinates.

[4] *Uputstvo o radnoj karti* /Instructions on Working Maps/, SSNO /Federal Secretariat for National Defence/ IV U-5, 1979 edition.

[5] (Approximate) rectangular coordinates of significant combat elements were verified on the basis of on-site expert inspections of the locations of firing positions and observation posts of JNA units.

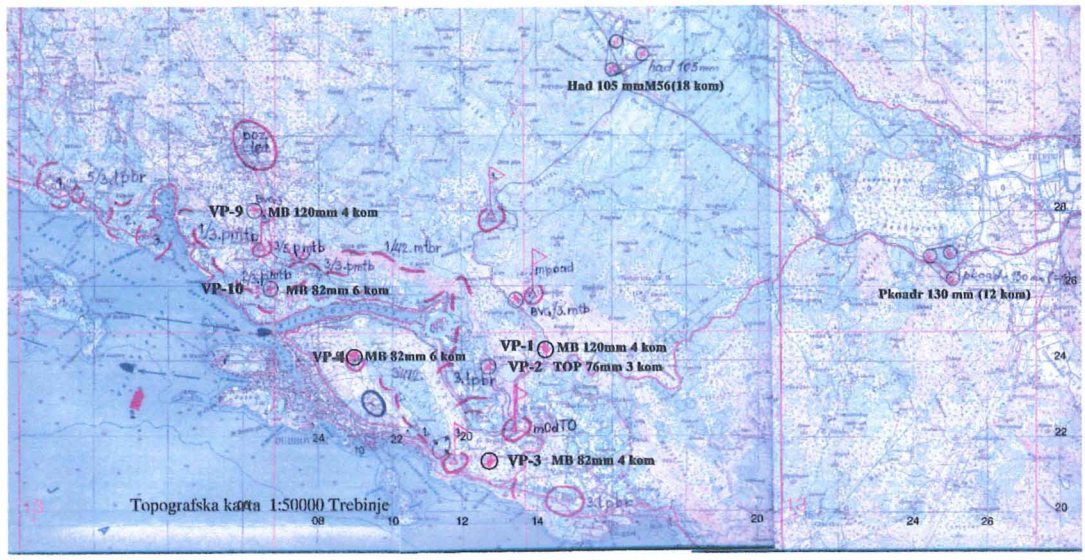

Figure 1.1 – Deployment of weapons of JNA on 6 December 1991; Scale 1:50000

– Firing position /VP/ of combined mortar battery (four 120 mm M75 LMBs /light mortars/) near Ledenica, on the road to Ivanica:

VP_1 x=24310 y=14180 z=335

– Firing position of gun platoon (three 76 mm M42 guns) in the Vrastica sector:

VP_2 x=23720 y=13140 z=390

– Firing position of mortar platoon (four 82 mm M69A mortars) in the Rajcevici sector:

VP_3 x=21480 y=12580 z=285

– Observation Post – also serving as Forward Command Post of the 3rd Infantry Battalion /3.pb/ in the Zarkovica sector (tt /trig point/ 315), was the post from which the fire of units from firing positions 1 to 3 was controlled and directed.

$O_{k\text{-}ta}$* 3.pb x=21320 y=11820 z=315

– Firing position of mortar platoon (six 82 mm M69A mortars) in the Strincijera sector:

VP_4 x=24160 y=08920 z=390

– Observation post for mortar platoon (six 82 mm M69A mortars) in the Strincijera sector (tt 412):

$O_{k\text{-}dira\ 3.pc}$* x=23950 y=08920 z=412

– Firing position of M55 tanks (three) in the Dubac sector:

VP_5 x=21920 y=11250 z=260

– Firing position of 105 mm M56 howitzer battalion (18 howitzers) in the Hum sector;

VP_6 x=32400 y=16500 z=270

– Firing position of 122 mm D30 howitzer (one) in the Cavtat sector:

VP_7 x=14780 y=18860 z=85

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* $O_{k\text{-}ta}$ – Commander's Observation Post/3pb-/3rd Infantry Battalion/

* $O_{k\text{-}dira}$ – Commander's Observation Post $_{3.pc\sim}$ – /3rd Infantry Company/

– Firing position of 130 mm M46 gun (one) in the Volujac sector:
VP_8 x=26650 y=24753 z=280
– Firing position of mortar platoon (four 120 mm M75 mortars) in the Greblje sector:
VP_9 x= 27965 y=06370 z=360
– Firing position of mortar platoon (six 82 mm M69A mortars) in the Pobrezje sector:
VP_{10} x= 26120 y=06720 z=218
– Firing position of *Maljutka 9K11*, (two) in the Dubac sector :
VP_{11} x=21340 y=11640 z=275

Proceeding from the fact that the primary combat task for the deployment of JNA forces was the taking of the old fort on Mt. Srdj (which DOS forces were using to fire at JNA forces and observe the battleground) using infantry forces with fire support from mortar units and a gun platoon, it is logical that the primary directions of fire of the fire support weapons were towards the Srdj fort.

It follows from this that when we retrace the directions from the firing positions of the JNA units' fire support forces to the fort on Mt. Srdj, the directional angles i.e. primary azimuths of base line (AzOP) can be determined for each unit, and their values are as follows:
– Firing position of combined mortar battery (four 120 mm M75 light mortars) near Ledenica, on the road to Ivanica:
VP_1 AzOP=42-00 using 1/60-00 increments i.e. 255 degrees:
– Firing position of gun platoon (three 76 mm M42 guns) in the Vrastica sector:
VP_2 AzOP=43-00 on the 1/60-00 scale i.e. 258 degrees
– Firing position of mortar platoon (four 82 mm M69A mortars) in the Rajcevici sector:
VP_3 AzOP=49-00 on the 1/60-00 scale i.e. 294 degrees
– Firing position of mortar platoon (six 82 mm M69A mortars) in the Strincijera sector:
VP_4 AzOP=26-00 on the 1/60-00 scale i.e. 156 degrees.
– Firing position of M55 tanks (three) in the Dubac sector:
VP_5 AzOP=00-00 on the 1/60-00 scale i.e. 000 degrees.
– Firing position of 105 mm M56 howitzer battalion (18 howitzers) in the Hum sector:
VP_6 AzOP=00-00 on the 1/60-00 scale i.e. 000 degrees.
– Firing position of 122 mm D30 howitzer (one) in the Cavtat sector:
VP_7 AzOP=00-00 on the 1/60-00 scale i.e. 000 degrees.
– Firing position of 130 mm M46 guns (12) in the Volujac sector:
VP_8 AzOP=00-00 on the 1/60-00 scale i.e. 000 degrees.
-– Firing position of mortar platoon (four 120 mm M75 mortars) in the Greblje sector:
VP_9 AzOP=25-00 on the 1/60-00 scale i.e. 148 degrees.
– Firing position of mortar platoon (six 82 mm M69A mortars) in the Pobrezje sector:
VP_{10} AzOP=23-00 on the 1/60-00 scale i.e. 138 degrees.

By entering these combat elements onto a topographical fire plotting board (TVPl) on a 1:25000 scale (the same scale as the topographical map in Annex 1), which is provided in Annexes 9 and 9a herein, and in accordance with the primary combat task of the JNA forces engaged as stipulated in the Attack Order[6] for 6

[6] No attack order for 6 December 1991 was provided for the experts' perusal, but they proceeded from the assumption that one must have been issued.

December 1991, and employing a knowledge of the basic physical data of these pieces, the following can be concluded:

1. From the firing position (VP_1) of the combined mortar battery (four 120 mm M75 light mortars) near Ledenica, on the road to Ivanica, it was potentially possible to fire from this position on Dubrovnik Old Town by altering the azimuth of base line (AzOP) and relocating the bipod (bipod mounting) for each mortar. If the unit at the firing position set about making changes to the AzOP and relocating the bipods, then the infantry units that were conducting the assault on the fort on Mt. Srdj would have been left without fire support and subjected to heavy and avoidable casualties. These contradictions and illogical factors substantiate the above conclusion.

2. From the firing position (VP_2) of the gun platoon (three 76 mm M42 guns) in the Vrastica sector, Dubrovnik Old Town could have been fired on, but it was not. This conclusion is also confirmed by the statements of experts on damage in Dubrovnik Old Town, in which it is stipulated that all damage was caused by the action of mortar shells. Given these facts, any firing by this unit will not be considered in the remainder of this analysis.

3. From the firing position (VP_3) of the mortar platoon (four 82 mm M69A mortars) in the Rajcevici sector it was potentially possible to fire from this position on Dubrovnik Old Town by altering the azimuth of base line and relocating the bipod (bipod mounting) for each mortar, and the consequence of doing this is set out in item 1 of this conclusion.

4. From the firing position (VP_4) of the mortar platoon (six 82 mm M69A mortars) in the Strincijera sector, as a result of gross errors in the work of the mortar crews and a failure to incorporate meteorological and ballistic adjustments into the firing data, as well as a large lateral terrain gradient, a certain number of mortar shells could have landed in Dubrovnik Old Town.

5. From the firing position (VP_5) of the T55 tank platoon (three tanks and a 100-mm gun) in the Dubac sector, it was possible to fire on Dubrovnik Old Town, but this did not happen.

6. From the firing position (VP_6) of the howitzer battalion (18, 105 mm M56 howitzers) in the Hum sector, it was not possible to fire on Srdj and Dubrovnik Old Town because the maximum range of the howitzers was less than the distance from the VP to Dubrovnik Old Town.

7. From the firing position (VP_7) of the howitzer (one 122 mm D30 howitzer) in the Cavtat sector, it was possible to fire on Dubrovnik Old Town, but this did not happen.

8. From the firing position (VP_8) of the gun battalion (12, 130 mm M46 guns) in the Cavtat sector, it was possible to fire on Dubrovnik Old Town, but this did not happen.

9. From the firing position (VP_9) of the mortar platoon (four 120 mm M75 mortars) in the Greblje sector, it was not possible to fire on Dubrovnik Old Town because the distance (>6300 m) was greater than the maximum range of the mortars.

10. From the firing position (VP_{10}) of the mortar platoon (six 82 mm M69A mortars) in the Pobrezje sector, it was not possible to fire on Dubrovnik Old Town because the distance (>4200 m) was greater than the maximum range of the mortars.

11. On the basis of the facts set out it is concluded that JNA units did not plan in advance to fire on Dubrovnik Old Town; rather, their main attack objective was to take the Srdj fort and counter the fire of the DOS pieces located outside the walls of Dubrovnik Old Town at Lapad.

Further analysis of the combat deployment of the fire support forces and observation posts of the 3rd pb /Infantry Battalion/ shown in Annex 9b (in addition to the above conclusions) reveals the following very important facts for further analysis:

a) From the ($O_{k\text{-}ta\ 3rd\ pb}$) observation post– serving also as the Forward Command Post of the 3rd Infantry Battalion, fire control and direction was exercised over fire support forces from firing positions VP_1 to VP_3. Fire was directed by Captain 1st Class Vladimir KOVACEVIC, which also tallies with the testimony of Zeljko SOLDO.

b) In the fire control and direction of fire support forces from firing positions VP_1 to VP_3 from the ($O_{k\text{-}ta\ 3rd\ pb}$) observation post, due to the specific configuration of the terrain the large target parallax (PC) has particular influence on the precision and accuracy of fire support.

c) The fire control and direction of fire support forces (six 82 mm M69A mortars) in the Strincijera sector (tp 412) from the firing position (VP_4) was exercised from the 3rd pc /Infantry Company/ commander's observation post ($O_{k\text{-}dira\ 3.pc}$). Fire was directed by the 3rd Infantry Company commander. From its observation post ($O_{k\text{-}ta\ 3.pb}$), the 3rd pb /Infantry Battalion/ Command could not exert any influence over the fire from this firing position, or its adjustment and precision.

d) Firing at Mt. Srdj (the fort, mark hypothetically as C-1 /target 1/ **aerial mast** and C-2 **tt 403** (trig point)) could have been fired on from all firing positions ($VP_{1\text{-}4}$) without moving the bipods or mountings, while only from the firing position (VP_1) of the combined mortar battery (four 120 mm M75 mortars) close to Ledenica on the road to Ivanica was it possible (without moving bipods) to lay down counter-battery fire on the firing position of the DOS forces' mortar group (comprising three 82-mm mortars) deployed close to the walls of Dubrovnik Old Town at ≈ 300 to 350 m, target mark hypothetically as C-3.

e) Counter-battery fire against the firing position of the DOS forces' mortar group(mark hypothetically as C-3) could also have been provided from firing positions VP_1 and VP_3, but would have required movement of the bipods, i.e. issuing the pieces with a new AzOP (direction of fire).

All these facts and conclusions will be analysed with specific examples later in the analysis.

Given the tactical importance of the fort on Mt. Srdj (large target surface area, high resistance to incoming fire from JNA fire support weapons) and its suitability for providing cover for the DOS forces' fire, in order to facilitate the examination of the firing of JNA fire support units, two dominant points can be picked out as particular targets, and their approximate rectangular coordinates are as follows:

1. Target no. 1 **aerial mast** (radio, TV or relay transmitter, 85 metres high):
   C-1 x=22920 y=09460 z=403

2. Target no. 2 **tt 403** (trig point):
   C-2 x=22800 y=09540 z=403

1.32 – Analysis of the combat disposition of DOS pieces

On the basis of the testimony of Nojko MARINOVIC given to Tribunal investigators on 3 August 2000 and 3 April 2003 for case IT-02-54-T regarding the deployment of weapons, mortars and artillery pieces in Dubrovnik (particularly the combat disposition shown on the town map), the available data on forces and weapons dug in at the fort on Mt. Srdj, the combat disposition shown on the 1:7,500 scale map of the town of Dubrovnik (**Annex 3**), the 1:25000 topographic map (**Annex 3a**), and the map with no scale indicated entitled Plan for the Operation of Artillery in Defence, /issued by/ the leader Captain Ivan NEGODIC, received from the Tribunal, numbered 03340718, and part of the same map numbered 03340719, the deployment of the pieces of the DOS forces is shown in Figure 1.1a, and on the basis of a knowledge of the combat characteristics, purposes, tactical and firing capabilities of the fire support weapons of the DOS forces, the following conclusions can be drawn:

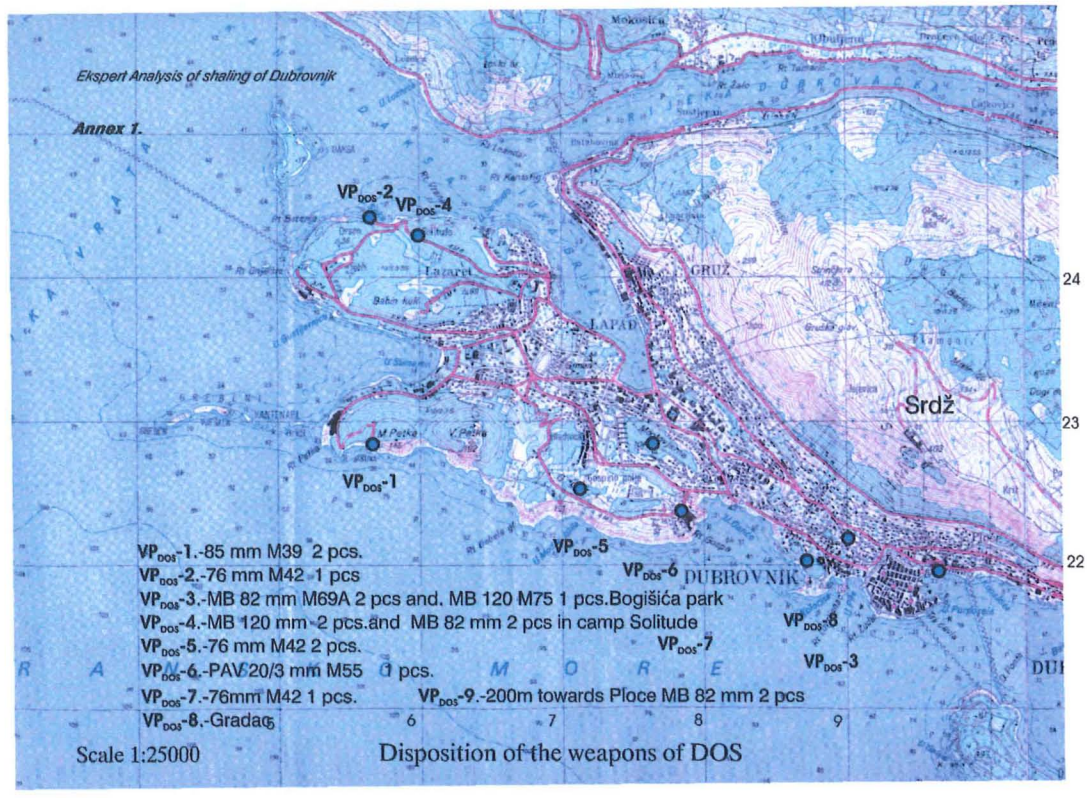

Figure 1.1a – Deployment of DOS pieces

1. From the firing position of the DOS forces' first mortar group (comprising two [or three[7] 82-mm mortars and one [or two[8] 120-mm mortars), which was deployed close to the Dubrovnik Old Town walls at a distance of ≈ 300 to 350 metres, mark hypotheticlly as target C-3, fire support was provided to forces deployed in the fort on Mt. Srdj, and if required (depending on the given AzOP and the method of engagement of three 82-mm mortars for supporting the defence of the fort on Mt. Srdj, and also occasionally firing the so-called *Leteci Carli* /Flying Charlie/[9] at the JNA forces could be fired on in the sectors of Strincijera, Bosanka, Zarkovica and Rajcevici. The (approximate) rectangular coordinates[10] of this firing position are:

VP_{DOS-3}	x=22220	y=08860	z=50 (mark hypothetically as target C-3)

[7] Statement of Nojko MARINOVI] of 2-7 August 2000, document in B/C/S, page no. 03028450
[8] Difference between the statements of prosecution witnesses Nojko MARINOVI], Dubrovnik defence commander, and Ivan NEGODI], Dubrovnik defence artillery commander.
[9] ***Leteci Carli*** was the established name used by soldiers for a weapon that DOS forces mounted on a truck body or tractor trailer in order to fire at JNA forces and then rapidly leave the firing position. In this way the DOS forces fired on JNA forces from all parts of Dubrovnik (outside and inside the Old Town). Anti-aircraft machine-guns, anti-aircraft guns and mortars can be mounted on a vehicle.
[10] Data for the rectangular coordinates of significant combat elements of the DOS forces entered onto the map (town map of Dubrovnik 97) on the 1:7500 scale were provided by witness Nojko MARINOVIC on 3 August 2000 at 1205 hours and verified by him with his signature. On the basis of these positions, they were transferred onto a 1:25000 scale map and the (approximate) rectangular coordinates of the significant combat elements of the DOS forces were read off.

2. From the firing position of the second DOS mortar group deployed around 200 metres from the Dubrovnik Old Town walls towards Ploce[11], hypothetically target C-4, fire support was also provided to forces deployed in the fort on Mt. Srdj and JNA units were fired on. The (approximate) rectangular coordinates of this firing position are:

VP_{DOS-4} x=21950 y=09720 z=40 (mark hypothetically as target C-43)

3. The remaining DOS forces, the third mortar group at the *Solitude* motor camp in Lapad (two 120-mm mortars and two 82-mm mortars), depending on the given AzOP, could provide support to the DOS unit on Mt. Srdj, while the remaining pieces (AT 76-mm M42 field gun and 85-mm M39 gun were deployed as defence against possible amphibious landings, and AA 20/3 /triple-barrelled 20-mm anti-aircraft gun/ was deployed for PVO /anti-aircraft defence/ fire). For the purposes of this analysis, importance is placed only on the firing positions of the 82-mm and 120-mm mortars, which fired on JNA forces and were located close to features outside the Dubrovnik Old Town walls in the park (mark hypothetically as target C-3) and at approximately 200 mm from Old Town towards Ploce (mark hypothetically as target C-4).

4. Of particular importance for further analysis of the possibility of projectiles also landing within the Dubrovnik Old Town walls is an examination of the counter-battery fire of JNA forces against DOS forces (three [or two 82-mm mortars in Bogisica Park) – mark hypotheticlly as target C-3 – and the DOS pieces located 200 metres towards Ploce from Old Town, mark hypotheticlly as target C-4.

[11] Plan for the Operation of Artillery in Defence, /issued by/ the leader Captain Ivan NEGODIC, received
from the Tribunal, numbered 03340718

II. TECHNICAL AND BALLISTIC CHARACTERISTICS OF WEAPON SYSTEMS ON THE DUBROVNIK BATTLEGROUND

2.0 – Basic weapon systems

According to the documents referred to in section 1 and section 3 items 1 of this analysis, the basic infantry, artillery and naval pieces and hardware that could fire on the Dubrovnik battleground were the following:

- 60-mm M57mortar
- 82-mm M69A mortar
- 120 mm M75 mortar
- AA /anti-aircraft/ gun 20-mm M75
- AA /anti-aircraft/ gun 20-mm M55 gun
- *Bofors* L60 40-mm naval gun
- *Bofors* L70 40-mm naval gun
- *Bofors* L70 57-mm naval gun
- AT Gn 76 mm M42 ZIS-3 gun
- 85-mm M39/44 coastal gun
- 100-mm cannon on T-55 tank
- 105 mm M56 howitzer
- 122-mm D 30 howitzer
- 130 mm M46 gun
- *Maljutka* anti-tank rocket system
- *Partizanac* 128-mm M71 light rocket launcher
- Amphibious assault boat
- PC-137, PC-178 and PC-179 patrol boats
- RTOP 403 missile patrol boat

For the weapon systems that could also fire on Dubrovnik Old Town, detailed technical and ballistic data are given below for the 82 mm M69A mortar and 120 mm M75 mortar, while data are given in **Annex 21** for the remaining systems that fired or could have fired on the Dubrovnik battleground.

A. MORTAR AND ARTILLERY WEAPONS ON THE DUBROVNIK BATTLEGROUND

2.1.- 82 mm mortar

Figure 2.1 M69A 82-mm mortar

2.11 – Basic mortar characteristics:

- Total mass at firing position ..... 45 kg
- Length of barrel ..... 1,150 mm
- Elevation ..... 45°-85°
- Traverse without moving bipod ..... 14°52′48″ or 2-48 (on the 1/60-00 scale) (or left and right by 1-24 on the 1/60-00 scale)
- Traverse with movement of bipod ..... 360°
- Maximum rate of fire ..... 25 shells/minute

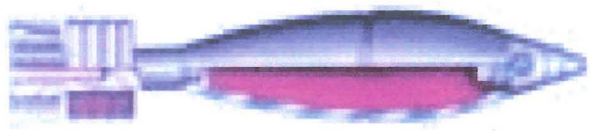

Figure 2.2 M74 82-mm high explosive mortar shell

2.12 – Basic characteristics of the M74 82-mm mortar shell:

– Mass of shell ..... 3050 g
– Mass and type of explosive ..... 680 g/*TNT or TH-50*[12]
– Type of fuse ..... *impact detonated*
– Number of gunpowder (propellant) increments..... 0+6

2.13 – Ballistic data:

– Maximum range with increment no. 6 (M74 TF /contact-fuse/ shell) 4850 m
– Maximum range with the smallest primary charge (M74 TF shell) ...471 m

2.14 – Other data[13]:

– The permissible rate of fire is 20-25 shells per minute without checking aim for every shell, or up to 15 shells per minute with full target data correction.
– In order to prevent damage to the mortar and ensure the full safety of the crew during firing, a firing regime (Table 1) has been prescribed, and its limits must not be exceeded.

Table 1

Length of fire in minutes	1	3	5	10	20	30	60
Number of shells per mortar	20-25	45	60	90	120	150	180

Note: *100 shells per hour thereafter*

2.15 – Firing Table[14]

The firing table was produced for *normal (standard table) conditions:*

a) ballistic conditions:
- standard muzzle velocity, from a new barrel
- temperature of gunpowder (tb°) = +15°C (288K)
- shell's shape, mass and centre of gravity
- new weapon

b) meteorological conditions:
- ground-level atmospheric (air) pressure (H)=1000mbar (750mm Hg)
- ground-level air temperature (t°)= +15°C (288K)
- relative air humidity 50%
- calm atmosphere (no wind or precipitation)

c) topographical conditions:
- mortar on a horizontal surface (base plate and bipod feet at the same level)
- target on the horizontal plane of the mortar, and the angle of elevation equal to the standard table angle

The shell's trajectory data are given in Tables 2.

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[12] A 50:50 mix of TNT /trinitrotoluene/ and RDX /Royal Demolition Explosive/
[13] TG /firing table/ for M69 and M69A 82-mm mortar, 1984 edition, classifcation UP-115, SSNO /Federal Secretariat for National Defence/, JNA G[/General Staff/ – Infantry Administration
[14] 82-mm Mortar Rules, item 2 page 13, SSNO JNA G[UP49, 1982 edition

An extract of the firing table for an 82-mm shell for minimum and maximum range is given in Table 2a and 2b.

Minimum range Table 2a

Charge	V_o m/s	X_{min} m	θ_o (°)	Y_{max} M	θ_c (°)	T_{let} s	V_c m/s	Vd m	Vp m	Wy 10m/s	Wx 10m/s	Δt 10°	ΔH 10mmHg	ΔVo 10m/s
0	70	84	85	243	85.2	14	68	2	2	34	3	0	0	23
0+1	121	222	-"-	668	85.5	23, 3	111	3	5	103	24	1	0	32
0+2	164	384	-"-	1177	85.7	31	141	5	9	107	43	2	1	38
0+3	200	499	-"-	1655	86.0	36	161	6	12	118	77	5	1	37
0+4	230	639	-"-	2053	86.1	41	176	8	15	142	94	6	2	40
0+5	259	751	-"-	2461	86.2	45	188	9	17	155	120	8	3	39
0+6	284	861	-"-	2810	86.3	48	190	12	19	163	142	10	3	38

Maximum range Table 2b

Charge	V_o m/s	X_{min} m	θ_o (°)	Y_{max} M	θ_c (°)	T_{let} s	V_c m/s	Vd m	Vp m	Wy 10m/s	Wx 10m/s	Δt 10°	ΔH 10mmHg	ΔVo 10m/s
0	70	485	45	122	45,7	10	67	11	1	4	4	0	0	134
0+1	121	1299	-"-	346	48,1	17	101	16	4	12	30	6	2	188
0+2	164	2180	-"-	602	50,3	22	132	22	6	15	60	14	4	215
0+3	200	3017	-"-	857	52,3	26	148	24	9	18	90	24	10	230
0+4	230	3669	-"-	1075	53,8	30	160	29	11	19	118	36	11	228
0+5	259	4336	-"-	1303	55,4	33	170	32	12	20	147	49	15	226
0+6	284	4850	-"-	1493	56,5	35	175	38	14	22	175	61	19	216

V_o – muzzle velocity; X_{min} – minimum range; θ_o –angle of elevation; Y_{max} – maximum ordinate; θ_c – angle of descent; T_{let} – time of flight; X_{max} – maximum range; Vd,Vp – probable range and deflection deviations; Wy,Wx, Δt ballistic corrections of projectile impacts for deviations in meteorological and ballistic data.

2.16 – Graphical firing tables for 82-mm shell

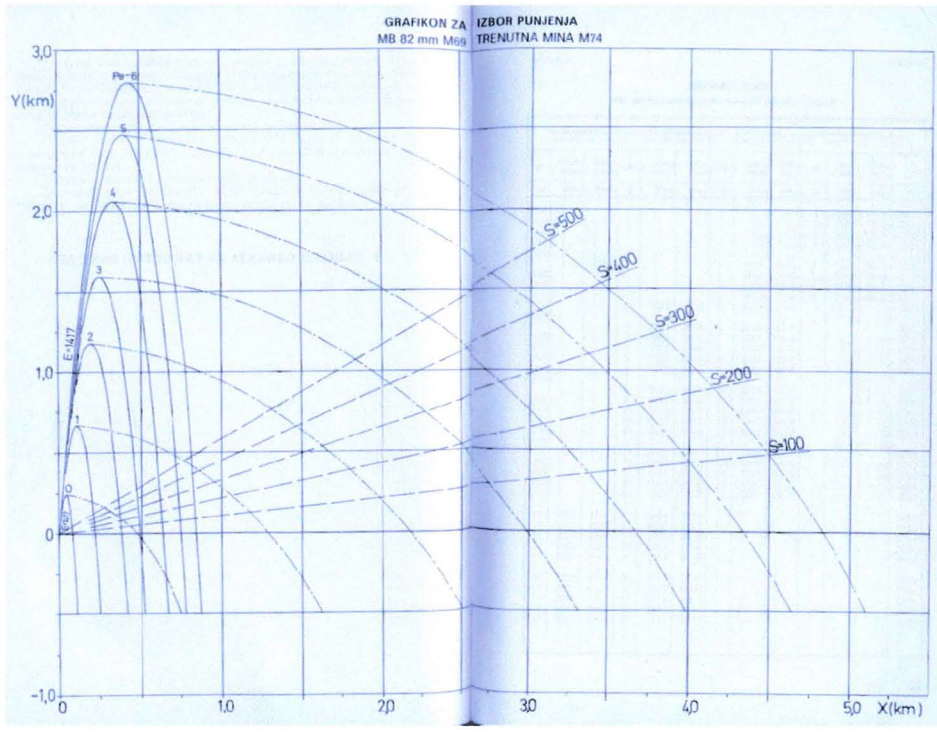


Figure 2.3 – Graphical firing tables for M74 82-mm shell with UTU M78 fuse

2.2.-120 mm mortar

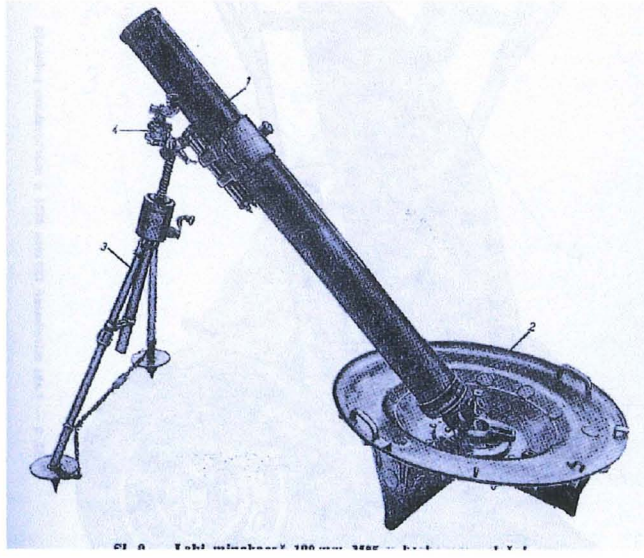


Figure 2.4 – 120 mm M75 mortar

Minimum range Table 4a

Charge	V_o m/s	X_{min} m	θ_o (°)	Y_{max} M	θ_c (°)	T_{let} s	V_c m/s	Vd m	Vp m	Wy 10m/s	Wx 10m/s	Δt 10°	ΔH 10mmHg	ΔVo 10m/s
0+1	130	275	85	808	85.3	26	123	3	6	52	15	1	0	39
0+2	176	474	-"-	1419	85.4	34	161	5	9	67	33	2	1	47
0+3	219	680	-"-	2083	85.7	41	189	7	10	83	58	4	1	51
0+4	256	890	-"-	2759	85.9	47	217	9	17	85	79	6	2	55
0+5	290	1055	-"-	3340	86.0	52	236	12	18	99	109	10	3	54
0+6	322	1154	-"-	3763	86.2	56	248	14	23	124	148	17	4	40

Maximum range Table 4b

Charge	V_o m/s	X_{min} m	θ_o (°)	Y_{max} M	θ_c (°)	T_{let} s	V_c m/s	Vd m	Vp m	Wy 10m/s	Wx 10m/s	Δt 10°	ΔH 10mmHg	ΔVo 10m/s
0+1	130	1574	45	410	47.3	18	121	13	4	7	22	5	1	222
0+2	176	2699	-"-	723	49.0	24	155	19	6	10	48	13	4	265
0+3	219	3907	-"-	1075	50.5	30	179	23	7	11	78	25	8	292
0+4	256	4932	-"-	1400	52.2	34	203	23	12	13	114	40	12	295
0+5	290	5782	-"-	1695	54.1	37	220	29	12	15	157	60	18	274
0+6	322	6340	-"-	1923	55.6	40	235	38	16	18	231	105	26	231

V_o – muzzle velocity; X_{min} – minimum range; θ_o –angle of elevation; Y_{max} – maximum ordinate; θ_c – angle of descent; T_{let} – time of flight; X_{max} – maximum range; Vd,Vp – probable range and deflection deviations; Wy,Wx, Δt ballistic corrections of projectile impacts for deviations in meteorological and ballistic data.

3.1 – Impact dispersion

The firing of a large number of projectiles from mortars and artillery pieces with the same firing data and under approximately the same conditions results in the grouping of impacts in the target plane around a central point in the shape of an ellipse. This phenomenon is known as dispersion.

Impact dispersion is a technical (ballistic) characteristic of piece-and-ammunition systems, and its indicators (probable deviations in range, deflection and elevation) are given in firing tables.

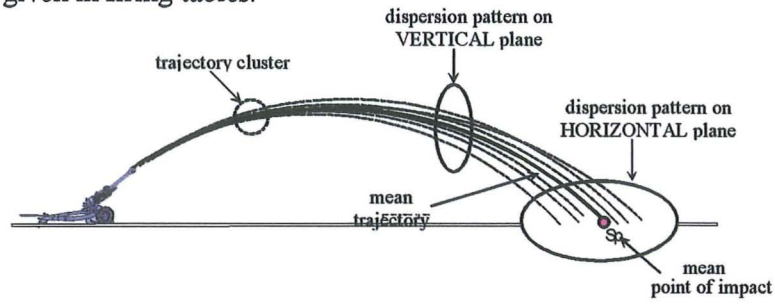


Figure 3.1 – Typical impact dispersion pattern in percussion fire

3.1.1 – Causes of dispersion

The dispersion of projectile impact points at a target is caused by trajectory dispersion and varies according to numerous factors that influence the flight of the projectiles.

Causes of trajectory dispersion can be divided into three groups of deviating factors as follows:

- Deviating factors caused by variations in muzzle velocities;
- Deviating factors that cause variations in angles of departure and directions of fire;
- Deviating factors that influence the flight of the projectile after it has left the piece's barrel.

Factors that cause variations in muzzle velocities are primarily the result of the non-uniform action of internal ballistic factors, and these may be categorised as follows:

- Differences in the mass of projectiles;
- Differences in the mass of gunpowder charges;
- Differences in the physical/chemical properties of the gunpowder charges;
- The influence of different gunpowder lots;
- The condition of the barrel.

Factors that cause variations in angles of departure and directions of fire can be divided into the following groups:

- Non-uniform handling of data on the range finder, angle gauge and position finder, which is caused by accidental errors on the part of the operating crew;
- Differences in aiming, aligning sights and balancing clinometers, which are again caused by accidental errors on the part of the operating crew;
- Variations in jump angles at the moment of discharge;

- Barrel warping, variations in the position of quadrant elevation, or an imperfect seal with the breech.

Factors that influence the flight of the projectile after it has left the barrel are:
- Non-uniform effect of the pressure of gunpowder gasses immediately after the projectile leaves the barrel;
- Differing atmospheric conditions;
- Differences in the mass of projectiles;
- Differences in the position of the projectiles' centre of gravity;
- The eccentricity of the projectile.

When firing projectiles fitted with percussion fuses, the projectile impact points are viewed on a plane that passes through the target.

Given that it is impossible to eliminate all the causes of impact dispersion, it is therefore also impossible to avoid dispersion itself. In order to limit the dispersion and ensure that firing is as effective as possible, appropriate measures need to be taken to reduce the dispersion.

3.1.2 – Characteristics of the law of dispersion

The firing of a number of projectiles with the same direction and elevation data and, as far as possible, under identical conditions, is in essence a matter of measuring (determining the position of the mean impact or centre of the cluster) on a plane, and so the accidental locations of particular impacts can be fully equated with the accidental results of particular measurements taken.

The conclusion that follows from this is that impact dispersion is subject to the normal law on a plane, and this gives rise to the following principles:

1. The principle of density – impacts are clustered in greater density around the mean point of impact, and become increasingly less concentrated towards the edge. This means that there is a greater probability of obtaining impacts with smaller deviations from the mean point of impact than impacts with larger deviations.

2. The principle of symmetry – the probabilities of deviations occurring on either side of the mean point of impact have identical absolute values.

3. The principle of extent – the probability of obtaining impacts outside particular borders (the dispersion pattern) is so small that it can be disregarded. For the purposes of gunnery, it is sufficiently accurate to say that the dimensions of dispersion patterns are limited by four mean probable deviations (mean probable errors) – Vs /probable deviation/ – in each direction from the mean point of impact (centre of cluster).

The dispersion can be examined in either the horizontal or vertical plane, and in both cases the dispersion pattern is an ellipse. For the characteristics of the law of dispersion on a **horizontal plane**, a basic ellipse with the following semi-axes (mean probable errors) is taken:
- Range Probable Error – ***Vd***
- Deflection Probable Error – ***Vp***

For dispersion on a **vertical plane**, a basic ellipse with the following semi-axes is taken:
- Vertical Probable Error – ***Vv***
- Deflection Probable Error – ***Vp***

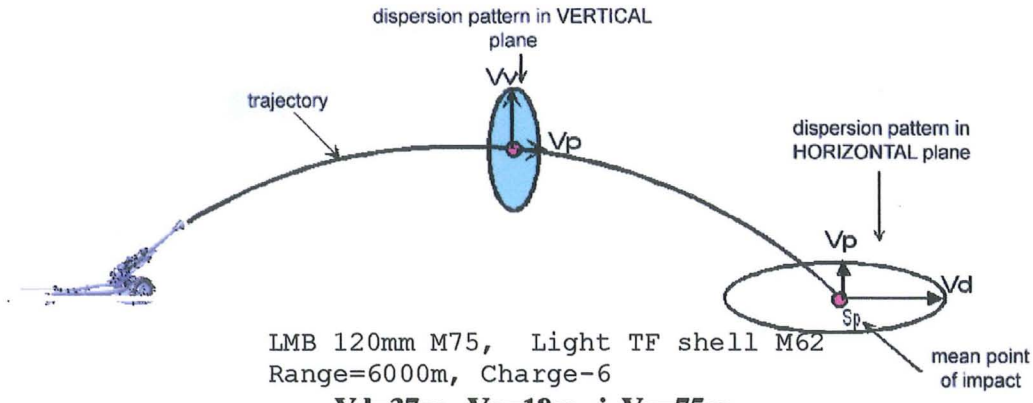


Figure 3.2 – Simple impact dispersion pattern for the firing of an 120 mm M75 light mortar with its characteristics Vd, Vp and Vv

The normal law of dispersion expressed through mean probable error in only one direction can be expressed using the following expressions:

- in range: $V_{(x)} = \frac{\rho}{Vd\sqrt{\pi}} e^{-\rho^2 \frac{x^2}{Vd^2}} dx$ (3.2)

- in elevation: $V_{(y)} = \frac{\rho}{Vv\sqrt{\pi}} e^{-\rho^2 \frac{y^2}{Vv^2}} dy$ (3.3)

- in direction: $V_{(z)} = \frac{\rho}{Vp\sqrt{\pi}} e^{-\rho^2 \frac{z^2}{Vp^2}} dz$ (3.4)

The normal law of dispersion on a surface, expressed by a basic ellipse as its only characteristic, on the basis of the common expression of the law of elliptical error, is as follows for:

- horizontal plane: $V_{(x,z)} = \frac{\rho^2}{Vd\,Vp\pi} e^{-\rho^2 (\frac{x^2}{Vd^2} + \frac{z^2}{Vp^2})} dxdz$ (3.5)

- vertical plane: $V_{(y,z)} = \frac{\rho^2}{Vv\,Vp\pi} e^{-\rho^2 (\frac{y^2}{Vv^2} + \frac{z^2}{Vp^2})} dydz$ (3.6)

Since the vertical plane – on which dispersion is viewed in terms of height – is perpendicular to the firing plane and the horizontal plane of the muzzle in the area of the impact points, it follows that the Deflection Probable Error (*Vp*) is the same for the dispersion patterns for both the horizontal and the vertical plane.

Vertical Probable Error (*Vv*), as the longer semi-axis of the basic ellipse of dispersion in the vertical plane, has a particularly important influence in the cases that are the subject of this analysis (due to the specific lie of the land on Mt. Srdj). The impact dispersion for this particular case is not covered in the firing tables for the 120 mm M75 light mortar, but it can be calculated by using the angle of descent (Θc) and the Range Probable Error (*Vd*).

- $Vv = Vd\ tg\Theta c$ (3.7)

An explanation of the relationship between *Vd*, *Θc* and *Vv* is given in Figure 3.3.

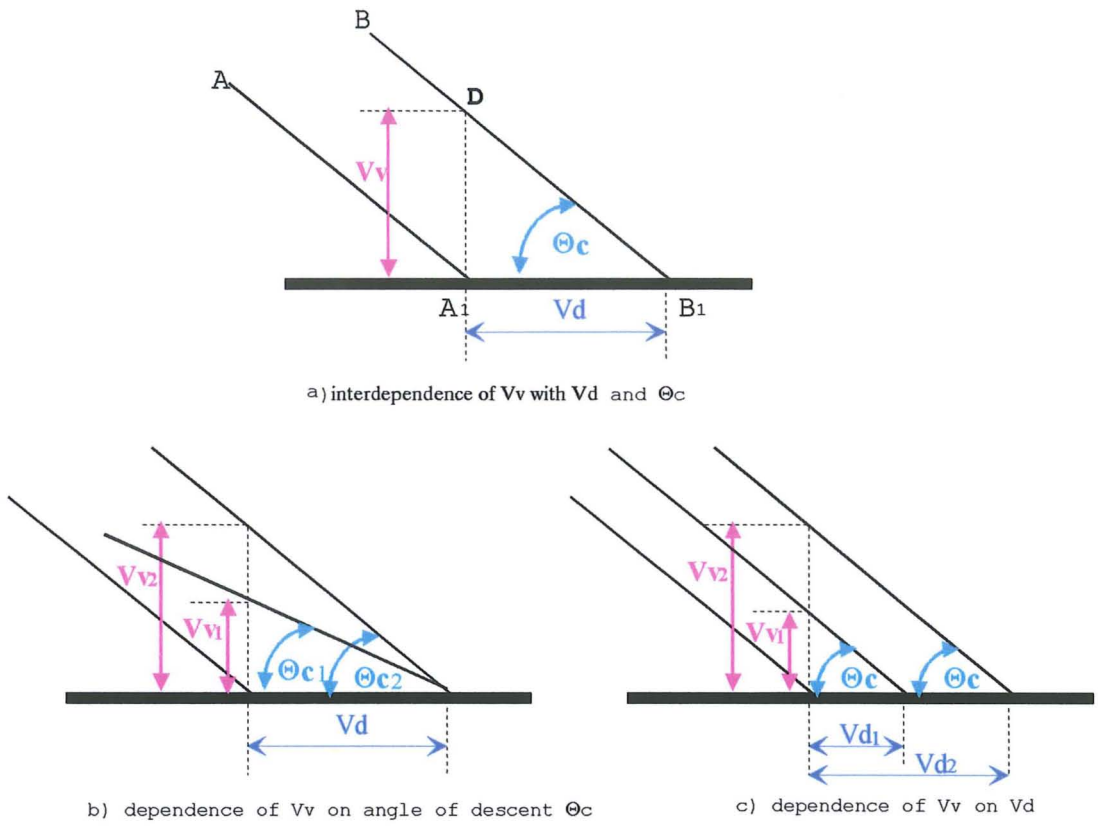


Figure 3.3. Relationships between Vd, Θc i Vv

Numerical values of the characteristics of the normal error function which dictates dispersion, i.e. the mean probable errors (*Vd*, *Vp* and *Vv*), can be found in the firing tables for each piece. The probable error values in the firing tables are determined by ballistic calculations on the basis of probable deviations of ballistic parameters and coefficients of the sensitivity of trajectory elements to changes to these parameters. The values tally with the results of firing range tests done in the course of research on weapons and ammunition.

For the specific conditions of the firing (at the fort on Mt. Srdj), the required values are read off from the firing tables for the given weapon, charge, type of projectile and firing distance, and the mean probable trajectory errors are calculated. Their relationships and characteristics are shown in the firing tables[18], and an extract is in Table 13.

In a real combat situation, firing conditions differ from those to be found on a firing range. The crews conducting the firing are not as highly trained, conditions for storing ammunition are less favourable, and meteorological disturbances are not taken into account. Accordingly, probable errors in real artillery firing conditions are 1.5 to 2 times greater than those in the firing tables.

[18] Data taken from: Firing Tables for M75 120-mm Light Mortar; SSNO UA-187/1, 1985 edition

3.1.3 – Characteristics of the law of dispersion for a number of pieces

When a number of pieces fire at a single target, in addition to the aforesaid factors pertaining to a single piece, some other factors also come into play that cause dispersion of the mean trajectories of particular pieces by deflection and range, even though the firing is conducted simultaneously under essentially identical conditions. This gives rise to a complex and bigger dispersion pattern (Figure 3.4).

EXTRACT FROM FIRING TABLE FOR 120 mm M75 LIGHT MORTAR
LIGHT CONTACT-FUSE M62P3 SHELL WITH UTU M78 FUSE

Table 13

CHARGE	MUZZLE VELOCITY OF SHELL (V_0)	DISTANCE	Table angle		Angle of descent (Θc)	*Probable Error of Trajectory*		
			1/60-00	**degrees**		By range (Vd)	By deflection (Vp)	**By elevation (Vv)**
	m/s	m	mils.	° ′	mils	metres		
		1	3	4	9	11	12	13
No. 5	290	4600	1061	63 39	1161	24	15	**65**
		4800	1030	61 49	1138	25	15	**63**
		5000	997	49 48	1112	26	25	**60**
		5200	959	57 31	1082	27	14	**58**
		5400	914	54 49	1046	28	14	**54**
		5600	855	51 18	996	29	13	**50**
		5782	750	45 00	902	29	12	**40**
		4800	1097	65 51	1205	31	21	**97**
		5000	1073	64 23	1188	32	20	**94**
		5200	1047	62 49	1169	33	20	**91**
		5400	1019	61 07	1148	34	20	**88**
		5600	987	59 13	1125	35	19	**84**
		5800	951	57 02	1098	36	19	**80**
		6000	907	54 24	1064	37	18	**75**
		6200	845	50 43	1015	38	17	**68**
		6340	750	45 00	933	38	16	**56**

The primary factors that cause a complex dispersion pattern are:

- Errors in determining the relative behaviour of the pieces;
- The relative behaviour of the pieces is frequently determined for only one (mean) charge and one (mean) firing distance (range).
- The impossibility of accurately turning calculated corrections (due to the relative behaviours of the piece) into corresponding divisions of the position finder or range finder;
- Errors caused by variations in the piece/ammunition system, which are unique to each particular piece;
- Errors caused by differing fluctuations in muzzle velocity that occur when projectiles are fired from new pieces before the barrel has worn in;
- Deflection errors of other pieces in relation to the primary piece.

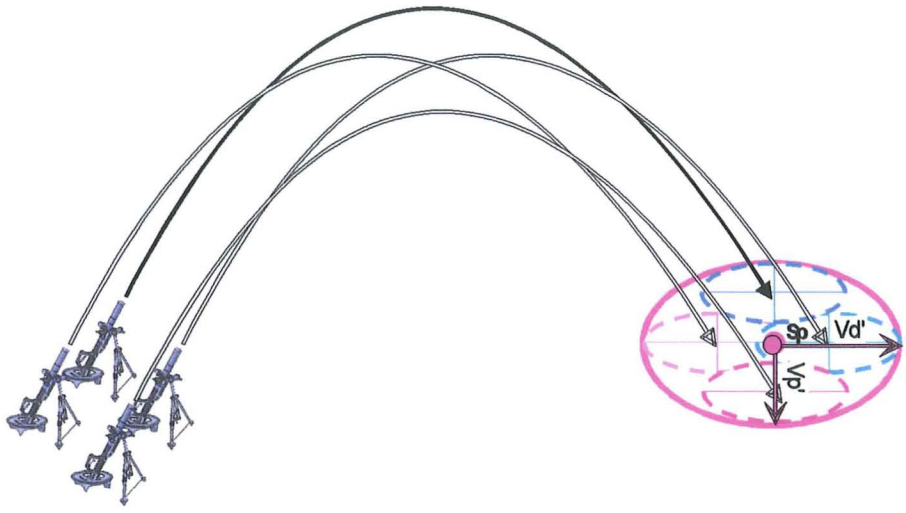


Figure 3.4 Impact dispersion pattern of a mortar battery

The complex impact dispersion pattern for the collective firing of a number of pieces with the same initial firing data increases in deflection and range by 1.5 to 3 times in relation to the simple dispersion pattern obtained for the firing of a single piece.

3.1.4 – The influence of sloping terrain on dispersion

The values of Range and Deflection Probable Errors (Vd and Vp) and the tabular angle are given in the firing tables for firing on a horizontal plane that passes through the horizontal plane of the muzzle (horizontal plane of the piece). However, with the uneven terrain encountered in examining the firing at DOS forces located in the fort on Mt. Srdj, the influence of the sloping terrain on the impact dispersion must be taken into account.

For examining the firing at Srdj from VP1 in the Ledenica sector, the terrain slope in the target sector – the fort on Srdj – has the following characteristics (determined using the 1:25000 TK /topographic map/):

- frontal gradient of 15 to 20 degrees
- rear gradient of 30 to 35 degrees
- side gradient of 8 to 12 degree

a) ***Influence of the frontal gradient on Range Probable Error (Vd):***

Figure 3.5 shows the relationship between the tabular Range Probable Error (*Vd*) and the effective Range Probable Error on the frontal gradient (Vd_1). The angle of the terrain slope is +n and Θc is the value of the angle of descent.

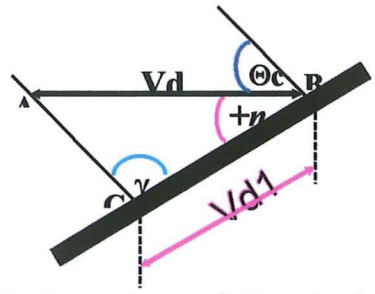


Figure 3.5a Dependence of Vd on the frontal gradient

The actual Range Probable Error Vd_1 is:

$$Vd_1 = Vd \times \lambda_1 \qquad (3.8)$$

Whereby the value of the coefficient λ_1 on the frontal slope (always less than 1, $\lambda_1 < 1$) takes the formula:

$$\lambda_1 = \frac{\sin \Theta c}{\sin(\Theta c + n)} \Rightarrow \lambda_1 < 1; \qquad (3.9)$$

b) ***Influence of the rear gradient on the Range Probable Error (Vd):***

Figure 3.5b shows the dependence of the tabular Range Probable Error (*Vd*) and the effective Range Probable Error on the rear gradient (Vd_2). The angle of the terrain slope is $-n$ and Θc is the value of the angle of descent.

The actual Range Probable Error Vd_1 is:

$$Vd_1 = Vd \times \lambda_2 \qquad (3.10)$$

Whereby the value of the coefficient λ_2 on the rear gradient (always greater than 1, $\lambda_2 < 1$) takes the formula:

$$\lambda_2 = \frac{\sin \Theta c}{\sin(\Theta c - n)} \Rightarrow \lambda_2 > 1; \qquad (3.11)$$

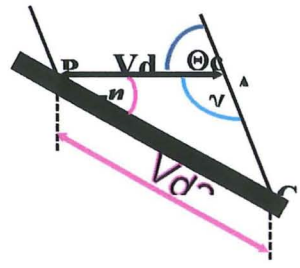
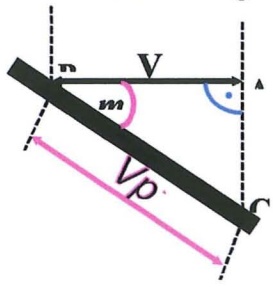


Figure 3.5b. Dependence of Vd on the rear gradient of the terrain

c) ***Influence of the side gradient on the Deflection Probable Error (Vp):***
-m value of the angle on the side gradient



- actual Deflection Probable Error Vp_1 is calculated using the formula:

$$Vp_1 = \frac{Vp}{\cos m} \qquad (3.12)$$

Figure 3.5c. Dependence of Vp on the side terrain gradient

The side gradient may be ***left*** or ***right***. From the Figure and formula it can be concluded that the extent of the Deflection Probable Error depends only on the extent of the terrain gradient, irrespective of the side towards which the terrain slopes. Since the value of the cosines of the acute angles equals approximately 1, on averagely rough terrain, where the terrain gradients are not greater than 20°, the influence on the side terrain gradient on an increase of dispersion by deflection is disregarded. However, ***with greater side gradient angles, where m>20°, it has to be taken into account.***

Example:

In order to show the magnitude of the error made in the event that corrections are not made to the firing data for the terrain gradient in the target area, a calculation is made of the magnitude of error for the case of an 120 mm M75 mortar in the Ledenica sector firing at a target 6050 metres away.

Firing is executed with a light TF shell M62P3R and charge no. 6 at a range of 6050 metres. An example of the calculation is given in Annex 7.

CONCLUSION

A failure to take into account the frontal gradient in the firing data causes certain shortfall, while the influence of the rear and side terrain slopes causes every shot to land beyond the target.

If the target bearing is close to or passes over Dubrovnik Old Town, this might lead to it being hit.

Accordingly, in the particular conditions under examination, the terrain gradient (frontal, rear and side) has an exceptional significiance.

3.2 – Causes of errors in the preparation and execution of fire

3.2.1 – General remarks on errors in the preparation and execution of fire

The preparation of initial firing data for indirect firing at a target with mortars encompasses a series of actions to designate the location of the mortar and its target, to establish the state of the barrel and the ammunition to be used for firing, and to determine the particular meteorological conditions that influence the accuracy of fire. When they have been established, these factors need to be compared with the topographic, ballistic and meteorological conditions under which the firing tables were produced (the standard conditions that are set out for each mortar in the section entitled "Analysis of Tactical and Technical Characteristics and Firing Capabilities of Fire Support Weapons of 3rd Battalion Units"), in order to determine the differences, calculate corrections, and include these corrections in the data originally determined, and thereby obtain the (corrected) initial firing data for the commencement of fire.

In the course of the procedure for preparing initial firing data and the subsequent execution of fire, mistakes are made which depend on the preparation method applied, the crew's level of training for determining and applying firing data, and the specific conditions arising from combat.

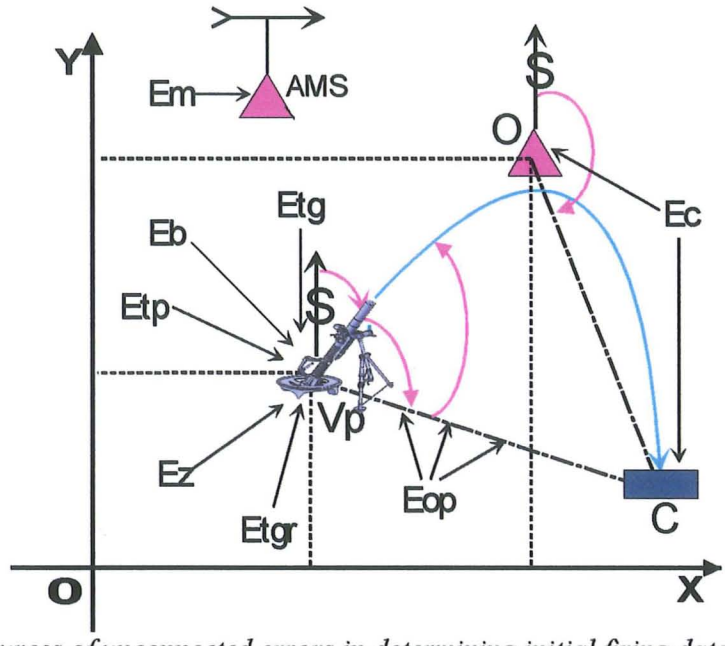


Figure 3.6 Sources of unconnected errors in determining initial firing data for mortar fire

In the course of preparing initial firing data for mortar fire, the sources of unconnected errors are as follows (see Figure 3.6):

a) Errors in determining the target location
b) Errors in topographic and geodetic work
c) Errors in ballistic preparation
d) Errors in meteorological preparation
e) Errors in technical preparation
f) Errors with firing tables
g) Errors in integrating data
h) Errors in processing data

These errors in preparing initial data for indirect fire with mortars are subject to the normal (Gaussian) law of error. All the requisite tables and formulae for determining the magnitude and seriousness of particular sources of error and summary mean range and deflection errors in relation to methods of preparing initial firing data are provided in Annex 6.

All errors depend on the procedure used during the preparation and execution of fire, which is not merely dependent on the will of the crew but on the general security conditions of the firing, available equipment, available accurate data, and the available crew members and their level of training for carrying out particular procedures.

The preparation of initial firing data[19] (following provisions of the Artillery Firing Rules) may be:

[19] Artillery Firing Rules, page 97, item 116; SSNO JNA G[UA-2, Military Publishing House, Belgrade, 1981

- Full;
- Abbreviated; or
- Simple.

The method of preparing initial firing data depends on time available, the accuracy of coordinates (targets, aiming marks and firing positions), knowledge and level of accuracy of meteorological and ballistic data (precise or approximate), or the existence on data from previous firing.

On the other hand, according to the Rules of Use for the 82 mm M69A mortar, it is anticipated that, depending on the execution method, the preparation of initial firing data (p/e)[20] should be done:

- By estimate;
- With a plotting circle;
- With a plotting circle and map; or
- By computer.

Similarly, for the preparation of initial firing data[21] for the 120 mm M75 mortar, it is anticipated that it should be done:

- By computer (using the natural values of trigonometric functions or artillery logarithms);
- Graphically (using an M56 or M80 fire direction set /PUV/);
- By estimate;
- Using a plotting circle or M80 PUV; or
- Using a plotting circle and map.

The operator decides on the method for preparing the initial firing data depending on the conditions and time available, striving to work as quickly as possible and to achieve the greatest possible accuracy of initial firing data.

A summary of the most frequent magnitudes of Range Probable Error (*Ex*) and Deflection Probable Error (*Ey*) for various methods of preparing initial firing data is given in Table 14[22].

METHOD OF PREPARING INITIAL FIRING DATA	MEAN ERROR	
	By Range *Ex* in %Dg	By Deflection *Ey* in 0-00
FULL PREPARATION	0.8-1.2	3-5
ABBREVIATED PREPARATION	3-5	10-15
SIMPLE PREPARATION	8-10	20-30

Dg-firing range (m); 0-00-in thousand of range

[20] 82-mm Mortar Rules, page 154, item 267; SSNO JNA G[UP-49, Military Publishing House Split, 1982

[21] M75 and M74 120-mm Mortar Rules, page 171, item 299; VJ G[UP-204, Military Publishing House, Belgrade, 2001

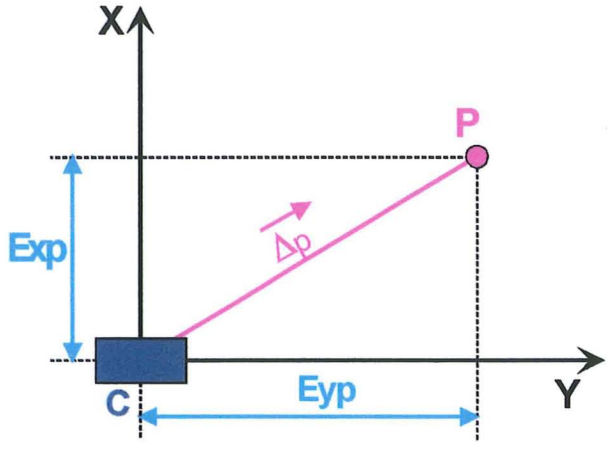
[22] Data from Table 1 taken from "Firing Theory –A Textbook for Military Schools (Artillery Stream) and Artillery Units", page 254; SSNO UA-216, Military Publishing House, Belgrade, 1979

3.3 – The influence of accuracy of initial firing data preparation on the precision of fire support and group firing by mortar units

Group firing /GG/ is a ***final phase of firing*** which consists of laying down mortar fire and achieving effects on material and/or morale at the target that influence the conduct of combat activities.

Successful group firing is achieved by:
- determining data for group firing as accurately as possible;
- engaging a suitable number of pieces and the requisite quantity of ammunition;
- the correct selection of shell type, fuse setting, charge, trajectory pattern, type of fire (percussion fire or airburst fire with proximity fuse) and type of multiple-shot firing;
- uniform distribution of fire on the target;
- sudden opening of fire;
- prompt correction of data in the course of group firing.

The task of preparing the initial firing data for group firing consists of determining the data (for range and elevation) that ensure that the mean trajectory passes through the centre of the target. To determine such data requires a large number of measurements to be taken and calculations performed, and certain accidental errors inevitably occur. As a result, the mean trajectory is directed to point *P* rather than point *C*, whereby a vector error $\overrightarrow{\Delta p}$ is obtained, which can be broken down into a mean range preparation error, *Exp*, and a mean deflection preparation error, *Eyp*.



- C - desired projectile impact point
- $\overrightarrow{\Delta p}$ - error in determining initial data for group firing
p/e za GG
- P - projectile impact point due to error $\overrightarrow{\Delta p}$
- Exp - mean error characterizing accuracy of initial data for range
- Eyp - mean error characterizing accuracy of initial data for deflection

Figure 3.7 – Errors in preparing initial data for group firing

The numerical values of mean errors in preparing initial firing data when transferring to group firing are shown in Table 15[23].

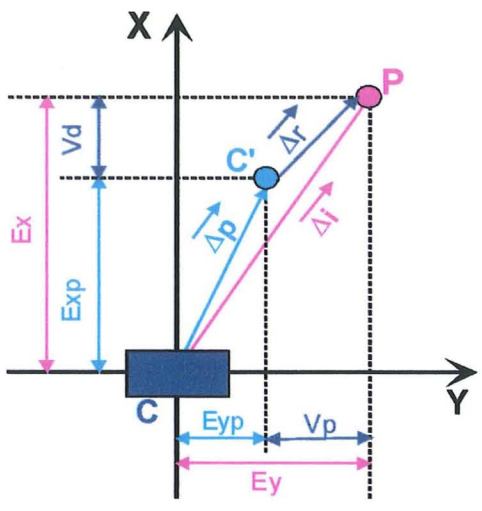
No.	***Method of determining initial firing data for transferring to group firing***	Mean error	
		Ex in *Vd*	*Ey* in *Vp*
1.	Adjustment directly at target	0.5 – 2.2	0.9 – 9.0
2.	Transfer of fire within permissible limits from the aiming mark (target)	1.3 – 1.5	2.5 – 3.5
3.	Full preparation of initial firing data	2	6
4.	Abbreviated preparation of initial firing data	8	16

In addition to errors in determining firing data, the accuracy of firing at the target and the effectiveness of group firing are also influenced by the size and character (simple or complex) of the dispersion pattern, which depends on whether the group firing is conducted by one or more pieces or mortars.

3.4 – Errors in execution of fire with a piece

In the execution of group firing with a piece, two groups of mutually unconnected errors can occur:

- Errors in preparing initial firing data for transferral to group firing ($\overrightarrow{\Delta p}$), the magnitudes of which remain constant through firing; when these are projected against the line of fire and the axis perpendicular to it the mean range preparation
- error (*Exp*) and mean deflection preparation error (*Exy*) are obtained – numerical data is provided in Table 15.
- Errors of dispersion ($\overrightarrow{\Delta r}$) with the characteristics *Vd* and *Vp*, which vary from piece to piece and do not repeat through the course of firing.



- $\overrightarrow{\Delta p}$ - *errors in preparing data*
- $\overrightarrow{\Delta r}$ - *dispersion errors*
- $\overrightarrow{\Delta i}$ - *summary error of firing with a piece*
- *C – desired projectile impact point*
- *C' - projectile impact point due to error* $\overrightarrow{\Delta p}$
- *P - projectile impact point due to error* $\overrightarrow{\Delta i}$
- *Exp - mean error characterizing accuracy of initial data for range*
- *Eyp - mean error characterizing accuracy of initial data for deflection*
- *Vd - mean Range Probable Error*
- *Vp - mean Deflection Probable Error*
- *Ex - summary mean range firing error for a single (primary) piece*
- *Ey - summary mean deflection firing error for a single (primary) piece*

Figure 3.8 – Errors in the execution of group firing with a single (primary) piece

[23] Data taken from Table 62, page 427, of "Firing Theory –A Textbook for Military Schools (Artillery Stream) and Artillery Units"; UA-216, Military Publishing House Belgrade, 1979

Since these two systems of unconnected errors on the horizontal plane are subject to the normal law of errors, so the summary law will also be the normal law of errors on the horizontal plane in the following form:

$$\rho(x,y)dxdy = \frac{\rho^2}{ExEy\,\pi} e^{-\rho^2\left(\frac{x^2}{Ex^2}+\frac{y^2}{Ey^2}\right)} dxdy$$

The law $\rho(x,y)$ is termed the summary law of discharge errors, while the mean errors *Ex* and *Ey* are termed the summary mean range and deflection discharge errors, and are calculated using the following formula:

$$Ex = \sqrt{Exp^2 + Vd^2} \qquad and \qquad Ey = \sqrt{Eyp^2 + Vp^2}$$

The mean errors are characterised by the error distance of the projectile impact point from a single discharge of the piece in relation to the point determined (calculated) by the data.

3.5 – Errors in the execution of fire by a platoon or company

In examining these errors we start with the assumption that group firing at a target is to be conducted by a basic tactical unit, i.e. a platoon or company (battery) consisting of /?n/ pieces with a concentrated cluster.

The standard procedure for conducting group firing by a unit encompasses the following stages:

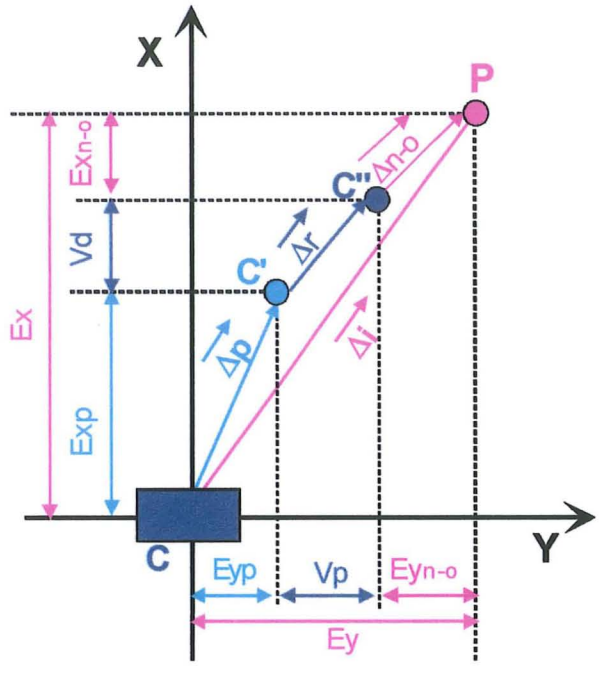
a) The initial firing data are determined and conveyed to the unit's primary piece;
b) The remaining pieces in the unit are calibrated with the primary piece, taking into account differences in topographic and ballistic conditions in relation to the primary piece;
c) Group firing begins.

Group firing thus conducted entails a substantially more complex system of errors than is the case with firing with a single weapon. These errors can be divided into three basic groups:

– The first group comprises so-called unit errors, *Ev-c*= ($\overrightarrow{\Delta v - c}$), which in essence is determined by an error in preparation ($\overrightarrow{\Delta p}$) and is identical for all pieces in the unit, both the primary piece and the other non-primary pieces;
– The second group of errors comprises dispersion errors ($\overrightarrow{\Delta r}$) with the characteristics *Vd* and *Vp*;
– The third group of errors comprises so-called piece errors, *Eo*=($\overrightarrow{\Delta o}$), which occur during the calibration of the non-primary pieces with primary piece ($\overrightarrow{\Delta n - o}$), and also errors that occur in the course of measurements taken by the crews of non-primary

pieces in order to obtain data needed to calibrate their pieces to the primary piece. In practice this error is always smaller than a preparation error ($\overrightarrow{\Delta n-o} < \overrightarrow{\Delta p}$), and its approximate value (depending on the number of pieces in the unit) is:

- Unit with four pieces – $Exo=Eyo=\overrightarrow{\Delta n-o} \approx 1Vd \approx 1Vp$
- Unit with six pieces – $Exo=Eyo=\overrightarrow{\Delta n-o} \approx 2Vd \approx 2Vp$



- $\overrightarrow{\Delta v-c\sim} = \overrightarrow{\Delta p}$ - unit errors = errors in preparing data
- $\overrightarrow{\Delta r}$ - dispersion errors
- $\overrightarrow{\Delta o} = \overrightarrow{\Delta n-o}$ - errors in calibrating non-primary pieces
- $\overrightarrow{\Delta i}$ - summary error in unit fire (platoon/company)
- C - desired projectile impact point
- C' - projectile impact point due to error $\overrightarrow{\Delta p}$
- C" - projectile impact point due to error $\overrightarrow{\Delta r}$
- P - projectile impact point due to error $\overrightarrow{\Delta i}$
- Exp and Eyp - mean error characterising the accuracy of preparation of range and deflection firing data
- Exn-o and Eyn-o - mean range and deflection error in changing non-primary pieces into primary pieces
- Vd - mean range dispersion error
- Vp – mean deflection dispersion error
- Ex and Ey – summary mean range and deflection error for group fire by unit

Figure 3.9 – Errors in the execution of group fire by platoon/company

If the above errors are projected onto the line of fire and the axis perpendicular to it, then their components can be added according to the rule of the addition of mean errors, which yields the following:

$$Ex = \sqrt{E(xv-c)^2 + Exo^2 + Vd^2} \qquad and \qquad Ey = \sqrt{E(yv-c)^2 + Eyo^2 + Vp^2}$$

The mean errors *Ex* and *Ey* characterize the dispersion of impact points from a single piece of a platoon/company with data for conducting group firing determined using one of the existing methods.

If we examine the equations for calculating mean range errors (*Ex*) and mean deflection errors (*Ey*), we find that there are two groups of errors:

- ***First group:*** Errors in preparing data for group firing made for the platoon/company as a whole (*Exv-c* and *Eyv-c*) and errors for each piece individually (*Exo* and *Eyo*). When they are added together we obtain the ***mean data preparation errors*** (*Exe* and *Eye*):

$$Ex = \sqrt{E(xv-c)^2 + Exo^2} \qquad i \qquad Ey = \sqrt{E(yv-c)^2 + Eyo^2}$$

- ***Second group:*** Dispersion errors of each piece (*Vd* and *Vp*).

The final formula for mean errors in the execution of group fire by a unit, i.e. a platoon/company, can now be expressed as follows:

$$Ex = \sqrt{Exe^2 + Vd^2} \qquad i \qquad Ey = \sqrt{Eye^2 + Vp^2}$$

The starting point for calculating the influence of the accuracy of the preparation of initial firing data on the precision of fire support by mortar units is the topographic[24] firing data.

3.6 – Calculation of initial firing data using abbreviated preparation method

In order to demonstrate the procedure for calculating initial firing data for a selected target from a particular firing position, we shall provide a full illustration of the calculations for the 120 mm M75 mortar platoon at firing position VP_1 in the Ledenica sector on the Ivanica road. For the other two 82 mm M69A mortar firing positions – firing position VP_3 in the Rajcevici sector and firing position VP_4 in the Strincijera sector – we shall provide only the departure data. The full calculations can be found in the annexes herein: ***Annex 11*** is for VP_3 in the Rajcevici sector, and ***Annex 12*** is for VP_4 in the Strincijera sector.

Firing position (VP_1) of the combined mortar battery (four 120 mm M75 light mortars) in the Ledenica sector on the Ivanica road firing at DOS forces, i.e. /?hypothetical/ targets:

- Target C-1 – aerial mast (radio, TV or relay transmitter, 85 metres high)
- Target C-2 – tt 403 (trig point)
- Target C-3 – first DOS mortar group (deployed close to the Dubrovnik Old Town walls at a distance of ≈ 300 to 350 metres in Bogisica Park)
- Target C-4 – second group of DOS mortars (deployed close to the Dubrovnik Old Town walls at a distance of ≈ 200 metres towards Ploce)

The approximate topographic data were calculated by computer (using abbreviated trigonometric tables) and they are shown in Annex 8a.

In an identical manner, using the above /?hypothetical/ targets, the approximate topographic data were calculated by computer and are shown for:

- Fire from the firing position (VP3) of the mortar platoon (four 82 mm M69A mortars) in the Rajcevici sector – see Annex 8b
- Fire from the firing position (VP4) of the mortar platoon (six 82 mm M69A mortars) in the Strincijera sector – see Annex 8b

[24] Topographic firing data are data pertaining to the angle gauge, range (range finder), fuse timing and position finder without meteorological and ballistic corrections taken into account. They are determined by means of a computer or graphically (on a target plotting board or map). When they are determined according to accurate target and firing position coordinates, this yields accurate topographic data, and when they are determined according to approximate coordinates, then approximate topographic data are yielded. "*Vojni Leksikon*" /"Military Lexicon"/, page 626, Military Publishing House, Belgrade, 1981.

The actual influence of the accuracy of the preparation of initial firing data on the precision of fire support (group firing) directed at /?hypothetical/ targets C-1, C-3 and C-4 is shown by calculating the accuracy of the ***abbreviate method for preparing initial data*** for firing by mortar units in accordance with the specific conditions stated in **Example 1** provided in ***Annex 10***.

Note:

- Due to the fact that the altitude of the firing position is Z_{VP}=350m above sea-level, the range finder value (in 1/6000 increments) should be taken by interpolation from the Mountain Firing Tables (Table IIc) for an altitude of 500m according to the type of shell, charge and topographic distance to target (page 147 of the firing tables); the remaining data are taken from the Graphical and Numerical Firing Tables (Table IIa, pages 126-127) in an identical manner.
  Note:
  If the altitude of the firing position of the piece is not taken into account when determining the initial firing data, a serious error is made when discharging the first and subsequent shells. The specific errors are as follows:
  - DtC_1=4920.42≈4920m ⇒ for Z_{VP}=0-250m Dar=6-66 while for Z_{VP}=250-750m Dar=6-57 ⇒ ΔDar= Dar (Z_{VP}=0-250m) - Dar (Z_{VP}=250-750m)
  - = 6-66 - 6-57 = + 0-09
  - DtC_3=5715.81≈5716m ⇒ for Z_{VP}=0-250m Dar=7-81 while for Z_{VP}=250-750m Dar=7-65 ⇒ ΔDar= Dar (Z_{VP}=0-250m) - Dar (Z_{VP}=250-750m)
    = 7-81 - 7-65 = + 0-16

For the remaining methodology for calculating the accuracy of the ***abbreviated initial firing data preparation*** method (using working formulae shown in Annex 10) for the real conditions in Example 1, as well as the magnitude and seriousness of errors and RMPC /expansion unknown/ as a function of the distance of fire, see Annex 10 as follows:

Target C-1 – Annex 10a
Target C-3 – Annex 10b
Target C-4 – Annex 10c

3.7 – Calculation of error in firing by a single (primary) mortar and by a mortar platoon/company

On the basis of the theoretical section set out above regarding the calculation of the influence of the accuracy of the abbreviated preparation of initial data for group firing, the following are determined:

a) Errors in firing by a single (primary) mortar:

- for target C-1:

- Annex 10a shows the numerical values of the summary errors of the abbreviated preparation of initial firing data: *Exs=Exp*=138.85m and *Eys=Eyp*=76.4m
- The Firing Tables show the numerical values and characteristics of the dispersion pattern: *Vd*=31m and *Vp*=21m

- By using the aforesaid formulae and including the calculated values into them, we calculate that the summary mean discharge error of a single (primary) piece is:
  – by range:
  $$Ex = \sqrt{Exp^2 + Vd^2} = \sqrt{138{,}85^2 + 31^2} = 142.27m$$
  – by deflection:
  $$Ey = \sqrt{Eyp^2 + Vp^2} = \sqrt{76.40^2 + 21^2} = 79.23m$$
- Since these two systems of unconnected errors on a horizontal plane are subject to the normal law of error, it can be concluded that the error distance of the projectile impact point from a single discharge in relation to the point determined (calculated) with the initial firing data using the abbreviated preparation method ranges within the parameters of ±4Ex by range and 4Ey left and right by deflection.
- A summary of the error distance of the projectile impact point from a single discharge of a primary piece is given in Table 16:

Table 16

Error distance by range			Error distance by deflection			Probability in %
Ex	142.27	min-max	Ey	79.23	in 0-00 DtC	
+ 4Ex	569.08	**5489.08**	l 4Ey	316.92	**0-64**	2
+ 3Ex	426.81	5346.81	l 3Ey	237.69	**0-48**	7
+ 2Ex	284.54	5204.54	l 2Ey	158.46	**0-32**	16
+ 1Ex	142.27	5062.27	l 1Ey	79.23	**0-16**	25
DtC-1(m)	4920		AztC-1	42-27		
- 1Ex	-142.27	4777.73	d 1Ey	79.23	**0-16**	25
- 2Ex	-284.54	4635.46	d 2Ey	158.46	**0-32**	16
- 3Ex	-426.81	4493.19	d 3Ey	237.69	**0-48**	7
- 4Ex	-569.08	**4350.92**	d 4Ey	316.92	**0-64**	2

- When these data are entered onto a topographical map (in proportion, as a dispersion grid), the real influence of the error distance of the projectile impact point from a single discharge of a primary piece is obtained, and this is shown in Annex /no number/.

  - In an identical way, abbreviated preparation data have been calculated for targets C-3 and C-4, and these are shown together with the data for target C-1 in ***Annex 10d***.

b) Errors in firing by a mortar platoon/company

- for target C-1:

- Annex 10a show the numerical values of the unit error *Exv-c*:
  Ex(v-c)=Exp=138.85m and *Ey(v-c)=Eyp*=76.40m
- The Firing Tables show the numerical values of the dispersion pattern characteristics:
  Vd=31m and *Vp*=21m
- We give an approximate value to the piece error *Exo* (depending on the number of pieces in the unit), which is:
  - unit with four 120 mm M75 mortars $\Rightarrow Exo=Eyo\approx 1\,Vd\approx 1\,Vp$

– By using the aforesaid formulae and including the calculated values into them, we calculate that the summary mean discharge error of a single (primary) piece /as printed/ is:
– by range:

$$Ex = \sqrt{Ex(v-c)^2 + Exo^2 + Vd^2} = \sqrt{138.85^2 + 31^2 + 31^2} = 145.61m$$

– by deflection:

$$Ey = \sqrt{Ey(v-c)^2 + Eyo^2 + Vp^2} = \sqrt{76.40^2 + 21^2 + 21^2} = 81.97m$$

A summary of the error distance of the projectile impact point after completing the abbreviated method of preparing initial firing data ***when conducting group firing by a platoon consisting of four 120 mm M75 mortars*** is given in Table 17.

Table 17

Error distance by range			Error distance by deflection			Probability in %
Ex	145.61	min-max	Ey	81.97	u 0-00 DtC	
+ 4Ex	582.44	5502.44	l 4Ey	327.88	0-67	2
+ 3Ex	436.83	5356.83	l 3Ey	245.91	0-50	7
+ 2Ex	291.22	5211.22	l 2Ey	163.94	0-33	16
+ 1Ex	145.61	5065.61	l 1Ey	81.97	0-17	25
DtC-1(m)	4920		AztC-1	42-27		
- 1Ex	-145.61	4774.39	d 1Ey	81.97	0-17	25
- 2Ex	-291.22	4628.78	d 2Ey	163.94	0-33	16
- 3Ex	-436.83	4483.17	d 3Ey	245.91	0-50	7
- 4Ex	-582.44	4337.56	d 4Ey	327.88	0-67	2

When these data are entered onto a topographical map (in proportion, as a dispersion grid), the real influence of the error distance of the projectile impact point from a single discharge of a primary piece is obtained, and this is shown in ***Annex 13***. Using the above methodology, for fire from the firing position of the combined mortar battery (four 120 mm M75 light mortars) in the Ledenica sector on the Ivanica road, when the initial data are determined using the abbreviated preparation method, the data are calculated for targets C-3 and C-4, and they are provided together with the data for target C-1 in ***Annexes 10d and 10e***.

In an identical way, calculations were produced for the firing of other JNA mortar units on the Dubrovnik battleground, regarding which we wish to highlight the following specific features and differences:

3.71 – 82 mm M69A mortar platoon in the Rajcevici sector

a) For fire from the firing position of the mortar platoon (four 82 mm M69A mortars) from the Rajcevici sector with (VP_3 X=21480 Y=12580 Z=285) firing at:

- C-1 – aerial mast, at a distance of 3436.28 m i.e. approximately 3436 m, charge no. 5 was used, AzOP=49-00;
- C-3: First DOS mortar group at a distance of 3792.89 m i.e. approximately 3793m, charge no. 5 was used, AzOp=47-00;

- C-4: Second group of DOS pieces at a distance of 2898.36 m i.e. approximately 2898m, charge no. 4 was used, AzOP=47-00.

Fire control and direction for this unit was conducted from the observation post of the commander of the 3/472 pb /3rd Battalion 472nd Infantry Brigade/, which was in the Zarkovica sector (tt 315), and the target data were as follows:

- C-1: target observation range was 2851.25 m i.e. approximately 2851m, target parallax was 1-56 (on the 1/60-00 scale);
- C-3: target observation range was 3093.80 m i.e. approximately 3094m, target parallax was 0-94 (on the 1/60-00 scale);
- C-4: target observation range was 2192.46 m i.e. approximately 2192 m, target parallax was 1-23 (on the 1/60-00 scale);

The terrain gradient in the firing position sector was 8 degrees.

Other data were identical to those in ***Example 1***.

The results of the calculations for firing from VP_3, when the initial data are determined by the abbreviated preparation method, at targets C-1, C-3 and C-4 are shown in ***Annexes 11a to 11e***, and a graphical representation is in ***Annex 14***.

3.72 – 82 mm M69A mortar platoon in the Strincijera sector

b) For fire from the firing position of the mortar platoon (six 82 mm M69A mortars) from the Strincijera sector with (VP_4 X=24160 Y=08920 Z=390) firing at:

- C-1 – aerial mast, at a distance of 1352.48 m i.e. approximately 1352 m, charge no. 2 was used, AzOP=26-00;
- C-3: First DOS mortar group at a distance of 1940.93 m i.e. approximately 1941, charge no. 3 was used, AzOp=30-00;
- C-4: Second group of DOS pieces at a distance of 2350.34 m i.e. approximately 2350m, charge no. 3 was used, AzOP=26-00.

Fire control and direction for this unit was conducted from the observation post of the commander of the 3/472 pc /?3rd Company 472nd Infantry Brigade/, which was in the tt 412 sector, and the target data were as follows:

- C-1: target observation range was 1162.97 m i.e. approximately 1163 m, target parallax was 0-69 (on the 1/60-00 scale);
- C-3: target observation range was 1731.04 m i.e. approximately 1731 m, target parallax was 0-03 (on the 1/60-00 scale);
- C-4: target observation range was 2154.07 m i.e. approximately 2154 m, target parallax was 0-31 (on the 1/60-00 scale);

The terrain gradient in the firing position sector was 12 degrees.

Other data were identical to those in ***Example 1***.

The results of the calculations for firing from VP_4, when the initial data are determined by the abbreviated preparation method, at targets C-1, C-3 and C-4 are shown in ***Annexes 12a to 12e***, and a graphical representation is in ***Annex 15***.

3.8 – Calculation of initial firing data using simple preparation procedure

The real influence of the accuracy of the preparation of initial data on the precision of fire support (group firing) directed at /?hypothetical/ targets C-1, C-3 and C-4 was also examined by calculating the accuracy of the ***simple preparation*** of initial data when firing with mortar units under the specific conditions stated in Example 2.

Example 2:

From the firing position of the combined mortar battery (four 120 mm M75 light mortars) in the Ledenica sector on the Ivanica road (VP1 x=24310 y=14180 z=335), using an M62P3 light TF /contact-fuse/ shell, charge no. 6, indirect fire is aimed at the following targets:

- C-1 – aerial mast (X=22920 Y=09460 Z=403) at a range of 4920.42 m, i.e. approximately 4920 m;
- C-3 – First DOS mortar group at around 300 m from the Dubrovnik Old Town walls in Bogisica Park (X=22220 Y=08860 Z=50) at a range of 5715.881 m, i.e. approximately 5716 m;
- C-4 – Second DOS mortar group at around 200 m from the Dubrovnik Old Town walls towards Ploce (X=21950 Y=09720 Z=40) at a range of 5045.91 m, i.e. 5046 m.

The location of the firing position and observation post was determined with the 1:50000 map (comparing the map with the terrain) by taking the rectangular coordinates.

A light or hand-held magnetic compass was used to determine the base line of pieces at the firing positions.

The location of the target was determined by comparing the 1:50000 map with the terrain (point sought is not a contour point) and taking the rectangular coordinates:

- C-1 – Target observation range was 2851.25 m, i.e. approximately 2851 m, target parallax was 8-42 (on the 1/60-00 scale);
- C-3 – Target observation range was 3093.80 m, i.e. approximately 3094 m, target parallax was 6-39 (on the 1/60-00 scale);
- C-4 – Target observation range 2192.46 m, i.e. approximately 2192 m, target parallax was 7-43 (on the 1/60-00 scale);

The basic characteristics with the application of the simple preparation procedure for initial firing data are as follows:

a) Determining the topographic data is performed graphically with a plotting circle and topographic map, while data are determined during correction by applying an estimated correction and assessing the impact /sentence unclear/.

b) The unit does not have data on muzzle velocity deviation for any of the pieces.

c) Meteorological conditions were not measured or taken into account when determining initial firing data.

On the basis of these data, ***the summary mean errors of simple preparation of initial firing data and their magnitudes in range and deflection were determined.***

RESULT:

The remarks made in the previous example pertaining to determining the initial *Dar* /expansion unknown/ from the Mountain Firing Tables also pertain to all other calculations.

Simple preparation of initial firing data is ***applied when the requirements for applying the abbreviated preparation method cannot be met*** and there is an urgent need to open fire. The requirement for applying the simple preparation method is that the operator knows (at least approximately) the location of the firing position and the target on the ground and that the range is no greater than 6 km.

Given that during combat operations in the Dubrovnik sector all the requirements were met for applying the simple preparation method for initial firing data (which was used as the primary preparation method for mortar units), and the equipment used for preparing and determining the topographic data was in accordance with the provisions of the 82-mm and 120-mm mortar rules (referred to in Section 2), ***the summary mean errors of simple preparation*** were as follows:

- By range: *Exs*=8-10% of the topographic distance to target /DtC/
- By deflection: *Eys*=20-30 mils of the topographic distance to target

– The specific numerical values of the summary mean errors of simple preparation based on the conditions in the example are:
  - for C-3:
    - By range: *Exs*=8-10%DtC = 9/100 * 5716 = 514.44 m
    - By deflection: *Eys*=20-30 mils DtC = 25/1000 * 5716 = 142.9 m
  - for C-4:
    - By range: *Exs*=8-10%DtC = 9/100 * 5046 = 454.14 m
    - By deflection: *Eys*=20-30 mils DtC = 25/1000 * 5046 = 126.15 m
  - for C-1:
    - By range: *Exs*=8-10%DtC = 9/100 * 4920 = 442.8 m
    - By deflection: *Eys*=20-30 mils DtC = 25/1000 * 4920 = 123 m

This procedure was used to calculate the influence of the accuracy of the simple preparation method for initial firing data for all firing positions of the mortar unit, and these are shown in tabular form together with the results of the calculations for the abbreviated preparation method in the appropriate annexes for the mortar firing positions: for VP_1 see ***Table 4.1 in Annex 10d*** and the graphical representation in ***Annex 13***; for VP_3 see ***Table 4.2 in Annex 11d*** and the graphical representation in ***Annex 14***; for VP_4 see ***Table 4.3 in Annex 12d*** and the graphical representation in ***Annex 15***.

The following are covered:

a) Fire from the firing position of the combined mortar battery (four 120 mm M75 light mortars) in the Ledenica sector on the Ivanica road (VP_1 x=24310 y=14180 z=335), ***Table 4.1, Annex 10d,*** aimed at targets:
   - C-1 – Aerial mast
   - C-3 – First DOS mortar group
   - C-4 – Second group of DOS pieces

b) Fire from the firing position of the mortar platoon (four 82 mm M69A mortars) in the Rajcevici sector (VP_3 x=21480 y=12580 z=285), ***Table 4.2, Annex 11d,*** aimed at targets:
   - C-1 – Aerial mast
   - C-3 – First DOS mortar group in annex /as printed/
   - C-4 – Second group of DOS pieces

c) Fire from the firing position of the mortar platoon (six 82 mm M69A mortars) in the Strincijera sector (VP_4 x=24160 y=08920 z=390), ***Table 4.3, Annex 12d,*** aimed at targets:
   - C-1 – Aerial mast
   - C-3 – First DOS mortar group
   - C-4 – Second group of DOS pieces

3.9 – Human error

In the analysis of factors that cause deviation in trajectory (impact) when firing mortars and artillery pieces, particular attention will be paid to human factors.

Human factors occur due to the imperfect limitations of organs and sensory perception, and the mental and physical condition of the operating crew. Also, an inadequate level of training and readiness in a crew has a decisive influence on increased impact dispersion, i.e. the precision of fire and the probability of hitting the intended target.

Accordingly, no matter how perfectly the piece and ammunition have been manufactured, and no matter how much the crew endeavour to work as accurately as possible, a state of exhaustion, lack of sleep or stress when under enemy fire leads to varying degrees of deviation and non-uniformity in aiming and other activities when firing, which invariably leads to increased dispersion.

3.10– Meteorological causes of impact deviation

Meteorological causes are all those that come from the conditions and changes in the atmosphere through which the projectile passes on its flight from the muzzle of the barrel to the point of impact. They cause the trajectory to change, either affecting the range, the deflection, or both range and deflection. The most important meteorological conditions are:

a) Air temperature and humidity
b) Air pressure
c) Wind direction and speed

All these meteorological factors have a very significant influence for this analysis because they have a direct impact on the accuracy of the preparation of initial firing data and the accuracy of correction and group firing, ***and a failure to take these factors into account when operating fire support weapons can be manifested in unintentional firing on Dubrovnik Old Town.***

Errors in preparing initial firing data occur due to:
- not taking meteorological factors into account (the case for simple preparation of fire);
- taking into account meteorological factors that were determined/measured wrongly (usually when applying the abbreviated firing preparation method);

- the changeability of meteorological factors with time and position/altitude (meteorological data are measured and taken into account, but the data change in a given time and area).

If a **radiosonde is used to measure the meteorological parameters,** which is required for full preparation of firing data, then the following errors[25] (probable deviations) can be expected:

- Error in ballistic value for temperature, Et_0=0.7 K
- Ballistic wind error, Ew_0=0.9m/s

Depending on the time (dt) in hours from moment of measurement to the use of the data, errors increase accordingly:

$$Et_t = 0.6 * \sqrt{dt}$$

$$Ew_t = 0.8 * \sqrt{dt}$$

Depending on the distance (dD) in km from the place of measurement to the place where the data are used, errors increase accordingly:

$$Etd = 0.6 * \sqrt{\frac{dD}{a}}$$

$$Ewd = 0.8 * \sqrt{\frac{dD}{a}}$$

Whereby the constant is a=10 or a=25, depending on the terrain configuration (lowland or mountainous).

The aggregate error for ballistic deviations is the geometric sum of these three components:

$$Ets = \sqrt{Et_0^2 + Et_t^2 + Et_d^2}$$

$$Ews = \sqrt{Ew_o^2 + Ew_t^2 + Ew_d^2}$$

Errors in measuring air pressure are of the order Eh_s=2.6 mb.

This level of errors occurring in radiosonde sampling of the atmosphere would influence accuracy of the firing of mortar/pieces in all the cases examined, such that the impact deviations would not threaten the old part of Dubrovnik town.

There is no information to indicate that in that period and in that area, anyone conducted radiosonde meteorological measuring or even pilot balloon observation in order to measure wind changes at altitude. The only possibility is that ground-level measurements were taken of pressure, temperature and wind speed and direction, or

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[25] L.S. SAVKIN and B.D. LEBEDEV, "*Meteorologiya i strel'ba v artillerii*" /Russian title: "Meteorology and Artillery Fire"/, *Voenoizdat* /Military Publishing/, Moscow 1974.
V.G. DYAKONOV and A.A. CHERVONII, "*Teoriya strel'bi nazemnoi artillerii*" /Russian title: "The Theory of Surface-to-Surface Artillery Fire"/, Moscow 1956.

that these values were assessed in order to take them into account when determining firing data.

– For ground level pressure	Eh_0=3-5 mbar
– For temperature	Et_0=3-6 K
– For wind	Ew_0=0.3*W

A non-uniform change of temperature at altitude (temperature inversions of as much as 5°C are possible) would cause an increase in error even if the temperature was measured. However, even a particular ballistic temperature error of 5°C would only cause a deviation in range of about 40 m for a firing distance of 4900 m, which again would not threaten the security of the no-fire zone.

However, changes of wind at altitude in relation to ground-level wind are significantly greater and cause a greater dispersion. Detailed research[26] – see extract in Annex 19 – shows that wind at an altitude of 300 metres is approximately five times stronger than wind at sea level. On the basis of measurements taken – see ***Annex 5*** – in the period under examination and in the area that is the subject of analysis, ground level wind ranged between 3 and 4 on the Beaufort scale, i.e. 3.5 m/s to 8 m/s, which means that the ballistic wind could have been between 15 m/s and 30 m/s without the crewmember preparing the firing data being aware of this. At a range of 5000 metres, a 10 m/s wind alters the projectile impact point by around 200 metres. This means that a projectile impact deviation of 200 m to 600 m from the target was possible, due only to a lack of knowledge of the ballistic wind. The same level of deviation could also be expected with the simple preparation of firing elements when the influence of the wind is not taken into account.

By taking into account the errors in preparation and execution of fire given in ***Annexes 10, 11 and 12***, it can be shown that the level of deviation in the case in question regarding firing at targets at the Srdj fort or during counter-battery fire against targets close to Dubrovnik Old Town – target C-3 Bogisica Park, and target C-4, the position 200 metres from Dubrovnik Old Town towards Ploce – ***is sufficient to jeopardise the no-fire zone***.

3.11 – Calculation of the depth of penetration of projectiles into the stone walls and pavements of Dubrovnik Old Town

On the basis of the disposition of the JNA mortars and artillery pieces on the Dubrovnik battleground between 11 November and 6 December 1991, conclusions can be drawn regarding the possibility of hitting the selected targets on the territory under DOS control. The primary targets were: C-1 – fortified positions on Mt. Srdj; C-3 – DOS first platoon of three 82-mm mortars in Bogisica Park, approximately 300 to 350 metres west of the Dubrovnik Old Town walls; and C-4 – DOS second group of pieces 200 metres from Dubrovnik Old Town towards Ploce.

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[26] *"Tipovie kharakteristikii nizhnego 300-metrovogosloya atmosferi po izmereniyam na visotnoi mesta"* /Russian title: "Standard Characteristics of the Lower 300-Metre Layer of the Atmosphere According to Measurements Taken at Altitude"/, *Institut eksperimentalnoi meteorologii* /Institute of Experimental Meteorology/, Moscow 1982.

According to the disposition of the JNA and DOS pieces, mutual counter-battery fire was also exchanged over the territory of Dubrovnik Old Town, which could have led to projectiles landing inside Dubrovnik Old Town. Thus, on the basis of an analysis of the probability of hitting Dubrovnik Old Town, the following can be concluded:

1. The JNA mortars in the sectors of Strincijera, Ledenica and Rajcevici, and the 130 mm M46 guns in the Volujac sector near Bihovo were capable of hitting Dubrovnik Old Town
2. The pieces on the boats and the 20-mm, 40-mm and 57-mm anti-aircraft guns were capable of hitting the fortification on Mt. Srdj and parts of Dubrovnik Old Town towards Mt. Srdj, although they were only capable of hitting the upper stone walls and roofs of buildings inside Dubrovnik Old Town that were visible from the sea.
3. The battalion of 105 mm M56 howitzers in the Hum sector and the M39/44 85-mm anti-aircraft guns in the Cilipi airport sector (at the eastern end of the runway) were not capable of hitting Mt. Srdj or the DOS mortars.

In order to establish which projectiles struck the stone walls of the Old Town, the steps, decorative features on buildings and the stone slabs in the Old Town, calculations on the penetration of projectiles on impact have been performed.

The calculations were performed using two methods: the method of Sandia National Laboratories[27], USA, and the Russian Berezan[28] method.

The basic formulae for calculating the depth of penetration are:

a) Sandia:

$$lp = 0{,}000018 * Ks * Kn * (\frac{m}{A})^{0.7} * (Vc - 30{,}5) \qquad (3.17)$$

b) Berezan:

$$lp = \lambda * Kp * (\frac{m}{d^2}) * Vc \qquad (3.18)$$

where:

Ks– the coefficient of the ground material, stone, is Ks=1;

Kn – the coefficient of the projectile

$$Kn = 0.18 * \frac{Ln}{d} + 0.56 \qquad (3.19)$$

where:

Ln– length of ogive of projectile (m)
d – calibre of projectile (m)

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[27] C.V. YOUNG, "Penetration Equation", SAD(&-2426, Sandia National Laboratories, Albuquerque, New Mexico 87185 and Livermore, California 94550.
[28] A. STAMATOVI], "*Konstruisanje projektila*" /The Construction of Projectiles/, Belgrade, pp. 188-189.

λ – coefficient of projectile shape; Berezan method for $Ln/d>1.5$ is 1.3

Kp – coefficient of material's resistance; for a stone wall it is $Kp = 2.5*10^{-6}$

m – mass of projectile (kg)
A – lateral cross-section of projectile (m^2)
Vc – impact velocity of projectile (m/s)

The penetration depths calculated for projectiles that could hit the stone surfaces of Dubrovnik Old Town provided that the fuse functioned correctly and the projectile exploded – the penetration depths lp calculated according to the Sandia (3.21) and Berezan (3.22) formulae – are re-calculated for the adopted time of a time-delay fuse, $Tr = 0.001$ s, according to the formula (3.24) and are provided in Table 18.

$$lp' = Vc*Tr(1-\frac{Vc*Tr}{4*lp}) \qquad (3.20)$$

Table 18

Projectile	Range	Impact velocity	Impact angle	Sandia penetration	Berezan penetration
d(mm)	(m)	Vc (m/s)	θ_c (^{0})	lp'(m)	lp'(m)
20	2500	500	87	0.396	0.388
40 L60	2500	558	87.62	0.470	0.482
40 L70	2500	508	87.35	0.442	0.444
57 L70	2500	693	87.8	0.623	0.631
76	4000	341	83.3	0.308	0.316
100	2000	745	89.26	0.691	0.689
122	11500	281	81.12	0.260	0.266
130	8000	558	84.8	0.312	0.317
82 mortar	2500	170-190	60	0.094-0.0105	0.128
120 mortar	5000	235	60	0.172	0.204

On the basis of the calculated penetration depths, up to the moment of the projectile's explosion, and for the adopted time of the time-delay fuse, the depths of penetration into the stone surfaces of the Old Town were of the order of 9 to 20 cm for mortar projectiles and 26 to 47 cm for artillery projectiles.

The destructive effect of a projectile is in direct proportion to the mass of the explosive, and in terms of this effect, 122-mm and 130-mm artillery projectiles and 120-mm mortar projectiles had the greatest effect. The quantities of explosives in projectiles are provided in section II and Annex 21 herein. An assessment of which kind of projectile penetrated a stone surface is made on the basis of the projectile penetration depth measured in relation to the plane that the projectile struck and the values of the penetration depths shown in Table 18.

3.12– The size and composition of combat sets of fire support mortars and artillery pieces engaged on the Dubrovnik battleground

A combat set[29] (b/k) is a prescribed quantity and type of ammunition individually provided for a soldier (or officer), firearm, piece, or item of hardware; or an estimate and supply norm for estimating reserves of ammunition and expressing consumption (a unit of operational estimation). The size and composition of the combat sets for each calibre and type of weapon, broken down by ammunition types and models, are specified in special tables (lists).

For our purposes here, the term combat set will refer to a unit of estimation for expressing the quantity and type of ammunition located with each mortar or artillery piece. The sizes and compositions of the combat sets of fire support mortars and artillery pieces engaged by the JNA on the Dubrovnik battleground are shown in Table 19. When examining these quantities, it must be kept in mind that each piece has an untouchable reserve of 0.3 b/k, which cannot be used without the express authorisation of a superior officer.

SIZE AND COMPOSITION OF COMBAT SETS

Table 19

Name of piece	Composition and type of projectile	1 b/k	2 b/k	3 b/k	RESERVE	NOTES
		Quantity (rounds)			0.3 b/k	
82 mm M69A mortar	Contact-fuse shell	60	120	180	18	
120 mm M75 light mortar	Light TF /contact-fuse/ shell	40	80	120	12	
M42 *ZIS* 76-mm gun	TF shell	30	60	90	9	
	Shaped-charge tracer shell	20	40	60	6	Designed for anti-armour combat
105 mm M56 howitzer	TF projectile	40	80	120	12	
	Time-fuse projectile	10	20	30		
	Anti-tank tracer projectile (POZ)	20	40	60	6	Designed for anti-armour combat
D30 122-mm howitzer	TF projectile, full charge	16	32	48	5	
	TF projectile, reduced/variable charge	16	32	48	5	
	Time-fuse projectile, full charge	4	8	12		
	Time-fuse projectile, reduced/variable charge	4	8	12		
	Shaped-charge tracer reduced-spin projectile	10	20	30	3	Designed for anti-armour combat
130 mm M46 gun	TF projectile	27	54	81	8	
	Time-fuse projectile	3	6	9		

[29] See "*Vojni Leksikon*" /"Military Lexicon"/, page 67, Military Publishing House, Belgrade, 1981

The success of firing tasks depends on a number of interdependent factors, one of the most import of which is determining ammunition consumption.[30] The specific firing capabilities of fire support mortars and artillery pieces engaged by the JNA on the Dubrovnik battleground can be illustrated on the basis of the approved quantities of ammunition for executing firing tasks and the prescribed projectile consumption norms provided in *Annex 19*.

IV – BALLISTIC ANALYSIS OF THE FIRING OF JNA ARTILLERY WEAPONS

On the basis of witness statements, the summary of video recordings and the assessment of the destructive effect of projectiles inside Dubrovnik Old Town and outside the Old Town walls, it is evident that most of the damage to features was caused by mortar fire. In order to examine the causes of why mortar projectiles also hit features in the Dubrovnik Old Town sector, ballistic calculations were conducted for the JNA mortar units.

The artillery fire support pieces of the JNA units did not fire on the Dubrovnik Old Town sector:

– AT Gn 76 mm M42 artillery pieces at VP-2 in the Vrastice sector were not capable of firing on the town of Dubrovnik due to the flatness of the trajectory. When firing at the old fortification on Mt. Srdj, every projectile that missed landed in the sea;

– The 105 mm M56 howitzers in the Hum sector were positioned at a distance from the town of Dubrovnik that was greater than their maximum range;

– The 122 mm D30 howitzer in the Cavtat sector fired at the fortification on Mt. Srdj;

– The 85-mm M39/44 guns in the Cilipi sector did not fire;

– The 130 mm M46 guns in the Volujac sector did not fire.

From firing position VP1, the combined mortar battery (four 120 mm M75 light mortars) near Ledenica firing at DOS forces, i.e. /?hypothetical/ targets, was capable of firing at:

– Target C-1 – aerial mast (radio, TV or relay transmitter, 85 metres high);
– Target C-2 – tt 403 (trig point);
– Target C-3 – first DOS mortar group (three 82-mm mortars deployed close to the Dubrovnik Old Town walls at a distance of ≈ 350 to 400 metres in Bogisica Park);
– Target C-4 – second group of DOS pieces at a distance of approximately 200 metres from the Dubrovnik Old Town walls towards Ploce.

The approximate topographic data were calculated by computer (using abbreviated trigonometric tables) and they are shown in ***Annex 8a***.

In an identical manner, using the above /?hypothetical/ targets, the approximate topographic data were calculated for:

– Fire from the firing position VP) of the mortar platoon (four 82 mm M69A mortars) in the Rajcevici sector – see ***Annex 8b***;
– Fire from the firing position VP4 of the mortar platoon (six 82 mm M69A mortars) in the Strincijera sector – see ***Annex 8c***.

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[30] All requisite formulae, tabular norms of projectile consumption and coefficient values are provided in Annex XI (summary 1 to 5), and are specified and explained in detail in item 142 of the Artillery Firing Rules, page 108, UA-2-1 edition, 1981.

By comparing the calculated approximate topographic data and the representation of the positions of pieces (***Annex 9a***) with the graphical representation of the directions and sectors of fire of 82-mm and 120-mm mortars and 76-mm Pot pieces (***Annex 9b***) according to the construction data of the 82-mm and 120-mm mortars (horizontal field of movement without moving the bipod) the conclusions set out in section 1.31 are confirmed, particularly the facts stated under d) and e).

4.1 –120-mm mortars firing from VP1 ib the Ledenica sector

In ***Annex 10*** a full example is given of the calculation of the magnitude and seriousness of the sources of errors in preparing initial firing data according to the ***abbreviated preparation*** method for targets C-1 (the fortification on ***Mt. Srdj***), ***Annex 10a;*** for target C-3, the first group of 82-mm mortars in Bogisica Park, ***Annex 10b***; and for target C-4, the second group of mortars approximately 200 metres from the Old Town towards Ploce, ***Annex 10c***.

Table 4.1, Annex 10d, gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated and simple preparation*** of initial data).

Annex 10g gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated preparation*** of initial data) when firing ***with one*** primary 120 mm M75 mortar from VP1 in the Ledenica sector; ***Annex 10h*** – the execution of ***group firing*** with a platoon of four 120 mm M75 mortars from VP1 in the Ledenica sector on the Ivanica road; and in ***Annex 10e and Annex 10f*** after completing simple preparation of initial firing data.

A 1:25,000 scale drawing is given in ***Annex 13***.

In order to assess the possibility of projectiles landing within the Dubrovnik Old Town walls when firing at the DOS firing positions located at target C-1 – the radio and television mast on Mt. Srdj, target C-3 – the first mortar group in Bogisica Park, and target C-4 – the second DOS mortar group located approximately 200 metres from the Dubrovnik Old Town walls towards Ploce, the main part of this Expert Analysis will provide only some characteristic dispersal patterns where it is evident that they also cover parts of Dubrovnik Old Town. On the basis of this fact it is to be expected that, as a result of normal projectile dispersion and errors in preparing initial firing data caused by failing to take into account real firing conditions – meteorological, ballistic and topographic (which deviated substantially from the standard tabular conditions) – a number of projectiles would land within the Dubrovnik Old Town walls.

Annex 13 provide probable patterns of projectile impact point dispersion for the calculated values in ***Tables 10e, f, g and h*** on the 1:25000 scale.

On the dispersion pattern images, dispersion when firing with one primary piece is marked in black, while dispersion when firing with four or six pieces is marked in red[31].

Note:

On the morning of 6 December 1991 there was an exceptionally strong gale-force wind.

This is confirmed by the following facts:

[31] The dispersion pattern for group firing increases in relation to the basic dispersion pattern obtained for a single piece; see page 23 /in the original/ of this Expert Analysis.

– Statement of prosecution witness Djelo JUSIC when testifying before the Tribunal on 24 February 2004;

– CD recording, no. V000-2732, at 4 minutes 20 seconds, where tree branches can be seen swaying strongly which, according to Annex 5, corresponds to a wind strength of Force 6 on the Beaufort scale.

Given this fact, in addition to the impact dispersion pattern for the selected targets for normal conditions, for each case and position dispersion patterns are given for a lateral wind of 10 m/s, which corresponds to the strength of the local wind classified as Gale Force 5 to 6 on the Beaufort scale.

As a result of the effect of the gale blowing from the land towards the sea, during the flight of projectiles their trajectories deviated in terms of deflection. Since the firing positions of the JNA mortars were positioned laterally in relation to the selected targets, the effect of the wind naturally led to deviation of the projectiles towards the sea, i.e. towards Dubrovnik Old Town.

4.11 – 120-mm mortar firing from VP1 iz the Ledenica sector, abbreviated preparation of initial data for firing at target C-3, the first group of DOS mortars in Bogisica Park

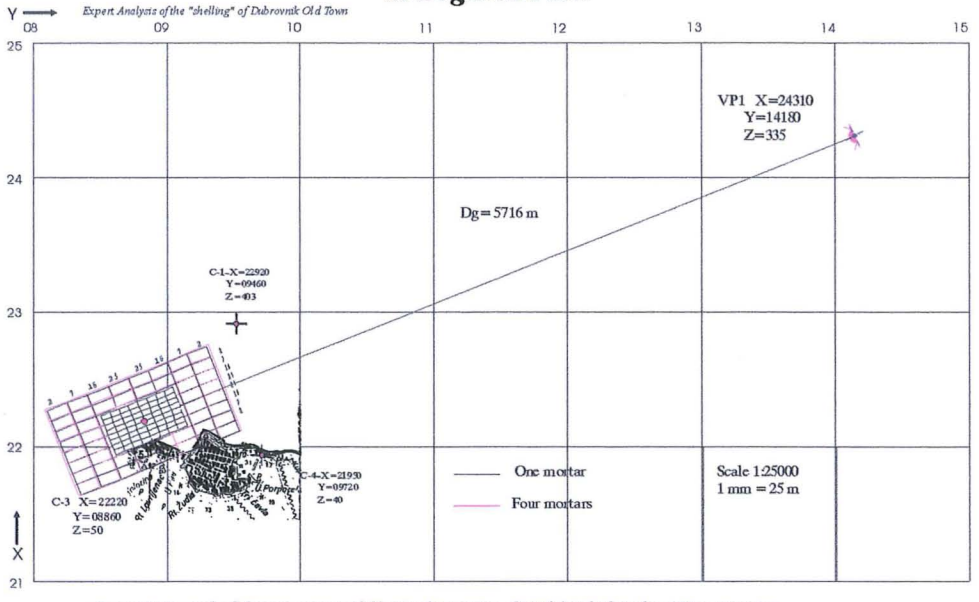

Figure 4.3 Magnitude of dispersion pattern of abbreviated preparation of initial data for firing from VP1 at target C-3 the first group of DOS mortars in Bogisica Park

Figure 4.3 – Magnitude of dispersion pattern of abbreviated preparation of initial data for firing from VP1 at target C-3, the first group of DOS mortars in Bogisica Park

An analysis of Figure 4.3 leads to the conclusion that the northern part of Dubrovnik Old Town lies within the 2% dispersion zone of the 7% probability belt[32].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
5716	165	86	35	19	577.5	313.5

After the correction of fire the dispersion of mortars bombs don't cover the surface of Old Town.

[32] *If 100 120-mm bombs were fired, none would land in the Old Town.*

4. 12 - 120 mm mortars firing from VP1 in the Ledenica sector, abbreviated preparation of initial firing data against target C-3, the first group of DOS mortars in Bogisica park, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

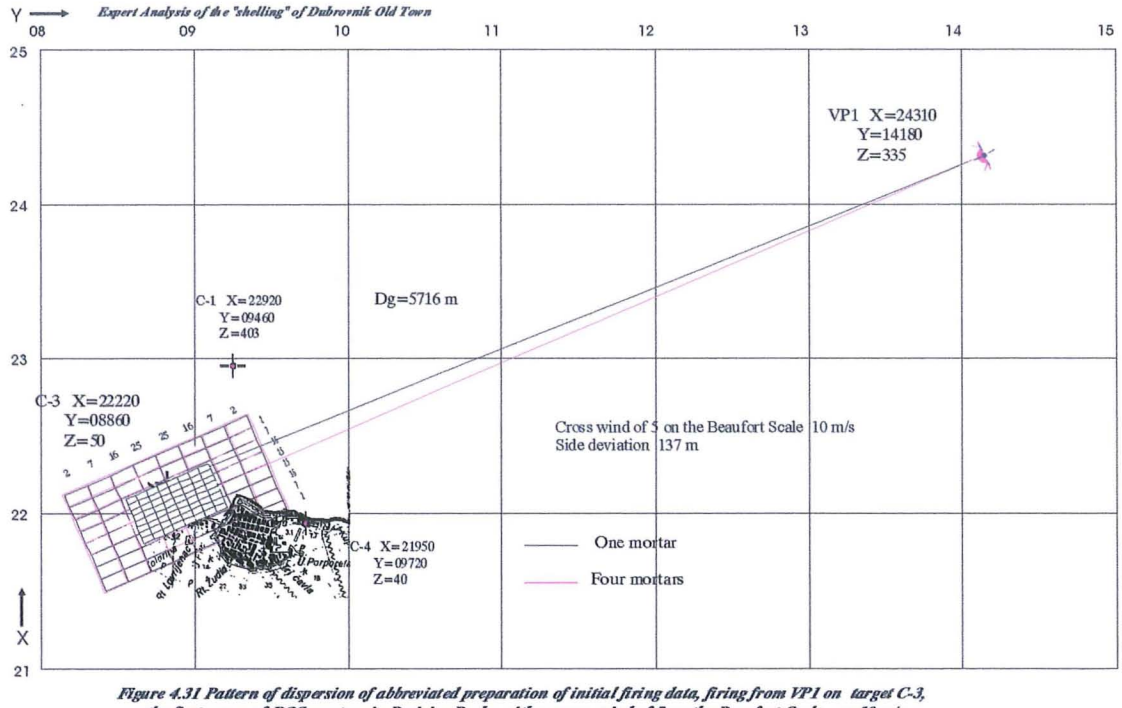

Figure 4.31 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 on target C-3, the first group of DOS mortars in Bogisica Park, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 4.31 Magnitude of the pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 at target C-3, the first group of DOS mortars in Bogisica Park, with a cross wind of 5 on the Beaufort Scale, or 10 m/s

An analysis of Figure 4.31 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 16%, 7% and 2% dispersion zones in the 16% and 7% probability bands[33].

After the correction of fire the dispersion of mortars shells don't cover the surface of Old Town.

[33] *Of 100 120-mm shells fired two would land in the Old Tow if the correction of fires is not done .*

4. 13 - 120 mm mortars firing from VP_1 in the Ledenica sector, simple preparation of initial firing data against target C-3, the first group of DOS mortars in Bogisica park

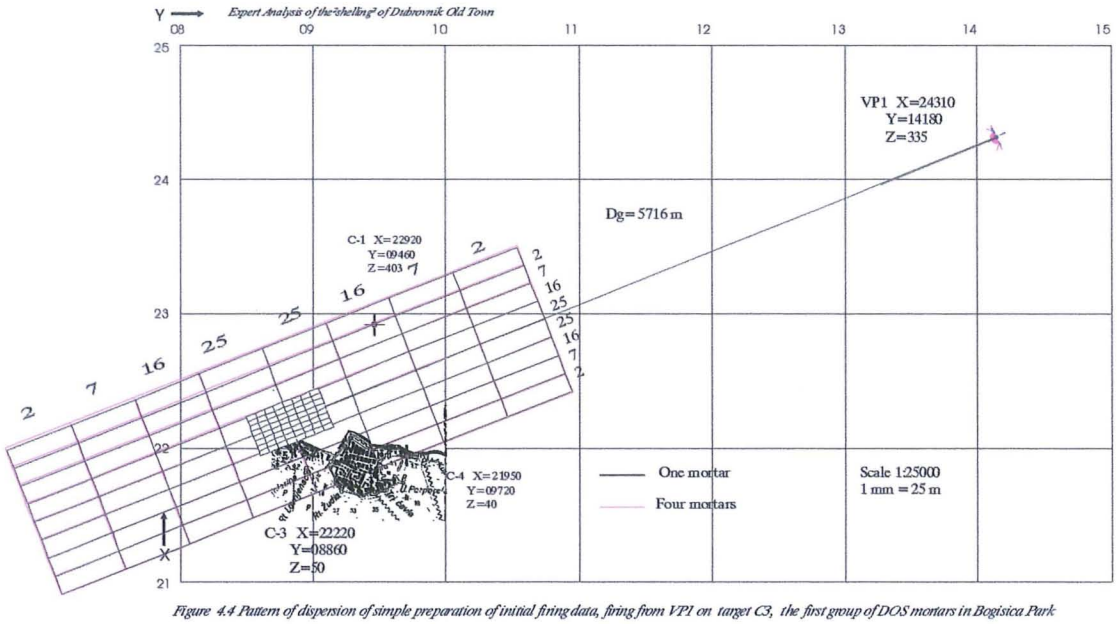

Figure 4.4 Pattern of dispersion of simple preparation of initial firing data, firing from VP1 on target C3, the first group of DOS mortars in Bogisica Park

Figure 4.4 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP1 at target C-3, the first group of DOS mortars in Bogisica Park

An analysis of Figure 4.4 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 7% and 2% dispersion zones in the 25% and 16% probability bands[34].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
5716	516.8	145.4	35	19	577.5	313.5

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by simple method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

After the correction of fire the dispersion of mortars bombs don't cover the surface of Old Town.

[34] *Of 100 120-mm shells fired three would land in the Old Town if the correction of fire is not done.*

4. 14 - 120 mm mortars firing from VP1 in the Ledenica sector, simple preparation of initial firing data against target C-3, the first group of DOS mortars in Bogisica park, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

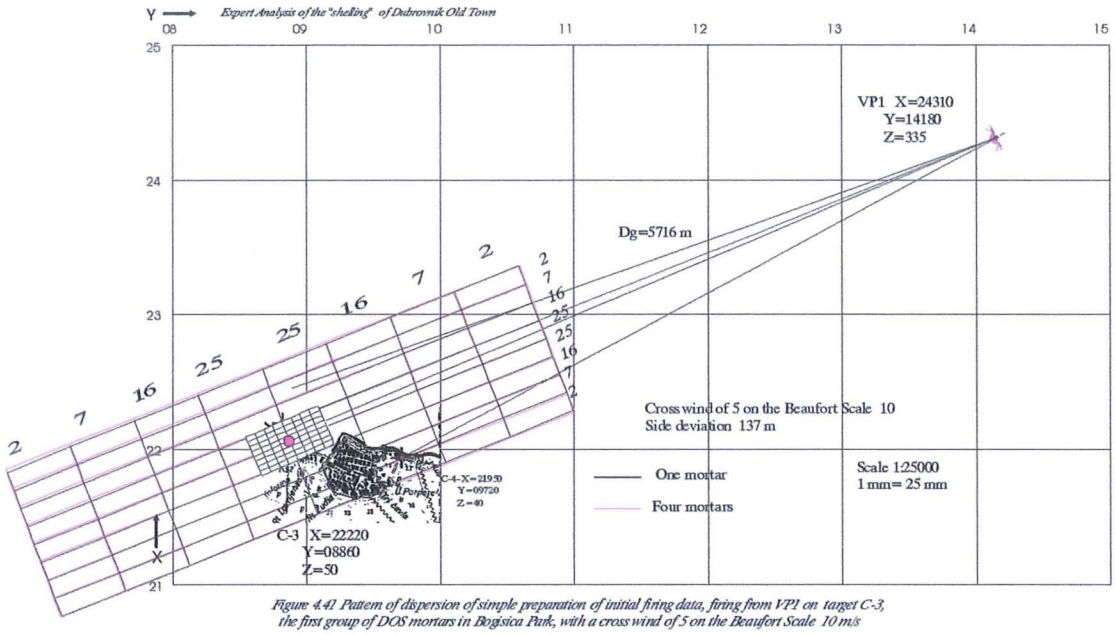

Figure 4.41 Pattern of dispersion of simple preparation of initial firing data, firing from VP1 on target C-3, the first group of DOS mortars in Bogisica Park, with a cross wind of 5 on the Beaufort Scale 10 m/s

Figure 4.41 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP1 at target C-3, the first group of DOS mortars in Bogisica /Park/, with a cross wind of 5 on the Beaufort Scale, or 10 m/s

An analysis of Figure 4.21 leads to the conclusion that the entire surface of Dubrovnik Old Town lies in the 16%, 7% and 2% dispersion zones in the 25% and 16% probability bands[35].

After the correction of fire the dispersion of mortars bombs don't cover the surface of Old Town.

[35] *Of 100 120-mm shells fired five would land in the Old Town if the correction of fire is not done.*

4. 15 - 120 mm mortars firing from VP1 in the Ledenica sector, abbreviated preparation of initial firing data against target C-4, the second group of DOS mortars 200 m from Dubrovnik Old Town towards Ploce

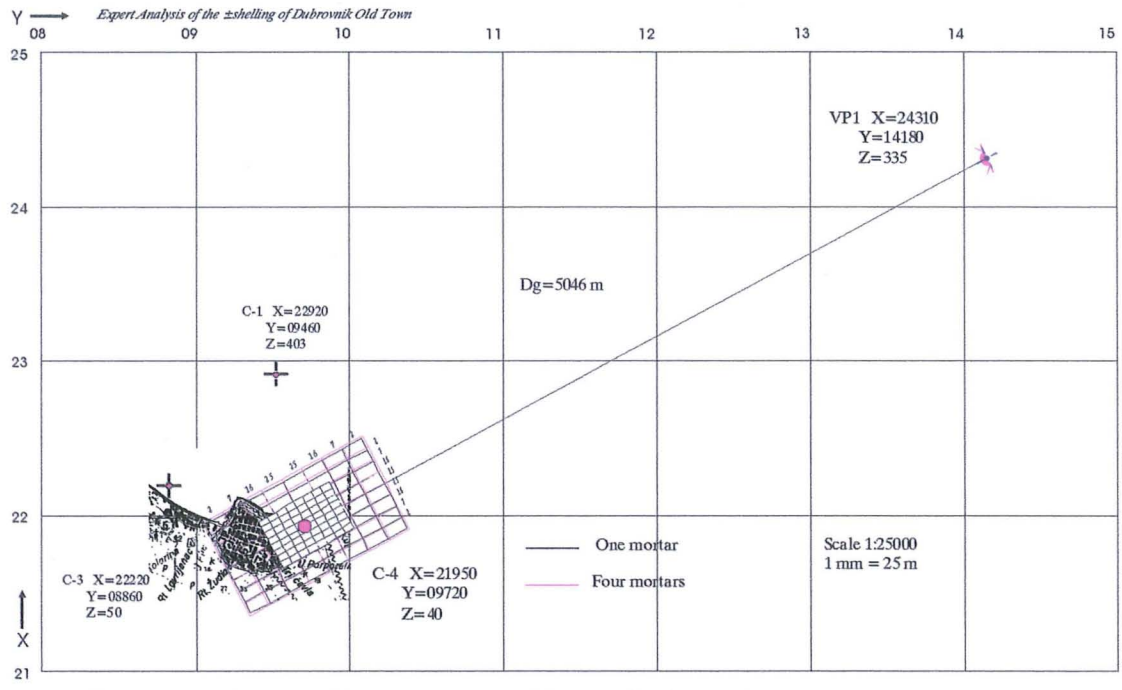

Figure 4.5 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 on target C-4, the second group of DOS mortars towards Ploce

Figure 4.5 Magnitude of the pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce

An analysis of Figure 4.5 leads to the conclusion that the entire surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 25%, 16%, 7% and 2% probability bands[36].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
5046	149.1	82.3	32	20	528	330

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *abbreviated* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,

After the correction of fire 3 shells would land in the Old Town.

---

[36] Of 100 120-mm shells fired 10 to 12 would land in the Old Town and after the correction of fire 3 would land in the Old Tow.

4. 16 - 120 mm mortars firing from VP1 in the Ledenica sector, abbreviated preparation of initial firing data against target C-4, the second group of DOS mortars 200 m from Dubrovnik Old Town towards Ploce , with a cross wind of 5 on the Beaufort scale, or 10 m/s.

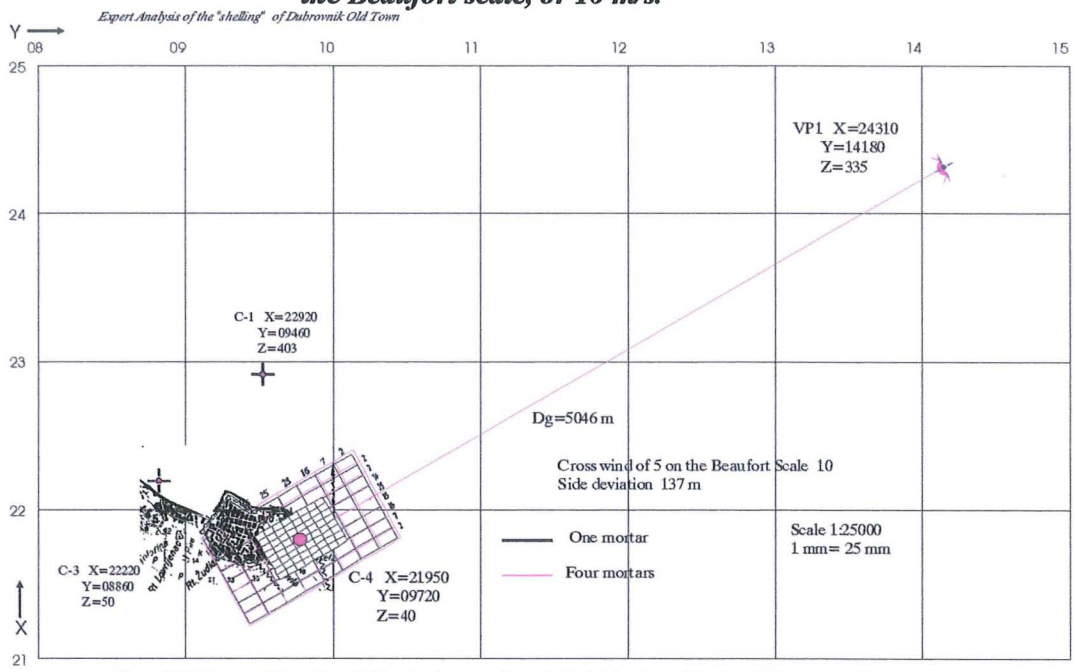

Figure 4.51 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 on target C-4, the second group of DOS mortars towards Ploce, with a cross wind of 5 on the Beaufort scale - 10 m/s.

Figure 4.51 Magnitude of the pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

An analysis of Figure 4.51 leads to the conclusion that most of the surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 25%, 16%, 7% and 2% probability bands[37].

[37] ***Of 100 120-mm shells fired between seven and nine would land in the Old Town and after the correction of fire 4 would land in the Old Tow.***

4. 17 - 120 mm mortars firing from VP1 in the Ledenica sector, simple preparation of initial firing data against target C-4, the second group of DOS mortars 200 m from Dubrovnik Old Town towards Ploce

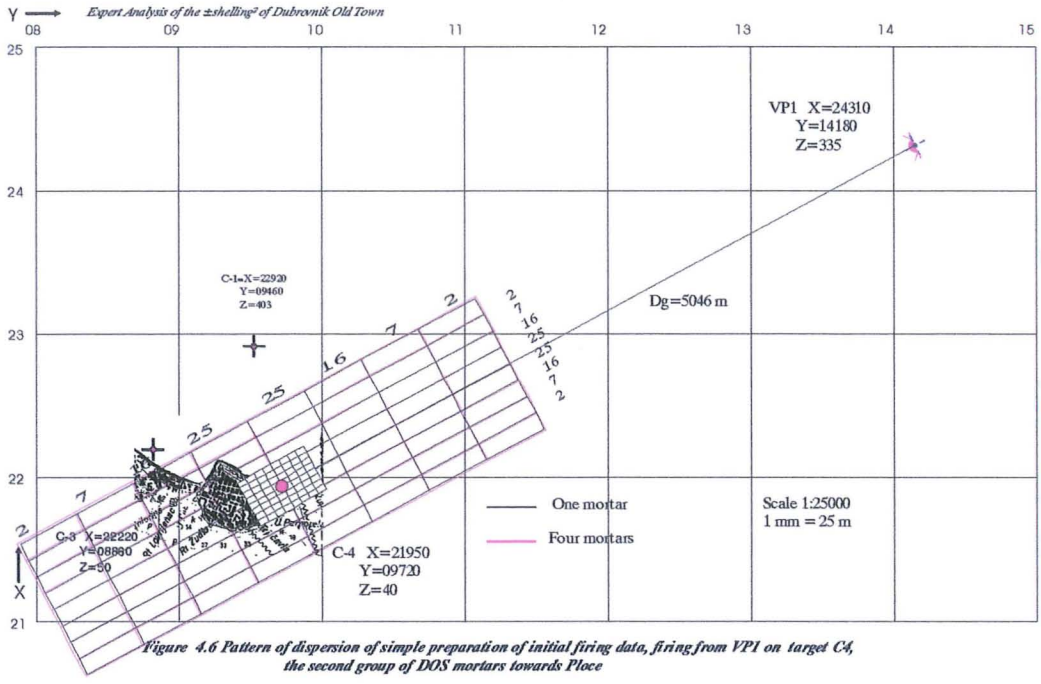

Figure 4.6 Pattern of dispersion of simple preparation of initial firing data, firing from VP1 on target C4, the second group of DOS mortars towards Ploce

Figure 4.6 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP1 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce

An analysis of Figure 4.6 leads to the conclusion that the entire surface of Dubrovnik Old Town lies in the 25%, 16% and 7% dispersion zones in the 25% and 16% probability bands[38].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
5046	456.4	129.3	32	20	528	330

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *simple* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

[38] *Of 100 120-mm shells fired between 10 and 12 would land in the Old Town and after the correction of fire 3 would land in the Old Tow.*

4. 18 - 120 mm mortars firing from VP1 in the Ledenica sector, simple preparation of initial firing data against target C-4, the second group of DOS mortars 200 m from Dubrovnik Old Town towards Ploce , with a cross wind of 5 on the Beaufort scale, or 10 m/s.

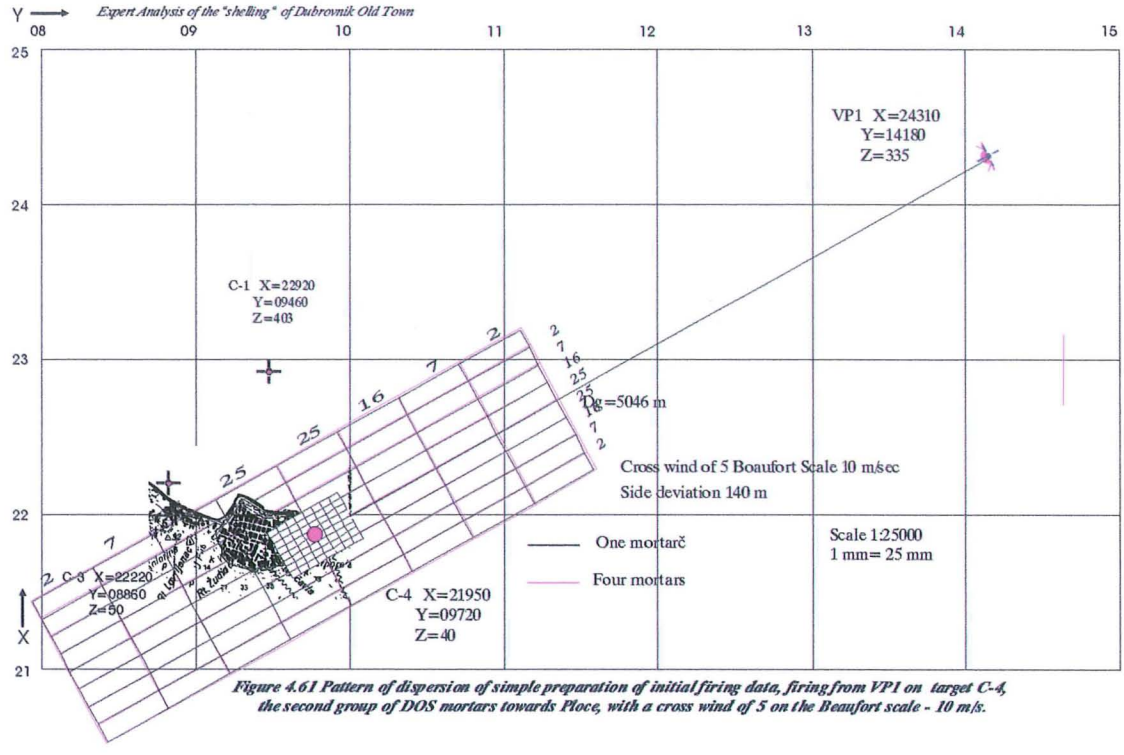

Figure 4.61 Pattern of dispersion of simple preparation of initial firing data, firing from VP1 on target C-4, the second group of DOS mortars towards Ploce, with a cross wind of 5 on the Beaufort scale - 10 m/s.

Figure 4.61 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP1 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

An analysis of Figure 4.61 leads to the conclusion that the entire surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 25% and 16% probability bands[39].

[39] *Of 100 120-mm shells fired nine or ten would land in the Old Town and after the correction of fire 4 would land in the Old Tow.*

4.2. 82-mm mortars firing from VP3 in the Rajcevici sector

Annex 11 gives a full example of calculations of the magnitude and seriousness of sources of errors in the preparation of initial firing data according to the ***abbreviated preparation*** method – for target C-1 (Fort on Srdj), ***Annex 11a;*** for target C-3, the first group of 82-mm mortars in Bogisica Park, ***Annex 11b*** ; and for target C-4 the second group of mortars approximately 200 metres from the Old Town towards Ploce, ***Annex 11c***.

Table 4.2, Annex 11d, gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated and simple preparation*** of initial data).

Annex 11g gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated preparation*** of initial data) when firing ***with one*** basic M69A 82-mm MB from VP3 in the Rajcevici sector; ***Annex 11 h*** – the execution of ***group firing*** with a platoon of four M69A 82-mm MBs from VP3 in the Rajcevici sector; and in ***Annex 11e and Annex 11f*** after completing simple preparation of initial firing data.

A 1:25,000 scale drawing is given in ***Annex 14***.

4. 21 - 82 mm mortars firing from VP3 in the Rajcevici sector, simple preparation of initial firing data against target C-3, the first group of DOS mortars in Bogisica Park

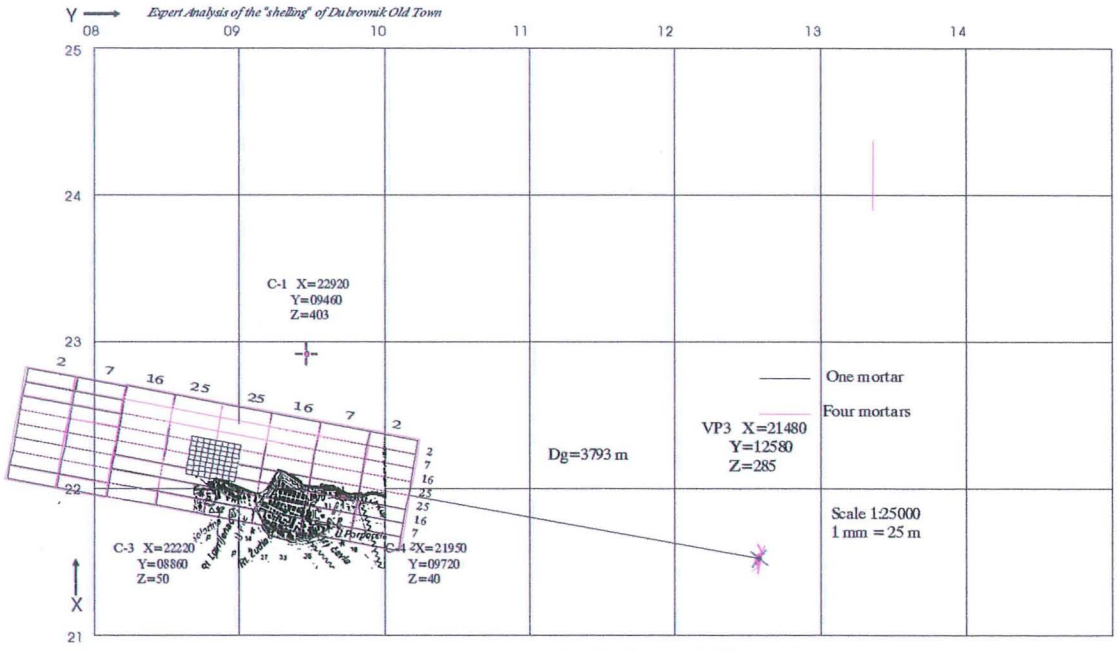

Figure 4.10 Pattern of dispersion of simple preparation of initial firing data, firing from VP3 on target C-3, the first group of DOS mortars in Bogisica Park

Figure 4.10 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP3 at target C-3, the first group of DOS mortars in Bogisica Park

An analysis of Figure 4.10 leads to the conclusion that a large part of the surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 25% and 16% probability bands[40].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
3793	343.81.4	97.2	29	15	478.5	247.5

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *simple* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

After the correction of fire the dispersion of mortars bombs don't cover the surface of Old Town.

[40] ***Of 100 82-mm shells fired four or five would land in the Old Town if the correction is done.***

4. 22 - 82 mm mortars firing from VP3 in the Rajcevici sector, simple preparation of initial firing data against target C-3, the first group of DOS mortars in Bogisica park, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

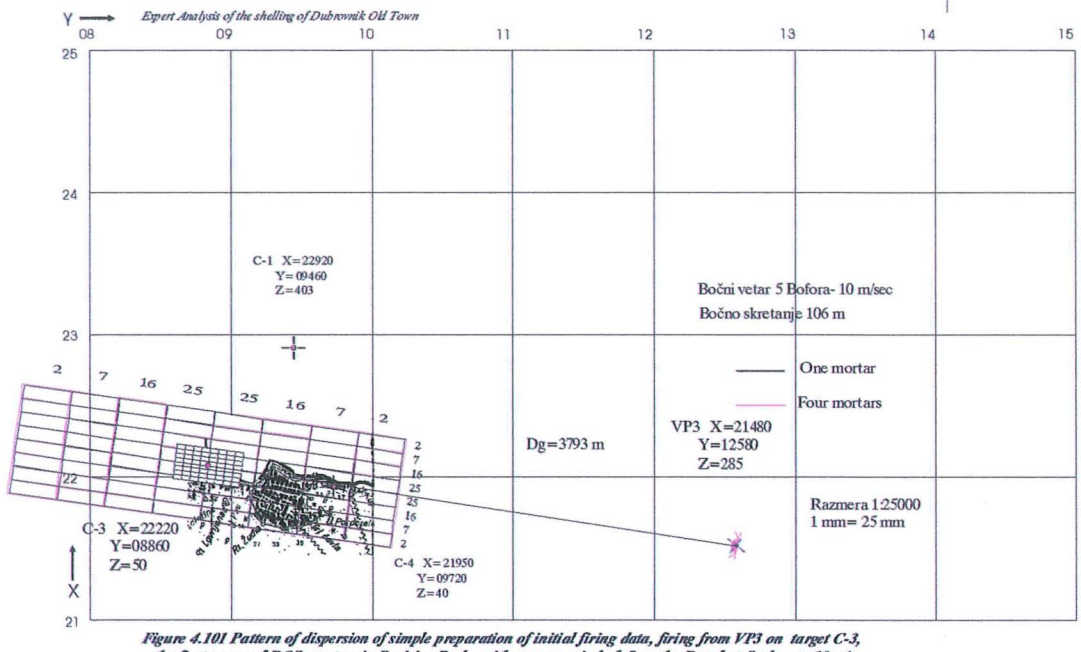

Figure 4.101 Pattern of dispersion of simple preparation of initial firing data, firing from VP3 on target C-3, the first group of DOS mortars in Bogisica Park, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 4.101 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP3 at target C-3, the first group of DOS mortars in Bogisica Park, with a cross wind of 5 on the Beaufort Scale, or 10 m/s

An analysis of Figure 4.101 leads to the conclusion that the entire surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 16% and 7% probability bands[41].

After the correction of fire the dispersion of mortars bombs don't cover the surface of Old Town.

[41] ***Of 100 82-mm shells fired eight to ten would land in the Old Town.***

4. 23 - 82 mm mortars firing from VP3 in the Rajcevici sector, abbreviated preparation of initial firing data against target C-4, the second group of DOS mortars 200 m from Dubrovnik Old Town towards Ploce

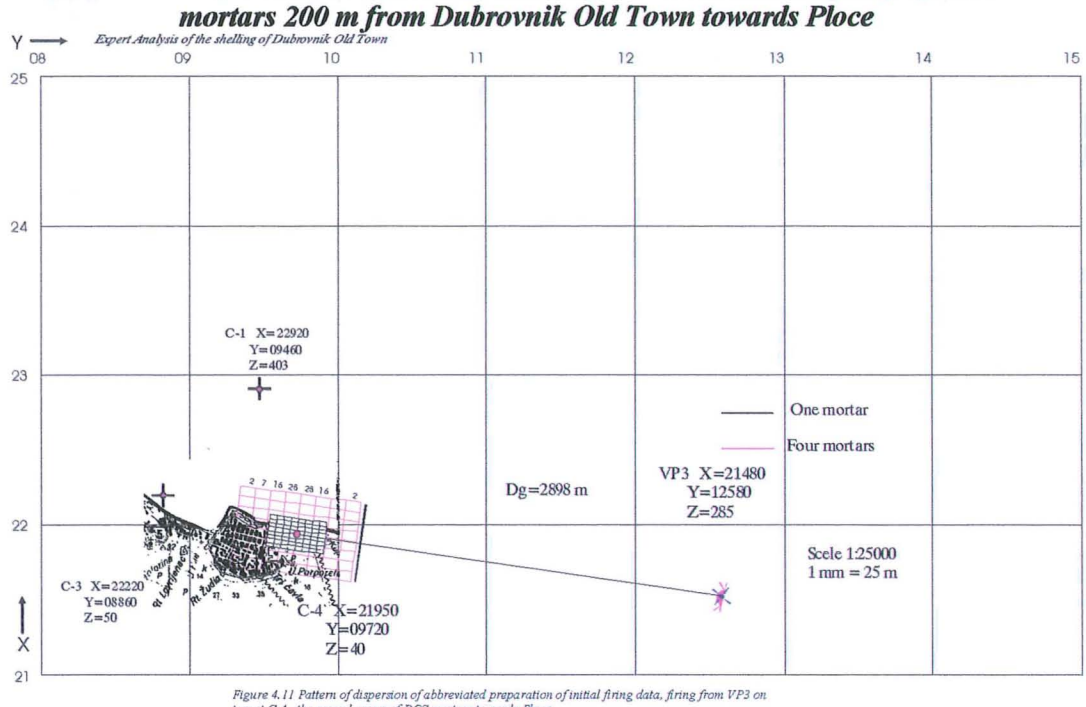

Figure 4.11 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP3 on target C-4, the second group of DOS mortars towards Ploce

Figure 4.11 Magnitude of the pattern of dispersion of abbreviated preparation of initial firing data, firing from VP3 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce

An analysis of Figure 4.11 leads to the conclusion that a large part of the surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 16%, 7% and 2% probability bands[42].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
2898	102.98	66.94	23	13	379.5	214.5

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *abbreviated* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

[42] *Of 100 82-mm shells fired four or five would land in the Old Towand after correction two to three would land to Old Town. .*

4.24 - 82 mm mortars firing from VP3 in the Rajcevici sector, abbreviated preparation of initial firing data against target C-4, the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

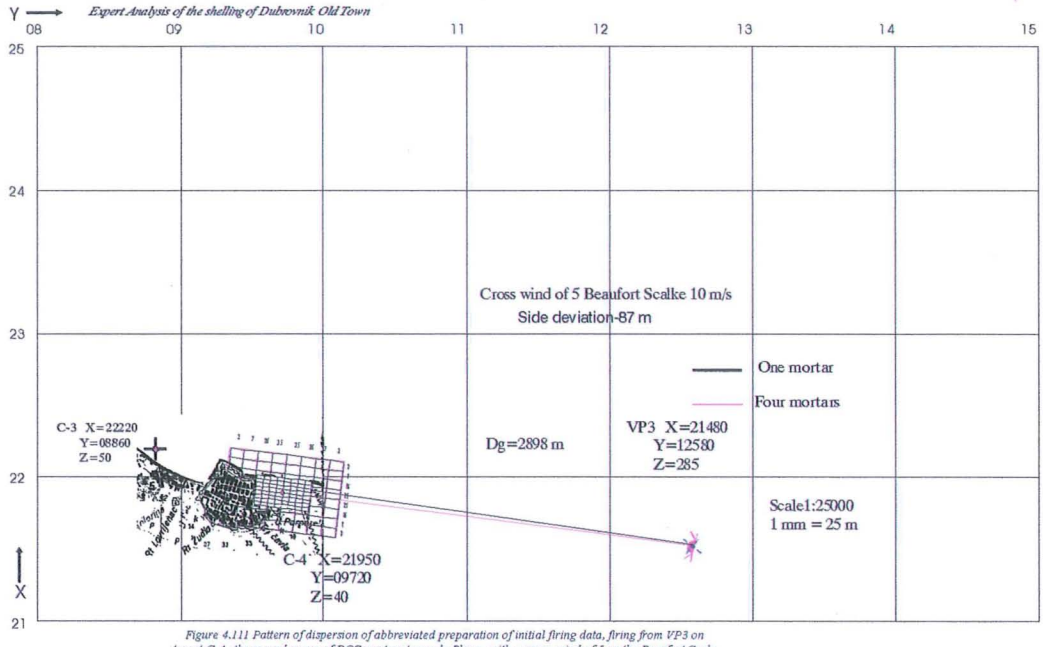

Figure 4.111 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP3 on target C-4, the second group of DOS mortars towards Ploce, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 4.111 Magnitude of the pattern of dispersion of abbreviated preparation of initial firing data, firing from VP3 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort Scale, or 10 m/s

An analysis of Figure 4.111 leads to the conclusion that a large part of the surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 16%, 7% and 2% probability bands[43].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
5046	456.4	129.3	32	20	528	330

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *abbreviated* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

[43] ***Of 100 82-mm shells fired six or seven would land in the Old Town and after the correction two to three would land in the Old Town.***

4.25 - 82 mm mortars firing from VP3 in the Rajcevici sector, simple preparation of initial firing data against target C-4, the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce

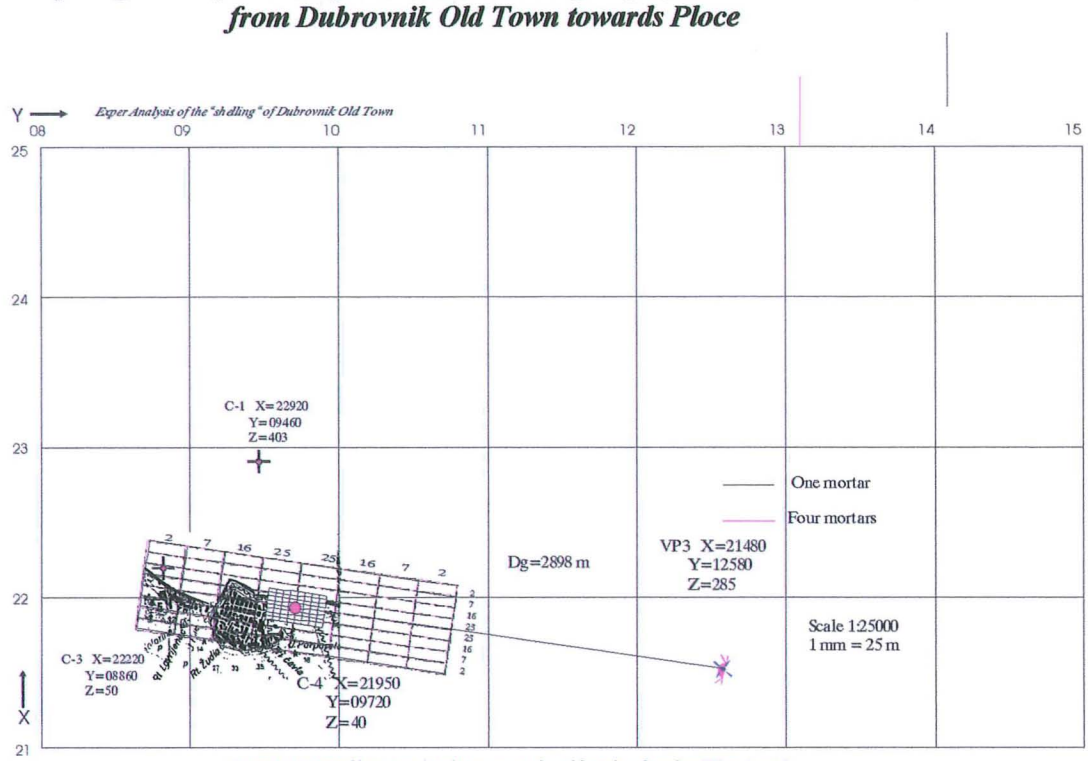

Figure 4.12 Pattern of dispersion of simple preparation of initial firing data, firing from VP3 on target C-4, the second group of DOS mortars towards Ploce

Figure 4.12 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP3 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce

An analysis of Figure 4.12 leads to the conclusion that the entire surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 16% and 7% probability bands[44].

[44] ***Of 100 82-mm shells fired 14 to 16 would land in the Old Town.and after the correction of fire two to three would land in the Old Town.***

4.26 - 82 mm mortars firing from VP3 in the Rajcevici sector, simple preparation of initial firing data against target C-4, the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

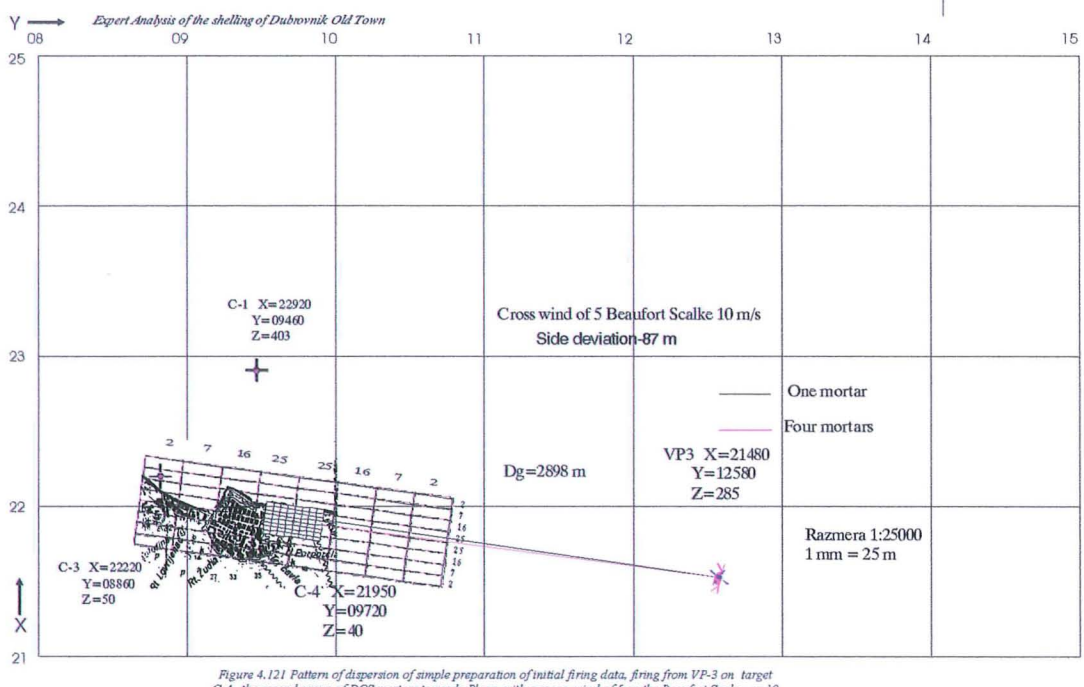

Figure 4.121 Pattern of dispersion of simple preparation of initial firing data, firing from VP-3 on target C-4, the second group of DOS mortars towards Ploce, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 4.121 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP3 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort Scale, or 10 m/s

An analysis of Figure 4.12 leads to the conclusion that the entire surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 25%, 16% and 7% probability bands[45].

[45] ***Of 100 82-mm shells fired between 13 and 15 would land in the Old Town and after the correction of fire two to three would land in the Old Town.***

4.3 82-mm mortars firing from VP4 in the Strincijera sector

Annex 12 gives a full example of calculations of the magnitude and seriousness of sources of errors in the preparation of initial firing data according to the ***abbreviated preparation*** method – for target C-1 (Fort on Srdj), ***Annex 12a;*** for target C-3, the first group of 82-mm mortars in Bogisica Park, ***Annex 12b*** ; and for target C-4 the second group of mortars approximately 200 metres from the Old Town towards Ploce, ***Annex 11c***.

Table 4.3, Annex 12d, gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated and simple preparation*** of initial data).

Annex 12g gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated preparation*** of initial data) when firing ***with one*** basic M69A 82-mm MB from VP3 in the Strincijera sector; ***Annex 12h*** – the execution of ***group firing*** with a platoon of four M69A 82-mm MBs from VP3 in the Strincijera sector; and in ***Annex 12e and Annex 12f*** after completing simple preparation of initial firing data.

A 1:25,000 scale drawing is given in ***Annex 15***.

4.31 - 82 mm mortars firing from VP4 in the Strincijera sector, abbreviated preparation of initial firing data against target C-4, the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce

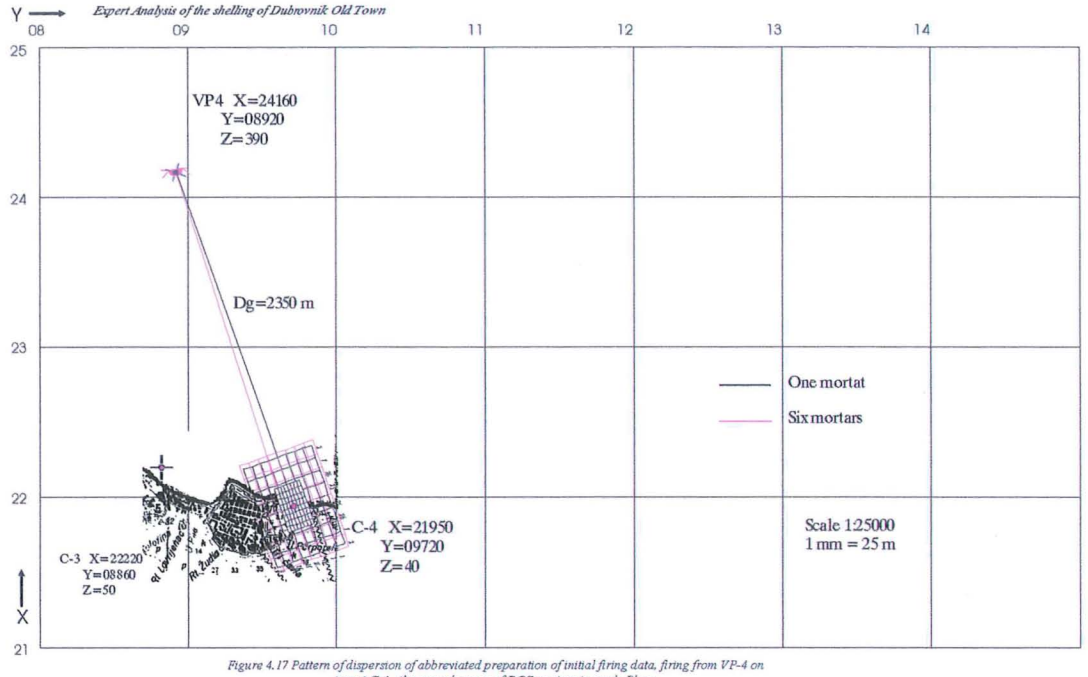

Figure 4.17 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP-4 on target C-4, the second group of DOS mortars towards Ploce

Figure 4.17 Magnitude of the pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce

An analysis of Figure 4.17 leads to the conclusion that a small section of the surface of Dubrovnik Old Town lies in the 7% and 2% dispersion zones in the 25% and 16% probability bands[46].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
2350	95.2	66.6	19	11	313.5	181.5

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *abbreviated* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

[46] ***Of 100 82-mm shells fired two or three would land in the Old Town and after the correction of fire no one shell would land in the Old Town.***

4.32 - 82 mm mortars firing from VP4 in the Strincijera sector, abbreviated preparation of initial firing data against target C-4, the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

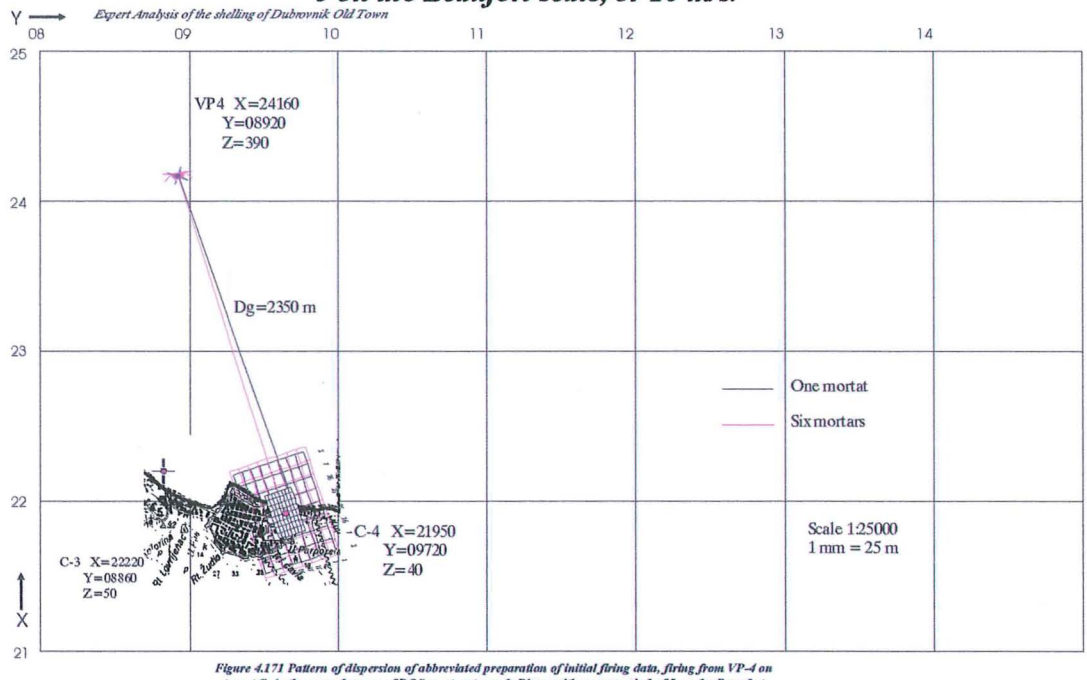

Figure 4.171 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP-4 on target C-4, the second group of DOS mortars towards Ploce, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 4.171 Magnitude of the pattern of dispersion of abbreviated preparation of initial firing data, firing from VP4 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort Scale, or 10 m/s

An analysis of Figure 4.171 leads to the conclusion that a large part of the surface of Dubrovnik Old Town lies in the 16%, 7% and 2% dispersion zone in the 25%, 16%, 7% and 2% probability bands.[47]

[47] ***Of 100 82-mm shells fired twelve to fourteen would land in the Old Town and after the correction of fire twenty to twenty two shells would land in the Old Town.***

4.33 - 82 mm mortars firing from VP4 in the Strincijera sector, simple preparation of initial firing data against target C-4, the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce

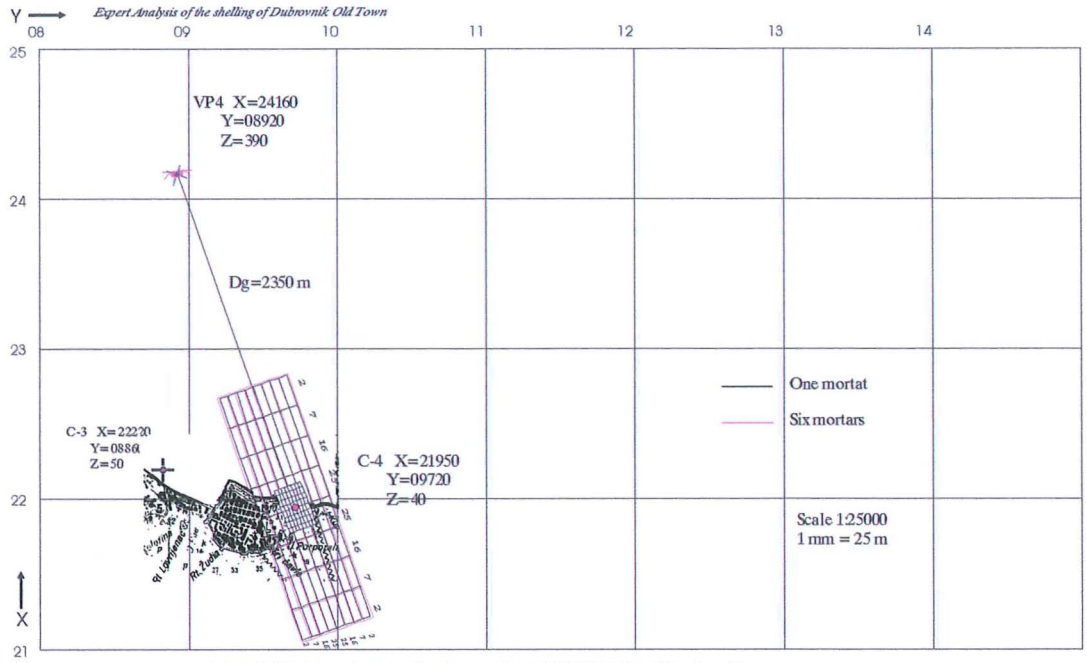

Figure 4.18 Pattern of dispersion of simple preparation of initial firing data, firing from VP-4 on target C-4, the second group of DOS mortars towards Ploce

Figure 4.18 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP4 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce

An analysis of Figure 4.18 leads to the conclusion that a section of the surface of Dubrovnik Old Town lies in the 7% and 2% dispersion zones in the 25% probability band[48].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
2350	215.7	63.7	19	11	313.5	181.5

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *simple* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

[48] *Of 100 82-mm shells fired two would land in the Old Town and after the correction of fire no one shell would land in the Old Town.*

4.34 - 82 mm mortars firing from VP4 in the Strincijera sector, simple preparation of initial firing data against target C-4, the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

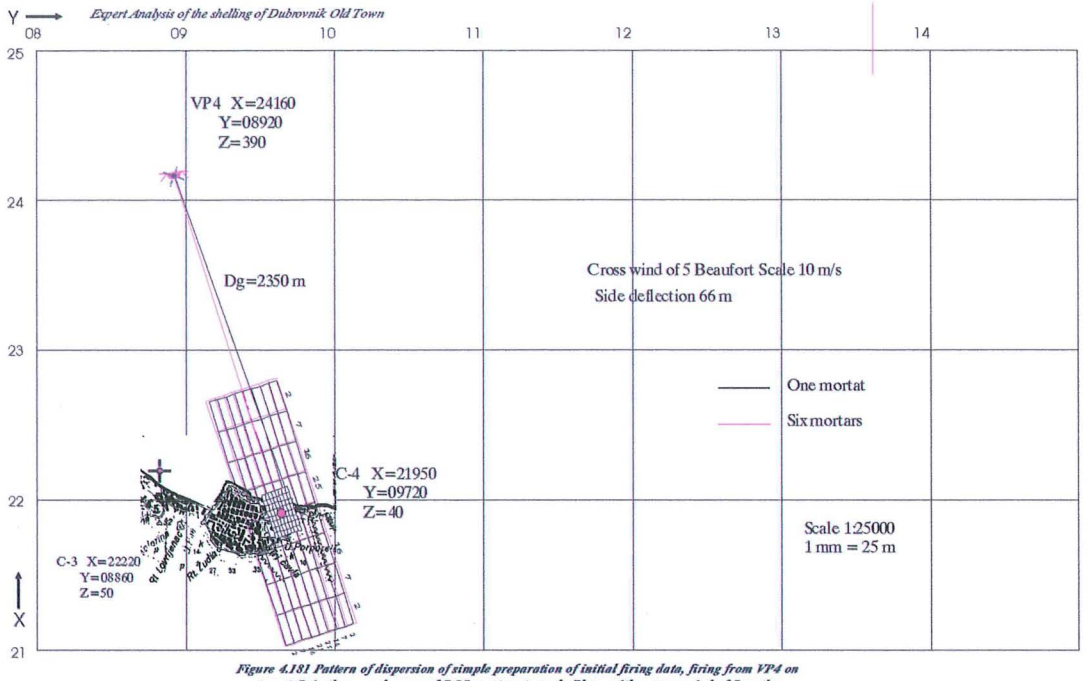

Figure 4.181 Pattern of dispersion of simple preparation of initial firing data, firing from VP4 on target C-4, the second group of DOS mortars towards Ploce, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 4.181 Magnitude of the pattern of dispersion of simple preparation of initial firing data, firing from VP4 at target C-4, the second group of DOS mortars 200 metres from the walls of Dubrovnik Old Town towards Ploce, with a cross wind of 5 on the Beaufort Scale, or 10 m/s

An analysis of Figure 4.181 leads to the conclusion a section of the surface of Dubrovnik Old Town lies in the 25%, 16%, 7% and 2% dispersion zones in the 25% and 16% probability bands[49].

[49] ***Of 100 82-mm shells fired five or six would land in the Old Town and after the correction of fire twenty to twenty two shells would land in the Old Town.***

4.4. Procedure for determining the number of impacts of mortar shells inside Dubrovnik Old Town

The number of shells that could land inside Dubrovnik Old Town was determined on the basis of superimposing the pattern of probable dispersion of impacts over the picture of Dubrovnik Old Town.

The basis for this calculation was the pattern of 100% of probability of dispersion, dimension 8 Exo times 8 Eyo, given in Figure 4.19 showing the percentage of probability of impacts and the possible number of projectiles in the zones on the basis of 100 fired projectiles.

2	7	16	25	25	16	7	2	%
0,10	0,25	0,5	1	1	0,5	0,25	0,10	2
0,15	0,5	1	1,75	1,75	1	0,5	0,15	7
0,25	0,75	2,5	4	4	2,5	0,73	0,25	16
0,5	2	4	6	6	4	2	0,5	25
0,5	2	4	6	6	4	2	0,5	25
0,25	0,75	2,5	4	4	2,5	0,73	0,25	16
0,15	0,5	1	1,75	1,75	1	0,5	0,15	7
0,10	0,25	0,5	1	1	0,5	0,25	0,10	2
2	7	16	25	25	16	7	2	%

Figure 4.19 100 per cent of probable dispersion with zones

4.5 Summary of the possible number of projectiles (82-mm and 120-mm mortar shells) that would land inside Dubrovnik Old Town as a normal consequence of the probable dispersion of impacts when targeting targets C-3 and C-4

Table 20 gives the total number of mortar shells that could land inside the walls of Dubrovnik Old Town as a consequence of the normal dispersion of projectiles when targeting C-1, the fort on Srdj; C-3, the first group of DOS mortars in Bogisica Park; and C-4, the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce.

The table gives a calculated number of shells which could land inside Dubrovnik Old Town on the basis of 100 per cent of probability for 100 fired shells and for each mortar firing one complete combat set of shells (1 b/k) for 100 per cent pattern of dispersion according to calculations given in Annex 10, Annex 11 and Annex 12.

Piece Firing position Location		Target	100 shells for 100% probability of impact pattern abbreviated preparation of initial firing data	abbreviated preparation of initial firing data with cross wind	simple preparation of initial firing data	simple preparation of initial firing data with cross wind
M75 120mm MB VP1 Ledenice		C-1	0	0	0	0
		C-3	0	1-2	2-3	4-5
		C-4	10-12	8-10	16-17	10-11
M69 82mm MB VP3 Rajcevici		C-1	0	0	0	1-2
		C-3	0	0-1	4-5	7-8
		C-4	8-10	10-12	21-23	19-21
M69 82mm MB VP4 Strincijera		C-1	0	0	0	0
		C-3	0	0	0	0
		C-4	3-4	8-10	2-3	7-8
			1 combat set per mortar for 100% probability of impact pattern			
M75 120mm MB VP1 n=160shells Ledenice		C-1	0	0	0	0
		C-3	0	2-5	3-5	13
		C-4	16-19	13-16	25-27	16-18
M69 82mm MB VP3 n=240 shells Rajcevici		C-1	0	0	2	2-5
		C-3	0-2	0-2	10-12	16-19
		C-4	19-24	24-29	50-55	44-50
M69 82mm MB VP4 n=360 shells Strincijera		C-1	0	0	0	0
		C-3	0	0	0	0
		C-4	11-14	29-36	7-11	25-29
Total shells for 1 combat set	120mm	C-1	0	0	0	0
	82 mm		0	0	2	2-5
	120mm	C-3	0	2-5	3-5	13
	82 mm		0-2	0-2	10-12	16-19
	120mm	C-4	16-19	13-16	25-27	16-18
	82mm		30-38	53-65	57-66	69-79

1 combat set = 40 shells for M75 120mm MB 1 combat set = 60 shells for M69 82mm MB

Table 21 gives the number of shells that could land inside the walls of Dubrovnik Old Town for 100 shells fired from a separate position for 50% of dispersion pattern (only shells that land in the range of 25% probability around the designated target, the mean projectile impact.

Table 21

			100 pieces for 50% probability of impact pattern			
M75 120mm MB VP1 Ledenice		C-1	0	0	0	0
		C-3	0	0	2-3	4-5
		C-4	0	1-2	14	11
M6982mm MB VP3 Rajcevici		C-1	0	0	0	0
		C-3	0	0	0	0
		C-4	0	0	5-6	5
M69 82mm MB VP4 Strincijera		C-1	0	0	0	0
		C-3	0	0	0	0
		C-4	3-4	6-8	2-3	7-8
Total shells for 1 combat set	120mm	C-1	0	0	0	0
	82 mm		0	0	0	0
	120mm	C-3	0	0	2-3	4-5
	82 mm		0	0	0	0
	120mm	C-4	0	1-2	14	11
	82mm		3-4	6-8	7-9	12-13

Table 22 gives the number of projectiles that could land inside the walls of Dubrovnik Old Town when each piece fires one combat set.

Table 22

			1 combat set per piece for 50% probability of impact pattern			
M75 120mm MB VP1 n=160 shells Ledenice		C-1	0	0	3	10
		C-3	0	0	3-5	6-8
		C-4	0	2-4	22	18
M69 82mm MB VP3 Rajcevici		C-1	0	0	0	0
		C-3	0	0	0	0
		C-4	0	0	12-14	12
M69 82mm MB VP4 Strincijera		C-1	0	0	0	0
		C-3	0	0	0	0
		C-4	11-14	22-29	7-11	25-29
Total shells for 1 combat set	120mm	C-1	0	0	3	10
	82 mm		0	0	0	0
	120mm	C-3	0	0	3-5	6-8
	82 mm		0	0	0	0
	120mm	C-4	0	2-4	22	18
	82mm		11-14	22-29	19-25	37-41

On the basis of results provided in Table 22 a conclusion can be reached that relatively the largest number of mortar shells would fall inside Dubrovnik Old Town when firing in order to neutralise fire from DOS pieces in the sector 200 metres from Dubrovnik Old Town towards Ploce and Bogisica Park.

4.6. Calculation of the consumption of 82-mm and 120-mm mortar shells required for firing at targets C-3 or C-4

On the basis of the prescribed projectile consumption norms for the execution of fire missions according to target type and characteristics[50] and the norm unit, Annex 16, Annex 17 gives an example of a calculation of the required quantity of ammunition for the execution of a fire mission[51], the destruction of target C-3, the first group of DOS 82-mm mortars in Bogisica Park or C-4, the second group of DOS mortars 200 metres from the Old Town towards Ploce.

On the basis of the calculation the following conclusions can be drawn:

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[50] *Artillery Firing Rules, page 97, item 116, SSNO /Federal Secretariat for National Defence/, G[JNA /JNA General Staff/ UA-2, VIZ /Military Publishing House/, Belgrade, 1981*

[51] *The experts did not have access to an order for the execution of the combat task, but guessed its content according to the characteristics of the target.*

1 – To carry out the task of destroying targets C-3 or C-4 from the firing position of a 120-mm combined mortar battery (four pieces) in the Ledenica sector it is necessary to fire the following:

a – with abbreviated preparation 360 shells, i.e. nine combat sets, or 2.25 combat sets from each mortar;

b – with simple preparation 480 shells, i.e. 12 combat sets, or three combat sets from each mortar.

2 - To carry out the task of destroying C-3 or C-4 it is necessary to fire the following from the firing position of an 82-mm mortar battery (four pieces), in the Rajcevici sector, or from the firing position of the 82-mm mortar battery (six pieces), in the Strincijera sector:

a – with ***abbreviated preparation*** 675 shells, i.e. 11 combat sets, or approximately 2.8 combat sets from each mortar from the Rajcevici sector, or two combat sets from the Strincijera sector,

b – with ***simple preparation*** 900 shells, i.e. 15 combat sets, or approximately 3.7 combat sets from each mortar from the Rajcevici sector, or 2.5 combat sets from each mortar from the Strincijera sector.

On the basis of rules that when executing combat tasks mortar units must not consume all the ammunition at their disposal and that they have to keep in reserve at least one combat set a conclusion can be made that units at firing positions VP1, a combined 120-mm mortar battery in the Ledenica sector and an 82-mm mortar platoon in the Rajcevici sector or an 82-mm mortar platoon in the Strincijera sector, could have consumed up to 3 combat sets when executing the combat task.

Annex 17 gives a table of the overall possible quantity of ammunition for mortar units for firing positions Ledenica, VP1; Rajcevici VP3 and Strincijera VP4.

On the basis of this calculation it is possible to estimate the number of mortar shells that would land inside the walls of Dubrovnik Old Town if the targeting had been carried out according to the norms for the destruction of designated targets.

4.7 Action of artillery fire support weapons

The artillery support weapons on the Dubrovnik battleground were guns and howitzers:

1 – The 76 mm M42 guns in the Vrastica sector were used for direct support in the attack on the fort on Srdj. By their construction and ballistic characteristics, the flat trajectories and low angles of descent and the range at which they were used, as well as the lie of the land – they were unable to fire at Dubrovnik Old Town. Every case of overshooting or missing the target, the fort on Srdj, resulted in the projectiles landing in the sea or in the Petak sector on Lapad.

2 – By their range 105 mm M56 howitzers in the Hum sector could not offer fire support to JNA units which were attacking Srdj, nor did they participate in counter-battery fire against DOS units in Dubrovnik.

3 – The 122 mm D30 howitzer[52] in the Cavtat sector was active up to 12 November during attacks on Srdj and supported the attack of a part of the 3rd lpbr

[52] *Summary report by the 2nd Operations Group Command on the situation in units on 11 and 12 November 1991.*

/light infantry brigade/ in the Komolac sector and fired at Srdj. The artillery piece belonged to the Technical Test Centre at Prevlaka and its crew consisted of professional commanders and operators and executed tasks with great precision. It did not open fire at Dubrovnik Old Town.

4 – 130 mm M46 guns fired at firing targets during JNA attacks until Bosanka was taken, when they stopped firing.

Remark:

If the 130-mm artillery pieces had fired at the town of Dubrovnik destruction would have been of the highest degree given the high-impact 130-mm projectiles.

5 – 76 mm M42 Pot /field/ guns for direct support were under the command of the commander of the Trebinje Brigade 3rd Battalion; 105 mm M56 howitzers, 122 mm D30 howitzers and 130 mm M46 guns were under the command of the 9th VPS (9th Naval District) and the 2nd OG (2nd Operations Group).

V. REVIEW OF JNA INTELLIGENCE DATA

On the basis of intelligence data at the JNA's disposal during the Dubrovnik operation, to this expert report gives positions and weapons at DOS disposal.

The following conclusions can be reached on the basis of analysis of the given data, *:*

1 –DOS mortars fired from firing positions in the Imperial Hotel sector immediately next to the walls of Dubrovnik Old Town;

2 - an 82-mm mortar platoon was located immediately next to the walls of the Old Town, on the west side;

3 – an 82-mm mortar platoon was located behind the Imperial Hotel;

4 – a 120-mm mortar battery was located at Babin Kuk near the Solitude caravan site.

5 – mobile mortars mounted on vehicles were active west and north of the Old Town moving along Jugoslovenska Narodna Armija Street, Iza Zica /Street/, Iza Grada /Street/, north of Dubrovnik Old Town up to Obodinska street;

6 – a 12.7-mm anti-aircraft machine-gun was located near the fish market in Dubrovnik Old Town which opened intense fire at JNA units at Zarkovica;

7 –firing positions of DOS pieces were located next to or at a short distance from residential facilities - hotels Minceta, Stadion and Ero - where refugees were accommodated and from where intense fire was opened;

8 – because of this kind of conduct, residents of these facilities[53] organised protest rallies and foreign journalists[54] also protested against DOS conduct;

9 – an 82-mm mortar was located in the Mrtvo Zvono sector at Juzna Kula /South Tower/ towards the sea;

10 – a 20/1-mm PAV /anti-aircraft gun/ was located in Sv.Luka /Saint Luke/ Tower which opened fire towards Zarkovica;

11– a *Carli* mobile artillery piece mounted on a vehicle fired from the northern side in the Sv.Marija /Saint Mary/ Tower sector.

This disposition of DOS firing positions and particularly their proximity and movement behind and along the walls of Dubrovnik Old Town also contributed to the

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[53] *War Diary of the 9VPS /9th Naval Sector/, date 6 December 1991, 1125 hrs page 69*

[54] *Journalist Filiph Devis /as printed/ was once wounded during this kind of firing, because of which he protested, document in English number 03260367.*

increased number of projectiles falling, particularly while trying to locate the firing position of DOS weapons.

VI CALCULATION OF THE POSSIBLE NUMBER OF PROJECTILES THAT COULD FALL IN THE OLD TOWN IN COUNTER-BATTERY FIRE AGAINST DOS *CARLI*[55] ARTILLERY PIECES

Proceeding from witness statements[56] and JNA intelligence data we shall analyse JNA mortar counter-battery fire against mobile DOS artillery pieces mounted on vehicles which fired while changing firing positions /which/ created conditions for significant damage of the general area of the town of Dubrovnik.

Given that these artillery pieces most frequently fired along Jugoslovenske Narodne Armije Road, along Iza Grada road up to Obodinska road, we have chosen two

positions to estimate whether it was possible for projectiles to land within the Old Town walls during counter-battery fire from JNA mortars. To that purpose we have chosen two
positions: hypothetical target C-5 (x=22375, y=08875 and z=90) on JNA Road, 500 metres from Minceta Tower, and hypothetical target C-5 (x=22125, y=09250, z=90) on the crossroads of JNA Road and the approach to the northern Vrata od grada /Town Gate/ which is situated behind Drezdvenik Tower and Sv.Jakov /Saint Jacob/ Tower, 100 metres north of the town walls.

Given the configuration of these locations we shall only examine counter-action from JNA 120 mm M75 mortars from the firing position VP1, the Ledenica sector, and from the firing position VP3 of M69A 82-mm mortars in the Rajcevici sector. Fire from these positions could be directed from the observation position O1 at Zarkovica.

In the identical way, the same as for targets C-1, C-3 and C-4, approximate topographic elements were calculated according to the previously-mentioned hypothetical targets C-5 and C-6:

- for firing from firing position VP1 by a mortar platoon (four 120 mm M75 mortars) in the Ledenica sector, in ***Annex 8d*** of this expert report.
- for firing from firing position VP3 by a mortar platoon (four 82 mm M69A mortars) in the Rajcevici sector, in ***Annex 8e*** .

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[55] *Pieces mounted on motor vehicles, primarily lorries, are called ^arli pieces. The chassis of a lorry has the ability to absorb the recoil of the 82mm and 120mm mortars; it also offers the option of mounting anti-aircraft machine-guns and guns up to 35mm.*

In case IT-98-24 before the Tribunal in The Hague witnesses testified that the BH Army had placed 120mm mortars in a train car at the Railway Station in Sarajevo and 120mm mortars on lorries from which they opened fire while changing firing positions.

There are well-known standard solutions of mounted pieces – 82mm and 120mm mortars mounted on motor vehicles-lorries in the armament of foreign armies, for example France etc.

[56] *Witness SAMARDZIJ said that fire from such a piece destroyed five houses in the street where he lived in Dubrovnik, paper number...*

6.1 - Firing of 120-mm mortars from VP-1 in the Ledenica sector

Annex 21 gives a full example of calculations of the magnitude and seriousness of sources of errors in the preparation of initial firing data according to the ***abbreviated preparation*** method - for target C-5 (*Carli* on JNA Road north of the Old Town walls), ***Annex 21a;*** and for target C-6, (*Caril,* 500 metres from the Old Town), ***Annex 21b***.

Table 4.4, Annex 21d, gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated and simple preparation*** of initial data).

Annex 21g gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated preparation*** of initial data) when firing ***with one*** basic piece 120 mm M75 /mortar/ from VP1 in the Ledenica sector on the road to Ivanica; ***Annex 21 h*** – the execution of ***group firing*** with a platoon of four 120 mm M75 MBs from VP1 in the Ledenica sector on the road to Ivanica; and in ***Annex 21e and Annex 21f*** after completing the simple preparation of initial firing data.

A 1:25,000 scale drawing is given in ***Annex 23;*** the main part of the expert analysis gives only the cases when the pattern of probable impact dispersion overlaps with the surface of Dubrovnik Old Town to a smaller or greater degree.

6.11 - 120 mm mortars firing from VP1 in the Ledenica sector, abbreviated preparation of initial firing data against target C-5, Carli 100 metres north of Sv. Josip Tower

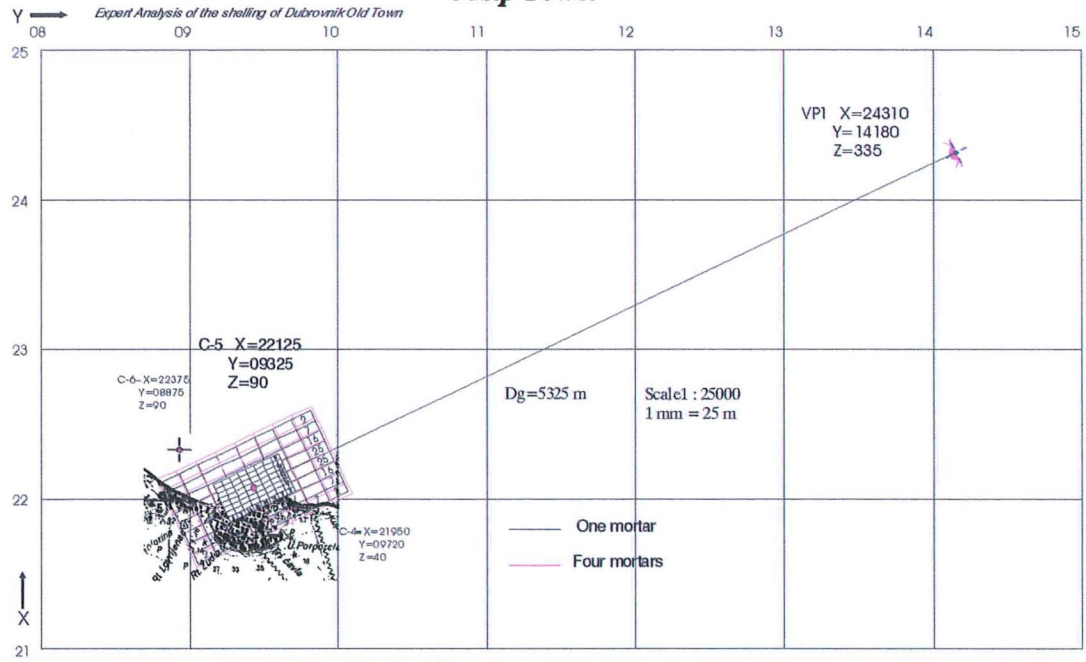

Figure 21.1 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 on target C-5, Carli 100 metres north of Old Town

Figure 21.1 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 on target C-5, Carli 100 metres north of Old Town

An analysis of Figure 21.1 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 25%, 16%, 7% and 2% dispersion zones in the 25%, 16%, 7% and 2% probability bands[57].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
5325	155.4	84	33	20	544.5	330

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *simple* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

6.12 - 120 mm mortars firing from VP1 in the Ledenica sector, abbreviated preparation of initial firing data against target C-5, Carli 100 metres north of Sv. Josip Tower, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

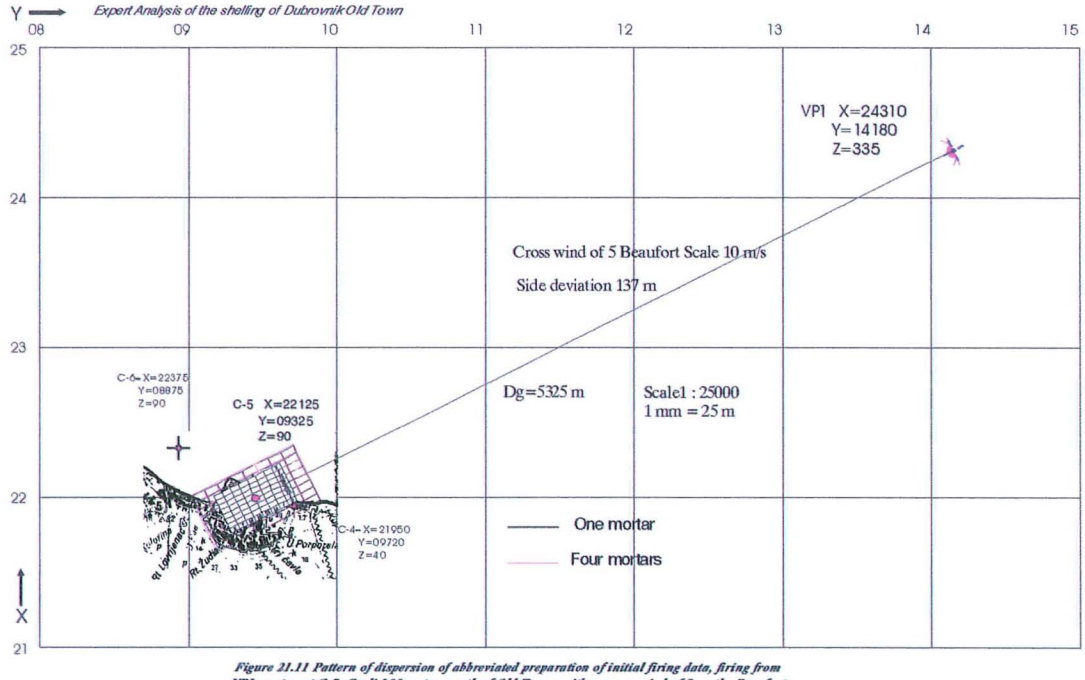

Figure 21.11 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 on target C-5, Carli 100 metres north of Old Town, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 21.11 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP1 on target C-5, Carli 100 metres north of Old Town, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

[57] ***Of 100 120-mm shells fired 29 or 30 would land in the Old Town and after the correction of fire 74 shells would land in the Old Town .***

An analysis of Figure 21.11 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 25%, 16%, 7% and 2% dispersion zones in the 25%, 16%, 7% and 2% probability bands[58].

6.13 - 120 mm mortars firing from VP1 in the Ledenica sector, simple preparation of initial firing data against target C-5, Carli 100 metres north of Sv. Josip Tower

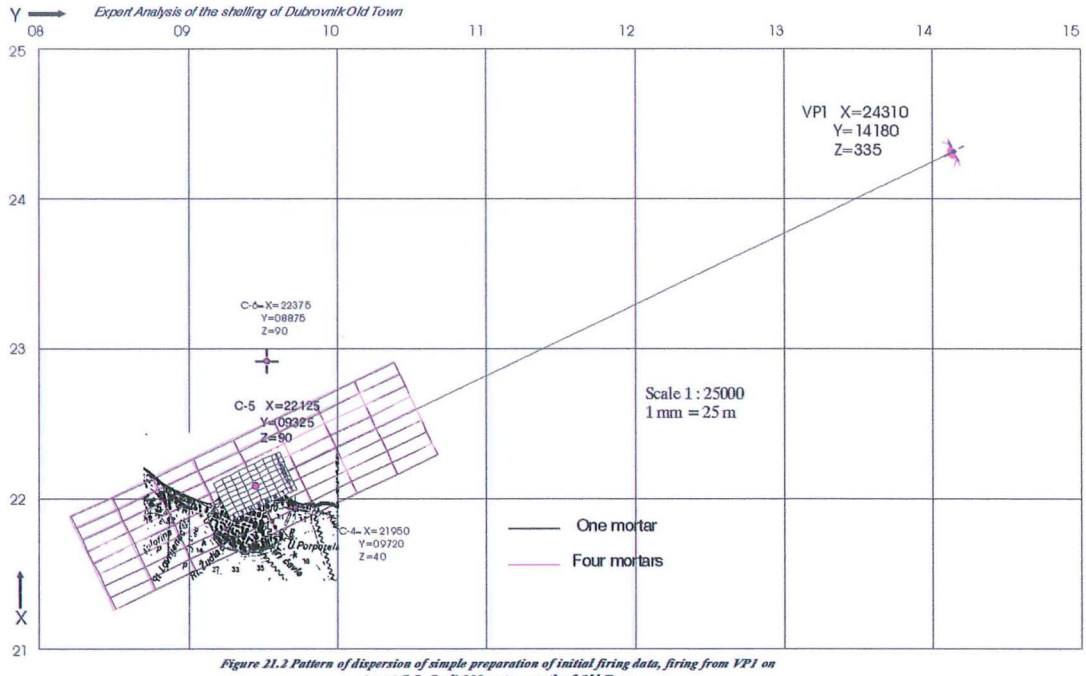

Figure 21.2 Pattern of dispersion of simple preparation of initial firing data, firing from VP1 on target C-5, Carli 100 metres north of Old Town

Figure 21.2 Pattern of dispersion of simple preparation of initial firing data, firing from VP1 on target C-5, Carli 100 metres north of Old Town

An analysis of Figure 21.2 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 25%, 16%, 7% and 2% dispersion zones in the 25% and 16% probability bands[59].

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[58] ***Of 100 120-mm shells fired 53 would land in the Old Town and after the correction of fire 37 to 38shells would land in the Old Town .***

[59] ***Of 100 120-mm shells fired 21 would land in the Old Town and after the correction of fire 37 to 38shells would land in the Old Town .***

6. 14 - 120 mm mortars firing from VP1 in the Ledenica sector, simple preparation of initial firing data against target C-5, Carli 100 metres north of Sv. Josip Tower, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

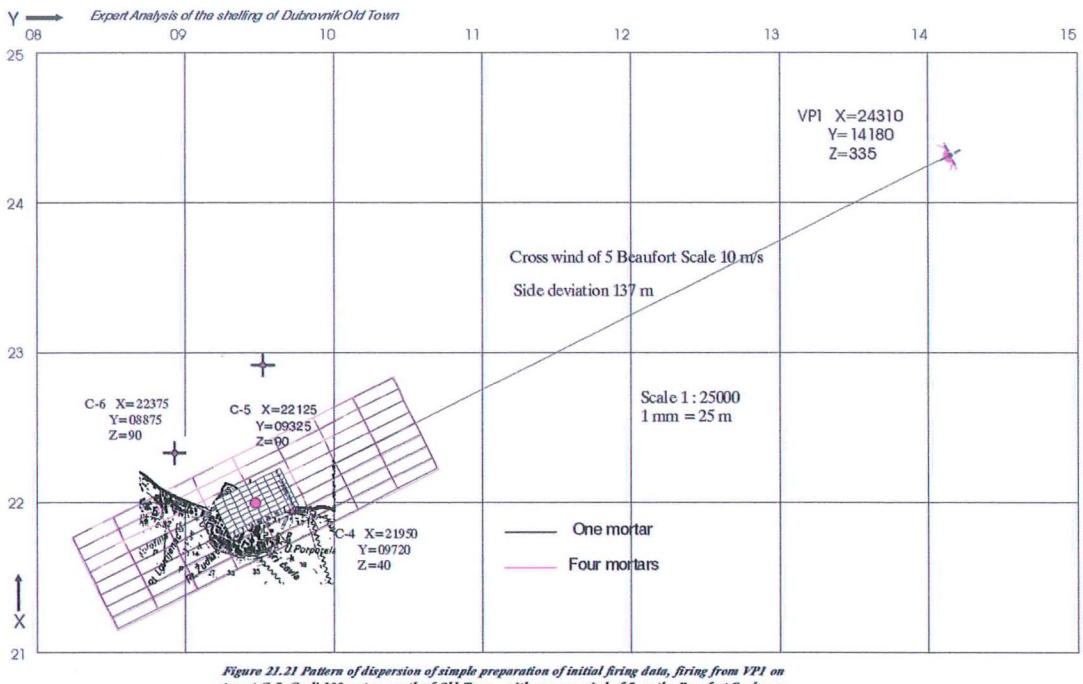

Figure 21.21 Pattern of dispersion of simple preparation of initial firing data, firing from VP1 on target C-5, Carli 100 metres north of Old Town, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 21.21 Pattern of dispersion of simple preparation of initial firing data, firing from VP1 on target C-5, Carli 100 metres north of Old Town, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

An analysis of Figure 21.21 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 25%, 16%, 7% and 2% dispersion zones in the 25% and 16% probability bands[60]. ``

[60] ***Of 100 120-mm shells fired 22 would land in the Old Town and after the correction of fire 74 shells would land in the Old Town .***

6.2 Firing of 82-mm mortars from VP-3 in the Rajcevici sector

Annex 22 gives a full example of calculations of the magnitude and seriousness of sources of errors in the preparation of initial firing data according to the ***abbreviated preparation*** method - for target C-6 (*Carli* 500 metres from the Old Town), ***Annex 22a;*** and for target C-6, (*Carli* on JNA Road north of the Old Town walls), ***Annex 22b***.

Table 4.5, Annex 21d, gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated and simple preparation*** of initial data).

Annex 22g gives calculated values of the mean error of dispersion of the point of impact (according to range and deflection after completing the ***abbreviated preparation*** of initial data) when firing ***with one*** basic piece 82 mm M69A /mortar/ from VP3 in the Rajcevici sector; ***Annex 22 h*** – the execution of ***group firing*** with a platoon of four 82 mm M69A MBs from VP3 in the Rajcevici sector; and in ***Annex 22e and Annex 22f*** after completing simple preparation of initial firing data.

A 1:25,000 scale drawing is given in ***Annex 24;*** the main part of the expert analysis gives only the cases when the pattern of probable impact dispersion overlaps with the surface of Dubrovnik Old Town to a smaller or greater degree.

6.21 - 82 mm mortars firing from VP3 in the Rajcevici sector, simple preparation of initial firing data against target C-5, Carli 100 metres north of Sv. Josip Tower

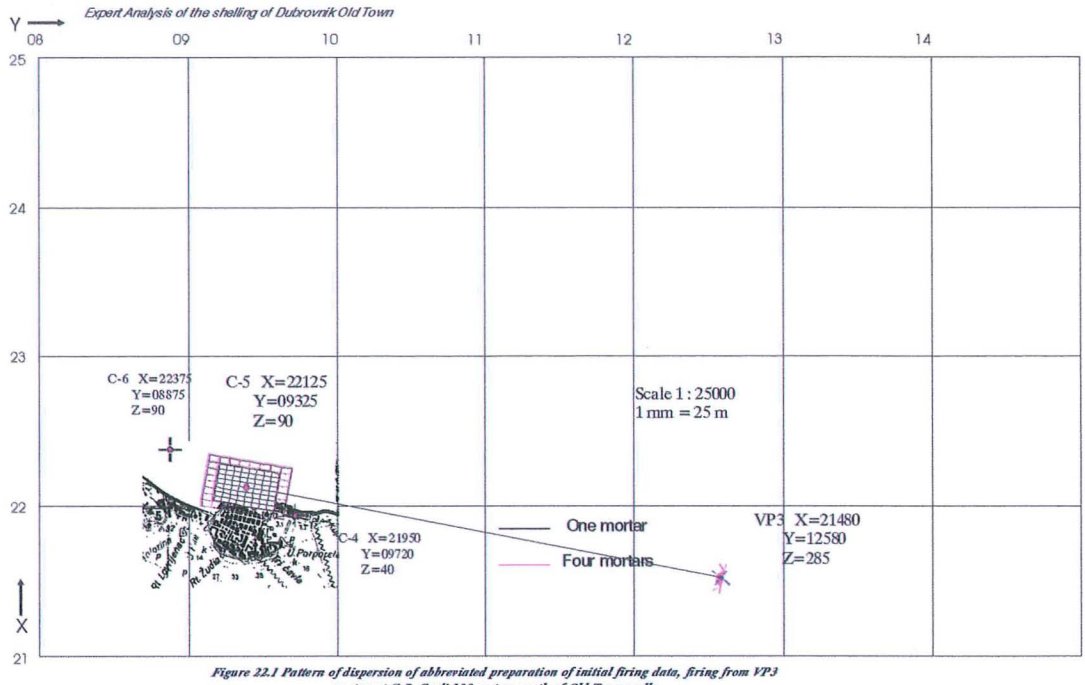

Figure 22.1 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP3 on target C-5, Carli 100 metres north of Old Town walls

Figure 22.1 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP3 on target C-5, Carli 100 metres north of Old Town walls

An analysis of Figure 22.1 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 16%, 7% and 2% dispersion zones in the 16% and 7% probability bands[61].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
3318	116.0	69.8	25	15	412.5	247.5

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *abbreviated simple* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

[61] ***Of 100 82-mm shells fired 19 or 20 would land in the Old Town and after the correction of fire 23 to 25 shells would land in the Old Town.***

6. 22 – 82 mm mortars firing from VP3 in the Rajcevici sector, simple preparation of initial firing data against target C-5, Carli 100 metres from Sv. Josip Tower, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

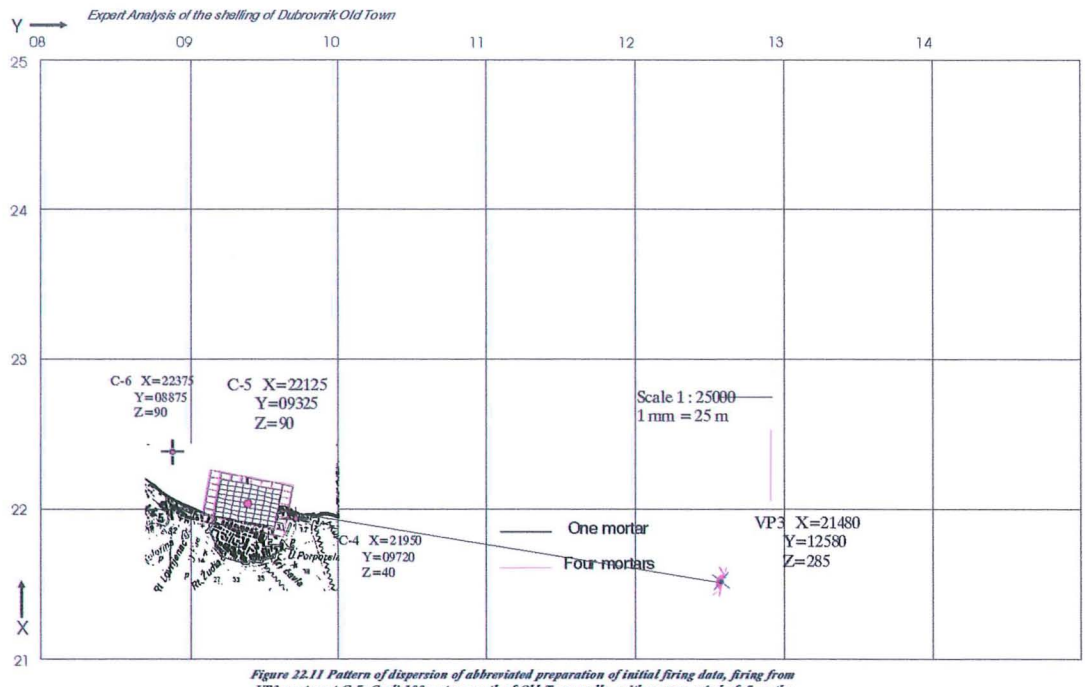

Figure 22.11 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP3 on target C-5, Carli 100 metres north of Old Town walls, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 22.11 Pattern of dispersion of abbreviated preparation of initial firing data, firing from VP3 on target C-5, Carli 100 metres north of Old Town walls, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

An analysis of Figure 22.11 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 25%, 16%, 7% and 2% dispersion zones in the ranges of 25% and 16% probability bands[62].

[62] ***Of 100 82-mm shells fired 36 or 37 would land in the Old Town and after the correction of fire 45 to 47 shells would land in the Old Town.***

6. 23 – 82 mm mortars firing from VP3 in the Rajcevici sector, simple preparation of initial firing data against target C-5, Carli 100 metres from Sv. Josip Tower

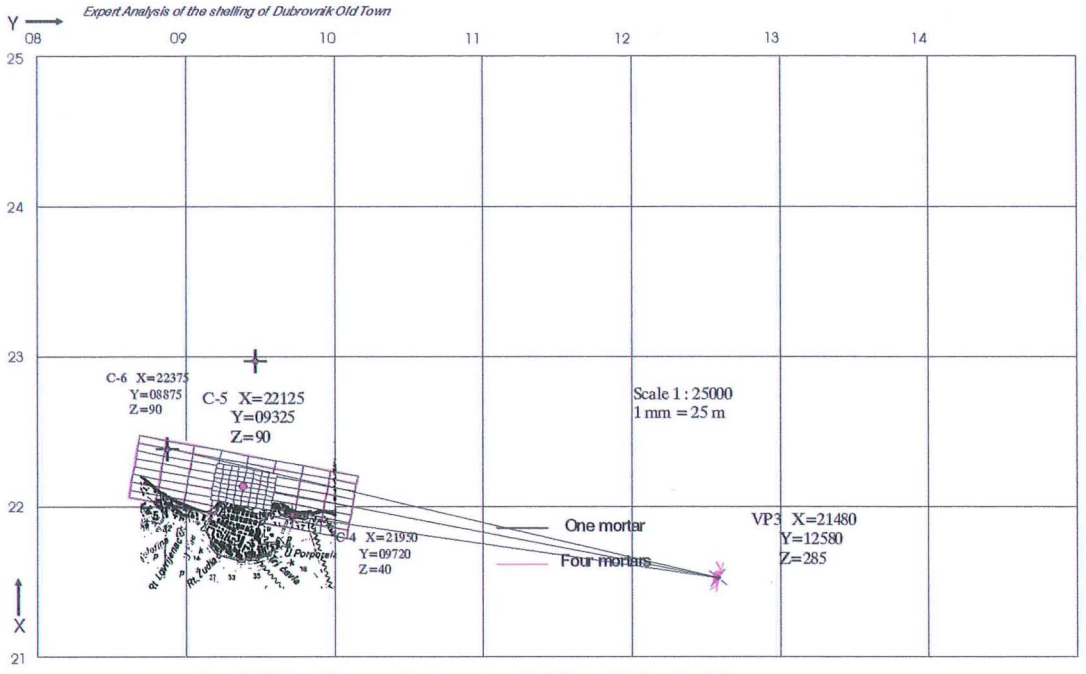

Figure 22.2 Pattern of dispersion of simple preparation of initial firing data, firing from VP3 on target C-5, Carli 100 metres north of Old Town walls

Figure 22.2 Pattern of dispersion of simple preparation of initial firing data, firing from VP3 on target C-5, Carli 100 metres north of Old Town walls

An analysis of Figure 22.2 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 16%, 7% and 2% dispersion zones in the 25% probability band[63].

Calculated probable errors of dispersion

Dg	Ex	Ey	Vdt	Vpt	11xVd	11xVp
3318	300.7	85.6	25	15	412.5	247.5

Dg(m)-range,
Ex,Ey(m)-range probable error and deflection probable error determined by *simple* method,
Vdt,Vpt(m)- range probable error and deflection probable error from the firing table,
Vd=1,5 xVdt, Vp=1,5xVpt- range probable error and deflection probable error in real condition of firing,
11xVd, 11xVp-axes of figure of dispersion the mortars bomb when fire the group of mortars.

[63] ***Of 100 82-mm shells fired eight or nine would land in the Old Town and after the correction of fire 23 to 25 shell would land in the Old Town.***

6.24 – 82 mm mortars firing from VP3 in the Rajcevici sector, simple preparation of initial firing data against target C-5, Carli 100 metres from Sv. Josip Tower, with a cross wind of 5 on the Beaufort scale, or 10 m/s.

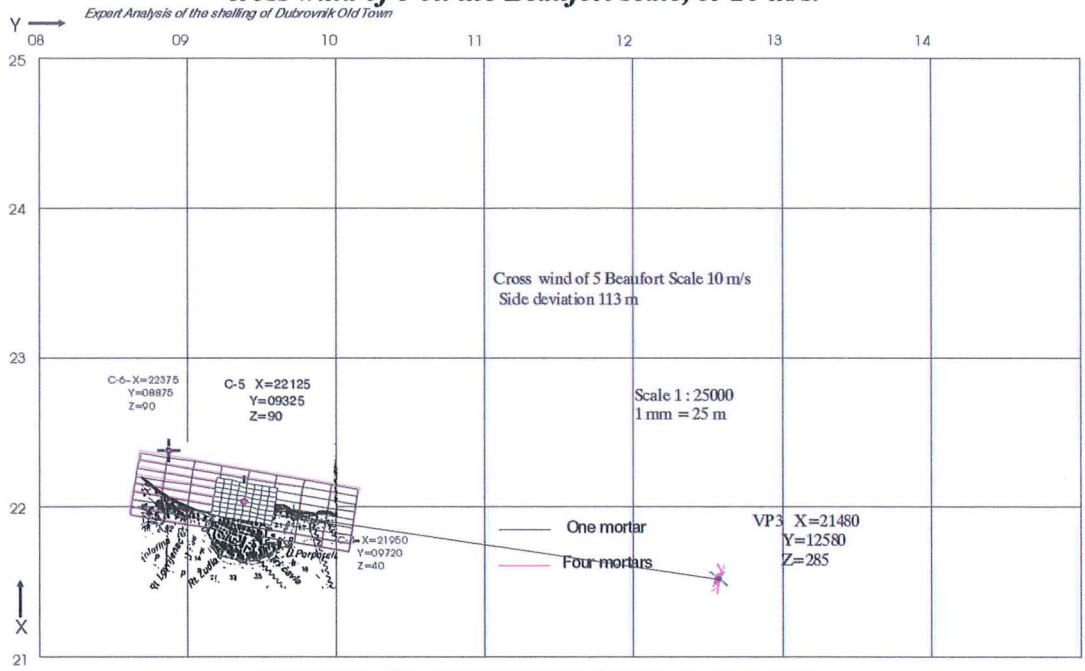

Figure 22.21 Pattern of dispersion of simple preparation of initial firing data, firing from VP3 on target C-5, Carli 100 metres north of Old Town walls, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

Figure 22.21 Pattern of dispersion of simple preparation of initial firing data, firing from VP3 on target C-5, Carli 100 metres north of Old Town walls, with a cross wind of 5 on the Beaufort Scale - or 10 m/s

An analysis of Figure 22.21 leads to the conclusion that the northern and north-western parts of Dubrovnik Old Town lie in the 25%, 16%, 7% and 2% dispersion zones in the range of 25% probability band[64].

[64] ***Of 100 82-mm shells fired 24 or 25 would land in the Old Town and after the correction of fire 45 to 47 shells would land in the Old Town.***

6.3 Summary of the possible number of projectiles (82-mm and 120-mm mortar shells) that could land inside Dubrovnik Old Town as a normal consequence of the probable dispersion of impacts when targeting targets C-5 and C-6

Table 23 gives the total number of mortar shells that could land inside the walls of Dubrovnik Old Town as a consequence of the normal dispersion of impacts when targeting targets C-5 (*Carli* 500 metres from the Old Town) and C-6 (*Carli* 100 metres north of Dubrovnik Old Town).

The table gives a calculation of the number of shells which could land inside Dubrovnik Old Town on the basis of 100 per cent probability for 100 fired shells and for each mortar firing one complete combat set of shells for 100 per cent pattern of dispersion according to calculations given in Annex 21 and Annex 22.

Table 23

Piece / Firing position / Location		Target	100 shells for 100% probability of hit pattern: abbreviated preparation of p/e	abbreviated preparation of p/e with cross wind	simple preparation of p/e	simple preparation of p/e with cross wind
M75 120mm MB VP1 Ledenice		C-5	29-30	53	21	22
		C-6	0	0	0	0
M69 82mm MB VP3 Rajcevici		C-5	19-20	36-37	8-9	24-25
		C-6	0	0	0	0
			1 b/k per mortar for 100 probability of impact pattern			
M75 120mm MB VP1 n=160 shells Ledenice		C-5	46-48	85	34	35
		C-6	0	0	0	0
M6982mm MB VP3n=240 shells Rajcevici		C-5	46-48	86-89	19-22	56-60
		C-6	0	0	0	0
Total max. shells for 1 b/k	120mm	C-5	46-48	85	34	35
	82 mm		46-48	86-89	19-22	56-60
	120mm	C-6	0	0	0	0
	82 mm		0	0	0	0

/p/e - initial firing data/ /b/k – combat set/
1 b/k = 40 shells for M75 120 mm MB 1 b/k = 60 shells for M69 82 mm MB

Table 24 gives the number of shells which could fall inside Dubrovnik Old Town walls when 100 shells are fired from a separate position for the 50 per cent pattern of dispersion (only those shells which fall within the range of 25 per cent probability around the designated target, mean hit of the projectiles).

Table 24

			100 pieces for 50% probability of impact pattern			
M75 120mm MB VP1 Ledenice		C-5	13-14	22	18	18
		C-6	0	0	0	0
M69 82mm MB VP3 Rajcevici		C-5	7-8	24-25	8-9	24-25
		C-6	0	0	0	0
Total shells	120mm	C-5	13-14	22	18	18
	82 mm	C-6	7-8	24-25	8-9	24-25

Table 25 gives the number of projectiles which could land inside the walls of Dubrovnik Old Town if each artillery piece fires one combat set.

Table 25

			1 combat set per piece for 50% probability of impact pattern			
M75120mm MB VP1 n=160 shells Ledenice		C-5	21-22	35	29	29
		C-6	0	0	0	0
M69 82mm MB VP3 n=240 shells Rajcevici		C-5	17-18	58-60	19-22	58-60
		C-6	0	0	0	0
Total shells	120mm	C-5	21-22	35	29	29
	82 mm		17-18	58-60	19-22	58-60

On the basis of results presented in Table 23 a conclusion may be drawn that the highest number of mortar shells fall within Dubrovnik Old Town walls when fire is opened to neutralise fire from DOS *Carli* artillery piece in the sector north of Dubrovnik Old Town.

6.4 - Conclusion on the firing of mortars from VP-1, VP-3 and VP-4 at Dubrovnik Old Town

1 – Based on the calculation of the magnitude of errors when calculating initial firing data and on the basis of the probable dispersion of impacts of 82-mm and 120-mm mortar shells when firing according to initial firing data determined according to the method of the abbreviated and simple preparation of initial firing data, the pattern of impact dispersion catches to a smaller or greater degree the surface of Dubrovnik Old Town, on condition that the azimuth of firing is correctly set.

2 – The disposition of DOS firing positions was such that when targeting target C-3, during counter-battery fire against the first group of DOS 82-mm mortars in Bogisica Park, and in particular for counter-battery fire against the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce, there was a the higher probability of projectiles landing in Dubrovnik Old Town.

3 – Bad meteorological conditions and an extremely strong wind – Bura – on 6 December 1991 in particular, considerably contributed to the diversion of trajectories of projectiles fired from all positions, covers the surface of Dubrovnik Old Town, on condition that the azimuth of firing is correctly set. /as printed/

4 – The disposition of DOS firing positions was such that when targeting target C-3, counter-battery fire against the first group of DOS 82-mm mortars in Bogisica Park, and in particular for counter-battery fire against the second group of DOS mortars 200 metres from Dubrovnik Old Town towards Ploce, there was a higher probability of projectiles landing in Dubrovnik Old Town.

5 – Bad meteorological conditions and an extremely strong wind – Bura – on 6 December 1991 in particular, considerably contributed to the diversion of trajectories of projectiles fired from all positions, VP1, VP3 and VP4 towards Dubrovnik Old Town, which also resulted in a higher number of projectiles landing within the walls of Dubrovnik Old Town.

6 – What particularly contributed to a considerably higher number of projectiles landing in Dubrovnik Old Town was firing from DOS artillery pieces mounted on Carli[65] mobile vehicles which fired from the northern and western sides of the walls of Dubrovnik Old Town.

7 – During the attack by JNA forces on Srdj on 6 December 1991 DOS forces opened intensive fire and fired around 3,000 mortar shells[66]. In such conditions it is normal that JNA mortar units fired at the firing positions of DOS forces. Given the fact that the so-called Carli artillery pieces fired from impermissibly close to the Old Town, it is normal that a number of JNA projectiles landed in the Old Town[67].

8 – According to established norms, Annex 19 gives the required number of 120-mm mortar shells for the destruction of targets, DOS firing positions with 480 /shells/ with simple preparation and 240 /shells/ with abbreviated preparation of initial firing data for firing from firing position VP1, from the Ledenica sector, and 720 82-mm mortar shells for firing from VP3 in the Rajcevici sector, or 720 82-mm

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[65] *Statements by prosecution witnesses: Nojko MARINOVI], Ivan NEGODI], Mujica JUSI] and others.*

[66] *Statement by Tribunal witness Zoran PRIMI], page 03029568 of 28 September through to 2 October 2000 in B/C/S given to Michael Stephens.*

[67] *Map entitled Plan for the Operation of Artillery in Defence, Prosecution number 03340718 drawn up by Ivan NEGODI].*

mortar shells for firing from VP4 in the Strincijera sector for neutralising with counter-battery fire target C-3, the first group of DOS 82-mm mortars in Bogisica park, or for neutralising with counter-battery fire target C-4, the second group of DOS mortars 200 metres from the walls of the Old Town towards Ploce, or the Carli artillery piece from positions C-5 or C-6 according to norms given in Annex 17.

9 – The available documentation[68] on distributed and consumed ammunition clearly shows that mortars at firing positions VP1, VP3 and VP4 on 6 December 1991 fired up to one combat set of shells each – 120 mm M75 mortars up to 160 shells from the Ledenica sector, 82 mm M69A mortars up to 240 shells from the Rajcevici sector and 82 mm M69A mortars up to 360 shells from the Strincijera sector, in other words, considerably fewer than is prescribed by the mentioned norms.

10 – On the basis of the calculation of the possible number of shells fired in support of an infantry attack on 6 December 1991 and in counter-battery fire against the first group of DOS 82-mm mortars in Bogisica park, target C-3, and also in counter-battery fire against the second group of DOS mortars 200 metres from the walls of Old Dubrovnik, not more than 79 (41)[69] 82-mm mortar shells and not more than 27 (22) 120-mm mortar shells could have fallen, depending on the method of preparing initial firing data if every mortar used one combat set. In the most unfavourable case not more than 106 (63) 82-mm and 120-mm mortar shells could have fallen inside Dubrovnik Old Town.

11 – If targeting had been carried out according to the prescribed norms up to 81 (66) 120-mm shells and 206 (52) 82-mm shells with simple preparation of initial firing data, i.e. a total of up to 287 (118) shells would have landed in the Old Town, and most of the features in the Old Town would have been completely destroyed.

VII - ANALYSIS OF VIDEO RECORDING OF THE SHELLING OF DUBROVNIK OLD TOWN

Video recordings received from the Tribunal relating to different days of hostilities between JNA units and the DOS in the period between 1 October and 6 December 1991 and later until 8 June 1992 were viewed.

Tapes that contain video footage showing the firing of projectiles around the Old Town and inside Dubrovnik Old town were viewed first.

On the basis of viewing certain tapes the following is a brief analysis of parts of the scanned video footage, for each tape separately:

1. ***Tape marked V000-00380*** relates to shelling on 6 December 1991. The recording is for a period of 7 hours and 36 minutes /as printed/. In the period between 0736 hrs and 1050 hrs the duration of recorded tape is 28 minutes and five seconds. The following was registered in this period:

- 20 impacts accompanied by white smoke of short duration within the walls of Dubrovnik Old Town, and
- nine impacts outside the walls of Dubrovnik Old Town.

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[68] *9th VPS war diary and statement by the commander of 120 mm mortar platoon Zlatan JEREMIC*

[69] *The given value is equivalent to 100% probability of impacts, or 50% probability of impacts in brackets*

The conclusion is that 29 impacts were registered in the period of three hours and 14 minutes, or one projectile every seven minutes on average.

The total duration of the recorded tape is one hour and 56 minutes.

2. ***Tape marked V000-0100*** relates to shelling within and outside the walls of Dubrovnik Old Town on 6 December 1991.

The recording contains clips of shelling, bombing and air-strikes of the fort and the TV aerial on Srdj (the clip was recorded on some other date because there were no air operations on 6 December), followed by a recording of a day in Dubrovnik (date not given), from the time an alarm was given up to the arrival of a ship with humanitarian aid and the departure of children, women and the elderly from the Port in Gruz.

The tape contains a recording of five impacts against the outer wall of Muc and Sv. Ivan /Saint John/ Fort, one impact against the outer wall of Sv. Stjepan /Saint Steven/ Tower, two impacts in the sea and one impact in Zitnica Rupa sector in the Old Town.

As there were no air operations against Srdj on 6 December, it is obvious that this video recording is a medley of recordings shot at different times on different days.

A large part of the scanned tape of the duration of around 25 minutes relates to recordings of stricken features, penetration of walls and damage caused to roofs by mortar shells in the Port of Gruz area.

The total duration of the recorded tape is around two hours.

3. ***Tape marked V000-0062*** relates to the same events as recorded on tape V000-0380, but from a terrace of a restaurant or a hotel, at a higher angle of shooting and from a smaller distance in relation to Dubrovnik Old Town, followed by a part of a clip which relates to a recording made on 7 December 1991.

The recordings relate to damage in Dubrovnik Old Town:

Damage caused by mortar shells to the pavement in Stradun (characteristic trace of a mortar shell, an 82-mm shell judging by the shape of the trace, damage caused by a projectile penetrating the dome of a building in the Old Town, mortar shell impacts on the roofs with the characteristic circular openings, buildings and a shop in Stradun damaged by fire.

What is characteristic is the large-scale caving in of roofs on old buildings because of the action of mortar shells. Film of an impact by a Malyutka rocket against the wall of a building in the Old Town is shown.

The tape also records the moment when a fire broke out on 6 December 1991 on two boats anchored in the old port in Dubrovnik. The time the fire on the boats broke out was registered by the camera at 0921 hrs.

At 0934 hrs a puff of white smoke was registered, probably as a consequence of a projectile impact to the right of Mrtvo Zvono Tower.

The tape also contains recordings of the firing of projectiles on 25 May, 29 May, 30 May and 31 May 1992; one impact in the Old Town and one in the sea at 0934 hrs and one impact outside the Old Town at 1916 hrs on 8 June, and recordings of 9 June 1992.

It is obvious that this tape was recorded by NIK TV and is a collage made from a number of video clips, which differ in the time and date they were shot.

The total duration of the recorded tape is around two hours.

4 – ***Tape marked V000-0253*** relates to shelling inside and outside the walls of Dubrovnik Old Town.

The tape is a collage of different recordings, clips from tape V000-0100, in English. It shows the bombing and air-strikes against the TV and communications tower at Srdj fort. It shows clips of boats opening fire on Srdj, wounded people in hospital, penetration of a wall in the monastery, two projectiles fired outside the walls of the Old Town, the Grand Hotel in flames. It then goes on to show four impacts against the outer wall of Sv. Ivan Fort, two impacts in the sea, two impacts in the Old Town, the flight of three projectiles from the direction of Sv. Stjepan Tower towards a boat anchored in the Old Town port in front of the break-water near the Fish Market and the subsequent start of a fire on the boat.

Characteristic is the moment of the firing and flight of these three projectiles from Sv. Spasitelj /Saint Saviour/ Tower, eight minutes from the beginning of the recorded tape (camera time is not registered) towards the anchored boat in the old port of Dubrovnik. The first two projectiles overshot and the third one hit the boat which caught fire. Projectile flight time from the direction of Sv. Spasitelj Tower is around two seconds, with an angle of descent of approximately 45 degrees, which cannot correspond to the flight of 20-mm, 40-mm or 57-mm projectiles fired from boats, but corresponds to the flight of a reactive anti-tank projectile.

This conclusion is drawn from the following facts:

- the high angle of projectile descent;
- the flame behind the projectile;
- the flight-time of around two seconds, i.e. a flight speed of around 120 m/sec;
- a relatively small explosion when the projectile fell into the sea;
- the instantaneous fire on the boat as a consequence of shaped charge projectile impact.

The tape contains a recording of international observers and a commentary in English presented by a journalist who probably made this video collage. A commentary can be heard on the tape that mortar shells have begun to fall around a hotel outside the walls of the Old Town where observers are accommodated.

The tape contains the following internal time markings: CTL 00:35:28 to 0:46:28 making the total duration of the recorded tape 11 minutes.

5 – ***Tape marked V000-0181*** relates to shelling inside and outside the walls of Dubrovnik Old Town.

An abbreviated version with separate clips, as on tape V000-0253. The recording has an audio commentary in English, probably by a foreign correspondent. Total duration is approximately 10 minutes.

6 – ***Tape marked V000-2759*** relates to shelling inside and outside the walls of Dubrovnik Old Town in 1991.

The tape is a collage of a number of clips with a TV logo of the figure five with the capital letter A hanging from it.

The tape starts with recordings of 19 June 1991 followed by recordings of 6 December 1991 and then goes back to recordings of 1 October 1991.

The recordings show Stradun, shattered pieces of roof-tiles, a pierced 30x30 cm stone plaque, damaged figures on the walls, a damaged staircasee, a conversation with people in a shelter, damage to Minceta Tower, the Port of Gruz, and then it goes back to shattered pieces of roof-tiles in Stradun near Orlandov Stub /Orlando's Column/. The recordings are the same as on tape V000-0181. It goes on to show Stradun and burnt shops and damaged roofs by the church near Bokara Fort. It then

goes on to show a ferry sailing into the Port of Gruz, the shelling of Srdj videoed from Lovrjenac, a poorly-lit recording shot at dusk. 20-mm PAV guns opening fire towards Srdj, probably from patrol boats.

It further contains recordings shot on 1 October 1991, recordings from a hotel, two aircraft carrying out air-strikes on Srdj and fire being opened from two boats towards Srdj, the TV and communications aerial and the fort.

Damage to Ravelina Fort is shown and then a recording of the firing of projectiles (3 pieces) outside the walls towards Srdj, followed by the firing of a series of nine projectiles inside the Old Town with gaps of several minutes between impacts.

It then goes on to clips of a ferry arriving in Dubrovnik with food supplies, visits to Dubrovnik by Stipe MESIC, Tereza KESOVIJA, Branko BULAJIC and others. Finally, it shows clips of a visit by Dubrovnik Mayor POLJANAC to Trebinje and Trebinje Mayor Boza VUCUREVIC.

This is followed by clips of the firing of projectiles at Srdj, and probably also clips of firing at Zarkovica. It again shows a clip of a ferry arriving in Dubrovnik and then a news conference by Stipe MESIC in Dubrovnik.

It then goes to show the *Plakir* and *Tirera* hotels at Babin Kuk with refugees, the Hotel *Minceta*, destroyed warehouses, probably in the Port of Gruz, and then burnt houses along the main road, a shot of two patrol boats in the waters off Dubrovnik and in conclusion a rally on the Stradun.

Judging by the time of filming and themes treated, the tape is a collage of different developments in and around Dubrovnik with many clips which were shown in the tapes mentioned earlier in this expert report.

The duration of recorded footage on the tape is around two and a half hours.

6 – A video recording received from the Tribunal on CD number V000-4263 65 ter 562, 4 Channel Audio Recording, is a recording of damage in Dubrovnik Old Town on 8 December 1991 filmed during an inspection of the Old Town by a JNA officer in order to establish damage caused by projectiles that hit the Old Town on 6 December 1991.

7 - A video recording on CD number V000-2732, JUSIC film 44 minutes, 4 Channel Audio Recording, is a recording made by \elo JUSIC with his video camera on 6 and 7 December 1991. Given that the recording does not bear the time and date markings, it cannot be established whether the entire video footage was shot only on these two dates. Apart from some details the recorded footage cannot be used more thoroughly to assess the operations on 6 December 1991.

Conclusion of analysis of video recordings

1 – The scanned tapes represent a collage of clips of various dates and places which makes them unusable for a more thorough analysis of impacts in Dubrovnik Old Town. Only some clips could be used to assess the type of projectile that hit features in Dubrovnik Old Town.

2 – The most complete information on the number of impacts in Dubrovnik Old Town can be registered from tape marked V000-380.

3 – Impacts on roofs, the pavement in Stradun, staircases and ornaments on buildings show that these are impacts of mortar shells of small calibre, mostly 82-mm. Two unexploded 120-mm shells were registered, as was the penetration of the

pavement stone, which corresponds to the possible penetration of a 120-mm shell, particularly if the fuse had failed, which can be concluded from warnings of passers-by that the crater which was created by the projectile still contained the projectile itself..

4 – Impacts on the outer wall of Dubrovnik Old Town could not be analysed because we had no access to crime-ballistic reports drawn up by Croatian police representatives in Dubrovnik and could not inspect the site and see whether repairs had been carried out in the meantime.

5 – The fact that the six scanned tapes and two videos on CDs are a collage of clips of various dates and times of recording, simultaneous records of the same events with different cameras and from different locations basically prevented a more thorough assessment of the events.

6 – Different authors –following their own whim rather than the sequence of events[68] *inserted certain clips, repeated them in a number of video recordings, which indicates that the authors worked according certain clips, repeated them in a number of video recordings, which indicates that the authors worked according to their own design, rather than chronologically to depict the events as they unfolded. /as printed/*

[68] *The example is video recording V000-0380- two boats in the old port hit 19 minutes and 27 seconds from the beginning of the video recording, and then 47 minutes and 45 seconds from the beginning of the recording a video clip of the same undamaged boats in Dubrovnik old port is shown again? There are identical examples in other video recordings.*

VIII - ANALYSIS OF DAMAGE CAUSED BY SHELLING OF DUBROVNIK OLD TOWN IN ORDER TO ASSESS THE NUMBER OF PROJECTILES THAT FELL WITHIN THE OLD TOWN

The basis for the analysis of the damage caused by the shelling of Dubrovnik Old Town was a document that the Tribunal submitted to the defence team:

1 – Damage in Dubrovnik Old Town of 6 December 1991: the document /?appended to/ the second amended indictment in case IT-01-42-Annex II quotes 450 cases of all categories of damage.

A review of the reported categories of damage is given in Table 26:

Damage category	I	II	I/II/ III	III	IV	I/II/ III	I/II/III/ IV	I/II	II/III	II/III/ IV	III/IV	N/A	Total
6 Dec 1991	8	77	1	199	145	1	1	3	7	1	8	2	450
Total Old Town	8	77	1	199	145	1	1	3	7	1	8	2	450

Category of damage: I – Completely destroyed feature II – Feature with extensive damage to the structural elements III – Feature with damage to structural elements IV – Feature with damage to non-structural elements N/A – degree of damage not assessed

The analysis was carried out according to the category of damage and the location of the damaged feature; cases of damage classified in categories of damage I to IV were marked on the map of the Town of Dubrovnik[70].

To facilitate better insight and analysis of damage within the walls of the Old Town, Figure 8.1 – the basic map of Dubrovnik Old Town, page 94a, gives only the cases of damage of the I, II, I/II, II, II/III and III degrees of damage, while the IV degree of damage is indicated only for those features which were simultaneously classified as having more than one of the above categories of damage.

(Damage was marked with circles filled with different colours according to the category of damage: I degree of damage is red, II degree is blue, III degree is green and IV degree is yellow).

In order to analyse damage within the Old Town Walls, Figure 8.2 on page 94b shows damage within the contours of Dubrovnik Old Town of the I, I/II, II, II/III and III degrees of damage, while the IV degree of damage is indicated only for those features which were simultaneously classified as having more than one of the above categories of damage.

[70] *Published by FOCIS CO d.o.o /limited liability company/ Dubrovnik*

VIII - ANALYSIS OF DAMAGE CAUSED BY SHELLING OF DUBROVNIK OLD TOWN IN ORDER TO ASSESS THE NUMBER OF PROJECTILES THAT FELL WITHIN THE OLD TOWN

The basis for the analysis of the damage caused by the shelling of Dubrovnik Old Town was a document that the Tribunal submitted to the defence team:

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Total Old Town	8	77	1	199	145	1	1	3	7	1	8	2	450

Category of damage: I – Completely destroyed feature II – Feature with extensive damage to the structural elements III – Feature with damage to structural elements IV – Feature with damage to non-structural elements N/A – degree of damage not assessed

The analysis was carried out according to the category of damage and the location of the damaged feature; cases of damage classified in categories of damage I to IV were marked on the map of the Town of Dubrovnik[70].

To facilitate better insight and analysis of damage within the walls of the Old Town, Diagram 8.1 – the basic map of Dubrovnik Old Town, page 94a, gives only the cases of damage of the I, II, I/II, II, II/III and III degrees of damage, while the IV degree of damage is indicated only for those features which were simultaneously classified as having more than one of the above categories of damage.

(Damage was marked with circles filled with different colours according to the category of damage: I degree of damage is red, II degree is blue, III degree is green and IV degree is yellow).

In order to analyse damage within the Old Town Walls, Diagram 8.2 on page 88c shows damage within the contours of Dubrovnik Old Town of the I, I/II, II, II/III and III degrees of damage, while the IV degree of damage is indicated only for those features which were simultaneously classified as having more than one of the above categories of damage.

[70] *Published by FOCIS CO d.o.o /limited liability company/ Dubrovnik*

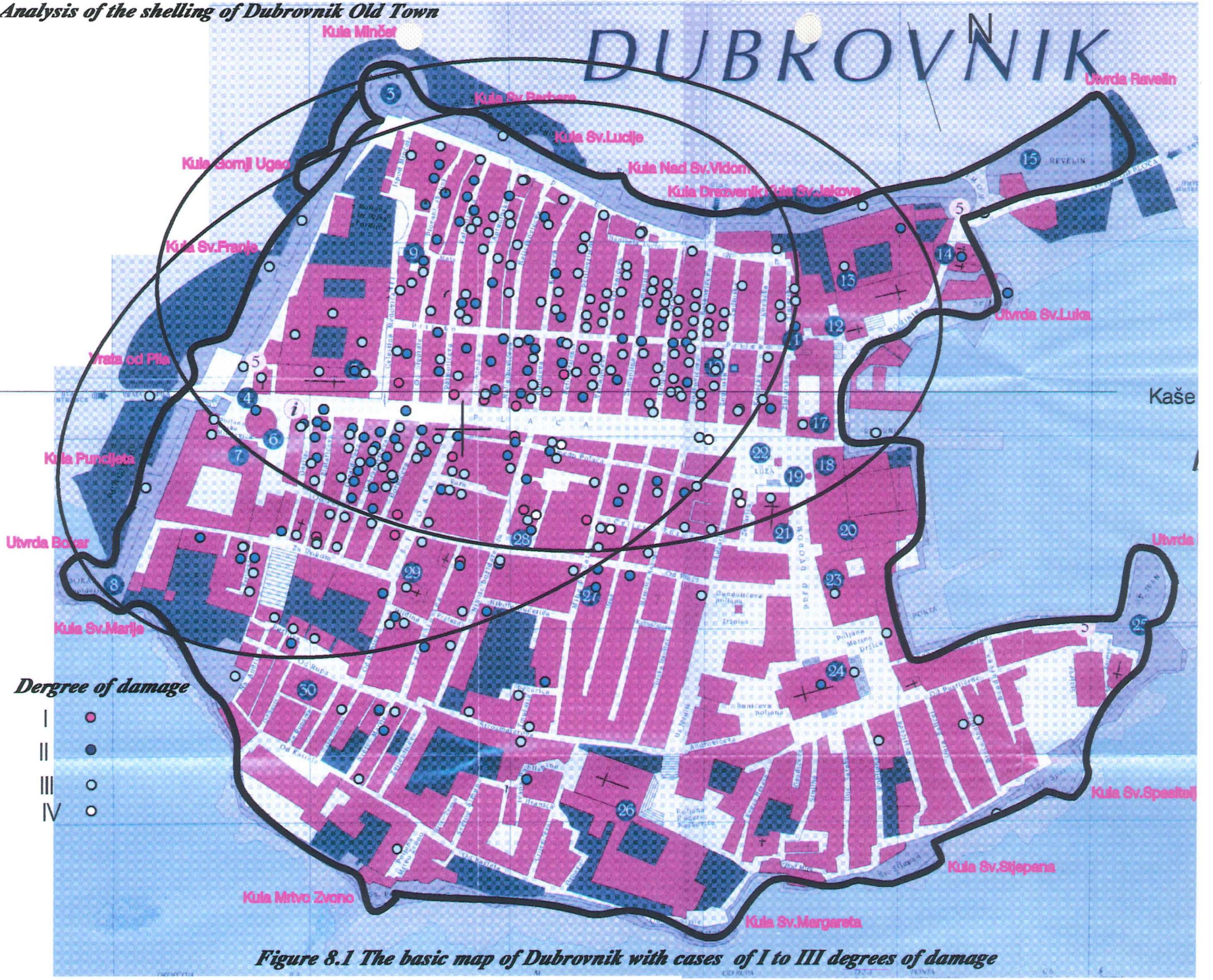

Figure 8.1 The basic map of Dubrovnik with cases of I to III degrees of damage

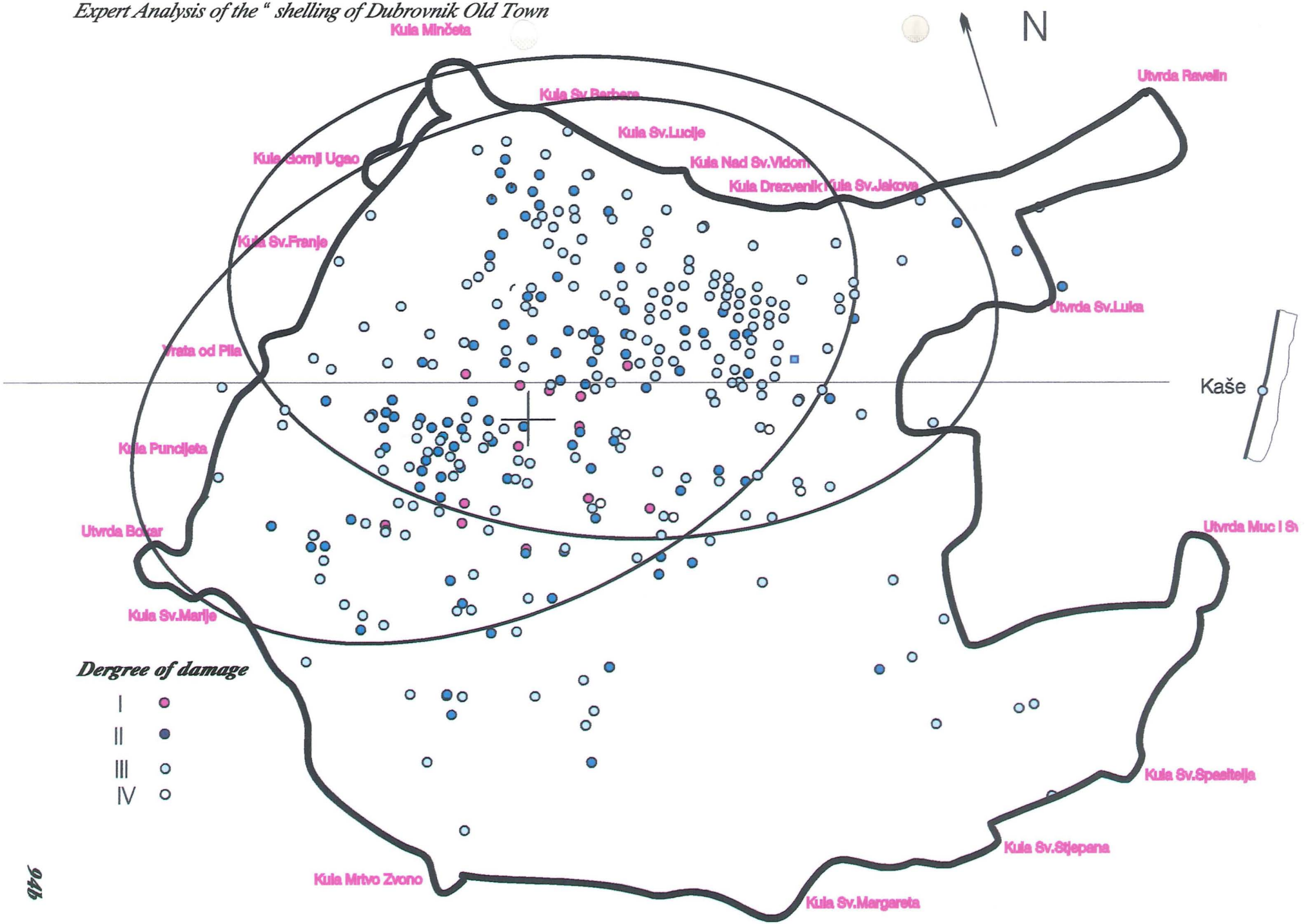

Figure 8.1 The basic map of Dubrovnik with cases of I to III degrees of damage

The analysis of damage was carried out proceeding from the premise that the categories of damage of the I, I/II, II, II/III and III degrees were caused by direct impact of projectiles, or by impact of projectiles in the immediate proximity of the damaged feature.

The following can be concluded on the basis of the distribution of impacts, Diagram 8.2:

- the density of damaged features of the classified degrees of damage between I and III indicates approximately two groups of impacts which could be encompassed by two ellipses of dispersion whose longer radii extend in two directions;
- that cases of damage classified as the I degree of damage are located in the western part, within the walls of the Old Town;
- that cases of damage classified as the II and III degrees of damage are located in the northern and north-western part within the walls of the Old Town;
- that a small number of cases of damage are visible on the eastern wall of Dubrovnik Old Town, caused by impacts from the easterly and north-easterly direction;
- that there are no damaged features in the southern and south-eastern part of the Old town.

8.1 – ***Conclusion of analysis of damage caused to featuress within the walls of the Dubrovnik Old Town***

On the basis of analysis of the category of damage and the estimate of the probable number of 82 and 120 mm projectiles presented in Attachment 20 of this expert analysis, the following number of shells could have fallen within the walls of Dubrovnik Old Town, as a consequence of counter-battery fire against DOS mortars during the infantry attack on Srdj:

1 –Up to 27 high-impact 120-mm projectiles, and up to 79 82-mm shells of lower destructive power.

2 – It is evident that the missile patrol boat did not fire the SS-N-2 rockets at Dubrovnik Old Town.

3 – The number of 20, 40 and 57-mm projectiles fired from patrol boats 137, 178 and 179, which patrolled the waters off Dubrovnik, and from Missile Patrol Boat 403, is impossible to estimate because damage and direct impacts cannot be seen in the video footage.

On the basis of these conclusions, damage to buildings can be primarily linked to the following facts:

- that there was a firing position of the first group of DOS mortars in the immediate vicinity of the Old Town walls, approximately 300 to 350 metres to the west, which – according to witnesses[70] - in order to defend the fort on Srdj, opened strong mortar fire from Bogisica Park at JNA units which were attacking Srdj;
- that a second group of DOS mortars was stationed approximately 200 metres from the Old Town towards Ploce;
- that vehicle-mounted weapons, the so-called *Carli*, fired from the northern side of the Old Town, changing positions;

[70] *Tribunal witnesses: Nojko MARINOVIC, Zeljko SOLDO and others.*

- that a JNA 82-mm mortar battery (six pieces) was stationed north-west of the Old Town, in the Strincijera sector;

- that a 120-mm mortar battery (four pieces) was stationed north-east of the Old Town, in the Ledenica sector;

- that an 82-mm mortar battery (four pieces) was stationed east of the Old Town, in the Rajcevici sector;

which – in order to neutralise DOS mortar fire, during target acquisition and adjustment of fire, and also due to unfavourable local meteorological conditions (primarily a strong seaward wind), as a consequence of normal dispersion of mortar shells, led to a number of shells landing within Dubrovnik Old Town walls - the section located along the JNA mortars' firing line towards DOS mortar firing positions in Bogisica Park, the fort on Srdj and the second group of DOS mortars 200 metres from the Old Town towards Ploce.

The fact that at least two DOS artillery pieces were mounted on lorries which changed positions after opening fire and which fired from the immediate vicinity of the Old Town walls on the western and northern sides resulted in an increased number of projectiles hitting parts of the Old Town and particularly the part of Dubrovnik outside the Old Town, which resulted in a higher degree of destruction of this part of the Town of Dubrovnik.

[71] Statement by witness Slobodan SIMONOVIC of 20 June and 22 September 2000 that four houses were damaged in his street because a lorry-mounted weapon changed positions.

IX – CONCLUSION OF THE EXPERT ANALYSIS

1. Based on analysis of the disposition of JNA forces during the operation on the Dubrovnik battleground, the disposition of JNA mortar and artillery weapons was primarily focused on attacking DOS located in the old fort on Srdj and in the Lapad sector, to the west of the walls of Dubrovnik Old Town.

The main JNA 82-mm and 120-mm mortar units were aimed in terms of direction and effective range for firing at the fort on Srdj:

- an 82-mm mortar platoon from the Strincijera direction (six 82 mm M69A MBs),
- a 120-mm mortar platoon from the Ledenica direction (four 120 mm M75 MBs) and
- an 82-mm mortar platoon from the Rajcevici direction (four 82 mm M69A MBs).

2. DOS mortar position 300 to 350 metres from Dubrovnik Old Town, constantly on the move and vehicle-mounted DOS artillery pieces firing at JNA units created objective conditions for JNA counter-battery fire, primarily from 82-mm and 120-mm MBs. The fact that the main directions of fire intersected each other and went over into the territory of Dubrovnik Old Town naturally created conditions for some projectiles to fall within the walls of Dubrovnik Old Town.

3. A cross wind had a big influence on the flight of projectiles and led to a significant deflection of the mortar shells from the designated direction of fire. The conditions prevalent in the Dubrovnik region in winter months, in December 1991 in particular, had a significant influence on the deflection of the projectiles from the designated impact area: the fortress on Srdj, DOS mortars in Bogisica Park and mortars 200 metres from Dubrovnik Old Town towards Ploce.

4. The level of training of crews of mortars and other artillery pieces could have contributed significantly to the low precision of fire. Not all relevant procedures were taken into consideration when determining the elements for firing while providing fire support for infantry attacks on the fort on Srdj or during counter-battery fire against DOS artillery pieces located outside, but in the proximity of the walls of Dubrovnik Old Town. In particular, no account was taken of the gradient of terrain in the target area and the prevailing weather conditions, particularly the direction and the strength of wind. All this created conditions for low precision of fire and led to a high degree of deflection and range errors. Given the deployment of JNA and DOS artillery pieces, this led to targets being missed, to overshooting and shortfall, which resulted in some projectiles landing within Dubrovnik Old Town and increased destruction of features outside Dubrovnik Old Town, particularly in the sector where DOS mortar and artillery pieces were deployed, in Pile, to the west of the Old Town.

Fire from DOS mobile artillery pieces in the proximity and outside of Dubrovnik Old Town caused JNA artillery pieces to intensify firing at features outside the walls of Dubrovnik Old Town.

[72] *Effective range is considered to be up to 2/3 of the maximum range.*

5. Fire from 120-mm mortars from the Ledenica sector and 82-mm mortars from the Rajcevici and Strincijera sectors, supporting infantry attacks on Srdj, and counter-battery fire against DOS artillery pieces, particularly against 82-mm mortar platoon firing positions at a location 300 to 350 metres west of the walls of Dubrovnik Old Town and the 82-mm mortar position at a location 200 metres east of the Dubrovnik Old Town, as well as against artillery pieces mounted on *Carli* mobile vehicles, at two designated locations 100 metres north above Sveti Josip Tower and 500 metres west of Dubrovnik Old Town, on the basis of JNA intelligence, with the preparation of initial firing data by the abbreviated and simple preparation methods and in adverse meteorological conditions in December 1991 in Dubrovnik normally led to deflection errors and with the normal impact dispersion some projectiles landed within Dubrovnik Old Town.

6. The observation post of the 3rd Battalion of the 472nd Trebinje Brigade was at the Zarkovica location, trig. point 315m, and facilitated observation of the JNA units firing towards the fort on Srdj and a view of Dubrovnik Old Town.

The observation post enabled command of the adjustment of mortar and other artillery fire from the south-easterly direction, Ledenica (MB 120) and Rajcevici (MB 82), but this observation post was unable to facilitate command of the adjustment of mortar fire from the direction of Strincijera.

7. On the basis of analysis of damage to features within Dubovnik Old Town, eight cases of the I degree damage to features and four cases of the I/II degrees of damage and the I/II/III degrees of damage to features, in total 12 destroyed features, have been registered.

A thorough analysis of the reported damage[73] within Dubrovnik Old Town leads to the conclusion that of the total cases of reported damage – 450 cases of all degrees of damage (four degrees in total: I, II, III and IV) in December 1991 – over 90 per cent of all reported cases of damage were registered in north-western and western parts of Dubrovnik Old Town, i.e. on the line of JNA artillery fire towards the fort on Srdj and in counter-battery fire against DOS firing positions located in the vicinity of Dubrovnik Old Town.

8. The big time gap between the impact of some projectiles within Dubrovnik Old Town shows that the Old Town was not the target of JNA forces (video tapes V000-0100 and V000-0380).

9. Damage to buildings within Dubrovnik Old Town is in most cases on the roofs (report on damage to features in the Old Town and video recordings received from the Tribunal), primarily corresponding to 82-mm mortar fire and in a smaller number of cases to 120-mm mortar fire.

10. It is particularly stressed that JNA forces could not have fired three rocket projectiles from the direction of Sv.Stjepan Tower at a boat anchored behind the breakwater in the Old Town port and set it on fire (video recording, 8 minutes on tape V000-0253).

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[73] *Category of damage: I – Completely destroyed feature II – Feature with extensive damage to the structural elements III – Feature with minor damage to structural elements IV – Feature with superficial damage*

This could be done only by forces which were located within the walls of Dubrovnik Old Town - the DOS!

11. Naval weapons on patrol boats and the gunboat which were active in the waters off Dubrovnik and sporadically opened fire towards Srdj and over Dubrovnik Old Town could not have caused the destruction of features within the Old Town.

The so-called flat trajectories of projectiles fired from these weapons, with a low angle of descent and the primarily anti-aircraft fragmentation projectiles used, could not cause more extensive damage and destruction or set fire to features with stone walls within Dubrovnik Old Town. The only minor damage could be caused to roofs, i.e. roof-tiles on buildings in the Old Town in case of shortfall of projectiles or dispersion of projectiles fired from boats and to upper parts of walls of buildings within Dubrovnik Old Town.

According to video recordings received from the Tribunal weapons on boats fired were not observed firing at Dubrovnik Old Town.

X – GENERAL CONCLUSION

On the basis of analysing JNA forces' actions at Dubrovnik battleground, primarily on the basis of information that prosecution witnesses (Nojko MARINOVIC and Zeljko SOLDO) gave to Tribunal representatives, and also in the testimony at the Tribunal by Nojko MARINOVIC in case IT-02-54T of 3 April 2003, as well as other prosecution witnesses[74], it cannot be concluded that fire from JNA mortars and other artillery and naval pieces was primarily directed towards Dubrovnik Old Town as its primary target. Individual projectiles landed inside Dubrovnik Old Town during counter-battery fire and target acquisition in order to neutralise DOS mortars, primarily as a result of the disposition of DOS strong points and their fire at JNA units.

Continuous fire from DOS artillery weapons mounted on vehicles which were on the move in the zone west and north of Dubrovnik Old Town increased the number of individual impacts of 82 and 120 mm mortars shells within the walls of Dubrovnik Old Town.

Extremely unfavourable meteorological conditions in the Dubrovnik sector in wintertime, and a particularly strong Bura /gale-force wind/ on 6 December 1991, contributed strongly to the deflection of mortar shell trajectories and their landing
within Dubrovnik Old Town.

Individual shells fired by JNA forces hit Dubrovnik Old Town as a result of support for JNA infantry attacks[75] against the fort on Srdj and as counter-battery fire against DOS mortars[76] located relatively near the walls of Dubrovnik Old Town.

Janko VILICIC, Ph.D. Eng.

Milan GAJIC, Mr.Eng.

Belgrade, 2004 *Lieutenant Colonel Mr.Tugomir KOKELJ*

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[74] *Statement by Senior Lieutenant Zoran PRIMIC, platoon commander of the first group of DOS 82-mm mortars in Bogasica Park that on 6 December 1991 he fired 3,000 (three thousand) 82-mm mortar shells at JNA positions.*

[75] *Nojko MARINOVIC's testimony, 0302953, page 01071328 in B/C/S*

LIST OF DOCUMENTS USED DURING THE PRODUCTION OF THE EXPERT ANALYSIS

A. Prosecution Documents

1. Amended indictment issued by the Tribunal in case number IT-01-42 against Pavle STRUGAR and Vladimir KOVACEVIC with annexes I and II.

2. Witness statement of Nojko MARINKOVIC, pages 01011308 to 0107336, 29 pages in total, in B/C/S;

3. Witness statement of Nojko MARINKOVIC given before the Tribunal while testifying in case IT-02-54-T on 3 April 2003, pages 18509 to 18599, in English;

4. Witness statement of Zeljko SOLDO given before a Tribunal representative, pages 03029593 to 03029599, in B/C/S;

5. Interim report by Major Richard P. O'LEARY prepared for the Tribunal, pages 03035116 to 03035126 in B/C/S;

6. Report on destruction in Dubrovnik Old Town and Dubrovnik municipality, no page numbers, in B/C/S;

7. Report of **the Mission for the Investigation of War Crimes in Dubrovnik**, /unknown word/ FOR DUBROVNIK AND THE LAW ON ARMED CONFLICT,
prepared for the United Nations Expert Commission, 4 November 1993, in B/C/S;

8. Witness statement of Ivan NEGODIC given before Tribunal representatives Richard PHILIPPS and Azim ARSHAD on 12 and 13 December 2003, in B/C/S, file no. 0345-9157-0345-9164-BCST.doc/vb, 7 pages in total

9. Report on the STRUGAR *et al* case, Jozef POJE in B/C/S, number 02992787 to 02992819, 33 pages in total;

10. Addendum to Jozef POJE report of 1 April 2004, number 03540296 to 03540272, 10 pages in total;

11. Witness statement of Zoran PRIMIC given before a Tribunal representative, pages 03029565 to 03029570 in B/C/S, 6 pages in total;

B. Video tapes and CD

Video tape of the shelling of Dubrovnik, markings:

1. V000-0062_____ (1 piece);
2. V000-0100_____ (1 piece);
3. V000-0181_____ (1 piece);
4. V000-0253_____ (1 piece);

5. V000-0380_____ (1 piece);
6. V000-2759_____ (1 piece);
7. V000-2732_____ (1 piece);
8. V000-4263_____ (1 piece).

C. Scale maps and maps

1. Dubrovnik 1:25,000 scale map, published by the JNA Military Geographical Institute;

2. Trebinje 1:50,000 scale map, published by the JNA Military Geographical Institute;

3. Map of the Town of Dubrovnik, document of the Tribunal number 01026552;

4. Map entitled Plan for the Operation of Artillery in Defence, document of the Tribunal number 03340719

5. Sketch "Locations of damage to features damaged in the war-time destruction of the old town centre of Dubrovnik October-November-December 1991," page number 01069369

6. Dubrovnik map showing the positions and types of weapons used by DOS, data based on JNA intelligence from Dubrovnik battleground;

7. A panoramic map of Dubrovnik showing the disposition of artillery pieces used by DOS in and around Dubrovnik Old Town, data based on JNA intelligence from Dubrovnik battleground;

E – Expert literature

Quoted in footnotes of "Expert Analysis of the Shelling of Dubrovnik Old Town"

ANNEXES TO THE EXPERT ANALYSIS

Annex 1 – Dubrovnik topographical 1:25,000 scale map, published by the JNA Military Geographical Institute, 1985, Belgrade.

Annex 2 - Trebinje topographical 1:50,000 scale map, published by the JNA Military Geographical Institute, 1985, Belgrade.

Annex 3 – Dubrovnik town map, received from the Tribunal, showing the positions of DOS weapons, marked by Nojko MARINOVIC, 01026552.

Annex 3a – Disposition of DOS artillery pieces, topographical 1:25,000 scale, map, published as under Annex 1.

Annex 4 – Section of map entitled Plan for the Operation of DOS Artillery number 03340719, by Ivo NEGODIC

Annex 5 – Meteorological data for Dubrovnik area

Annex 6 – Errors in the preparation of initial firing data for mortars

Annex 7 – Calculations of firing data for 120-mm M75 mortars from the firing position at Ledenice, VP-1, taking into consideration the gradient of terrain in the target area

Annex 8 – Approximate topographical coordinates determined with abbreviated trigonometric tables 60-00:

Annex 8a – for the 120 mm M75 MB, from VP-1 to C-1, C-2, C-3 and C-4 and the observation post-target relation

Annex 8b – for the 82 mm M69A MB, from VP-3 to C-1, C-2, C-3 and C-4 and the observation post-target relation

Annex 8c – for the 82 mm M69A MB, from VP-4 to C-1, C-2, C-3 and C-4 and the observation post-target relation

Annex 8d – for the 120 mm M75 MB, from VP-1 to C-1, C-5 and C-6 and the observation post-target relation

Annex 8e – for the 82 mm M69A MB, from V-3 to C-1, C-5 and C-6 and the observation post-target relation

Annex 9 –Technical drawing of the zones of possible mortar fire from VP-1, at Uskoplje, VP-3 at Radojcic and VP-4 at Strincijera, 9a and 9b.

Annex 10 - Summary of magnitude and seriousness of sources of errors of the abbreviated and simple preparation of the initial firing data for C-1, C-3 and C-4 for 120 mm M75 mortars from the Ledenica sector

Annex 11 –Summary of magnitude and seriousness of sources of errors of the abbreviated and simple preparation of the initial firing data for C-1, C-3 and C-4 for M69A 82-mm mortars from the Rajcevici sector

Annex 12 – Summary of magnitude and seriousness of sources of errors of the abbreviated and simple preparation of the initial firing data for C-1, C-3 and C-4 for M69A 82-mm mortars from the Strincijera sector

Annex 13 – Sectors of the possible position of a target upon completing abbreviated and simple preparation of the initial firing data for execution with one (basic) /platoon/ and an 120 mm M75 MB platoon from the Ledenica sector against C-1, C-3 and C-4.

Annex 14 - Sectors of the possible position of a target upon completing abbreviated and simple preparation of the initial firing data for execution with one (basic) /platoon/ and an M69A 82-mm MB platoon from the Rajcevici sector against C-1, C-3 and C-4.

Annex 15 - Sectors of the possible position of a target upon completing abbreviated and simple preparation of the initial firing data for execution with one

(basic) /platoon/ and an M69A 82-mm MB platoon from the Strincijera sector against C-1, C-3 and C-4.

Annex 16 – Calculation of the quantity of mortar shells required for the destruction of targets C-1, C-3 and C-4, with 120 mm M75 mortars firing from the Ledenica sector and M69A 82-mm mortars firing from the Rajcevici and Strincijera sectors.

Annex 17 – Norms of ammunition consumption

Annex 18 – Coefficients of wind velocity changes with altitude in relation to surface wind

Annex 19 – Calculation of the possible number of impacts within the walls of Dubrovnik Old Town

Annex 20 – Other artillery pieces and boats at Dubrovnik battleground

Annex 21 - Summary of magnitude and seriousness of sources of errors of the abbreviated and simple preparation of the initial firing data for C-1, C-5 and C-6 for 120 mm M75 mortars from the Ledenica sector

Annex 22 – Summary of magnitude and seriousness of sources of errors of the abbreviated and simple preparation of the initial firing data for C-1, C-5 and C-6 for M69A 82-mm mortars from the Rajcevici sector

Annex 23 – A 1:25,000 scale drawing of sectors of the possible position of a target upon completing abbreviated and simple preparation of the initial firing data for execution with one (basic) /platoon/ and an 120 mm M75 MB platoon from the Ledenica sector against C-1, C-5 and C-6,

Annex 24 – A 1:25,000 scale drawing of sectors of the possible position of a target upon completing abbreviated and simple preparation of the initial firing data for execution with one (basic) /platoon/ and an 82 mm M69A MB platoon from the Rajcevici sector against C-1, C-5 and C-6

Annex 25-Addendumn No 1

Addendum N° 1 to the Expert Analysis of the Dubrovnik Shelling

Difference between table and real firing condition values of range and probable dispersion patterns of 82 and 120-milimetre mortar shells

The Prosecution witness Poje Jožef in his document entitled "Report on the Case Strugar et al.", in B/H/S, pages No. 02992787 to 02992819, and Addendum No.1. to the Report, pages No. 03540263 to 03540272 dated April 1, 2004 and Addendum No. 2 to the Report, pages No. xxxxxxxxxxxx to xxxxxxxxx xxx dated x May 2004 dealt with a number of target and mortar positions and arrived at conclusions unfounded in the Theory and Rules of fire and not in compliance with dispersion patterns related to range and individual hits and values regulated by Technical conditions for acceptance and assessment of quality of produced series of 82 and 120-mm mortar shells of Yugoslav origin, accepted according to the set standard marked SNO 2369/84. We feel it is necessary to point out in particular that the above conclusions did not take into consideration the real conditions prevailing in the region of Dubrovnik on the day of December 6 1991.

We shall deal with the following errors the Prosecution witness revealed in his testimony before the Trial Chamber of the Tribunal on May 10, 11 i 12 2004:

1.-That the probable dispersion patterns in terms of range and direction under real conditions of firing are equal to their table values;

2.-That the difference in altitude between the firing position of mortars and the target has no influence upon the size of dispersion ellipse of a mortar shell;

3.-That the slope of terrain in the target region, either rear or front, the value of which being around 20 degrees[1] has no influence upon the size of dispersion patterns of mortar shells since the angle of impact of the shells is too high;

4.-That the weather conditions prevailing at the time and place of firing have no significant impact on the size of dispersion patterns;

5.-That the mortar group (platoon or company) firing has no influence upon the size of dispersion patterns;

6.-That by correction of fire all errors of preliminary elements of firing are eliminated and that all deflections from range and probable dispersions given in tables are the grounds for drawing such conclusion.

We shall deliberate, in detail, upon the facts not taken into consideration by Poje Jožef, the error resulting in inaccurate conclusions with respect to selected targets and artillery pieces positions taken into consideration in Addendum No.1 and Addendum No.2.

The witness did not consider the following facts in his conclusions:

1[1] Transcript in English, May 12 2004, from page 22, line 22 to page 32, line 10.

1.-Range dispersion and probable dispersion in terms of range and direction Firing Tables

Firing Tables are prepared for each and every system of weapons and ammunition. In case one system of weapons uses several types of ammunition, Firing Tables necessarily include numerous data which shall provide for successful targeting of selected objectives by any ammunition of choice.

When prepared, the Firing Tables contain a certain degree of error[2] followed up during the use of the particular weapon and ammunition in test firing and, based upon the results of such firing, the errors are corrected by issuing enclosures or simply by changing the original Firing Tables.

Based upon technical conditions for acceptance of serial production of ammunition, particularly with respect to mortar shells considered in this case, the following norms have been prescribed:

1.1 Range at mortar shell acceptance test firing series (rates)

The standards of People's Defense SNO-2369/84[3] stipulate that the firing range of mortar missiles may deflect, upon summarizing of test results in the form of Table conditions , up to "2.6% of the Table range.

Acceptance of serial production of mortar missiles is performed by test firing under the firing angle of 45^0, that is, by selecting the maximum range for the selected ammunition.

1.2 Probable range and direction dispersion

The Standard of the People's Defense SNO-2369/84 stipulates that probable dispersion of a group of fired mortar shells can be more than 1.5 times larger than the set table value of Vd_t.

If during the testing of a group of mortar shells, the probable dispersion proves to be more than 1.5 times Vd_t the test firing is extended to include two more groups of mortar missiles, on the same day, and the median value of probable dispersion for all three fired groups of mortar missiles needs to be lower or equal to 1.5 times of the Table value of probable dispersion of Vd_t .

If, upon test firing of 15 to 20 groups of mortar missiles the realized probable dispersion is, for example, bigger than 1.2 times of the table value, then the set condition for acceptance of mortar missiles must be changed by increasing the table value of probable dispersion by 1.8 times.

Conclusion:

Under real conditions of firing, even upon adjusting firing results to conform to normal conditions, i.e., at thorough understanding and taking into account all parameters necessary for calculation of corrections, technical state/condition of artillery pieces and ammunitions, ballistic and weather information/data, there is deflection of range from the set table value.

Also, the probable range and direction dispersion is different from that stated in the Table and it can, even in the course of acceptance test, be up to 1.8 times larger than the table values, i.e., much larger than the Table values under real conditions of firing.

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[2] Balistika (Ballistics),textbook for Military Academies and secondary military schools, artillery department, J.Vilicic,, M.Gajic, 1979,UA-214-SSNO, page.421

[3] SNO 2369/84 is the standard of the people-s defense-technical conditions for ballistic testing at acceptance test firing rates of mortar rounds, Enclosure 1. to this Addendum of the Expert Analysis.

2-Impact of altitude difference between firing position and target region.

In case the firing position is at a higher altitude than the target region, the probable range and direction dispersion shall be larger than if both the firing position and the target were at the same altitude.

For instance, during the 120-milimetre mortar M75 firing using a TF missile 120 mm M62P3 from a position 300m higher than the location of the target, the probable dispersion pattern for the range of 5700 meters (the firing range from the firing position VP_1-Ledenica at the altitude of 335 m is higher by approximately 3%, without taking into consideration possible impact of rear slope of terrain of the target region upon the value of the probable dispersion.

3.- Impact of target region inclination upon probable range and direction dispersion pattern

Dispersion pattern of a hit is smaller if the target is located on the slope facing the fire direction than if the target is located at a horizontal location.

Dispersion pattern increases if the target is located on the rear slope depending on drop angle of the projectile-mortar missile and the degree of the rear slope the target is located on, with respect to the horizon[4].

Size of dispersion ellipse increases with increase of range, i.e. decrease of falling angle of a mortar shell and increase of the real slope of the target region.

Probable direction dispersion is always larger at side slopes with respect to the horizon.

Example:

Probable position of PA artillery is approximately 100 m north of the Old City walls toward the so called Adriatic motorway the altitude of which is 80 m and which is about 200 m far from the Old City walls. When firing at this firing position from the 120-mm mortar position located in the region of Ledenice at a distance of approximately 5600 m, the falling (impact) angle of a 120-mm mortar missile M62P3 is 1125 one-thousandths or 67.36 degrees.

The rear slope of terrain is n= 80/200= 0.4, i.e., the slope angle is 21.8 degrees. The coefficient of dispersion increase per range is λ_2= 1.25 so the probable dispersion per range of Vd compared to the table value is larger and amounts to: Vd_n= 1.25xVd_t = 1.2x35= 44 m. This means that in the given example, increase of range dispersion due to existence of a rear slope in the target region is 25,7%.[5]

4.-Impact of weather conditions upon dispersion and deflection of mortar missile trajectories

Due to their construction characteristics, mortar missiles are particularly prone to impacts of longitudinal and side winds. Since trajectories of mortar missiles are extremely curved, compared to other projectiles,(as a consequence of firing under angles of 45^0 to 85^0) ordinate of the trajectory apex for each range is much higher than for other projectiles. This means that mortar missiles fly in the higher levels of atmosphere. It is a common knowledge

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[4] *Expert analysis of the Dubrovnik shelling, page 24 to 26*

[5] *For the given example, Poje Jozef stated before the Tribunal in his testimony given on May 12 2004 that, due to high falling angle of a mortar missile, increase of dispersion ellipse is insignificant. Transcript dated May 12 2004, from line 22 page 22 to line 10 page 32.*

that the wind speed changes with altitude and that winds at high altitudes can achieve speed several times higher than ground/surface winds.[6]

Since on December 6 1991 the region of Dubrovnik was exposed to the strong 'bura' wind[7] and based on hydrographic measurement and the average speed in the previous ten years of measurement in the region, the wind force was in the vicinity of 3 Beaufort[8]. According to video records and registered tree movements the assessed force of the bura wind was up to 6 Baufort (thick branches are swaying), i.e., between 10.8 and 13.8 m/sec.

According to the table of correlation between ground/surface and high-altitude wind in the winter time, it would be real to assume that on December 6 1991, from 7 a.m. to 11.30 a.m when shells ceased to fall inside the walls surrounding the Old City of Dubrovnik, according to enclosure 18, the ballistic wind was 4 to 5 times stronger than the surface wind.

Note:

The bura wind is of changeable/unstable intensity and direction and it blows in bursts. Its main direction, however, is northeast from the coast towards the sea.

For the JNA mortar firing positions dealt with in the Expert analysis, deflection from original direction of certain projectile trajectories under impact of the side wind blowing at the speed of 10 m/s[9] is, for 82 mm mortar shells up to about 100 meters and for 120 mm mortar shells up to 140 meters and, in case of longitudinal wind blowing at the speed of 10 m/s, range deflection for 82 mm mortar shells is from 80 to 150 meters and for 120 mm mortar shells from 210 to 225 meters.

Conclusion:

The impact of side and longitudinal winds under conditions prevailing on December 6 1991 when the wind force was about 6 Beaufort, with unstable intensity and direction must have resulted in deflection of trajectories of a certain number of mortar shells in terms of both direction and range (which in turn resulted in considerably higher values of probable dispersions in terms of range and direction than the values given in the Firing tables.

Note:

If the wind force of the bura is 6 Beaufort, i.e., surface wind from 10.8 to 13.8 m/s, the high altitude wind would be of the intensity of 40 to 50 m/s, the consequence of which would be a four or five times higher value of dispersion in terms of range and direction.

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[6] Tables of correlation of ground and high wind, Enclosure 18.to the Expert analysis of the Dubrovnik shelling.

[7] This was confirmed by the Prosecution witness DJelo Jusic in his statement given on February 22 2004, transcript, page 3105, line 19-22

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19          THE WITNESS: [Interpretation] Now we're going to see the shells
20    falling on the Old Town.  You can hear the strong wind blowing then.  This
21    is the bura wind that is famous in Dubrovnik.
22          We can go on now.
23          MR. KAUFMAN:
24       Q.    Yes, sir.  We're about to hear some noise and I didn't want you to
25    be speaking whilst we hear the noise.  The bura wind that you mentioned,
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[8] Enclosure 4 to the Expert analysis of the Dubrovnik shelling.

[9] In the Expert analysis of the Dubrovnik shelling it s assumed that the ballistic wind was 10 m/s i.e., that the average speed of ground wind was 2 B. or about 2 m/s which is considerably lower than the actual force of the wind on December 6 1991.

5.-Value of dispersion pattern at group (platoon or company) firing

The Expert analysis of the Dubrovnik shelling gives a detailed description of errors possible at execution of fire by mortar platoon-company.[10] According to the theory of targeting/firing used by witness Poje Jožef as the ground for his work, the deflection of median hits when firing is executed by two artillery pieces simultaneously under ideal conditions is at least up to 3 Vd-of the probable dispersion in terms of range and direction.[11]

6.- Correction

Since the total error in preparation of starting firing elements for abbreviated and simple preparation of starting firing is considerable and amounting to numerous table values of probable dispersion in terms of range and direction, it is necessary, for the purpose of neutralization of a selected target, to perform a correction of the starting elements based on obtained results of firing and observation of hits. Depending upon the character and position of the target, the correction can be performed by means of assessment of impact of hits or by measurement of hits.

If a target is hidden/covered as was the case in Dubrovnik on December 6 1991, correction was possible to perform by observing smoke occurring after explosions of shells and thereby assessing possible shortfalls or overthrows with respect to the intended target.

Firing is executed at a range for which the preparation of starting firing elements has been performed. In such a case of correction, the target position shall be, with the probability of 100%, within the dispersion pattern value of: in terms of distance "8xEx and in terms of direction "8xEy, where Ex and Ey stand for median errors in preparation of starting firing elements in terms of distance and direction. Their values depend upon the method applied in preparation of starting firing elements. Since at the time of the Dubrovnik operation, in the region of Dubrovnik, conditions for complete preparation of such starting firing elements were less than adequate, all deliberations/conclusions in the Expert analysis have been made in terms of preparation of starting firing elements using the method of ***abbreviated*** and ***simple*** preparation.

However, due to the very strong bura wind on December 6 1991, the impact dispersion was extremely large. Thus, the conditions for correction by means of assessment of hit were also extremely unfavorable, primarily because observation of accuracy of impact of mortar shells based on location and width/extension of smoke was highly limited and inaccurate due to the strong surface wind.

Observation and correction of mortar fire from the positions in the region of Ledenice and Rajčevići was performed from the observation post in the region of Žarkovica. In spite of good visibility of the Old Town of Dubrovnik, observation of the DOS mortar positions was extremely difficult since the positions were shielded and located behind the walls and in the wooded part of Dubrovnik. This excluded the possibility of execution of targeting correction by means of calculation of distance and gradual closing in on the target as foreseen for such cases.

Depending upon observation of a hit, whether a shortfall or an overthrow, the next adjustment (('jump') of a range adjuster is done by the value of a single median error value with respect to range Ex. For the selected targets C-1, C-3, C-4, C-5 and C-6 the median errors for a abbreviated/simple preparation are in the vicinity of 140 to 160 meters. For that

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[10] *The Expert analysis of the Dubrovnik shelling , page 31.*

[11] *Theory of firing , Zivanov, page 272.*

reason, for the next a range adjuster 'jump' of 200 meters,(without any impact of side and longitudinal wind on a single weapon), after the performed correction, the minimal dispersion pattern of 11 Vdt in terms of direction of fire is obtained. For more than one weapons, at group firing, the size of a hit dispersion pattern in terms of range is up to 14 Vdt. If, on top of that, one adds individual dispersion of trajectories due to side and longitudinal winds, then deflections measured for the targets dealt with in the Expert analysis of the Dubrovnik shelling, regarding 82 millimeter mortar shells, in terms of range, are up to 150 meters and in terms of direction, up to 100 meters. Deflections of 120 millimeter mortar shells, in terms of range, are up to 225 meters and, in terms of direction, up to 140 meters, which means that the dispersion patterns under real conditions of fire are considerably larger than the dispersion patterns obtained by the use of table values of probable dispersion in terms of range and direction.

Poje Jožef's general conclusion as stated in the Report and Addendums No.1 and No.2

The approach of the witness Poje Jožef in consideration of dispersion, median hit and region of target position, i.e. hits that occurred as a result of mortar fire at selected objectives the witness listed in Addendum No.1 and Addendum No.2 to the 'Report on the case Strugar et al.', ***does not conform to the basic postulates of the Theory and Rules of firing*** *and to* ***the real conditions prevailing in the region of Dubrovnik on December 6 1991*** *in particular,* ***and therefore it cannot be deemed relevant as such.***

Conditions and assessments the witness failed to take into consideration and which are defined in 'Teorija gadjanja' (The Theory of Firing) written by Živojin Živanov, VIZ, 1979, Belgrade the textbook the witness referred to are as follows:

a.-Characteristics of the law of dispersion[12]*;*
b.-Impact of terrain inclination upon dispersion;[13]
c.-Dispersion in case of group firing;[14]
d.-Errors with abbreviated/simple preparation[15]*;*
e.- Errors due to difference in meteorological conditions[16]
f.-Simple preparation[17]*;*
g.-Correction[18]*;*
h.-Accuracy of elements defined for the start of group fire[19]*;*
i.-Impact of accuracy of elements on artillery group firing[20] *and*
j.-Errors at execution of battery firing (mortar platoon)[21]

All the above quoted is stated in detail in the Expert analysis of the Dubrovnik shelling.

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[12] *Teorija gadjanja, (The Theory of Firing) Zivanov, p. 198*
[13] *Teorija gadjanja, Zivanov, p. 201*
[14] *Teorija gadjanja, Zivanov, p. 205 i p.212.*
[15] *Teorija gadjanja, Zivanov, p. 248..*
[16] *Teorija gadjanja, Zivanov, p. 251.*
[17] *Teorija gadjanja, Zivanov, p. 253.*
[18] *Teorija gadjanja, Zivanov, p. 255.*
[19] *Teorija gadjanja, Zivanov, p. 387.*
[20] *Teorija gadjanja, Zivanov, p. 426.to 428, Table 62.(p. 427)*
[21] *Teorija gadjanja, Zivanov, p. 429.*