Application support for Topographical-geodetic issues for Tactical and Technical Control of Artillery Fire

Martin Blaha, Karel Šilinger

***Abstract*—**This paper is focused on suggestions and recommendations for suitable guidelines for fulfilling of The sketch of topographical-geodetic connection and aiming guns through line rod in the prepared firing positions. This method belongs to the fast and accurate Aiming works into the main firing direction, and consequently the target. This paper contains table of contents and method of "The sketch of topographical-geodetic connection" fulfilling. Moreover, this article aims to clarify the issue Aiming guns through line rod and show new possibilities for their placement. Stakes are still standard placed before or after the cannon in the main direction of fire. In case it is not possible in this way to place stakes can be positioned also in another direction as described in the article. With the change in tactics deployment works in firing positions, the guns are no longer on the linear line and therefore can deploy stakes in direction and eventually left to right cannon. The paper gives the instructions for the respective commanders also use those spaces that are not typically used to Aiming guns into the line of fire through line rod. Paper explains the general principle of targeting guns by line rod, particularly for 152 mm ShKH vz.77. The paper presents problems of current Artillery communication and information system and suggests requirements of the future system.

***Keywords*—**Artillery, Decision-making process, software development, Command, Control and Information System, C2I, Artillery direction finding through line rod, cannon, grid azimuth.

I. Introduction

THIS paper is focused on Application support for tactical and technical control of artillery units, especially on Topographical-geodetic data. Artillery units of the Army of the Czech Republic, reflecting the current global security neighborhood, can be used outside the Czech Republic. Fire position and artillery reconnaissance emplacement data (Topographical-geodetic data) are simultaneously basic sources for technical fire control and indispensable information in command and control of units of artillery support. The paper presents principles, evolution and calculation in the process of complete preparation.

The paper also presents problems in process of complete preparing of fire especially problems in permanently information (firing table) and calculated values. The paper presents problems of current Artillery communication and information system and suggests requirements of the future system.

The target of topographical-geodetic preparation is to discover data for calculation of elements for firing, except the supply of artillery by required topographical-geodetic data and information. Topographical-geodetic authorities have to fulfil a whole range of measures and to execute topographical--geodetic connection of elements of combat formation for fulfilling this task. Results of this activity are entered to documentation which should be unified for all the artillery of AČR. The basic document containing all the essentials data for control and command of artillery's fire is "Topographical-geodetic sketch of connection".

Aiming master gun into main direction of shooting with stakes is one of the most common used ways. It is a accurate and fast way, which enables us to shorten time of master gun staying in emplacement before executing a fire. With stakes is possible to aim even the other cannons, which is known under term: "adjustment of parallel fan".

Shortening of time period of cannons staying in emplacement is obtained by accomplishing preparatory work of reconnaissance group in the selection and preparation of emplacement, which is done by optical angle measuring device demarcation of main direction of shooting from point of emplacement of the cannon, which is designed by auxiliary stake. Pair of stakes is placed in marked direction in lengths of 20 – 40 m or 80 m..

II. Table of Contents of "The Sketch of Topographical-Geodetic Connection"

A. Topographical-geodetic connection

"The sketch of topographical-geodetic connection" is an official document and a part of battle documentation for unit's commanders and of all command level's staff. Formal content of document's head has to fit the publication STANAG 2014 Order's structure. There is an example of head fulfilling in scheme:

1. line: to write down which copy from total number of copies it is about (e.g. copy nr. 1 from 5 copies),

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2. line: to write down the name of headquarters of unit, whose unit discovered data contained in the document and made this document (e.g. Headquarters of 131. Artillery's battalion),
3. line: to write down name of area where the mentioned headquarters was situated at the time of publication of document (e.g. Brno),
4. line: to write down the time of processing of document in compliance with STANAG 2014, the form: day, hour + minute + time zone, month (English abbreviation, e.g. 26 01800A FEB, which means 26th February at 18:00 of Central European Time),
5. line: to write down the negotiating number under which the document is registered (e.g. 12-8/1564-2010).

Below the document's name "The sketch of topographical-geodetic connection" (which does not change), there is written the specification of element of combat formation, for which the document is processed. It could be the emplacement of the master's gun of platoon (termed as the platoon's fire position in the document), for observation post of unit of artillery's reconnaissance (observation point – OP) or fire position of fire system (system emplacement). The author will specify the element of combat formation by blacking these unsuitable names out. Then he will fulfil a map scale number, which he used during measuring and processing of the scheme of orientation directs.

The scheme of orientation directions contents schematic drawing of connecting of element of combat formation, and points of map where the orientation bearings were detected, with values of bearing written down. Symbols are used in drawing. The scheme is oriented on the basis of comparison of frame's shape for scheme to the real location of connecting elements of combat formation and land marks. It is necessary to mark out the north because of the terrain orientation. Also, it is appropriate to enter approximate distance to land marks (2,5 km, 300 m, etc.) which serve for easier point searching in terrain.

The three tables in the lower part of document are identical; the number of them is opted as needed. The tables content data necessary for tactical and technical fire control. The author fulfils the left part of 2nd line by numerical mark of elements of combat formation, for which the table is processed.

The angle coordinates and an altitude of element of combat formation (E, N, A) are written into next lines of left part of the table. It is possible to re-count discovered coordinates into adjoining zone (E1, N1), in compliance with combat order of commander of task force (TF); and to calculate correct of bearing for adjoining zone -$\Delta\alpha$.

The author has to mark out the zone into which he re-counted the coordinates by blacking the unsuitable variant out in the 4th line of table. The procedure of recalculation of coordinates into adjoining zone in the system WGS-84 is developed by specialists of Military geographic and hydrometeorological authority in Dobruška. Discovered or recalculated coordinates are inserted into "Combat formation" form and serve as bases for calculation of topographical distance, direction to target, elements for completely prepared firing and correction of range.

An important detail is a determination of precision of specified values as well. The precision of coordinates is entered in meters and precision of bearings in artillery quantity. These values serve for assessment whether the conditions for complete preparation are met or not. The precision is set by functionary, who was looking into these values, according to used sources, devices and methods. It is proper to prepare methods for determination of precision of detected coordinates and orientation directs depending on used sources for this purpose.

There is a value of distance between fires systems (in meters) mentioned in the 1st line on the right side of the table. There are written values of discovered orientation bearings below that. These are values discovered from compass position of commander of fire platoon to main, alternate and night land mark. Except for that, there are mentioned bearings (angles) differences between main and alternate land mark, and between main and night land mark as well. These values will be used for calculations of value of basic sides to land marks for the case that necessary to lay by one of current ways. Weapon sets using AFCS-ASPRO will have its own automatic system securing independent orientation of system and laying of barrel at target direction on the basis of autonomous discovered bearing of vehicle axle and of the system sources. The orientation bearings are not necessary for artillery reconnaissance resources, by which are artillery reconnaissance units equipped currently, due to their capability to orientate themselves.

There is another data on the right side of the table. These values are: elevations of top of cover under fire position and the distance to cover. This is biggest elevation of cover measured from the fire emplacement of systems in the direction of main direction of fire and to its right and left side. The procedure is next: To calculate bearings of left and right fire lines, i.e. bearings from the emplacement of the master's gun of platoon (battery) to left and right point of line of observation point.

Angle coordinates of left and right side of line of observatory point are the sources, acquired from combat order of commander of TF and the angle coordinates of the master gun of platoon (battery). Difference between calculated bearings will be divided by three, which will divide the sector of fire of platoon (battery) into 3 the same parts. Value of obtained angle will be added to the bearing of left line of fire and it will cause acquiring of the left sector of fire in which necessary to discover biggest elevation of cover, adequate to biggest position angle of top of cover for every gun.

The distance to cover with biggest elevation in left sector

will be discovered and position angle of top of cover and both values will be written to appropriate columns of table. It will be acted similarly when calculating for middle and right sector of fire. The middle sector is named MD (main direction), left sector MD – to the left, right sector – to the right. These values will be used by functionaries when technical controlling of fire for calculation of shoot over distance when firing with particular charge in the following way:

1. To discover the distance of locator (from fire tables) adequate to distance to cover for specified charge.
2. To add discovered position angle of top of cover to the value of distance.
3. To divide the quadruple of probable altitude difference (adequate to discovered distance of locator) by the distance to cover (in kilometers) and to add it to calculated value.
4. The result is value of minimal distance of fire with particular charge for that sector of fire.

For firing on particular target, the shoot over distance will be detected automatically by a forward looking weapon sets by comparing altitude of points of trajectory of flying projectile to altitude of terrain objects lying in vertical going through direct plane, obtained from digital map basis.

The shoot over distance will be calculated for every projectile individually. It will ensure that the cover will not be reached even in the case of changing of direct during the adjustment, or repairing of fire for effect or changeover to another kind of projectile when firing.

The author will describe points of orientation directs below the graphic part of document so that other user (usually commander of firing platoon) could find them easy and use them for orientation of his device and for control of detected values and so on.

The commander of topographic (reconnaissance) squad (group) will include his rank and surname below these tables.

These information indicate that table for topographical--geodetic connection will contain following data in the case of new weapon sets: coordinates of emplacement of every weapon set for particular fire and their precision, bearing of vehicle axle and its precision, coordinates re-calculated into established neighboring zone and correction of bearing for neighboring zone -$\Delta\alpha$. These tables will be made in electronic form by automatic system in number adequate to current number of elements of fire control system. The system will save all detected data about all elements of combat formation just in case to re-use it, subsequent control and so on. It will be possible to print it with all formal data for when necessary to control the fire in replacement way or need to register document.

B. Reconnaissance and target acquisition (TA)s

Fire Publication Pub-74-14-01 sets, that for complete preparation target coordinates must be set with a maximal probable circle mistake of 50 m. This is conditioned by carrying out the following requirements:

- Targets must be found in bounds of effective range of artillery (TA) instruments (DPz).
- Reconnaissance emplacement has to be desired geodetically, by GPS or topographically via a map and by using instruments or by using navigation instrument.
- Orientation bearings have to be set gyroscopically, astronomically, geodetically with possibility of switching a bearing, or magnetically including rectification of compass set in the distance of 5 km from emplacement. [3]

The term “effective range” of instrument is not defined anywhere. But it can be characterized as a distance at which it is possible to reliably acquire the target data necessary for artillery fire. Technical range of artillery TA optical instruments is mentioned in the table 1. However, acquisition of targets at the instruments maximal technical range is unreal, since above 10 km it is not possible to precisely identify objects.

That means unreliable determination of target (if the target is a person, animal, civilian or a soldier, military or civilian vehicle, etc.). This is given by optical attributes of instruments (mainly magnification) and by possibility of “detection” of object by using optical instruments mentioned in table 1. It is necessary to bear in mind that detection means discovering the object (a person, personal vehicle, helicopter, etc.), not its determination. So it is necessary to count with an effective range of current optical instruments used by artillery units on its effective range up to 10 km.

In the case when new artillery TA instrument is established with such attributes, which allow this instrument to identify targets on distance above 10 km, this instrument will have to meet more strict norms on orientation accuracy so that spatial norm for determination target coordinates will not be exceeded.

The mistake for setting coordinates of emplacement for PzPK Sněžka using navigation instrument is 0,2% of the driven distance. This means, 20ms fault of 10 km movement. A probable mistake for setting the target coordinates by using a radar type SCB 2130 L-2 is 10 m in a distance and 2 units of an artillery quantity in a direction. The mistake in distance is constant and this accuracy is invariable with increasing distance.

The mistake in direction increases with increasing distance and at the distance of 15 km the mistake is of 30m. In a case where PzPK is moving on a distance of 10 km, the setting of target coordinates accuracy for complete preparation for targets in a distance above 15 km would not be allowable. If the PzPK emplacement position determination is more accurate and it is set on a value of 0,1% of driven distance, the target coordinates determination accuracy will be allowable for the target distance up to 20 km.

From the mentioned dependences it is possible to deduce a relation for calculation of maximum target distance from an emplacement for PzPK Sněžka:

$$d_p = ½ [50 – (0{,}002 \times d_{př})] \quad (1)$$

where:
d_p….. observer distance;
½……constant, invert value of probable mistake for setting target coordinates using radar type SCB 2130 L-2 in direction (2 dc);
50…..constant, characterizing maximal mistake for setting target coordinates in direction in meters, which results from maximal probable circle mistake for setting target coordinates;
0,002…constant, characterizing a mistake for setting emplacement for PzPK Sněžka coordinates using navigation instrument (0,2 %);
$d_{př}$….movement distance before taking observer emplacement by PzPK Sněžka in meters.

A calculated observer distance (d_p) is possible to take for an effective range of radar SCB 2130 L-2.

The probable circle mistake for setting target coordinates, detected by radar ARTHUR in range of its technical possibilities, is 50 m including mistakes of its own positioning, which meets the requirement for APF. Effective range of radar ARTHUR is identical to its technical range. [2]

The accuracy of artillery TA instrument positioning (setting coordinates) is defined with table T-2.1 in publication Pub-74-14-01. From this publication it is clear that the artillery TA emplacement has to be pinpointed with the same accuracy as gun firing positions. This means, up to 40 ms in length and 3 units of artillery quantity in orientation direction.

In the case of compliance with the mentioned requirements, the conditions for determining target coordinates for APF are met. An artillery observer has to count on described values (target coordinates determination accuracy and artillery reconnaissance instrument positioning) and in the case of call for fire (CFF), according to CFF in ASRPP-DEL, he will declare information “accurate” or “inaccurate”, mentioned behind the figure target position

III. Current Variants of Stake Placement Used in Conditions of AČR (Czech Republic Army)

According to regulation „Artillery ground service‘‘ (Děl 3-1) are stakes placed in following directions from auxiliary stake:

a) directly into main direction of firing, in front of the cannon. For aiming into HS is set value of basic side 30-00 (dc) on cannon telescope, as shown on figure 1,

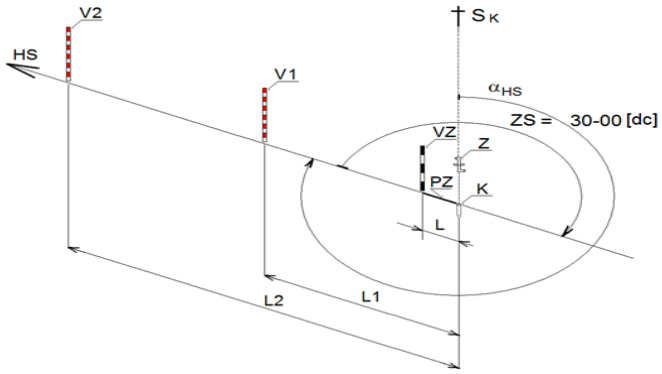

Fig. 1 Placement of stakes for aiming into HS in front of the cannon

Legend of Fig. 1:

HS – main direction (of fire),
K – auxiliary stake,
L – distance between auxiliary stakes, length of auxiliary tape (3,6 m for 152mm SHkH vz.77),
L1 – distance between auxiliary stake and closer stake,
L2 – distance between auxiliary stake and further stake,
PZ – auxiliary tape,
SK – north mileage,
VZ – stake,
V1 – closer aiming stake,
V2 – further aiming stake,
Z – sights with cannon binoculars,
ZS – basic side,
αHS – bearing of main direction.

b) in reversed direction of main direction of shooting, behind the cannon. For aiming into HS is set value of basic side 0-00 (dc) on cannon telescope for indirect shooting. As shown on figure 2.

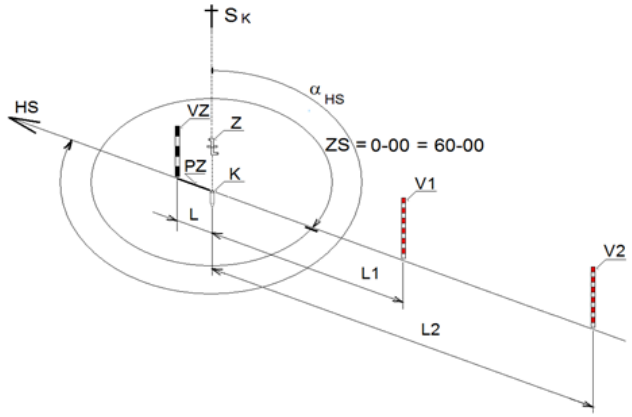

Fig. 2 Placement of stakes for aiming into HS behind the cannon

Legend of Fig. 2:

HS – main direction (of fire),
K – auxiliary stake,
L – distance between auxiliary stakes, length of auxiliary tape (3,6 m for 152mm SHkH vz.77),
L1 – distance between auxiliary stake and closer stake,
L2 – distance between auxiliary stake and further stake,
PZ – auxiliary tape,
SK – north mileage,
VZ – stake,
V1 – closer aiming stake,
V2 – further aiming stake,
Z – sights with cannon binoculars,
ZS – basic side,
αHS – bearing of main direction.

IV. Non-standard option of placement of stakes

In new tactical principles is preferred placement of cannons with distance between them, while keeping distances between cannons 30 – 50 m. That allows placement of stakes even from the side of the cannon without covering sight on the further stake by neighboring cannon.

New possible way of placement of the stakes is shown on the picture figure 3.

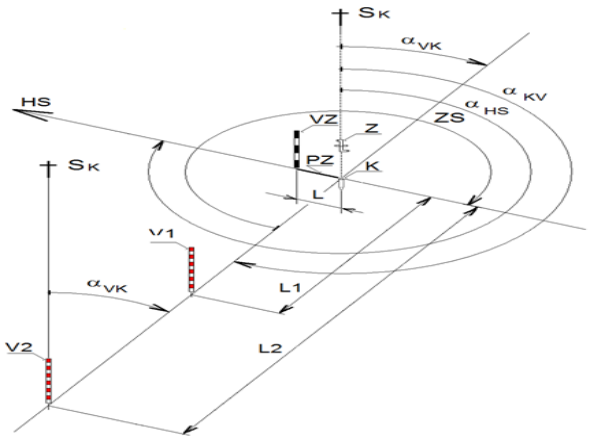

Fig. 3 Aiming the cannon into main direction of shooting (HS) while stakes are not in the HS

Legend of Fig. 3:

HS – main direction (of fire),
K – auxiliary stake,
L – distance between auxiliary stakes, length of auxiliary tape (3,6 m for 152mm SHkH vz.77),
L1 – distance between auxiliary stake and closer stake,
L2 – distance between auxiliary stake and further stake,
PZ – auxiliary tape,
SK – north mileage,
VZ – stake,
V1 – closer aiming stake,
V2 – further aiming stake,
Z – sights with cannon binoculars,
ZS – basic side,
αHS – bearing of main direction,
αVK – bearing from stakes on auxiliary stake,
αKV – bearing from auxiliary stake on stakes

A. Conditions for placement of stakes, which will not be in the auxiliary axis, in the preparation of emplacement

Choice of placement of the stakes depends on the terrain in emplacement. Following conditions must be fulfilled:

- stake and auxiliary stake must be on the same line, which is same as main direction of the shooting,
- both of the stakes must be visible at the same time from cannon telescope,
- both of the stakes must be placed into ground in the way, that prevents their tilting,
- stakes that belong to certain emplacement of the cannon must not be changeable with other items in that area,
- bearing of the main direction is rounded on hundreds of lengths (dc), and that is why regulation (Děl-3-1) states, main side set on cannon telescope for aiming of the cannon into main direction is in whole hundreds of lengths (dc).

B. Procedure in preparation of emplacement for aiming the cannons (cannon) with stakes, if the stakes are not in the auxiliary axis (main direction of shooting).

Work of the reconnaissance group in selection and preparation of emplacement is same as the standard.

If the commander of the reconnaissance group with regard on local conditions cannot place stakes in the auxiliary axis, he will choose proper bearing where it would be possible to place the stakes.

If the stakes cannot be placed in the main direction of the shooting, the procedure follows:

- reconnaissance group will first choose and set on the angle measuring device bearing in hundreds lengths (dc), which value is defined in the direction from auxiliary stake on stakes,
- the stakes are placed in this direction,
- the basic side for aiming the cannon is calculated.

V. Basic side (ZS) calculation

For calculation of basic side value (ZS) can be used the formula, which is used for control of gun aiming by artillery compass.

$$\alpha_{HS} = \alpha_{BD} + ZS \tag{2}$$

Where:

α_{HS} - bearing of main direction,

α_{BD} - bearing from protractor device (artillery compass PAB-2A) to the middle of the objective of gun telescope,

ZS - basic side, the value of gun telescope which is directed to the middle of the protractor device objective (artillery compass PAB-2A).

Stakes are considered a distant point, by which the aiming to the main direction is carried out. Bearing from the stake (distant point) to the drive stake is , as you can see in the picture 3. Then it valid:

$$\alpha_{BD} = \alpha_{VK} \tag{3}$$

This relation is substituted for equation of (2).

$$\alpha_{HS} = \alpha_{VK} + ZS \tag{4}$$

It's valid:

$$\alpha_{VK} = \alpha_{KV} \pm (30 - 00) \tag{5}$$

Where:

α_{VK} - bearing from the stake (stakes, which covers each other) to the drive stake).

To the equal (4) the equal (5) is substituted and ad adjustment is carried out

$$\alpha_{HS} = (\alpha_{KV} \pm (30 - 00)) + ZS \tag{6}$$

Where:

α_{HS} - bearing of the main direction,

$(\alpha_{KV} \pm (30 - 00))$ - bearing from the stake (stakes, which covers each other), to the drive stake,

ZS - basic side, the value on gun telescope which is directed on stakes, when the barrel is in the main direction.

Basic side is calculated by adjustment of equation of (6)

$$ZS = \alpha_{HS} - \alpha_{KV} \pm (30 - 00) \tag{7}$$

For inspection of correctness of basic side calculation (ZS) it is possible to use artillery compass PAB-2A, which is placed above the drive stake.

Process of calculation inspection:

- artillery compass is placed and orientated to the kilometer north,
- value of bearing is set on black scale by direction turn knob,
- value 30-00 is set on adjustable red scale without breach of artillery compass aiming,
- bearing is set by direction turn knob, which tallies to bearing from drive stake to the direction, where the stakes are placed,
- value of basic side (ZS) is read on red scale, which is set on gun telescope after fire position positioning.

For placing (sticking) stakes in required distance, the crew of artillery compass guides the person with stakes to place the stakes to cover with aiming cross of gun telescope.

VI. Exercise

The artillery compass is placed above the drive stake of master gun and oriented to the bearing of main direction αHS = 51-00 dc. In this direction the stake of drive is placed and tape of drive is placed. Commander of reconnaissance squad (reconnaissance group) determined bearing α_{KV} = 35-00 dc (from drive stake to stakes) according to terrain. Calculate the value of basic side (ZS) for aiming of master gun to main direction (HS) using stakes.

The Solution is below:

Bearing from stake (stakes) to drive stake (α_{VK}) is calculated.

$$\alpha_{VK} = \alpha_{KV} \pm (30 - 00) \tag{8}$$

$$\alpha_{VK} = (35 - 00) \pm (30 - 00) \tag{9}$$

$$\alpha_{VK} = 5 - 00 \tag{10}$$

Bearing from stake to drive stake is α_{KV} = 5-00 dc.

From equation of bearing of main direction calculation where the gun is aimed (3) the basic side is calculated.

$$\alpha_{HS} = \alpha_{VK} + ZS \tag{11}$$

$$ZS = \alpha_{HS} - \alpha_{VK} \tag{12}$$

$$ZS = (51 - 00) - (5 - 00) \tag{13}$$

$$ZS = 46 - 00 \tag{14}$$

For aiming master gun to main direction αHS = 51-00 dc using stakes, which are placed (stacked) in the direction of bearing α_{KV} = 35-00 dc it is necessary to set the value of basic side ZS = 46-00 dc at gun telescope.

VII. Proposed Organizational Structure

The proposed new procedures and calculations assume adequate new organization structures for artillery units.

A. The Brigade Staff and directly subordinated units

Within the Arty Bde Headquarters (Arty BdeHQ), there is the Bde Staff, Surveillance and Target Acquisition Battery (STA Bty) and several headquarters´ supporting units (Log, C4I) under the direct authority of Bde Commander (Com Bde).

The Staff structure does not require fundamental changes. However, capabilities of the Intelligence Department of 5 personnel (pax), Operation Department of 7 pax and Planning Department of 5 pax are challenged. Those offices are currently tasked with the brigade garrison peace-time administration issues mainly and their capability as well as the personnel strength to support any operational deployment is questionable.

Beside the staff there is Surveillance and Target Acquisition Battery (STA Bty). However, any driving logic of its origin and composition is very disputable. The STA Bty consists of the Artillery Hunting Radar Platoon (ARTHUR Plt) of free radar sets, the Technical Surveillance and Target Acquisition Platoon (TSTA Plt) of six TSTA mobile systems and the Airborne Target Acquisition Platoon (ATA Plt).

The issue is the pre-defined role and affiliation of these troops. From the operational perspective, the ARTHUR Pltis placed well since the plt of three radar sets is design to operate as one package and should not be anyhow divided. On the other hand, six TSTA systems of TSTA Plt are capable of independent operations.

Thus, the platoon could be easily dispersed and the TSTA squads proportionally inserted into the brigade´s Artillery Battalions (Arty Bn). Moreover, such a step would comply with operational (ops) principle of having fire support means as low in the command and control (C2) chain as effective. Finally, subordination of ATA Plt to STA Bty is seen completely non-systemic.

The platoon is specifically designed to keep pace and provide TA for the airborne battalion of the Rapid Deployment Brigade (RD Bde). Well, it is apparent that the most effective solution is to insert the ATA Plt into the structure of Arty Bn affiliated with the RD Bde.

The so far research shows an argument for keeping under ARTHUR Plt under the ArtyBde HQ only. However, it should be moved into structure of ArtyBde HQ Company (Fig. 4).

On the other hand, the personnel and equipment of Technical Surveillance and Target Acquisition Platoon as well as the Airborne Target Acquisition Platoon should be transferred into structure of the Arty Bns. I this way the STA Bty commands no plts anymore and can be disbanded.

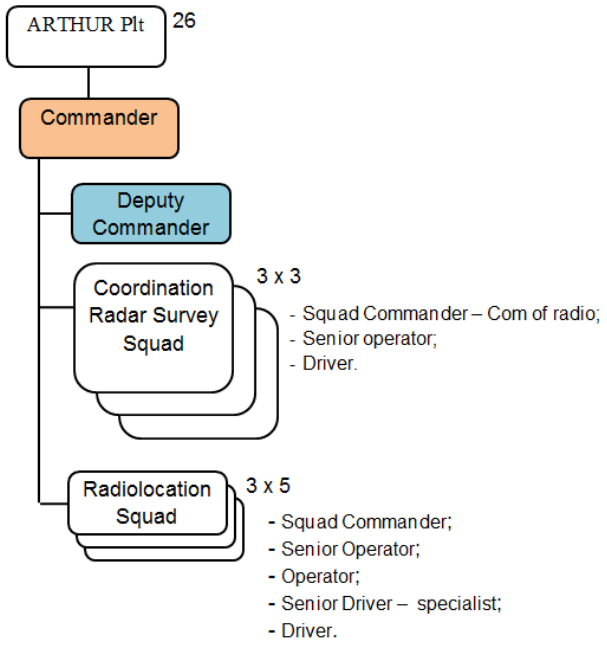

Fig. 4 - Artillery Hunting Radar Platoon

B. Artillery Target Acquisition Battery (ATA Bty)

The Artillery Target Acquisition Battery consists of 21 squads (91 pax). Each squad is equipped with FSDAS-Arty (Fig. 5). Five (5) of Fire Support Coordination squads (FSC) refers the number of FCS Groups/Centre (FSCG/C) to build up and incorporate into BCT structure (1 BCT FSC Centre, 4 BnTF FSC Group). This functionality is also reflected in composition of each squad. To ensure 24/7 supporting mode, it is recommended that one of the battle routine shifts will be run by the squad leader.

Due to this professional requirement, the squad leader should be Senior NCO in rank of Master Sergeant/Sergeant Master (OR5/OR6) with sufficient degree of education and experience or even junior officer (a squad leader standard rank of is Sergeant OR3, Junior NCO). The FSC Squad is equipped with utility vehicle, which can provide both transportation and working space.

Four (4) of Technical Surveillance and Target Acquisition Mobile Sets (TSTA MS) are tools predetermined to support BnTF level – one set per each of four BnTFs.

The squad personnel number is adopted as to effectively operate TSTA MS (TSTA MS “Snezka” in the particular case of CZE Army – 4 pax).

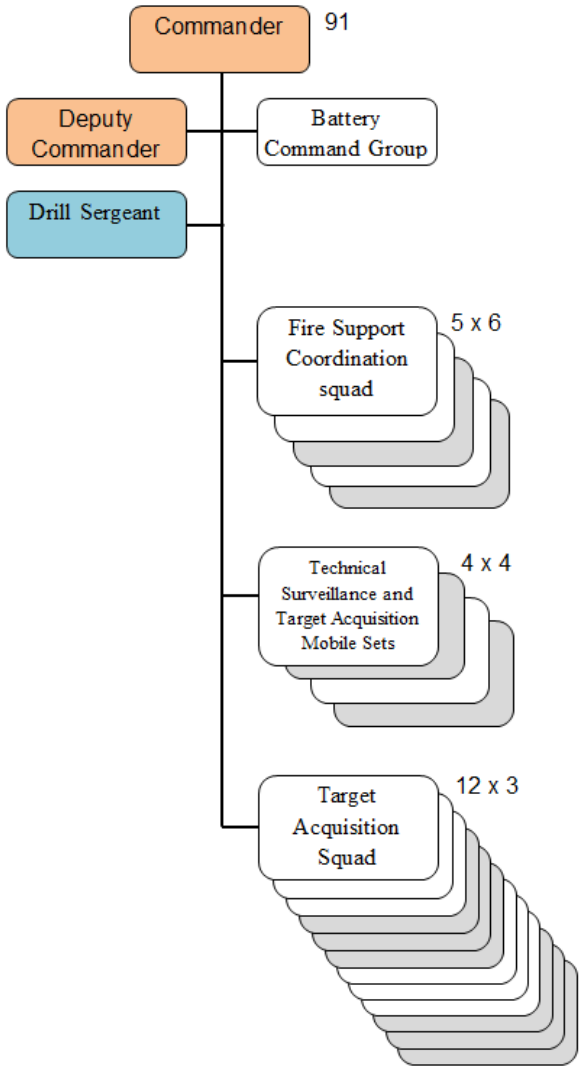

Fig. 5 – Artillery target Acquisition Battery

Twelve (12) of Target Acquisition Squads mirror the number of 12 maneuver companies or company size TFs they are to support (3 Coys per a BnTF). The number of squad personnel is adopted as to effectively operate the target acquisition mobile set (TA MS) actually in service (TA MS "LOS" in the particular case of CZE Army – 3-4 pax). The squad leader is to call for fire and collaborate with FDC and FSC Gp on the fire direction and the fire support coordination at a maneuver company level. Due to these professional requirements, the squad leader should be Senior NCO in rank of Master Sergeant/Sergeant Master (OR5/OR6) with sufficient degree of education and experience or even junior officer(a squad leader standard rank of is Sergeant OR3, Junior NCO).

VIII. Conclusion

A conclusion If "The sketch of topographical-geodetic connection" is made into text form, it will be necessary to meet the formal editing requirements in compliance with accepted allied publications. It has to contain data which enable user's quick and clear orientation in that and to utilize required information, e.g. when controlling fire in replacement way.

The document contains data obtained by realization of topographical-geodetic preparation under current circumstances considering new AFCS-ASPRO requirements. Proposed procedure when fulfilling document unites current principles of processing of "The sketch of topographical--geodetic connection" with requires for sources obtaining for automatic system of command and control of artillery's fire, in the form and precision which enable use automatic system fully.

Placement of the stakes for aiming into another direction than the main is used in following cases:

- in the main direction of shooting and opposite direction is not direct view on stakes,
- stakes cannot be placed in desired direction because of subsoil,
- stakes cannot be transported or placed in desired direction. (swamps, quicksand, high layer of snow, mined areas etc.).

Aiming of the main guns (gun) with stakes, which are not in the main direction of shooting, will be used in described specific cases. This type of aiming is not described in any literature. In general, stakes can be placed with any value of basic side.

In case of 152mm ShKH vz.77 will be the most appropriate basic side for placing stakes around 45-00, which is upright left from the axis of vehicle.

Using the value of 15-00 as basic side will be exceptional, because the aiming of the cannon is interrupted by loading device. That can be casted down, but it prolongs the time of aiming.

Appropriate interval of basic side for 152mm ShKH vz.77 for placement of stakes is 45-00 to 50-00, which is same as the recommended interval of basic side for attaching the collimator K1, which is used as locking point during impairment of visibility and during the night.

If "The sketch of topographical-geodetic connection" is made directly in system, i.e. only in electronic form, it will contain necessary data about particular elements of combat formation with their marking. Formal side of processing will be reduced. Data will be archived in system at least for a period of battle procedure due to needs of check back and so on.

The needs of automatic system show another need:

1. Processing of methods of detection of precision of detected coordinates and orientation directs depending on used sources, devices and methods.
2. Determination of process of re-calculation of coordinates into neighboring zone in system WGS-84.
3. Creation of methods of calculation of shoot over distance for calculated trajectory of projectile's fly using digital map basis.

4. Determination of request for capability of own position finding and orientation to kilometer's north, and then to the direct of target with precision enough for application of effective fire, on the basis of calculation of elements by complete preparation of new recently established weapon sets.

Main effort of topographical-geodetic preparation will be focused on period of preparation of combat, when necessary to enter all needed data into AFCS-ASPRO. During combat action, all the activity, related to localization of elements of combat formation and their orientation and also to calculation of shoot over distance when firing on particular target, will be done by automatic system in cooperation with reconnaissance systems and fire set of artillery.

It is necessary to keep the action of topographical squad (reconnaissance groups) to ensure obtaining of sources for artillery's fire in case that the automatic system of command and control of artillery will be out of order.

APPENDIX

LIST OF ABBREVIATIONS

ACR	Army of the Czech Republic
AFCS-ASPRO	Artillery Fire Control System - ASPRO
MD	Main Direction
STANAG	Standardization Agreement (unifying agreement)
TF	Task force
WGS	World Geographic System
BdeHQ	Brigade Headquarters
STA Bty	Surveillance and Target Acquisition Battery
Log	Logistic
TSTA Plt	Technical Surveillance and Target Acquisition Platoon
RD Bde	Rapid Deployment Brigade
FSC	Fire Support Coordination squads
TSTA MS	Technical Surveillance and Target Acquisition Mobile Sets

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