National Défense
Defence nationale

B-GL-361-001/FP-001

LAND FORCE ENGINEER OPERATIONS – VOLUME 1 (ENGLISH)

(Supersedes B-GL-319-001/FT-001 Engineers in Battle dated 90-05-31 and becomes effective upon receipt)

Issued on Authority of the Chief of the Defence Staff

Canada

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Canada

FOREWORD

1. B-GL-361-001/FP-001, LAND FORCE ENGINEER OPERATIONS, is issued on the authority of the Chief of the Defence Staff.

2. It is effective on receipt and supersedes B-GL-319-001/FT-001 Engineers in Battle.

3. Suggestions for amendments should be forwarded through normal channels to Chief Land Staff, attention DAD 8

4. Unless otherwise noted, masculine pronouns apply to both men and women.

5. The NDID for the French version of this publication is B-GL-361-001/FP-002.

PREFACE

AIM

1. The aim of Land Force Engineer Operations is to describe the policies and concepts for engineer operations in a theatre of operations.

SCOPE

2. The doctrine and concepts outlined in this publication are applicable to the tactical level of command in war and Operations Other Than War (OOTW). In certain situations the engineer doctrine and concepts may not apply or may be modified to fit the circumstances.

3. Engineer Operations details engineer operations at brigade and division level. This manual amplifies and complements both B-GL-300-001/FP-001 Land Force, Volume 1, The Conduct of Land Operations – Operational Level Doctrine For the Canadian Army, B-GL-300-002/FP-000 Land Force Tactical Doctrine and B-GL-300-003/FP-000 Command which are the foundation upon which this doctrine manual is based. Details on Corps engineer operations is outlined in the United States Army Field Manual FM 5-100-15 Corps Engineer Operations.

4. The terminology used in this publication is consistent with that of B-GL-303-002/FP-Z03, Army Vocabulary, B-GL-303-002/FP-Z07, Engineer Vocabulary and AAP-6 NATO Glossary of Terms and Definitions.

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CHAPTER 1
THE FUNDAMENTALS

SECTION 1
THE ROLE OF THE ENGINEERS

ROLES

1. The term engineer encompasses all military engineer support found in the theatre of operations. The roles of engineers are:

a. **The Primary Role**. To assist friendly troops to fight, move and live, and to denying the same ability to the enemy; and

b. **The Secondary Role**. To fight as infantry.

2. Military engineering covers a great variety of subject areas, and in one form or another enters into almost every activity undertaken by military forces. It extends from combat support tasks to construction in rear areas, and encompasses structural, civil, mechanical and electrical engineering. Military engineering can be classified as:

a. **Combat Engineering**. Combat engineering is conducted mainly in the combat zone and is primarily concerned with meeting mobility, counter-mobility and survivability requirements of the manoeuvre forces. Combat engineering is performed by close support units or in support of manoeuvre forces and general support units for the formation as a whole.

b. **Sustainment Engineering**. Sustainment engineering is conducted mainly to the rear of the forward manoeuvre elements and is primarily concerned with engineer work other than mobility, counter-mobility and survivability tasks provided directly to combat operations. Sustainment engineering tasks tend to be of a more permanent nature than combat engineering tasks and are usually designed with future developments in mind. General support units perform sustainment engineering.

3. To ensure speed in preparation for combat, to increase the speed of reaction and to enhance flexibility, the concept for employment of engineer support on the battlefield is to group engineers into close support and general support organisations. Engineer support utilising this concept is described as follows:

a. **Close Support**. That action of supporting forces against targets or objectives which are sufficiently near the supported force as to require detailed integration or co-ordination of the supporting action with the fire, movement or other actions of the supported force. Therefore, close support engineers are those units which provide intimate support (mobility, counter-mobility and survivability) to the commander of a manoeuvre unit or sub-unit to deal with tasks of immediate concern to his operations. The commander is provided with advice and communications from his close support engineers.

b. **General Support**. That support which is given to the supported force as a whole and not to any particular sub-division thereof. Therefore, general support engineers are those units which provide sustainment engineering (water supply, provision and maintenance of main supply routes, provision and maintenance of accommodations, utilities and services, provision of landing facilities, bulk water and fuel storage, etc.) to the formation as a whole. General support engineer units may also reinforce close support engineer capabilities in the support provided (mobility, counter-mobility and survivability) to units in operations. For example, general support reinforcement is provided to close support units in opposed water crossing operations and deliberate defensive operations. Finally, general support engineers provide mobility, counter-mobility and survivability support to division or corps level troops. This support is not considered to be close support because it is not in direct support of combat operations.

c. **Application of Close Support Concept**

(1) The combat engineer regiment (CER) is tasked and equipped to provide intimate support to the manoeuvre elements of its parent brigade or brigade group, and therefore, it is a close support unit. The commanding officer of the CER is the engineer adviser to the brigade commander for all engineer support within the brigade's boundaries. The squadrons within the CER will provide close support to the battle groups within the brigade. Close support units will deploy engineer staff to the supported headquarters to provide communications and staff advice; and

(2) The engineer support regiment (ESR) is a general support unit, which is tasked and equipped to provide sustainment engineering support to a formation (up to division level), to reinforce the engineer support provided by the close support units of the formation and to provide combat engineering support to the formation as a whole.

TASKS

4. Engineer tasks can be grouped within four combat functions:

a. *Manoeuvre* - maintain mobility;

b. *Protection* - counter-mobility;

c. *Protection* - enhance survivability;

d. *Sustainment* - sustainment engineering; and

e. *Information Operations* – geomatics.

MANOEUVRE - MAINTAIN MOBILITY

It is a truism that the prime duty of the sapper is to enable the Army to move, and to keep moving. A large proportion of engineer effort in a campaign is directed to this end, bridging, mine clearance, and above all road construction and maintenance.

Military Engineering (Field)
The War Office 1952

5. **Manoeuvre**. As the commander develops a concept of operations for the manoeuvre of the formation a balance will be struck in the application of firepower, protection and movement. The commander designates routes, avenues, or axis for manoeuvre units throughout the depth of the battlefield. In setting the conditions for manoeuvre the engineer prepares the battlefield, freeing the commander from terrain constraints, such that superior mobility may compensate for numerical inferiority. Ground manoeuvre aimed at securing a position that will have an enduring effect on the enemy will depend on the maintenance of mobility. When obstacles are encountered during manoeuvre the following will be attempted in priority:

a. Bypass the obstacle and maintain contact with the enemy forces defending it;

b. Overcome the obstacle using integral engineer support, maintaining momentum; or

c. Deploy obstacle crossing equipment for deliberate breaching.

6. **Maintain Mobility**. Mobility provides for freedom of manoeuvre such that the tempo and momentum of operations are preserved without forces becoming concentrated and vulnerable to enemy firepower. It is an engineer responsibility to provide the expertise and resources to assist friendly forces to overcome obstacles during manoeuvre, in accordance with the commander's intent and concept of operations, directed at the main point of effort. The maintenance of mobility in the face of the enemy will permit the manoeuvre force to go where it wills and depends on:

a. Terrain geospatial data to assist the commander in visualising the battlefield and predicting the effects of terrain and weather on military operations;

b. Deployment of the force in an appropriate manner, in order to rapidly overcome likely or unforeseen obstacles;

c. Early detection and reconnaissance to identify possible bypasses or to initiate breaching;

d. Shared situational awareness within an effective command and control system, and well rehearsed and adaptable drills and procedures; and

e. Destroying, neutralising or suppressing effective enemy fire on the obstacle.

7. **Sub Tasks**. The following mobility sub tasks are conducted to achieve concentration of effort, while engaging or disengaging from the enemy, during the current battle and in preparation for future operations to set the conditions for success in decisive operations:

a. **Counter-Obstacle**. Detect and overcome barriers and obstacles, permitting continuous manoeuvre to identified objectives, to include:

(1) Conduct of reconnaissance,

(2) breaching obstacles,

(3) reducing and clearing obstacles,

(4) Gap Crossing. The crossing of existing or reinforced obstacles including water, ditches, ravines, or any other wet or dry gaps,

(5) reduction of fortifications,

(6) detection of minefields,

(7) breaching of minefields, and

(8) marking and proving of lanes.

b. **Enhancement of Movement**. Permit freedom of movement relative to the enemy while retaining the ability to execute the commander's mission.

(1) Construction and improvement of fords and combat roads,

(2) repair of unpaved tracks and trails,

(3) construction of tactical aviation landing sites, and

(4) repair of forward airfield and airstrip operating surfaces.

c. **Inland Underwater Diving**

(1) Reconnoitre crossing areas and bridges;

(2) Destroy mines or other underwater obstacles; and

(3) Support gap-crossing operations.

PROTECTION - COUNTER-MOBILITY

Demolitions in Second World War proved of even greater importance than in the past owing to the advent of the armoured fighting vehicle. Most obstacles caused by demolitions are reasonably easily crossed by infantry who in the past formed the spearhead of the attack, and the object of the demolition became principally the prevention of the rapid follow-up of close support weapons, medium machine-guns and artillery with their attendant ammunition vehicles.

Although bridge demolition is therefore the commonest form of destruction, it must not be forgotten that it may also be necessary to destroy physical obstruction to movement such as wire-entanglements and road blocks, and aids to sight and fire direction such as buildings, trees and hedges. It may also be necessary for material such as armoured fighting vehicles, weapons, vehicles, stores and water, to be put out of action.

The application of demolition and denial schemes must be considered under three main heads.

The purpose to be attained and the part any such scheme will play in the general plans of operations.

The tactical plan of the scheme, including siting, timing, and control arrangements for the various parts.

The technical engineer problem including means to be employed, and method of carrying out each part.

Although of the above the first two are of importance to the staff and all arms, the last though primarily an engineer matter should be understood in general principle by all concerned, so that they may appreciate the difficulties and limitations, and the necessity for certain instructions and assistance to sappers.

The success of German demolitions in Northwest Europe was uneven, depending to a certain extent on the pace of the retreat. The bridges over the Seine were thoroughly destroyed, but after that few demolitions were encountered till after the check to the advance in Holland. Thereafter, up to and including the crossing of the Rhine, demolitions combined with inundations were fully and methodically used to endeavour to impede the allied advance. Beyond the Rhine demolitions, though plentiful, had not been co-ordinated.

Military Engineering (Field)
The War Office 1952

8. **Counter-Mobility**. Protection is achieved through co-ordinated employment of the combat functions of which, counter-mobility operations play a vital role. Counter-mobility hinders enemy movement through augmentation of impeding natural terrain features (e.g., rivers and streams, passes and defiles, narrow valley floors) with obstacle systems (e.g., minefields, pickets and wire, abatis). Counter-mobility bends the enemy to the commander's purpose; if he can move, it is done to our benefit and his detriment. With movement impeded, disrupted, turned, fixed, or blocked, the enemy is vulnerable. Counter-mobility operations are used for:

a. **Denying Use of Terrain and Approaches**. The co-ordinated creation of obstacles and the integration of these obstacles with fire and manoeuvre plans to disrupt, turn, fix, or block enemy manoeuvre, including the execution of reserved obstacles.

b. **Flank Protection**. The creation of obstacles to protect the flank(s) of manoeuvring or defending forces.

c. **Rear Area Security**. The creation of obstacles to restrict enemy freedom of movement in the rear combat zone.

9. **Barrier Planning**. The integration of obstacles with the direct and indirect fire plans and the manoeuvre plan is known as barrier planning. The barrier plan is a key component in the design of the battlefield for defensive and offensive operations. It is developed in accordance with the commander's intent. Barrier planning is the commander's responsibility. Engineer commanders and staff play a key role in advising their commander to ensure the integration of the engineer effort within the overall tactical plan.

10. **Sub Tasks**. The following counter-mobility sub tasks have overlapping objectives: to employ terrain as a combat multiplier against the enemy, to add depth to an area of influence, and to limit the enemy's ability to manoeuvre by disrupting his tempo and eliminating its ability to fight in a coherent manner before friendly forces are decisively committed.

a. **Barrier Planning**. To disrupt the enemy’s response to the commander's plan.

(1) review of terrain visualisation products,

(2) refection of sites to enhance obstacle value, and

(3) securing of locations for emplacement of barriers, obstacles and minefields.

b. **Emplacement of Barriers, Obstacles and Mines**. To break enemy formation cohesion before and during the battle.

(1) Preparation and execution of reinforcing obstacles,

(2) enhancement of natural and cultural obstacles,

(3) emplacement and explosion of demolition obstacles,

(4) delivery and installation of mines, and

(5) marking and recording of all mines.

c. **Deception**. To confuse the enemy as to his manoeuvre options and terrain reality.

(1) Deceiving the enemy as to the location/nature/depth of obstacles; and

(2) emplacement of phoney minefields.

PROTECTION - ENHANCE SURVIVABILITY

In 1940, one of the simplest yet most effective of wartime deceptions was the dummy tank, and Sidi Barrani is an early example of the successful use of this kind of deception.

Dummy tanks ranged from elaborate fakes that, from a distance, were indistinguishable from the real thing to crude shapes that might convince enemy reconnaissance aircraft that there was, at least a possibility of an armoured reserve. At Sidi Barrani the disposition of forces was so overwhelming in favour of the enemy that there was no time to create any sophisticated copies. Speed was of essence. In the autumn of 1940, the Italian Marshal Graziani had successfully advanced into Egypt with almost 250,000 men under his command, with another 100,000 troops at his disposal. Facing the Italians was General Archibald Wavell, C in C Middle East, who at the time could field no more that 50,000.

The odds stacked against him in North Africa made recourse to deception a natural step. The cover plan before the Battle of Sidi Barrani required that Graziani should perceive a threat to his flank. Native workers were hired, who drove their camels and horses relentlessly to and from trailing chains that whipped up the sand and suggested the incessant movement of large armoured columns. Meanwhile, three companies of Royal Engineers were busy constructing tank dummies which consisted of timber framework hulls covered in hessian.

The dummy tanks were then transported to Sidi Barrani where they were then handed over to the commander of an armoured formation for deployment.

It seemed that all of this trickery at least gave Graziani pause for thought. He did not press home his advantage and, when the British counter-attacked with real tanks on December 9, it eventually led to an advance of 650 miles into Libya. Ten Italian divisions had been destroyed and 130,000 prisoners taken.

Trojan Horses Deception
Operations in the Second World War
Mandarin 1991

11. **Protection**. Protection in the context of survivability encompasses those measures the force takes to remain viable and functional by protecting itself from the effects of (mainly) enemy indirect fire weapon systems, and natural occurrences. A combination of active and passive measures is undertaken to protect personnel, weapons and supplies, from detection and targeting. While all arms are responsible for personal survivability, engineers have the technical knowledge, skills, and equipment to assist other units to develop and improve defensive positions through fortification and hardening. They provide technical advice on camouflage and execute the non-electronic tasks of the formation deception plan.

12. **Enhance Survivability**. The engineer effort will be concentrated on tasks requiring specialist skills or equipment. Survivability measures begin with the use of all available concealment and natural cover, followed by digging and constructing fighting and protective positions and finally the improvement of natural camouflages. As time and the tactical situation permit, these positions may be improved. Survivability must be carefully planned and executed to enhance the security of the operational and tactical plans.

13. **Sub Tasks**. Across the range of potential conflicts, weapons of mass destruction (nuclear, biological and chemical) long range artillery and ballistic missiles pose a considerable threat. The following survivability sub tasks are designed to allow the force to fight where the commander chooses, to preserve combat power, and to enhance the cohesion and morale of the formation.

a. **Camouflage and Concealment**. Provide protection from enemy intelligence efforts and air or ground observation and surveillance in the visual, ultraviolet, infrared and radar bands.

(1) Provision of counter surveillance technical advice,

(2) employment of wide area screening/camouflage;

(3) guidance on noise, light, physical evidence control and radar signature; and

(4) provision of smoke, obscurants and corner reflectors.

b. **Protection of Personnel, Equipment and Supplies.** Exploit the battlefield's natural or artificial shelters, or dig in:

(1) Preparing vehicle firing positions and helicopter field fortifications,

(2) preparing crew served weapon protective positions,

(3) construction of field fortifications and earthworks,

(4) harden facilities for critical equipment and structures/functions,

(5) construction of collective nuclear, biological and chemical shelters, and

(6) emplacement of rapid protective barriers.

c. **Removal of Battlefield Hazards**. Protect friendly forces out of contact with the enemy from the residual effects of enemy weapons systems.

(1) Provide battlefield munitions disposal support;

(2) support nuclear, biological and chemical personnel and equipment decontamination operations;

(3) assist in route and area decontamination;

(4) clear booby traps; and

(5) conduct mine clearance operations.

d. **Conduct of Non-Electronic Deception**. Induce the enemy to react in a manner prejudicial to his interests.

(1) Provision of technical advice,

(2) construction of dummy facilities, structures and positions,

(3) employment of auditory deception,

(4) laying-out of phoney obstacles,

(5) employment of olfactory deception, and

(6) employment of passive radar reflectors.

SUSTAINMENT - SUSTAINMENT ENGINEERING

Requirements and priorities of construction varied with major developments in the tactical situation. Development of transportation and POL facilities to the extent necessary for movement of essential operational supplies was of first importance during all phases of the European campaign. Allocation of troops, supplies and equipment for the improvement of transport facilities above minimum standards, or for general construction, were subordinated to activities related to immediate support of military operations.

Prior to 1 October 1944, general construction and utilities construction was limited principally to rehabilitation of one existing hospital, construction of eleven tented hospitals, construction of two major headquarters, nominal repairs of municipal utilities and miscellaneous projects. As the tactical situation became more stabilised need for hospitals, storage facilities, utilities and similar installations became urgent and these were accorded higher priority. Transportation for movement of construction supplies to these projects was still critically short generally and secondary in priority to movement of operational supplies, particularly bridging and fortification supplies, especially during and immediately following the German counter-offensive in December 1944.

Final Report of the Chief Engineer (US)
European Theatre of Operations 1942-1945

14. **Sustainment**. Sustainment at the tactical level is achieved through a balance of combat service support, host nation support sustainment engineering and civil-military co-operation undertaken with the aim of planning and executing the movement and maintenance of the formation. Combat service support priorities are laid down by the commander to focus on the tactical point of main effort in order to generate and maintain operational effectiveness before and during combat as well as in the reconstitution phase and after combat. The established combat service support framework must have the capacity to rapidly restore the combat power of the forces engaging the enemy, to operate over large areas from a secure base, and be positioned to the rear of the formation to avoid interference by, and gain protection from, the enemy. While all areas of the battlefield are vulnerable to enemy action, pragmatism leads to the conclusion that sustainment tasks are normally conducted out of immediate contact with the enemy.

15. **Sustainment Engineering**. Sustainment engineering involves the provision of engineer advice, technical expertise, resources and work to allow the force the ability to maintain, reconstitute, and regenerate itself. Sustainment engineering does not include mobility, counter-mobility and survivability tasks provided directly to combat operations. Engineers performing this task do not have the equipment, mobility and armour protection of those supporting the manoeuvre force. The sustainment task requires large amounts of construction materials, which must be planned for, produced, or provided in a timely manner.

16. **Sub Tasks**. Sustainment engineering may be performed by a combination of engineer units, civilian contractors and host nation support.

a. **Rear Area Restoration**. Permit continuation of operations in the rear area.

(1) Conduct of damage assessment,

(2) control of flooding and fire protection,

(3) restoration of basic utilities,

(4) disposal of human and hazardous waste,

(5) clearance of debris and rubble, and

(6) demining.

b. **Maintenance of Lines of Communications**. Maintain the routes along which combat supplies and follow-on forces move.

(1) Construct roads and maintain main supply routes;

(2) repair and replace bridges;

(3) upgrade and expand landing zones;

(4) expand and construct airfields;

(5) exploit quarries and pits;

(6) exploit ports and beaches; and

(7) rivering operations.

c. **Vertical Construction (Accommodation)**. Establish facilities that provide deployed forces with protected, healthy and safe accommodations.

(1) Manage and contract for property (from acquiring to disposal);

(2) construct and maintain storage and distribution facilities,

(3) refurbish and repair fixed facilities;

(4) establish temporary camps; and

(5) supply construction material.

d. **Provide Utilities**. Acquired through contract, construction or repair.

(1) Supply mobile electric power;

(2) construct terminal pipelines and bulk storage facilities;

(3) produce bulk potable and non-potable water;

(4) maintain, operate and repair power production equipment; and

(5) provide environmental services: sewage and waste disposal.

e. **Conduct Civil-Military Engineering**. Promote stability in the formation area of responsibility.

(1) Dismantle fortifications;

(2) restore utilities for non-combatants;

(3) reopen non-essential lines of communication;

(4) co-ordinate host nation (engineer) support; and

(5) provide fire fighting services.

INFORMATION OPERATIONS - GEOMATICS

"Confirmation of the ground is of the greatest assistance in battle. Therefore, to estimate the enemy situation and to calculate distances and the degree of difficulty of the terrain so as to control victory are the virtues of the superior general.

Sun Tzu c 500 BC
The Art of War
(tr Griffith)

17. **Information Operations**. Information operations have as their objective: information dominance; that is providing the commander with timely and accurate information while denying equal access to information to the enemy, by what ever means possible. Seeking to achieve a tactical advantage by protecting and enhancing the commander's decision action cycle, information has to be seen as a shield and weapon across the full range of formation operations. Encompassing all operations that gain information, "Information Operations" are undertaken across four inter-related components: Command and Control Warfare, Information and Intelligence, Information Systems, and Interaction with the Global Information Environment.

a. **Command and Control Warfare.** Command and control warfare is a strategy that combines the disruption, destruction, denial and influence of information to attack the enemy's command and control system while simultaneously protecting the friendly formation's. Having the objectives of influencing the enemy's operating tempo and disrupting his tactical planning, command and control warfare prevents the enemy from being able to decisively focus combat power.

b. **Information and Intelligence**. Intelligence and information are fused in order to provide the commander with a thorough understanding of his areas of influence and interest. The collection of information about the enemy, friendly forces, the environment and other areas is managed through the intelligence cycle.

c. **Information Systems**. An integrated information system merges all information activities in the formation and provides the digitised picture of the battlefield. Specialised and narrow stovepipe systems are ineffective in providing the commander the timely and comprehensive information required to formulate a clear picture of the enemy and friendly force dispositions and capabilities.

d. **Interaction with the Global Information Environment (GIE)**. The GIE encompasses those processes and systems that are beyond the influence of the commander, which nevertheless directly impact on both the physical and the moral support required for the successful conduct of operations. Information operations require an awareness of, and sensitivity to, information published by non-military sources.

18. **Geomatics**. Geomatics are the scientific and engineering activities involved in the capture, storage, analysis, processing, presentation, dissemination and management of geospatial information. The physical environment in which formation operations are conducted is a common denominator to the attacker and the defender; whoever exploits its advantages, making the best use of its terrain, enjoys a key tactical advantage. Battles and engagements will take place on terrain whose features, natural and man-made, profoundly affect each combat function. Deficiencies in the availability of geospatial information to support information operations and the manoeuvre and firepower combat functions will have two significant impacts.

a. Indigenous forces will have the most comprehensive and accurate knowledge of the environment in the area of operations therein gaining a moral and physical advantage, undermining formation cohesion and mission success; and

b. Superior knowledge of the terrain will greatly benefit the enemy's preparation for battle allowing him to seize the initiative, exploiting the terrain to their tactical advantage, controlling the tempo of battle.

19. **Terrain Visualisation**. Each combat function requires digital military geographic information, in today's information environment, to maintain a clear and accurate vision of areas of interest and influence. In support of the current battle and future operations, engineer units provide foundation battlefield terrain knowledge that is synthesised with information gathered through the formation engineer information collection plan. Today's visualisation technologies permit commanders: to better understand the current operating environment, thus being able to focus on the enemy; to define the desired end state; and to visualise the sequence of activities of manoeuvre and move of the formation from its current position to the identified end state.

a. **Offensive Operations**. During the execution of the formation planning process, commanders will seek to identify objectives for capture/dominance which will shatter the enemy's cohesion and will to fight. To achieve these objectives the commander must decide on lines of operations, deep into the enemy's rear, which can be exploited with the resources available to the formation and provide security for follow-on forces.

b. **Defensive Operations**. With the purpose of defeating or deterring a threat, effective defensive operations depend to a great extent on the selection and the correct use of terrain. Once decided, every effort must be made to use it to the best advantage. This can only be achieved if every commander down to the lowest level knows in detail - to visualise and understand the terrain is the first step toward limiting the enemy's freedom of action.

20. **Sub Tasks**. Engineer units proactively provide commanders with essential geospatial information for terrain visualisation with which they will be able to analyse the greatest

number of physical environment factors in co-ordination with others, making better and more rapid decisions. The terrain images and analysis engineers provide are the underpinning to all appliquéd information used to digitally depict the battlefield. At the tactical level, geospatial information is provided in the form of products (maps/map substitutes/images) or services (terrain analysis/control survey/precision targeting) that portray terrain for the commander and formation staff.

a. **Support Mission Analysis and Enhance Decision-Making**. Assess the effect of the physical characteristics which could adversely affect the accomplishment of the mission for each course of action the formation is planning and capable of adopting.

(1) Evaluate the geo-political environment;

(2) integrate the environment with weather;

(3) develop impacts and focus the mission planning effort;

(4) predict effects of terrain and weather on military operations; and

(5) prepare and disseminate impact/effect studies.

b. **Provide Terrain Data for Mission Execution and Manoeuvre**. Determine and rank priorities to make available real-time geospatial information on weather (climate/forecasts) and the physical environment (terrain/hydrography/culture) across the formation area of operations focused in scale on unique areas of interest and influence.

(1) Conduct small team global positioning system survey control/positioning operations;

(2) maintain military geographic liaison to formations and allied units;

(3) collect military geographic information electronically; and

(4) control split-base operations and distribute maps and charts.

c. **Provide Rapid Data Updates for Terrain Visualisation**. Evaluate, store, and disseminate data and information in a form that optimises visualisation - existing as the common backdrop in all command and control, intelligence and engineer information systems across the formation.

(1) Develop tactical geographic information requirements;

(2) review holdings and fuse information digitally;

(3) maintain and manage the geospatial databank;

(4) publish/reproduce information/imagery;

(5) manage information and distribute imagery; and

(6) project future requirements to minimise interference with consideration of the commander's possible courses of action.

SECTION 2
CHARACTERISTICS OF COMBAT ENGINEERS

CHARACTERISTICS

21. Engineers can complete a wide variety of combat and sustainment engineering tasks. To carry out these tasks, engineer units have certain inherent characteristics of flexibility, mobility, reliance on equipment, skill and vulnerability.

FLEXIBILITY

22. **General**. The flexibility of engineer units results from their training, organisation and communications.

23. **Training**. Every sapper is a soldier first and an engineer second. Following general military training, sappers complete field engineer, field engineer equipment operator, construction, or mechanical occupation training. All engineer officers are trained to function in both a combat or construction engineer environment. Officer and non-commissioned member training include the essential infantry skills to allow combat engineer units to fight as infantry.

24. **Organisation**. Engineer units are organised and established to complete several minor tasks simultaneously. Alternatively, units or sub-units may be grouped together to perform a single major task.

25. **Communications**. Good communications down to section level provide the means for effective command and control of engineer work and rapid deployment of engineer resources. Communications also permits the passage of timely and accurate information.

MOBILITY

26. Engineer units must have vehicles with the same cross-country mobility as the units they are supporting. Engineer units

also carry a considerable quantity of equipment and stores, which must be retained on vehicles or moved by other means to the task sites.

RELIANCE ON EQUIPMENT AND STORES

27. Most engineer work requires the use of engineer heavy equipment or scarce specialised engineer equipment. Complex engineer equipment, such as amphibious bridging and all armoured engineer equipment is crew served. For flexibility of employment, this equipment is held and operated by specialist engineer units or sub-units and it is centrally controlled at the lowest practicable level.

28. Engineers differ from other arms in that most of their work requires construction material, defence stores and equipment not permanently held with units. Planning must include staff co-ordination to ensure that the appropriate priority is placed on the movement and use of this equipment and materials.

SKILL

29. Engineers are skilled tradesmen, and should not be used for general labour. They are most suitably employed on tasks requiring relatively skilled manpower and skilled supervision. They should be reinforced by unskilled labour whenever possible.

VULNERABILITY

30. Engineers have limited protection when mounted in armoured personnel carriers or wheeled vehicles. Most engineer tasks, except those done by armoured engineers, must be carried out by dismounted troops at critical locations not necessarily within defended areas. These tasks usually require the use of specialised engineer equipment that is characterised by high silhouettes and noise, which draw enemy attention and fire. All engineers carry personal weapons and man crew served weapons but cannot work and fight at the same time. Other arms may be required to provide protection for engineer work parties to permit uninterrupted work.

LIMITATIONS

31. **Night Work**. Engineers are trained to complete their tasks by day and by night. Tasks carried out in darkness require much more time to complete than similar tasks in daylight even when night vision devices are used. Therefore, the increased time required and fatigue caused by night work must be considered.

32. **Organic Resources**. Engineer work is limited by the amount of organic construction materials, defence stores, engineer equipment and engineer heavy equipment available to carry out the tasks. Additional resources may be available from higher formation engineer resources, however, they must be determined in advance and deployed so that they are in the right location at the right time.

33. **Maintenance and Rest Time**. Engineer work is physically demanding. During the planning of an engineer task, consideration must be given to the scheduling of regular rest and administration periods for soldiers and maintenance time for engineer heavy equipment, vehicles and engineer equipment.

SECTION 3
THE PRINCIPLES OF THE EMPLOYMENT OF ENGINEERS

INTEGRATION WITH OTHER COMBAT FUNCTIONS

1. Combat power, used to fix and strike the enemy, is the total means of destructive and/or disruptive force, which a military unit/formation can apply against the opponent at a given time. It is generated through the integration of a number of elements referred to as combat functions.

2. The engineer tasks of manoeuvre - maintain mobility; protection - counter-mobility; protection - enhance survivability; sustainment - sustainment engineering; and information operations - geomatics must be integrated with the other combat functions to optimise combat power. The responsibility for the correct mix of engineer support remains that of the commander, with advice from the engineer commander.

CENTRALISED COORDINATION, DECENTRALISED EXECUTION

3. The execution of engineer tasks requires very careful deployment and control of sappers, equipment and materials. The most efficient results are achieved by centralised co-ordination at the highest appropriate level, with responsibility for execution of the task delegated to the lowest practical level.

4. Our doctrine emphasises a command philosophy that promotes unity of effort, the responsibility to act, speed of action and initiative. This requires mission-oriented orders where subordinate commanders clearly understand the superior commander's intent, thus allowing them to accomplish their mission in their own manner. This philosophy of command requires a continuous assessment and estimate of the situation, decisions and operation plans, as well as the timely issuance of orders. The commander's intent must be clearly expressed in his decisions, operation plans and orders.

ALLOCATION OF PRIORITIES

5. Since it will seldom be possible to do all the required engineer tasks simultaneously, the engineer commander must ensure that he is provided with clear priorities of work from the commander. Engineers can then plan appropriately and avoid wasting scarce resources on low priority tasks. Changes in priority are wasteful of effort and should be avoided.

6. Engineers are not kept in reserve. However, it is essential to identify engineers available to carry out vital and unexpected tasks. To do this, engineers will be redeployed from lower priority tasks to carry out any unexpected vital tasks.

EARLY WARNING AND RECONNAISSANCE

> *On 8th June 1943, the C.R.E. 5th Canadian Armoured Division (Lieutenant-Colonel J.D. Christian) wrote the following observation of the Liri Valley campaign in his war diary:*

"Due to excess changes of plans Sapper Officers and even the men were unduly fatigued. A major change in the plan is not a good thing.

Throughout the operation no engineer information was received through other than our own channels. Air observation posts did report the odd bridge blown. Our resources are very limited and it is everyone's responsibility to get this information back"

The History of the Corps of Royal Canadian Engineers, Volume 2

7. Engineer operations require the assembly of heavy equipment, equipment, explosives, mines and other materials, as well as manpower. This may take considerable time. Foresight and forward planning are, therefore, of the greatest importance and commanders and staffs should ensure that engineers are given maximum possible warning of future operations and likely tasks.

CONTINUITY

8. Once work begins on an engineer task, the same engineer unit should complete it. Redeployment of engineer resources must be avoided. Breaks in continuity of engineer work causes delay and usually extra effort to complete the task.

COMMUNICATIONS

9. If the engineer commander is to effectively command his widely dispersed troops, advise his commander, and control the engineer effort, he must:

a. Receive reconnaissance and task progress reports quickly;

b. co-ordinate with the commander;

c. Liase with other engineer units and formations.

10. Best use should be made of command and control information systems for the rapid exchange of engineer information at all levels of command.

SECTION 4
STANDARDISATION AND INTEROPERABILITY

THE IMPORTANCE OF STANDARDISATION AND INTEROPERABILITY

1. Engineers should be aware that their allies are equipped with a wide range of engineer equipment and material for which there is little standardisation between nations. Engineer organisations at each level of command differ nationally, and while engineer missions and tasks are similar, procedures often vary, particularly when providing sustainment engineering support.

2. It is important to the successful execution of coalition/multinational operations that the differences in national organisations, engineer tasks and procedures are well understood. It is equally important that any adverse effect of these differences on the outcome of the engineer mission is minimised. For this purpose, North Atlantic Treaty Organisation (NATO) Standardised Agreements (STANAG) and America British Canada Australia Armies' Standardisation Program (ABCA) Quadripartite Standardisation Agreements (QSTAG) cover several important engineer activities. Also, it is important to maintain liaison during operations to ensure that differences in procedures are immediately identified and, if required, common standards established.

3. Engineer commanders must be aware of what is standard within NATO and ABCA, and adhere to the agreed principles and procedures. Where standardisation has not been achieved interoperability may still be feasible, either by adapting equipment for use with that of another nation, or by training one nation's engineers on the equipment of another. The ability to interchange engineer equipment and resources between nations may increase their combined effectiveness on the battlefield. Conversely, a lack of engineer interoperability could hinder combined operations.

PROCEDURES AND STANDARDISED AGREEMENTS

4. STANAGs and QSTAGs covering engineer procedures, and other related agreements, are listed at annex A.

FORCE PROTECTION HIERARCHY OF MANUALS

5. The Force Protection Hierarchy of Manuals is listed at Annex B.

ANNEX A
STANDARDIZED AGREEMENTS

STANAG	QSTAG	TITLE
	254	Design and Testing Requirements for Field Shelters Protecting Personnel and Equipment Against nuclear and Non Nuclear Weapons Effects
	479	Water Quality Analysis Set (Engineer and Preventative Medicine)
	2028	Bulk Water Supply on Extended Operations
1022	963	Combat Charts, Amphibious Charts and Combat/Landing
1103		Standard Procedures for the Emergency Printing of Nautical Charts
1113		General Specifications for Projections Required for Nautical Charts
1120		Code Designation System for Special Naval Charts
2002		Warning Signs for the Marking of Contaminated or Dangerous Land Areas, Complete Equipments, Supplies and Stores
2010		Military Load Classification Markings
2017	508	Orders to the Demolition Guard and Demolition Firing Party Commander (Non-Nuclear)
2019		Military Symbols for Land-Based Systems (APP-6)
2021	180	Military Computation of Bridge, Ferry, Raft and Vehicle Classifications
2025		Basic Military Road Traffic Regulations

STANAG	QSTAG	TITLE
2029		Methods of Describing Ground Locations, Areas and Boundaries
2036	518	Land Minefield Laying, Marking, Recording and Reporting Procedures
2079		Rear Area Security and Rear Area Damage Control
2096	530	Reporting Engineer Information in the Field
2101		Establishing Liaison
2113	534	Denial of a Units Military Equipment and Supplies to an Enemy
2123	743	Obstacle Folder
2136		Minimum Standards of Water Potability in Emergency Situations
2143	744	Explosive Ordnance Reconnaissance/Explosive Ordnance Disposal
2154		Regulations for Military Motor Vehicle Movement by Road
2174		Military Routes and Route/Road Networks
2201	541	Standard Unit of Vertical Measure to be shown on Land Maps
2205	542	Use of Identical Maps and Charts (excluding Nautical Charts)
2210	543	Trip Lists (Lists of Geodetic Data)
2211	544	Geodetic Datums, Ellipsoids, Grids and Grid References.
2213	545	Gazetteers
2215	546	Evaluation of Land Maps, Aeronautical Charts and Digital
2216	547	Vertical Aerial Cartographic Photography

STANAG	QSTAG	TITLE
2251	169	Scope and Presentation of Military Geographic Information
2253	174	MGD – Roads and Road Structures.
2254		Navigable Inland Waterways
2255		MGD – Ports
2256	177	MGD – Inland Hydrography
2257		MGD – Railways
2259		MGD – Terrain
2260		MGD – Electric Power
2263	179	MGD – Coastal Areas and Landing Beaches
2269		MGD – Engineer Resources
2271		MGD – Urban Areas
2366		Effectiveness of Land Minefields
2377	957	Procedure for the Management of an EOD Incident for use When Working With Other Agencies
2389	958	Minimum Standards of Proficiency for Trained Explosive Ordnance Personnel
2394		Land Force Combat Engineer Doctrine (ATP-52)
2395		Water Crossing Procedures
2430	1024	Land Force Engineer Messages Reports and Returns (AENGRP-2)
2818		Characteristics of Demolition Accessories to Determine their Operational Interchangeability
2885		Emergency Supply of Water in War
2889	742	Marking of Hazardous Areas and Routes Through Them

STANAG	QSTAG	TITLE
2929		Airfield Damage Repair
2963		Coordination of Field Artillery Delivered Scatterable Mines
2989	862	Transfer of Barriers
2990	820	Principles and Procedures for the Employment in Land Warfare of Scatterable Mines With a Limited Laid Life (ATP-50)
2991	943	NATO Glossary of Combat Engineer Terms and Definitions (AAP-19)
3408	1179	Position Reference Systems for Aeronautic Charts
3409		Projections for Aeronautic Charts
3412		Aeronautical info on Aeronautic Charts
3591		Criteria for Max. Elevation Figure for Aeronautic Charts
3600		Topographical Land Maps and Aeronautic Charts
3666		Max Sizes for Maps, Aeronautic Charts and Other
3671		Edition Designation System for Land Maps, Aeronautic Ch.
3672		Indexes to Series of Land Maps and Aeronautic Charts
3673		Identification of Source Data on Nautical and Special Nava
3675		Symbols on Land Maps, Aeronautic Charts and Special
3676		Marginal Information on Land Maps, Aeronautic Charts

STANAG	QSTAG	TITLE
3677		Standard Scales for Land Maps, Aeronautic Charts
3678		Method of Adding the Military Grid to Nautical Charts
3689		Place Name Spelling on Maps and Charts
3710		Military City Maps
3715		General Specifications for Non-Subcontacts (NSC)
3716		Map Series Numbering
3809		Digital Terrain Elevation Data Exchange Format
3833		Symbols for use on Maps of Training Areas for Land Force
3985		Preferred Magnetic Tape Standards for the Exchange
3986		Digital Data File Transmittal Form for Geographic Info.
3992		MGD – Terrain Analysis – AgeoP-1.
4387	1038	DRAFT – ARC Standard Raster Product (ASRP) – AgeoP
5621		Standards for the Interoperability of NATO Land Combat and Combined Operations Systems
7010		Positions for INS Settings on Airfields.
7016		Maintenance of Geographic Materials.
7021	1153	Position Information Graphic (PIG)
7035		Mapping, Charting and Geodesy (MC&G) Video Disc.
7054		Projected Areas Mapping (PAM)

STANAG	QSTAG	TITLE
7072	7054	DRAFT – Digital Chart of the World (DCW)
7074		Digital Geographic Information Exchange Standards
7077	7074	STUDY – UTM/UPS Standardised Raster Product (USRP)
7098		STUDY – Compressed ARC Digitised Raster Graphics
7099		STUDY – Controlled Image Base (CIB)
7108		STUDY – ARC Digitised Raster Graphics (ADRG)
7115		STUDY – Aeronautical Information Data set (AID)
7123		STUDY

ANNEX B
FORCE PROTECTION HIERARCHY OF MANUALS

- 300-006 LAND FORCE PROTECTION DOCTRINE
  - 361-001 LAND FORCE ENGINEER OPERATIONS
    - COUNTERMOBILITY
      - 361-005 OBSTACLES
      - 361-008 (2 VOLS) DEMOLITIONS
      - 361-009 (2 VOLS) MINES AND BOOBY TRAPS
    - MOBILITY
      - 361-010 WATERMANSHIP AND BRIDGING EQUIPMENT
    - SURVIVABILITY
      - 361-006 FIELD PROTECTION
    - GEOMATICS
      - 361-015 GEOMATICS
    - ENGINEER COMMAND AND CONTROL
      - 361-002 ENGINEER COMMAND AND CONTROL
    - SUSTAINMENT
      - 361-007 COMBAT DIVING
      - 361-016 ROADS
      - 361-018 PITS AND QUARRIES
      - 361-019 SOILS
      - 361-020 MATERIAL TESTING
      - 361-012 ACCOMMODATIOS AND INSTALLATIONS
      - 361-013 WATER SUPPLY
      - 361-014 BRIDGING (NON-STANDARD)
    - GENERAL TECHNICAL MANUALS
      - 361-003 BASIC FIELD ENGINEERING
      - 361-004 RIGGING
  - 362-001 LAND FORCE POLICE OPERATIONS
  - 364-001 LAND FORCE COUNTER SURVEILLANCE

CHAPTER 2
ENGINEERS IN THE CORPS, DIVISION, AND BRIGADE GROUP

SECTION 1
CORPS ENGINEERS

GENERAL

1. Engineers within divisions and brigade groups are combat oriented, and are not organised or equipped to provide either the depth or specialisation required to conduct all operations for which engineers are responsible. Therefore, apart from engineers at division and brigade group, corps must provide support in the form of several combat and specialist engineer support organisations. In addition, they are capable of providing the engineer support required by the myriad of corps troops and organisations.

AIM

2. The aim of this section is to provide an overview of corps engineer resources and outline their capabilities.

SCOPE

3. This section discusses in general terms the capabilities of the United States Army Engineers at corps level. Sections 2 and 3 outline the engineer resources with a Canadian division and brigade group. These organisations are presented within the framework of X Allied Corps, which is a generic multinational corps based on real organisations. Detailed organisations and staff tables for all the units can be found in the Staff Officers' Handbook.

THE CORPS

4. The corps is not a fixed organisation. It is tailored to the mission and the theatre in which it must operate. Once defined, a

corps contains all the combat forces, combat support, and combat service support capabilities required to sustain operations. The corps engineer formation, normally a brigade, will therefore be structured to support the divisions, independent formations/units, and corps troops within the corps.

5. The organisation of the corps engineer brigade is mission tailored like the corps itself. The corps engineer brigade commands and controls all engineer support to the corps and is assigned all engineer units that are not organic to divisions and independent formations/units. The corps engineer brigade may contain various numbers of engineer groups, corps engineer battalions (mechanised and wheeled), combat heavy engineer battalions and separate engineer companies. Other specialised engineer organisations will augment the corps engineer effort as the mission dictates. The engineer organisations that may form the corps engineer brigade are:

a. **Headquarters, Engineer Brigade (Corps)**. The brigade is comprised of an organic headquarters and signals company, a direct support topographic company and a variety of other subordinate engineer organisations.

b. **Headquarters Engineer Group (Combat)**. The combat engineer group is the principal subordinate unit of the corps engineer brigade. The engineer group is designed to provide command and control of five to seven subordinate corps engineer units on either an area or functional basis, either far forward in the division and brigade areas or in the corps rear area. Its mission may include being the crossing force engineer headquarters for major river crossing operations or during the deliberate breach of a complex obstacle system. The combat engineer group can also control engineer operations in the corps and the division rear areas, focusing on the construction of main supply routes and logistic support bases.

c. **Engineer Battalion (Corps) (Mechanised)**. It is designed to conduct engineer operations in close combat and can fight as mechanised infantry when properly trained and augmented. Mechanised corps engineers provide mobility support to reconnaissance, intelligence, surveillance, and target acquisition forces.

d. **Engineer Battalion (Corps) (Wheeled)**. It is designed to provide engineer support to corps close and rear operations and can fight as motorised infantry when properly trained and augmented.

e. **Engineer Battalion (Combat Heavy)**. The combat heavy engineer battalion executes a wide variety of horizontal and vertical construction missions. The battalion is capable of constructing and providing rapid repair of facilities such as airfields, roads, bridges, and buildings.

f. **Engineer Company (Combat Support Equipment)**. This company is a deployable equipment intensive organisation that possesses significant earth-moving capability. It is normally attached to a corps engineer battalion (wheeled or mechanised) to augment the battalion's horizontal construction capabilities. It can also operate independently while under the direct control of the combat engineer group.

g. **Engineer Company (Topographic)**. A topographic engineer company from the theatre topographic battalion is placed in direct support of the corps. Capabilities of this company include the full spectrum of topographic support.

h. **Engineer Company (Assault Float Bridge Ribbon)**. The engineer ribbon bridge company employs a dependable, versatile float bridge system which can be rapidly emplaced in a close combat environment.

i. **Engineer Company (Panel Bridge) and Engineer Company (Medium Girder Bridge)**. These engineer fixed bridge companies are capable of rapidly emplacing tactical standard bridging, either panel bridges (normally Bailey bridges) or medium girder bridges (MGB), over wet or dry gaps in a close combat environment.

j. **Engineer Team (Diving, Light)**. The engineer diving team (light) supports the corps commander's diving requirements on the battlefield.

k. **Engineer Company (Dump Truck**). The engineer dump truck company augments the material haul capability of construction units for large, long, or extended construction material haul requirements.

l. **Engineer Battalion (Prime Power**). The prime power engineer battalion provides quickly deployable prime power companies and teams to force projection theatres within 72 hours. Prime power units provide the necessary electrical continuity between tactical generators and commercial power sources in theatre. They also support general engineering operations in the communication zone, providing power generation and power related technical support to rear area units.

m. **Engineer Company (Pipeline Construction).** The engineer pipeline construction company is designed to augment a combat heavy battalion, resulting in a task force capable in providing pipeline construction and major maintenance for the movement of bulk petroleum, oils and lubricants.

n. **Engineer Company (Construction Support**). The engineer construction support company provides specialised construction capability and construction materials production. Its function includes rock crushing and bituminous mixing and paving for major horizontal constructions such as paved roads, storage facilities, and airfields. It normally augments a combat heavy battalion.

SECTION 2
DIVISION ENGINEERS

INTRODUCTION

1. The division engineer organisation is structured to support all brigades and division troops within the division. The engineer organisation normally consists of an engineer group containing close support and general support units.

ORGANISATION

2. The composition of the Division Engineer Group is as follows:

a. **Headquarters Division Engineers**. Staff to provide continuous engineer planning, information and liaison to the division staff. The headquarters is divided into three major components as follows:

(1) **Engineer Group Headquarters**. Organised into a main and an alternate headquarters which is physically separated from the Division Headquarters.

(2) **Division Engineer Staff**. Engineer staff dedicated to Division Main and Alternate Headquarters to provide direct support to the division staff.

(3) **Division Rear Engineer Staff**. Engineer staff co-located with Division Rear Headquarters.

b. **Combat Engineer Regiments (CER).** There are three CERs in the division in order that one CER may be grouped with each brigade to provide close engineer support. The CER is composed of a number of field, armoured engineer and support squadrons, based on whether it is supporting an infantry or armoured brigade. Squadrons within the CER are task organised depending on the mission and provide close engineer support to infantry or armoured units/battle groups

c. **Engineer Support Regiment (ESR)**. There is one ESR per division to provide sustainment engineering support. The activities of the ESR are controlled centrally at division level. The ESR provides sustainment engineering support to the division and combat engineering support to divisional troops, as well as augmenting the CERs for combat engineering tasks. The ESR is composed of a field engineer squadron, a number of specialist engineer squadrons normally: bridging, construction, equipment, and resources.

SECTION 3
BRIGADE GROUP ENGINEERS

INTRODUCTION

1. The combat engineer regiment (CER) integral to the brigade group provides the close engineer support.

ORGANISATIONS

2. The CER in the brigade group is structured identically to the CER in the division engineer group that supports the infantry

brigade. The CER consists of a number of field, armoured engineer and support squadrons. Squadrons within the CER are task organised depending on the mission and provide close engineer support to infantry or armoured battle groups; and

3. In the event that no Canadian division is deployed, elements or the whole ESR would provide the sustainment engineering to the brigade group. To ensure unity of command if the whole ESR is deployed, the command and control relationship between the two engineer units and the brigade commander must be specified.

CHAPTER 3
GENERAL TASKS IN BATTLE

SECTION 1
ENGINEERS AND THE OPERATION PLANNING PROCESS

The importance of thorough planning for engineer operations, especially the detailed planning for execution of projects, is often not sufficiently recognized, and ample time and facilities are sometimes not accorded to the military engineer. In civil engineering practice, considerable time is always spent in preliminaries before a sod is turned or a brick laid. The circumstances of war demand that the time taken in these preliminaries shall be reduced to a minimum, but it must not be forgotten that in the long run time spent on a sound preparation of a job will result not only in a more satisfactory result, but will in most cases produce what is required quicker.

In the case of detailed tactical planning carried out by the force commander and his staff and by his subordinate formations, engineering planning falls into two general but not always distinguishable categories: that concerned with the general operations of the force, and that concerned with the purely engineering problems necessary to implement the plan decided upon. For the former the most intimate co-operation is necessary between the staff and the engineers, and to ensure that the necessary engineer advice is available when required, and that the general plan is not in danger of being found at a late stage to be impractical from the engineer point of view, it is essential that the engineer adviser should be informed of intentions at the earliest possible moment.

Military Engineering (Field)
The War Office 1952

GENERAL

1. The planning for the employment of engineers is an integral part of the commander's plan. It is therefore essential that the engineer commander is included in planning from the beginning to ensure that the engineer effort is synchronised with other plans. In conjunction with the G2, the engineer commander, using the whole or part of the Intelligence Preparation of the Battlefield (IPB) process, should advise the commander on the terrain and how it can best be used to achieve the commander's aim. When possible, the engineer commander should be present when the commander receives new directives from the superior headquarter. This allows planning to begin immediately, and allows the engineer commander to be aware of, and understand the superior commander's intent including the engineer intent to better advise the commander and staff during the commander’s mission analysis

THE OPERATION PLANNING PROCESS

2. The Operation Planning Process (OPP) is simply a collective estimate of the situation that synchronises the efforts of the staff. It is a logical sequence of collective reasoning leading to the best solution within the available planning time. The commander, assisted by his staff, analyses a situation, develops and decides on a plan of action, issues orders and prepares for further contingencies. OPP is continuous and dynamic, involving concurrent activity and interaction between the commander, the staff and subordinate commanders. The process integrates other tools such as Targeting, IPB and war-gaming, which in turn generate products such as the decision support template, the synchronisation matrix and the attack guidance matrix.

3. OPP, similar to the estimate, occurs within the first three steps of the Battle Procedure – Direction, Consideration and Decision. It has been organised into a series of six steps as follows:

   a. Step 1 – Receipt of tasks.

   b. Step 2 – Orientation. This step begins with mission analysis and the commander’s initial estimate and concludes with planning guidance given by the commander to the staff.

c. Step 3 – Development of courses of action. Once the commander has given his planning guidance, the staff can begin to identify options for enemy and friendly courses of action.

d. Step 4 – Decision. Once the description of all the courses of action is complete, the COS/G3 recommends the course of action that he and the staff see as most likely to succeed. The commander then decides on the course of action to execute.

e. Step 5 – Plan Development. Once the commander has made the decision, the staff sections produce their portions of the order. Concurrently, the commander and key staff should wargame the course of action.

f. Step 6 – Plan Review. The commander should prioritise the possible contingencies resulting from the wargame completed in the Plan Development to address in further cycles of the OPP. These cycles will develop branches to the original plan if changes are required, or sequels to be ordered upon completion of the original plan for the next phase of the operation or campaign.

4. Detailed procedures and considerations related to the OPP are covered in the Command manual B-GL-300-003/FT-000.

THE EMPLOYMENT OF ENGINEERS

5. **General**. By virtue of the breadth of factors to be addressed by the commander during the OPP, he does not get involved in detailed engineer planning. Detailed engineer planning is done by the engineer adviser who, with assistance from his staff, completes his own engineer estimate of the situation. The

commander provides guidance to his engineer adviser. A graphical representation of the operation planning process with parallel engineer planning activities is shown at Annex A.

6. **Commander's Mission Analysis**. The first step in any operation is to receive tasks from the higher commander or assume a task due to a change in the situation. Once received or assumed, the commander, either alone (at lower levels) or assisted by his key staff, conducts his mission analysis to determine the area of his mission which warrants further analysis. This process ends with the issue of his planning guidance. At higher levels this guidance may be verbal or a written COS/G3 planning directive. At lower levels it will likely be provided during the commander's reconnaissance with his arms advisers.

7. **Engineer Adviser's Mission Analysis**. The engineer adviser conducts his own mission analysis, concurrent with the commander's mission analysis. The engineer adviser's mission analysis focuses specifically on engineer tasks with a view to defining his own mission and identifying key issues to be addressed with the commander and staff. As part of his analysis of the higher commander's concept of operations, the engineer adviser analyses the implied risk that the higher commander is willing to accept to accomplish the mission. All limitations that will impact on the operation are identified and any questions that require clarification by the commander, his staff or engineer staff are identified.

8. **Preliminary Staff Checks**. Based on the commander's planning guidance the various staff cells and arms/services advisers conduct a series of staff checks to determine if the operation is feasible and supportable. Having received the commander's planning guidance, the engineer adviser continues the engineer estimate process started following this mission analysis to determine if the commander's preliminary concept of operations is feasible and supportable from an engineer’s perspective. He keeps the general staff abreast of developments, and briefs the chief of staff during the Information Brief on any engineer related capabilities, limitations or issues requiring resolution by the commander.

9. **Engineer Adviser's Analysis of Relevant Factors**. Based on the commander's planning guidance and his own mission analysis the engineer adviser issues his planning guidance to his staff for the

conduct of an analysis of the relevant factors. This should include ground, enemy, own troops, resources available, and to a limited degree, time and space. With respect to ground and enemy, the engineer adviser is the expert on terrain analysis and the effects of weather on terrain, as well as on enemy engineer breaching capabilities, vulnerabilities and doctrine. He must answer the questions identified in the commander's planning guidance by providing the relevant deductions or tasks leading to an information brief, if necessary.

10. **Final Staff Check**. At the end of the Preliminary Staff Checks, the commander or chief of staff identifies the courses of action, which he wants further developed. The focus of the Final Staff Checks is to derive a comparison of the courses of action for the commander's decision. During the Final Staff Checks the engineer adviser develops the engineer concept to support each tentative friendly course of action. In his Assessment of Tasks, the engineer adviser identifies all tasks, and the resources and time required to complete them.

11. **Preparation and Issue of Orders**. Once the commander has made his decision, the various staff sections and arms advisers prepare their portions of the operation order. The engineer adviser will prepare his own order to deliver to those under his command, and will also prepare the Engineer sub-paragraph or engineer Annex A for the commander's orders.

12. **Execution of Orders**. Engineer advisers at all levels, in conjunction with the formation/unit commanders and staff, continuously monitor the execution of the engineer plan and make adjustments as required. This is done by:

a. Continually analysing incoming information to ensure the validity of the engineer plan in relation to the tactical situation and the anticipated threat;

b. Ensuring that engineer reports and returns are being forwarded;

c. Shifting assets, requesting additional assets, or modifying the plan; and

d. Continuing planning.

THE ENGINEER ESTIMATE

There are certain prerequisites to a good plan:-

A clear understanding of the object. This will usually be laid down by the commander or staff, though it may often be suggested by the engineer adviser of the particular force, and must be in considerable detail. For example, in a bridging operation it is necessary to know when the bridge is required, what traffic loads it is required to take in the first place, and whether the loads are likely to be increased in the near future.

Information as to the physical conditions. In a bridging-operation- the width, depth, and rate of flow of the river; the height and nature of the banks, liability to change in water-level; the approaches not only to the bridge site but also the road approaches for getting material forward, etc.(c) Availability of materials, including equipment, and where they are situated.

Availability of labour both skilled and unskilled and its mobility.

Availability of transport for men and material.

All this means that the engineer planners, who are usually the staff of the senior engineer officer of the forces concerned, must be in close touch with the commander and his staff. Where they are separated difficulties and delays are bound to occur.

Military Engineering (Field)
The War Office 1952

13. **Estimate of the Situation and Planning**. The development of the plan should follow the estimate process, but certain aspects peculiar to engineers need emphasis:

a. **Obtaining Information**. The engineer commander must base his decisions on the best possible information. This will normally come through engineer channels but may also come from the general staff. Foresight is needed to decide what information is likely to be required to assist in making future plans. This will be done in the form of an intelligence collection plan. Information from subordinate formations or units will have to be collected and then processed;

b. **Formulation of the Plan**. The engineer commander may well wish to discuss aspects of his plan with his subordinates before he issues his orders. This is particularly important when operating with Allied or regrouped engineer forces;

c. **Priorities**. Often, the demand for engineer resources will exceed immediately available supplies. Therefore, the engineer commander must advise the commander and obtain priorities for engineer work; and

d. **Allocation of Resources**. Based on priorities, the engineer commander allocates resources on the authority of the commander. He will allocate personnel, materials and time to tasks in accordance with the priority of work and his subordinate units' capabilities.

14. Annex B contains a list of some engineer factors that should be considered when preparing an engineer estimate of the situation.

15. **Co-ordination**. Engineer operations will influence and affect the operational plan. It is vital that the engineer commander

ensures that all such aspects of the engineer plan are co-ordinated with other arms.

16. Where practicable, all planning and execution must be in accordance with host nation directives, and commanders must co-ordinate their activities closely with host nation authorities.

SECTION 2
COMMAND AND CONTROL

COMMAND STATUS

1. Engineer support and advice will be provided at each level of command. Specific responsibilities at each level will be determined by the plan, but the following general principles apply:

a. Engineers will always be in short supply and their activities should be co-ordinated at the highest appropriate level in order to ensure their most efficient use. This will be achieved using a system of prioritisation. It will be necessary to harmonise the requirement to provide close support to formations with the overall priorities established by the commander. Close Support Engineers are normally placed under operational command and general support engineers are normally placed under operational control.

b. Engineer deployments and organisations should normally comply with boundaries at the tactical level. The commander would expect to retain his usual engineer commander, or his representative, even when engineers are regrouped. If other engineer units reinforce a formation, command of all the engineers operating in the supported area of a formation is vested in the engineer commander supporting that formation. Therefore, the attached engineer units shall be assigned a command relationship such that the existing engineer commander of the formation remains the sole engineer adviser and engineer commander for that formation. It is paramount that there be unity of command of engineers at all levels. This implies that only one engineer adviser will exist at all levels down to and including battle group.

ENGINEER ADVISER

2. An engineer commander is an adviser to a commander. There should be engineer advice provided to the commander and his staff at every level of command. Engineers should be included in reconnaissance groups at all levels and should also work closely with formation operation and administration staffs.

RESPONSIBILITIES FOR ADVICE TO THE COMMANDER

3. Responsibilities for advice are as follows:

a. integration of engineer plans into operation plans,

b. planning of engineer employment within the formation,

c. co-ordination of all engineer work within boundaries, and

d. co-ordination of the engineer plan with the sustainment plan.

LOCATION OF THE ENGINEER COMMANDER

4. The engineer commander's location depends upon the relative importance of the tasks currently underway and upon those being planned. An engineer commander is an adviser to the commander and therefore his location will be linked to the following functions:

a. **Planning Operations**. During the planning stages of an operation the engineer commander should be located with the engineer staff at the supported headquarters to advise the commander on how engineers can best influence the battle.

b. **Advice to the Commander**. Depending on the tempo and type of operation, the engineer commander must decide when he should be collocated with the commander to provide immediate engineer advice. When the engineer commander is not located with the commander, engineer advice can be provided by the engineer staff at the supported headquarters.

c. **Commanding his Troops**. After planning has been completed the engineer commander must visit his troops when implementing the engineer plan. He can personally influence events by committing additional engineer resources as well as providing personal direction for the execution of unexpected tasks.

AFFILIATIONS

5. Smooth and more effective relationships develop between units that routinely work together. Operational effectiveness is enhanced by familiarity between commanders, their staffs and units that know each other and have established and practised operational procedures together. Whenever possible, commanders should foresee probable operational groupings and group these elements together.

ENGINEER TECHNICAL CONTROL

6. Technical control is the specialised or professional guidance and direction exercised by an authority in technical matters. Much engineering work will fail, or will be wasteful, uneconomic in manpower and resources, if it is technically unsound.

Engineer commanders must be able to issue technical direction and receive technical advice. Engineer commanders are responsible for checking the technical soundness of the work of subordinate engineer commanders, and have the authority to pass down instructions or advice of a technical nature. Operational commanders may override this type of control any time its application is seen to jeopardise the mission of the military force.

LEVELS OF SUPPORT

7. There are three levels of engineer support to operations. They are divided as follows:

a. **Strategic Level**. For Canadian only operations, NDHQ/J3 Engr, on behalf of the CDS, is responsible for planning and co-ordinating engineer support. For multinational operations, the alliance headquarters is responsible for co-ordinating strategic level engineer support. NDHQ/J3 Engr will co-ordinate Canadian specific requirements in concert with the strategic direction issued by the alliance headquarters.

b. **Theatre Level**. For Canadian only operations, the Canadian Joint Task Force Engineer (the senior Canadian engineer in the Canadian Force Headquarters) is responsible to the Force Commander for co-ordinating engineer support to the force. For multinational operations, the Canadian Force Engineer will not always have an operational role. He is responsible for providing specialist and technical engineer support to Canadian engineers at the tactical level. The Canadian Engineer Support Unit is one of the many theatre engineer units. The Theatre Engineer (the senior multinational engineer) is responsible for co-ordinating the engineer effort, and performs engineer work in the communication zone. The Theatre Engineer accomplishes this by co-ordinating the various troop contributing nations theatre level engineer resources.

c. **Tactical Level**. For Canadian only operations, component engineers are responsible for co-ordinating tactical level engineer support for their components. For multinational operations, this function is performed by corps, division and brigade group engineers. Corps engineers normally work in the rear combat zone and augment divisions and independent formations, while divisions and brigade groups work in the forward combat zone.

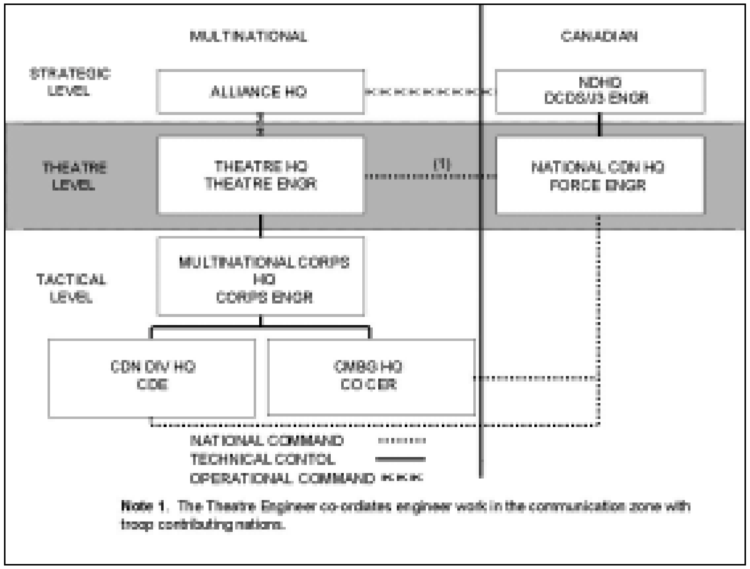

Figure 1: Levels of Engineer Support

COMMAND AT DIVISIONAL LEVEL

8. Since there will rarely be enough engineers to perform all the tasks required of them, engineer assets will be controlled and allocated at divisional level by the Commander Division Engineers (CDE). As such, the CDE will mainly be concerned with planning and correctly allocating resources to ensure that regiments are able to execute their missions. When engineer tasks within the division are

beyond the capability of the divisional engineers, corps engineers may be assigned.

9. **The CDE**. The senior engineer officer in the division is the CDE. The CDE has three principal responsibilities:

a. he commands the division engineers and any additional engineers allotted to the division;

b. he is the division commander's engineer adviser; and

c. he is the technical link between corps and division engineers.

10. **Command and Control**. In order for the CDE to exercise control of engineer resources within the division, the engineer group headquarters is organised into functional areas as follows:

a. **Engineer Group Headquarters**. The engineer group headquarters is divided into a main and an alternate headquarters. This headquarters is physically separated from the division headquarters, and is responsible for planning, issuing orders, monitoring and controlling the execution of current division engineer operations all under the direction of the Deputy CDE;

b. **Division Engineer Staff**. The engineer staff at division headquarters is divided into two groups to support division main and alternate headquarters. The engineer staff forms an integral part of the division staff. Under the direction of the G3 Engr, the engineer staff is responsible for the planning of division future operations, monitoring current operations, co-ordinating all engineer matters with the division staff and higher and flanking formations' engineers, the engineer input to the production of division orders, directing, processing and disseminating engineer intelligence, and providing geomatics support.

c. **Division Rear**. A small engineer staff is collocated with the division rear headquarters to facilitate the co-ordination of administrative and logistic matters.

d. **Engineer Support Regiment**. The senior engineer supporting divisional troops and the division rear area is the commanding officer of the ESR. He has three principal responsibilities:

(1) he commands the ESR and any other engineers allotted to the unit;

(2) he is the engineer adviser to the commander of the division rear area, and division troops. The ESR is established with an operations, intelligence and geomatics capability which may be deployed to the rear area headquarters for maintenance or damage control purposes, or to the artillery brigade when digging in the guns; and

(3) he provides the command and control for tasks executed by the ESR in support of the forward brigades such as route maintenance, bridge construction, and other area or task responsibilities given to the unit.

11. Once detailed plans have been drawn up and operations have begun, the CDE, apart from visiting supported formation headquarters and units to gain information firsthand should not become too involved with the detail of current operations. His primary role is to maintain an overall view and to ensure that the commander's plans are implemented. In this way, he will be better able to advise the divisional commander, use his resources in the most flexible manner, and foresee the need to commit additional resources, and concentrate on planning.

12. **Grouping**. Grouping is the tailoring of a force for an operation. Through this procedure the commander arranges his resources to accomplish the various specific tasks essential to his mission. When establishing the grouping, the commander will state the command relationship of the various elements of the force. Relationships are established by the status of command decided upon by the commander. These relationships determine degrees of command and control for both operational and administrative activities. While there is no permanent grouping of engineers, the likely initial allocation, unless the situation demands otherwise, will be as follows:

a. The ESR and any assets allocated from the corps will support the division as a whole and be under operational command of the CDE. Some elements may be further grouped under operational command, operational control or tactical command to the CERs.

b. Each brigade will normally receive one CER under operational command. However, the CDE may reallocate squadrons to support the main effort.

13. **Deployment**. The control of engineer units in the divisional area varies with the terrain and the type of operation. Typical deployment options are as follows:

a. **Centralised to the Commander Divisional Engineers**. The CDE retains control of his units and gives them area responsibilities or task responsibilities.

(1) **Area Responsibilities**. Regiments are assigned a specific area of the divisional sector within which they complete all engineer tasks.

(2) **Task Responsibilities**. Regiments are assigned a major task or several similar tasks throughout the divisional sector.

b. **Close Support to Brigades**. CERs are grouped under operational command of the brigades. In this instance the CDE exercises technical control.

c. **Portion Centralised and Portion in Close Support**. A combination of both forms of deployment to suit particular circumstances.

COMMAND AT BRIGADE LEVEL

14. **The Commanding Officer of the CER**. The senior engineer supporting a brigade is normally the commanding officer of the CER. He has three principal responsibilities:

a. he commands the CER and any other engineers allotted to the brigade;

b. he is the brigade commander's engineer adviser; and

c. as a commanding officer, he is the link between his CER and division engineers, or corps engineer in the case of the brigade group.

15. His headquarters is broken down into four components:

a. **Brigade Engineer Staff**. A portion of the CER regimental headquarters with an operation, intelligence and geomatics capability forms the engineer staff at brigade headquarters. The engineer staff forms an integral part of the brigade staff and is responsible for planning operations at formation level, monitoring current operations, co-ordinating all engineer matters with the brigade staff and higher and flanking formations, the engineer input to the production of formation operation orders, geomatics support to the formation and directing, and disseminating engineer intelligence.

b. **Regimental Headquarters**. The regimental headquarters, under the control of the DCO is responsible for planning and executing unit operations and the collection and dissemination of engineer intelligence.

c. **Regimental A2 Echelon**. The A2 is located within the Brigade or Division Services Area (BSA/DSA). The Administration Squadron Commander commands it. The A2 Echelon is a large organisation that provides engineer matériel and combat service support to the regiment. It is also well placed to command engineers working in support of the BSA carrying out such tasks as route maintenance and water supply.

d. **Regimental B Echelon**. The regimental B echelon may be located in the BSA or the DSA. It is commanded by the adjutant and is responsible for processing of reinforcements and logistic support, less combat supplies and transport.

16. **Grouping**. The commanding officer of the CER groups his regiment to support the tactical plan with emphasis on the brigade commander's main effort. The most common grouping, unless operations dictate otherwise, will be for close support engineer squadrons consisting of both armoured and field engineers to be under operational command or tactical command of supported battle groups. Engineer heavy equipment and/or ESR assets may also be included in the engineer grouping.

COMMAND AT BATTLE GROUP LEVEL

17. **Officer Commanding the Field/Armoured Engineer Squadron**. The senior engineer supporting a battle group is the officer commanding the field/armoured engineer squadron. He has three principal responsibilities:

a. he commands his squadron and any other engineers allotted to the battle group;

b. he is the battle group commander's engineer adviser; and

c. he is the link between his squadron and the CER.

18. His headquarters is broken down into three components:

a. **Battle Group Engineer**. He is co-located with the battle group headquarters and is responsible for planning operations, monitoring the current operation, co-ordinating all engineer matters with the battle group staff, the engineer input to the production of battle group orders and the provision of engineer intelligence to the battle group in support of operations.

b. **Squadron Second in Command**. The squadron second in command is responsible for planning and execution of squadron operations and collecting and disseminating engineer intelligence. He co-ordinates resupply with the administration squadron and commands the A2 Echelon.

c. **Squadron Sergeant-Major**. The squadron sergeant-major commands the A1 echelon. He is primarily concerned with support services.

COMMAND PROCEDURES

19. **General**. Command relationships are separated into operational and support relationships. These definitions are contained in B-GL-303-000/FP-000 Command. The following relationships shall be used:

a. **Command Terms**. Command terms are normally used with the manoeuvre arms, i.e. Infantry, Armour, Aviation and close support Engineers. OPCOM is the authority granted to a commander to assign missions or tasks to subordinate commanders, to deploy units, to reassign forces, and to retain or delegate operational/tactical command or control as may be deemed necessary. A commander assigned forces under TACOM may allocate tasks to those forces but only within the parameters of the current mission given to him by the higher authority which assigns the forces. TACOM is used where the superior commander recognises the need for additional resources for a task but requires the resources intact for a later role. An example would be an engineer firing party for a reserve demolition assigned TACOM to a combat team until the completion of the mission. This firing party is assigned the specific mission of firing of the demolition, and therefore cannot be used by the combat team for other tasks not related to the firing of the demolition. When the mission is complete, the TACOM relationship with the combat team ends.

b. **Control Terms**. Control terms are normally used with support or service support arms, i.e., Artillery, Signals, Military Police and general support Engineers. OPCON is the authority delegated to a commander to direct forces assigned so that the commander may accomplish specific missions or tasks which are usually limited by function, time, or location; to deploy units concerned and to retain or assign tactical control of those units. If the requirement develops for separate employment, the higher commander must approve the change. An example would be a heavy equipment troop from the ESR provided to a CER. They would be allocated OPCON in order for the CER to assign missions and tasks to the troop as a whole, and not as individual entities. TACON is the detailed and, usually, local direction and control of movements or manoeuvres necessary to accomplish missions or tasks assigned. An example of TACON is an amphibious troop tasked by the CDE to replace a damaged bridge on the division main supply route in a brigade rear area. This troop would be assigned TACON to the brigade to ensure that movement, local defence and real estate are co-ordinated with the force in place.

20. Figure 2 is a summary of command relationships.

CONTROL MEASURES

21. **General**. Engineers use the same control measures as the general staff. These include:

a. command relationships,

b. establishment of priority of tasks,

c. tasking of units,

d. designation of unit boundaries to indicate limits of geographically allocated work,

e. times for completion of tasks,

f. standards of work,

g. designation of rendezvous for stores and dump locations,

h. advising unit commanders of the future location of engineer units,

i. task progress reports from units,

j. submission of unit reports and returns, and

k. special instructions including SOPs.

COMMAND RELATIONSHIPS (1)

	Full Command (2)	Command		Control		Planning Authority
		OPCOM (2)	TACOM (3)	OPCON	TACON	
1. Assign Separate Employment of Components of Units/Fmns	X	X				
2. Assign Missions (5)	X	X		X		
3. Assign Tasks	X	X	X	X		
4. Delegate Equal Comd/Con Status	X	X	X	X		
5. Delegate Lower Comd/Con Status	X	X	X	X		
6. Coord of Local Mov, Real Estate and Area Def	X	X	X	X	X	
7. Planning and Coord	X	X	X	X	X	X
8. Adminis-trative Responsi-bility (4)	X					

Figure 2: Command and Control relationships

NOTES

1. Command relationships will always be qualified by the date-time group (DTG) AT WHICH they begin. The DTG AT WHICH THEY END should also be specified if known.

2. A commander assigned forces under FULL COMMAND or OPCOM may employ those forces for any purpose. Forces assigned under OPCON may only be employed within certain constraints, such as function, time or location, imposed by the higher authority which assigns the force.

3. A commander assigned forces under TACOM may allocate tasks to those forces but only within the parameters of the current mission given to him by the higher authority which assigns the forces.

4. Sustainment responsibility is not included with the command relationships for any joint, combined or multinational operation. within national arrangements only, OPCOM, TACOM and OPCON normally include ADMINISTRATIVE responsibility attached for daily maintenance. if the relationship is other than normal combat supplies, the exact relationship must be specified.

5. Mission is defined in AAP-6 as "A clear, concise statement of the task of the command and its purpose".

22. **Special Instructions**. The following special control measures also apply:

a. mine warfare policy including minefield design and marking criteria, scatterable mine laying policy, nuisance and phoney minefield policy,

b. booby trap policy,

c. denial measures policy concerning the destruction of facilities, utilities, matériel and contamination of water sources; and

d. flow of engineer information.

ORDERS

23. The issue of orders is an important means for the commander to impress his will on his subordinates. Depending upon the level of command, there may be a requirement for the engineer staff to prepare several types of orders. They are:

a. Engineer Annex to a formation Operation Order,

b. Engineer sub-paragraph to the EXECUTION paragraph of a formation Operation Order,

c. Engineer Operation Order,

d. Overlay Orders,

e. Operation Instruction,

f. Warning, and

g. Movement Orders.

LIAISON

24. If an engineer unit does not have a permanent representative at the headquarters of the formation it is supporting, it must make arrangements to ensure good liaison. This may entail frequent visits to the headquarters or visits at specific times. It is important that engineers be represented at all planning, co-ordination conferences, reconnaissance or order groups. If engineers of more than one nation are involved, it is essential that reciprocal engineer liaison teams be deployed.

THE CONTROL OF OBSTACLES

25. **General**. In all types of operations the planned use of obstacles must conform to the overall plan. The co-ordination of obstacles is covered within the framework of barrier planning. However, specific control measures need to be identified to ensure that obstacles of significant tactical importance are not executed before the appropriate time.

26. **Planning.** Barrier planning is the commander's responsibility with engineer advice. The selection of reserved obstacles depends on tactical factors and the technical requirements to prepare and complete the obstacle. Reserved obstacles are often manpower intensive, therefore a limited number of reserved obstacles should be selected. Host nations may impose additional obstacle control measures. These constraints must be known and understood by all concerned with barrier planning.

27. Defensive Operations, Chapter 5 Section 2 deals with barrier planning, the control of obstacles and the transfer of barriers.

SECTION 3
ENGINEER INTELLIGENCE

Full and accurate intelligence is vital to all engineer operations whether it be the major planning for a campaign, or for preparations for the smallest engineering job. The information must be the fullest possible so that detailed plans and provision of the necessary stores, labour and transport can be made. It must also be available in good time so that the necessary arrangements may be made in advance, and so that there shall be no delay when work on the site is possible.

To ensure that this intelligence is available, a very sound system for its collection, collation and distribution is essential, and this must permeate the whole engineer organization from the War Office down to the unit.

Much of the material required is common need of engineers in particular and the staff of the Army in general. Such information includes width and nature of roads, strength of existing bridges, obstacles to movement such as river canals and inundations, existing water supply, location and extent of enemy minefields, natural and industrial resources of the theatre, etc. Therefore engineer and general intelligence must be closely allied, and its organization must, as far as possible, avoid overlapping and duplication of effort, while ensuring the details of peculiar interest to engineers are not neglected. Whereas, for instance, the staff require to know what traffic a bridge will carry, the engineers also want to know details of its construction, and of the gap which it spans in case it may be necessary to destroy, strengthen, repair, or replace it. Again, while the staff will require to know the yield of existing water supply, the engineers should know the nature of the pumping gear, the depth of the well and the geological details of the subsoil in case it may be necessary to repair or replace the pump or to increase the yield.

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GENERAL

1. Engineer intelligence is that intelligence concerning enemy engineer capabilities, the weather, military geographic information and resource information required for the planning of combat operations. Engineer intelligence is but one element of the intelligence system. Many items of engineer intelligence are of interest to other agencies, and similarly, many items of combat intelligence or information are of interest to engineers. Engineer intelligence forms an integral part of the Intelligence Preparation of the Battlefield (IPB) process and is used by the engineer commander to:

a. Advise the commander on the effects that the terrain and weather may have on enemy and friendly force mobility;

b. advise the commander on the use of friendly engineers;

c. estimate the extent to which the enemy's engineers may affect the tactical plan and devise methods of countering this threat; and

d. identify critical local resources, which could be essential to support either the enemy or friendly force operations.

2. It is essential that the difference between intelligence and information be kept clear:

a. Information is unevaluated data acquired from a variety of sources; and

b. intelligence is information, which has been subjected to the intelligence process.

3. The scope of engineer intelligence is large. It includes physical and technical aspects of natural and manmade terrain features, engineer resources, intelligence on enemy engineer methods and equipment, and current intelligence. Engineer intelligence supports both the broader combat intelligence system and engineer plans and operations.

THE INTELLIGENCE CYCLE

4. The engineer intelligence cycle mirrors the normal intelligence cycle, that is direction, collection, process and dissemination. It ensures that information is collected, assembled, converted into intelligence and made available to users. In broad terms intelligence is the sum of our knowledge and understanding of an enemy and his activities. The complete intelligence cycle is detailed in B-GL-315-002/FT-001, Combat Intelligence.

5. In order for the intelligence cycle to be most effective, intelligence staffs must be informed of any operational aim or mission as soon as possible in order that the cycle be set in motion at the earliest opportunity. While the cycle portrays sequential steps, some overlap exists and concurrent activity is necessary. This process is continuous and is particularly important during fast moving operations when concurrent activity is the norm. It will also be normal to superimpose the cycles for ongoing and future operations.

6. At the operational level, engineer intelligence deals with the friendly and enemy ability to move military formations. It is concerned with the enemy engineer force structure and the ability of the enemy to use the ground and the resources available.

7. At the tactical level, knowledge of the enemy engineers will include his organisation, tactics, capability of his equipment, state of training as well as the experience and quality of his troops. In order to fight him on the best terms, the intelligence staff must also understand the military implications of the ground and climatic conditions on both friendly and enemy operations

8. **Direction**. The commander's mission determines intelligence requirements and it is his direction which provides specific parameters upon which intelligence staffs prepare collection plans and the operations staffs issue orders and requests to collection agencies. During his estimate, the commander identifies his information requirements. They are referred to as Commanders Critical Information Requirements (CCIR). Those which pertain to the enemy will normally take the form of a series of questions such as: Who will do what? When? How? And in what strength. These are the Priority Intelligence Requirements (PIR).

9. Using PIRs as a basis, intelligence staffs will develop information requirements (IRs), detailing those items of information, which need to be collected and processed. An intelligence estimate is usually done to determine IRs and their priorities. The commander or the G3 confirms the IRs, and they are included with the IRs received from superior and other headquarters in a collection plan in order that the various agencies can be tasked with the collection of the necessary information. Intelligence staffs will

determine which agencies are the best suited to collect the information.

10. The engineer commander, having been briefed on the commander's intentions, will do his own estimate to define engineer tasks and to determine what he needs to know about enemy capabilities and resources, climate and terrain. This information will enable him not only to advise the commander but it will also enable him to develop his engineer CCIRs based upon the commander's intentions.

11. His CCIRs are aimed at gaining information of an engineer nature in order to prepare the engineer plan. The G2 Engr develops PIRs and prepares IR. A collection plan tasking engineer units with the collection of information as well as passing the same tasks to the supported formation G2 for inclusion in the commander's collection plan.

12. **Collection**. The collection stage is the exploitation of sources of information by collection agencies and the delivery of same to an intelligence staff or processing agency for the use in production of intelligence. It is a continuous process. Collection agencies are numerous and varied. They may include deployed forces, special reconnaissance forces, interrogation teams, liaison officers, partisans, and remote sensing means to mention a few. The intelligence collection plan must be developed so that it relates the PIRs to the responsible collection agencies.

13. As orders and requests concerning engineer intelligence requirements are received by engineer headquarters they are examined and responded to immediately, provided the information is on hand or the appropriate sources and agencies are tasked. Although PIRs and IRs establish the engineer commander's specific needs, they do not relieve units of their responsibility to continue to report all engineer and combat information. The engineer commander will continually review his information requirements. This may result in new PIR/IRs and orders being issued.

14. It is difficult to start from scratch and quickly assemble the engineer information required during an operation, then integrate the resulting engineer intelligence with combined arms intelligence. Engineers must maintain knowledge of the doctrine, tactics and

equipment of enemy engineers through a proactive collection programme in peacetime. A full time collection programme in garrison will allow the timely dissemination of up to date engineer intelligence to units and formations in operations, which will then help, accelerate engineer battle procedure.

15. The collection plan is an aid in planning specific requests for information and is used by the engineer intelligence staff to co-ordinate the collection of information. The overall responsibility for a collection plan rests with the operational commander and his operations staff. The engineer intelligence collection requirements must always be integrated into the overall formation collection plan. The detail, extent and formality of the collection plan will vary with the pace of the battle and the level of command.

16. The tasking of engineers to collect information is achieved by:

a. issuing specific tasking for collecting information normally in the form of reconnaissance orders to units; or

b. the Intelligence Annex of an Engineer Operation Order which will list the PIRs and any other specific taskings for information gathering.

17. **Processing**. At this stage information is translated into intelligence. Processing consists of collation, evaluation, analysis, integration and interpretation.

18. **Dissemination**. The object of dissemination is to provide engineer staffs and units, and through them their commanders, with timely engineer intelligence. Dissemination to higher, lower and adjacent units can be done by means of reports, summaries and studies, intelligence estimates, analyses of the area of operations, operation plans and orders, overlays and maps, and engineer advice.

19. Engineer intelligence is channelled upward through the engineer or formation intelligence staffs, and downward to the engineer commanders through their intelligence staffs or through the network of engineer technical control. Engineer intelligence, which

may be used by other arms, should also be channelled upward and downward through the formation G2 staff. In these ways, both engineer and other arms staffs and units are kept abreast of enemy engineer technical and operational developments and other matters of importance.

INTELLIGENCE PREPARATION OF THE BATTLEFIELD

20. Intelligence Preparation of the Battlefield (IPB) is a systematic and continuous process conducted to assess threat capabilities, vulnerabilities and probable courses of action in a specific geographical area. The purpose of IPB is to define information requirements and help the staff answer these requirements. This in turn provides the commander with the intelligence necessary to synchronise combat power on the battlefield. IPB consists of four steps:

a. **Step 1 - Defining the battlefield** to ensure a common understanding of the battlefield dimensions and formation/unit limits of responsibility. It focuses the IPB effort on the area of operations and identifies for further analysis those characteristics which will influence the mission.

b. **Step 2 - Describing the battlefield** by identifying the limitations and opportunities of the area of operations and their impact on the friendly and enemy forces. This assessment always includes the examination of terrain and weather and may also include any other factors that could effect the mission.

c. **Step 3 - Evaluating the enemy** by completing the intelligence database and developing doctrinal models without terrain or weather constraints. These could be depicted in a graphical, matrix or narrative format; and

d. **Step 4 - Determining the enemy courses of action** by integrating the doctrinal models with the effects of the specific environment in which he is operating.

21. The basic elements of IPB are the same as those that underpin the Intelligence Estimate; it is only the means by which those elements are developed and displayed that is different. IPB uses graphical displays, making it easier to prioritise information requirements, update databases and understand and distribute intelligence products. The results and products of IPB, conveyed in the intelligence estimate are essential elements of decision making. Accordingly, the major IPB effort occurs early in the staff planning process.

22. IPB can be used in all theatres and in all types of conflicts. It is closely intertwined with operations, intelligence, fire support, manoeuvre and barrier planning. The full IPB process is feasible at division and above. At brigade and below, the limitations of staff, time and information will influence the detail and formality, but should not affect the process. IPB products are designed to exploit automation and can be distributed to subordinate formations and units whose capabilities to conduct detailed IPB are limited. It is therefore essential that all commanders and staff understand the IPB process and its products. This is paramount in combined operations where army units and formations could be subordinate to other national and allied formations (NATO, ABCA or other coalitions) that employ the IPB process.

23. The IPB process is dynamic and responds to the commander's information requirements before, during and after the execution of the assigned mission. During the initial planning phase, IPB concentrates on building a database for the area of operations and determining probable enemy courses of action. During operations, IPB steers the intelligence system and provides the commander with the relevant intelligence before he reaches a decision point. IPB continually updates and validates its database throughout the execution of current operations and in anticipation of the commander's subsequent mission.

24. **Step 1 - Defining the Battlefield**. The definition of the battlefield is an operations responsibility. The battlefield is defined

in the four dimensions of width, depth, height and time. It is the responsibility of a formation to designate the area of operations and area of intelligence responsibility for its subordinate formations and units as required by the mission. The subordinate formation/unit commanders will then identify their area of influence and area of interest based upon their superior's intent and their own. At brigade and above, or when considered appropriate by the commander, the division of responsibility for close, deep and rear operations is identified. Close, deep and rear operations are not geographical, but functional and are considered together and fought as a whole at each level of command. Characteristics of demography such as politics, civilian press, local population and the civilian infrastructure in the area of operations and area of interest must also be considered.

25. **Step 2 - Describing the Battlefield**. The effects of the environment on the conduct of operations are evaluated. Until the threat courses of action are developed in the last step of the IPB process, this evaluation focuses on the general capabilities of each force. This assessment of the battlefield always includes an analysis of terrain and weather.

a. **Terrain Analysis**. Terrain analysts will provide an assessment of the influence of terrain on operations. The IPB process is supported at the division level by a terrain analysis team, which is integral to the Intelligence Company's Collection and Analysis Centre. Terrain analysis will, therefore, be a joint effort between the terrain analysts in the Intelligence Collection and Analysis Centre (ICAC) and those that are part of the Division Engineer Staff. At brigade and below, such specialist support will normally only be found in the engineer staff supporting the formation or unit. Where terrain analysis support is not available, the commander and/or staff must consider the effects of terrain. Use of the mnemonic FLOCARK (**F**eatures, **L**anes, **O**bjectives, **C**analising ground, **A**pproaches, **R**ating avenues and **K**ey terrain selection) will assist the commander in analysing the ground from a map or photographs. Neither technique is a substitute for physical reconnaissance, but allows the commander to focus his limited time for reconnaissance on those portions of the ground that are critical to the success of the mission.

b. **Weather Analysis**. Weather has implications for air and aviation support, surveillance and target acquisition systems, communications, equipment performance and the ability of the soldier to fight. Accurate weather predictions are crucial.

26. **Step 3 - Evaluating the Enemy**. The G2 and his staff determine how the enemy normally organises for combat and how he has conducted operations under similar circumstances. When facing a well-known enemy, the G2 can rely on his historical databases and enemy models. In some situations the enemy may not have a well-developed doctrine. It will then be necessary to study his operations, determine his methods of operation and document his doctrine.

a. **IPB Products**. The G2's evaluation is portrayed in an enemy model, which depicts how the enemy operates when unconstrained by the effects of the battlefield environment. Enemy models are described graphically, in matrix or simple narrative format. The enemy capabilities, doctrinal principles, tactics and standard operating procedures identified during this step allow the G2 to develop the following products:

(1) **Doctrinal Templates**. They illustrate the deployment pattern preferred by the enemy's doctrine when not constrained by the effects of the battlefield environment. They are usually scaled graphic depictions of enemy dispositions for a particular type of operation such as: battalion in defence, regiment in the attack, etc. Doctrinal templates can depict the enemy's normal organisation for combat, frontage, depths and boundaries.

(2) **High Value Target (HVT) List**. Assets whose loss to the enemy will result in a substantial degradation of an important combat capability are identified. The HVTs are rank ordered based on their relative worth to the enemy's operation and recorded as part of the threat model. The HVT list can be presented as a target list and/or annotated on an enemy course of action overlay (Situation Templates). HVTs are dependent upon the level of command conducting the analysis. At brigade and battle group, HVTs may be engineer assets, command posts, reserves or mortars. At division and corps, HVTs focus more on capabilities such as headquarters, subsequent echelons and reserve forces, electronic warfare units, nuclear and conventional fire support systems, lines of communications, aviation and air assets.

(3) **Threat Order of Battle**. This illustrates the possible enemy order of battle and layout based on the doctrinal templates when considering the effects of the battlefield environment.

(4) **Description of Tactics and Options**. This is a description of the enemy's preferred tactics. It addresses the operations of the major units or elements depicted on the templates and how the different enemy combat capabilities interact. It also includes a description of options normally available to, or preferred by, the enemy should the operation succeed or fail. If the database reveals any decision criteria that would cause the enemy to prefer one option over another, it is included in the description.

27. **Step 4 - Determining the Enemy's Courses of Action**. In determining the enemy's courses of action, the G2 integrates the results of the previous steps into a meaningful conclusion. Given what the enemy normally prefers to do, and the effects of the specific environment in which he is operating now, what are his likely objectives and the courses of action available to him? The G2 develops likely models that depict the enemy's available courses of action.

28. These models are used by the staff to portray the enemy during the OPP. The results of this step are valid only if the G2 establishes a good foundation during the first three steps of the IPB process. The G2 develops the following products during this step:

a. Situation Templates (an overlay for each course of action),

b. Event Templates (multiple courses of action overlay), and

c. Event Matrix (list of indicators used to determine enemy course of action adopted).

29. The complete IPB process is detailed in B-GL-315-002/FT-001, Intelligence, Volume 2, Combat Intelligence.

ENGINEER INTELLIGENCE PREPARATION OF THE BATTLEFIELD

> *One of the problems confronting the Chief Engineer was the organization of an effective Engineer intelligence service. There were many organizations involved in securing intelligence of all types, but none was engaged in presenting Engineer intelligence in a form or in detail suitable for the use by Engineers. Few appreciated the big part Engineer intelligence would play in the planning of major military operations and the logistical support thereof. It was not realized until quite late that good Engineer intelligence could, and would, enable the*

preparations of sound plans, and that without it some very serious blunders could be made.

Final Report of the Chief Engineer (US)
European Theatre of Operations 1942-1945

30. The products of IPB prepared by a division or corps G2 will only partially satisfy the basic requirements for engineers. At the very least these products must be refined and expanded upon to meet the need of engineers. Similarly, during the preparation phase the G2 Engr will provide significant input on enemy engineer capabilities and doctrine and the terrain. The following list provides many of the additional factors to be considered by engineer intelligence staffs in Engineer IPB.

31. **Step 1 - Defining the Battlefield**. The area of operations given by the higher commander and the area of influence for engineers will normally be the same as that of the formation being supported. Engineers will also be concerned with the area of intelligence responsibility and area of interest for the operation.

32. **Step 2 - Describing the Battlefield**.

a. **Terrain**. When evaluating the terrain's effects on engineer operations:

(1) Analyse the defensible terrain within each avenue of approach to determine locations, which lend themselves to the use of obstacles.

(2) Further identify where the terrain lends itself to breaching operations at each location. This includes concealed and covered routes towards the breach site and terrain that supports suppressing fire during the breaching operation.

(3) Analyse drainage and coastal features within the area of operations. Focus on bridges; ford sites and areas that lend

themselves to river crossing and amphibious operations.

(4) Identify other manmade or natural obstacles within the area of operations, such as railroad tracks with steep embankments. Identify the effect of each obstacle upon the movement of different types of units. Further analyse the locations where these obstacles can be easily traversed or crossed.

b. **Weather**. When conducting weather analysis for engineer operations, determine:

(1) How reduced visibility affects breaching/crossing operations.

(2) How weather affects obstacle effectiveness. For example, how does recurring rain change the effectiveness of an antitank ditch.

(3) How weather affects equipment (i.e. mine breaching ploughs, mechanical minelayers, etc.).

(4) How weather affects trafficability.

(5) The effects of weather upon survivability positions.

(6) The effect of precipitation upon rivers and streams. During winter, also estimate the degree to which waterways are frozen and their load capacity.

c. **Infrastructure and Engineer Resources**

(1) Identify local sources of potable water;

(2) identify local sources of barrier material;

(3) identify local sources of engineer equipment;

(4) analyse the ability of the local road network to support anticipated traffic and determine the need for immediate repairs;

(5) assess the state of local ports and airfields to determine repair and maintenance requirements; and

(6) assess the state of local infrastructure to support operations.

d. **Economics**. When considering economics, identify the engineer projects which would most help the local population if time permits. Such projects are especially pertinent for nation assistance/building. Projects could include building roads, schools, power generation facilities, water, sanitation and other public buildings and services.

e. **Treaties, Agreements and Legal Restrictions**. During peacekeeping and peacemaking operations, determine legal constraints on engineer operations.

33. **Step 3 - Evaluating the Enemy**

a. **Enemy Order of Battle**. The evaluation should include:

(1) Organisation, equipment and standard operations of enemy engineer units. Consider the capability to conduct the following types of operations: mobility, counter-mobility and survivability;

(2) capabilities of enemy engineers units;

(3) tactics that enemy engineers use while conducting each of the above operations;

(4) ability of the enemy's logistical system to sustain engineer operations;

(5) capabilities of enemy weapons to penetrate friendly obstacles;

(6) information on enemy survivability techniques; and

(7) engineer capabilities of enemy infantry, armour and other non-engineer units.

b. **Enemy Models**. Enemy models should include:

(1) schematic drawings of standard obstacles,

(2) schematics of vehicle pits,

(3) standard enemy employment of obstacle support to defensive systems and categorisation of each obstacle by its effect (disrupt, turn, fix or block),

(4) typical techniques for combined arms units during breaching operations,

(5) typical employment of combined arms units during crossing operations,

(6) descriptions of mine warfare doctrine, marking systems and standard patterns, and

(7) technical information on barrier material, mine fuses, mine delivery systems (such

as air, artillery) and details of construction.

34. **Step 4 - Determine Enemy Courses of Action**

a. **Situation Templates**. In order to develop situation templates for engineers, begin with the manoeuvre situation templates. For each manoeuvre course of action available to the enemy, develop multiple engineer courses of action that include:

(1) An estimate of the likely engineer support to each enemy course of action for the defence, particularly the ability of the enemy to dig in vehicles and positions as well as the likely extent of barriers;

(2) an estimate of the mobility support for each enemy course of action for the offence, particularly, the breaching and fording capabilities of both the manoeuvre and the supporting engineer detachments;

(3) an estimate of likely enemy support during delaying and transitional operations.

b. **Event Templates**. When using event templates:

(1) Attempt to use the same Named Areas of Interest established by the supported formation; and

(2) if necessary, establish separate Named Areas of Interest to support the execution of engineer operations.

c. **Event Matrix**. Decision points for engineers should focus on decisions such as:

(1) Forward deployment of breaching/crossing assets,

(2) employment of artillery or ground emplaced scatterable mines,

(3) shifting the type and priority of engineer effort, and

(4) closing of lanes in obstacles.

SOURCES OF ENGINEER INTELLIGENCE

Although the planning at all levels of engineer operations depends chiefly on intelligence data the actual tasks of units were normally based on immediate reconnaissance reports. It is of course an advantage if the reconnaissance is carried out by those responsible for the actual work. This is not always possible, and the reconnaissance may have to be carried out by other individuals. It is therefore of the utmost importance that such reports should be clear and accurate, and should contain all the information required.

In almost every theatre senior engineer officers have commented on the insufficiency of training of officers and N.C.O.s in this aspect of engineer work, and efforts were made in schools of instruction and courses to improve the standard and to establish common forms of report. Comments on the operations all stress the importance of the presentation of information in standard form, and the standardisation of formats of reports from various sources. In the end all this was fairly well achieved though quite late in the campaign and differences in method led to waste of time and energy. For example, the standard form of report on certain matters varied between Second (UK) and First Canadian Armies, so that a corps had to change its form of report on transfer *from one army to the other, and back again when its period of attachment was over.*

Military Engineering (Field)
The War Office 1952

35. Engineer information can be collected from the following sources:

a. **Reconnaissance**. To obtain specific information, reconnaissance is undertaken by all arms including engineers. The ability to obtain timely information by this method depends largely on the reconnaissance unit's mobility, means of communication and level of training. Engineer reconnaissance should be preceded by a review of available information. Ground reconnaissance is frequently required to confirm data in critical sectors. In advising engineer operations staff on reconnaissance requirements, engineer intelligence staffs should meet the following criteria:

(1) Engineer reconnaissance for engineer work should be made well in advance without unduly jeopardising security of the operation;

(2) incomplete but timely engineer information can be useful;

(3) engineer reconnaissance should be repeated as often as is necessary to keep information up-to-date; and

(4) aerial reconnaissance by the engineer reconnaissance party should precede ground reconnaissance.

b. **Geomatics Products**. In most cases, maps are essential to the adequate interpretation of an engineer report and no such report should contain information in its text that is already available on a map**.** Geomatics sub-units are capable of producing many types of standard products that are used to better understand the area in question. Cross Country Movement Maps, Road and Bridge Maps and Terrain Analysis Databases fall into this category. There are also many special purpose products which can be produced by Geomatics sub-units.

c. **Air Photographs and Remotely Sensed Imagery**. These are excellent for obtaining large amounts of terrain information. Although air photos are useful before an operation, updated air photographs should also be requested as the operation progresses. In an area which is subject to violent seasonal changes, resulting in flooding for instance, air photos taken in one season cannot be relied upon to present an accurate description of the ground in other seasons.

d. **Ground Photographs**. Ground photographs are a useful tool to supplement air photographs when examining detail. While they cannot always give precise dimensions, they are very important because the information they contain is accurate, concise and easy to assimilate. The taking of photographs will produce a clearer report.

e. **Captured Enemy Documents**. Engineer intelligence staffs should review captured enemy documents so that any engineer information may be extracted. After processing, copies of captured plans of enemy minefield should be passed to the unit on whose front the minefields occur and to flanking units that may cross the particular ground. Copies of enemy documents required for the operation of installations should remain in location so that engineers may keep such installations running.

f. **PW**. Enemy PWs are a useful source of information. All PWs are best handled centrally by intelligence units but engineer intelligence staffs can obtain information by preparing specific questions for use in questioning of PWs;

g. **Resources**. Engineer Intelligence personnel are interested in all the engineer resources within the area of operations such as:

(1) Enemy engineer matériel found or captured by troops in battle; and

(2) civilian construction materials, equipment, and utilities.

h. **Civilian Sources**. Reports on items of engineer interest can be obtained from civilians living in the area of operations, but these may lack technical details. Useful information can be acquired concerning obstacles, but this should always be checked against maps or air photographs. Information can also be obtained from municipal and public works authorities. If possible an engineer officer should be present during the questioning of civilians.

i. **Agencies**. Engineer information and intelligence is obtained by engineer intelligence staffs from the following agencies:

(1) Higher, lower and flanking engineer intelligence staffs,

(2) engineer reconnaissance parties,

(3) formation and unit intelligence staffs, particularly the division ICAC; through the ICAC engineers have access to SIGINT, IMINT and other sources,

(4) formation G5 or CIMIC representative, and

(5) the appropriate organisations provided through host nation agreements.

ENGINEER INTELLIGENCE STAFF ORGANISATIONS

36. **General**. Engineer units from division engineers to the CER/ESR level have dedicated intelligence staffs. Although there is no dedicated intelligence staff at the squadron/field troop level, both organisations are responsible for handling engineer intelligence. The role of engineer intelligence staffs, at all levels is:

a. To provide engineer intelligence support for the engineer commander; and

b. to provide engineer intelligence for higher and flanking headquarters and for use by subordinate units and formations.

37. **Tasks of Engineer Intelligence Staffs**. The engineer commander is responsible for all engineer intelligence activities for his command. The engineer intelligence office is responsible for the overall direction and co-ordination of engineer intelligence activities according to the commander's policies and the operational plan. The engineer intelligence staff carry out some or all of the following tasks:

a. Maintain and review:

(1) Basic intelligence records on the terrain, climate, lines of communications and local resources in the area of interest, and

(2) basic technical intelligence records on enemy engineer capabilities.

b. In conjunction with the operations staff and other intelligence staffs, determine the engineer information requirements (IR);

c. through the engineer operations staff, task collection agencies or sources under engineer control;

d. provide or arrange for specialist engineer advice/personnel as required to formation intelligence staffs and to intelligence sub-units responsible for interrogation of PW and interpretation of captured documents and material;

e. record and process information from all sources on terrain, climate, lines of communications, local resources and enemy engineers within the area of interest; and

f. disseminate basic and current engineer intelligence.

38. **Division Engineer Intelligence Staff**. The Division Engineer Group intelligence staff is responsible to the CDE for the provision of engineer information and intelligence to enable the Division Engineer staff to provide advice on tactical operations and to make decisions concerning the employment of all engineers under command. Of equal importance is the requirement to disseminate engineer intelligence to division staffs, brigades and engineer units.

39. The engineer intelligence staff within the Division Engineer Group is split into three activity areas:

a. **Engineer Group Headquarters**. This is where the current battle is fought, and therefore, engineer intelligence is gathered and utilised for current operations.

b. **Division Engineer Staff**

(1) **Division Main Engineer Staff**. This is the main activity area for engineer intelligence. All planning, is conducted here, therefore all direction, collection, processing and dissemination of engineer

intelligence is located here. An engineer and geomatics capability is required.

(2) **Division Alternate Engineer Staff**. Consists of one officer to maintain engineer intelligence and information and monitor operations.

40. One staff officer from Division Main Engineer Staff acts as the ICAC Engr LO. His primary task is to keep the Division Engineer Staff abreast of the intelligence situation and provide engineer intelligence advice to the ICAC staff.

41. Although subordinate to the G3 Engr, the G2 Engr is the chief adviser to the CDE on intelligence matters and has direct access to the CDE, both staff officers are responsive to the Division COS and G3. When planning operations, both the G2 Engr and G3 Engr will assist/advise the CDE and the Division staff. It is necessary for the G2 Engr to be part of the planning process as he receives the CCIRs from the CDE and can determine the PIRs for the Engineer Intelligence Collection Plan. He can also determine what information is required from the Division ICAC, and directs the preparation of the necessary maps and overlays and terrain analysis products.

42. **Responsibilities of the Division Engineer G2 Staff**. Under the direction of the G3 Engr, the G2 Engr staff is responsible for:

a. Keeping the CDE and operations staff informed of the enemy engineer situation and capabilities,

b. preparation of the Division Engineer intelligence estimate, engineer intelligence input to operation orders and plans and engineer intelligence studies required for special purposes,

c. recommending engineer IR requirements to the CDE,

d. advising the engineer operations staff on the tasking of units to fulfil the Division Engineer intelligence collection plan,

e. collecting information/intelligence from engineer units and other sources,

f. liaison with the Division ICAC and Division G2 staff on intelligence matters,

g. maintaining and reviewing basic intelligence records on terrain, climate, communications and engineer resources by location and quantity in the area of interest,

h. disseminating engineer intelligence and/or information to those who need it,

i. ensuring engineer intelligence required for planning future and current operations is provided, and

j. assisting the G3 Engr staff with the maintenance of accurate records and maps of all obstacles within the division area and engineer unit/sub-unit locations.

43. **Engineer Regiment Intelligence Staff**. The duties and responsibilities of the regimental intelligence staff are similar to those of the division engineer intelligence staff in terms of advising, planning, directing and collecting of information and to some extent the processing of limited information. In broad terms, the CO of the Combat Engineer Regiment advises his affiliated brigade commander, while the CO of the Engineer Support Regiment is the adviser to the commander of the division rear area. Regimental intelligence cells normally operate within the Division Engineer Intelligence framework. Requests for information from other agencies will normally go through the G2 at Headquarters Division Engineers except for regiments under OPCOM of brigades or brigade groups where such requests will be made to the brigade G2.

44. The Engineer Staff at brigade headquarters will normally deploy with an engineer intelligence and geomatics capability. The Engineer Staff is responsible to keep both the engineer unit and the brigade intelligence staff advised of common concerns. The Engineer Staff is also required to advise the brigade G3 and G2 on all aspects of terrain and enemy engineer operations. The intelligence staff within a CER or ESR is normally comprised of an intelligence officer and intelligence NCO.

45. **Field Squadron Intelligence Staff**. The squadron commander assists the commander's fight within his area of influence. He will not have time to conduct extensive studies of maps and file databases as he plans for operations. The regimental intelligence staff must provide useful engineer intelligence and information to simplify the squadron commander's battle procedure.

46. At the field squadron level, only the collection and dissemination stages of the intelligence process will be carried out. Direction and processing are left to higher engineer headquarters. All personnel in the squadron headquarters require knowledge of engineer intelligence procedures. The intelligence function is integrated with the operations function. The squadron second in command acts as the intelligence officer.

RELATIONSHIP WITH OTHER INTELLIGENCE STAFFS

47. **Higher and Flanking Formations**. The passage of engineer information/intelligence is effected on the engineer technical net. The Division Engineer G2 liases with the Corps Engineer G2 with respect to obtaining information from flanking formations. Information can also be passed between flanking units through normal liaison procedures.

48. The requirement for, or passage of, information between the Division Engineer G2 and the Corps Engineer G2 will be concerning engineer matters only. The Corps Engineer G2 could be used to request information/intelligence from the Corps G2 as a means of expediting the passage of information.

49. **Division Intelligence Collection and Analysis Centre (ICAC)**. The ICAC is formed from the Division Intelligence Company and is tasked by the G2 for intelligence collection and analysis. The ICAC allows the G2 to present to the commander a detailed and comprehensive estimate of enemy intentions based on a co-ordinated all source assessment. Intelligence requirements are developed by the Commander, G2 and G3 and passed by the G2 to the ICAC for action. All collection and analysis is completed by the ICAC.

50. Liaison with intelligence staffs and units of other formations and nations is the responsibility of the G2 staff at division. The Division G2 prepares intelligence estimates and intelligence collection plans, as well as disseminates processed intelligence. The G2 staff neither receives nor analyses raw information or intelligence, nor does it direct the minute-by-minute activities of any collectors.

51. Although the division Intelligence Company provides the framework for the ICAC, there are some critical elements that are assigned to it upon deployment. They include:

a. artillery intelligence staff,

b. G2 Engr representative (ICAC Engr LO),

c. electronic warfare specialists and

d. meteorological team.

52. The G2 Engr submits all intelligence/information requests to the Division G2. This can be in the form of questions to be included in the Division Intelligence Collection Plan, as a separate Engineer Intelligence Collection Plan or by separate requests for information. Intelligence will be passed from the ICAC to the G2 Engr through the Division G2. The G2 Engr representative (ICAC Engr LO) provides constant liaison and co-ordination with the ICAC staff.

53. **Brigade G2 Cell**. The brigade G2 cell can liase directly with the Division Engineer Staff on matters of engineer concern and

on terrain advice if that information is not available from supporting engineers.

SECTION 4
HOST NATION SUPPORT

DEFINITION AND DESCRIPTION

1. Host Nation Support (HNS) is civil and military assistance rendered in peace and war by a Host Nation to Allied Forces and NATO organisations which are located on or in transit through the Host Nation's territory. The type of HNS which may be provided ranges from services using only civilian resources to support from military units. HNS may be provided to all arms. Engineers frequently will be major users of HNS because of their roles and reliance on machines and matériel.

HOST NATION SUPPORT RESOURCES

2. HNS resources which are likely to be of particular interest to engineers include:

a. Airfields/Sea ports,

b. civil Labour, both skilled and unskilled,

c. construction services,

d. maintenance and storage facilities,

e. supplies and services, and

f. transportation and movement assets.

PROVISION OF HOST NATION SUPPORT

3. The efficient provision of HNS requires close liaison between Allied Forces and the Host Nation authorities. Whenever possible HNS should be pre-planned in peace. There are three options for the provision of HNS:

a. **Generic Planning**. Generic plans are those which are developed for possible operations where some of the planning factors have not been fully identified or cannot be fully assumed.

b. **Contingency Planning**. These plans are developed for possible operations where planning factors have been identified or can be assumed. They are produced in as much detail as possible.

c. **Ad Hoc Planning**. Ad hoc plans are tailored to meet unforeseen circumstances as they arise or to update generic or contingency plans.

SECTION 5
ENGINEER RESOURCES

Stores play a great part in the Royal Engineers' scheme of things. Without a vast range of specialist equipment, such a highly technical branch of the Army obviously can hardly begin to function. Stores, in fact, are vital - stores and equipment of every conceivable description, from the angle-iron pickets to water supply fittings, from mine detectors to bulldozers, from barbed wire to forty-foot steel girders.

Sappers at War (1949)
Anthony Armstrong

INTRODUCTION

1. The provision of engineer resources, including equipment and defence stores, but excluding those obtained locally by engineers (i.e. through HNS), is a logistics responsibility. Control of these items is usually exercised by the staff with engineer advice, but in some cases, may be exercised by the appropriate engineer commander. This provision is necessary because without control of his resources, it would be impossible for an engineer commander to advise properly his commander, or guarantee the timely and economical completion of tasks.

2. Based on the operational situation, and engineer advice, the staff will lay down the system to be followed for the satisfactory supply of engineer material, and will designate those items which are to be engineer controlled. Subject to this broad policy, decision responsibilities are as follows:

a. **Engineers**

(1) Advising the staff on the requirements for all engineer resources including defence stores,

(2) advising the staff on which engineer resources, and what quantity of each, should be under engineer control,

(3) authorising the release of resources placed under engineer control,

(4) providing early advice to logistic staff and units as to where, when and in what quantity, engineer controlled resources and ancillary supplies are required,

(5) acquiring local resources, manufacturing items required for current projects, and when requested, providing similar materials and items to other units, and

(6) knowing the location, and state of engineer controlled resources.

b. **Logistics**

(1) The procurement of engineer materials, and

(2) assisting with the delivery of engineer materials.

CLASSES OF SUPPLY

3. Engineer resources is a generic term applied to anything required by engineer units to carry out their functions. The term includes manpower, engineer materials, engineer equipment, engineer heavy equipment, transport and money.

4. Engineer resources may comprise Class I, II, III, IV, V, VII, and IX items of supply:

a. **Class I** - Subsistence including food and water.

b. **Class II** - General and technical stores comprising clothing, individual equipment, tentage, tent sets and tool kits, hand tools, administrative and housekeeping supplies and equipment. Includes items of equipment, other than principal items, prescribed in authorisation/allowance tables and items of supply (not including repair parts). Engineer tools, consisting of man-portable, hand-operated tools and small machines used repeatedly and not consumed, such as augers, camouflet, jack-hammers, chain saws, pionjars, pumps, small generators and compressors are considered a Class II item of supply.

c. **Class III** - Petroleum oil and lubricants comprising lubricants, hydraulic and insulating oils, preservatives, liquid and compressed gases, chemical products, coolants, de-icing and anti-freeze compounds, together with component additives of such products as coal.

d. **Class IV - Construction and Defence Stores**. Comprise defence stores and all items that may be used for any type of construction by any unit. Construction material and defence stores are defined as:

(1) Construction Materials. Materials normally consumed in engineer tasks which may be recoverable, but which will usually be left in place. These include such items as culverts, lumber, construction hardware, sand, gravel, and asphalt.

(2) Defence Stores. Non-explosive stores for the construction of field defences. They include wire, pickets, sandbags, timber, revetment materials and special purpose shelters.

e. **Class V - Ammunition**. Comprise all types of ammunition, including mines, demolition material and accessories. These latter items are required mainly by engineers, or have been obtained for engineer operations, and will normally be classified as engineer resources and placed under engineer control.

f. **Class VII - Major End Items**. Comprise those items, which, because of their operational importance, are designated controlled items including engineer equipment and engineer heavy equipment. They are defined as:

(1) **Engineer Equipment**. Large tools, machines, and systems which are not man-portable, such as compressors with

accessories, assault trackway, water supply equipment, generators, mine clearing systems, bridging, including amphibious bridging, and mechanical minelayers.

(2) **Engineer Heavy Equipment**. Earth-moving and construction equipment used to perform vertical and horizontal construction tasks. Some examples of heavy equipment are earth-moving equipment (dozers, graders, scrapers, loaders and excavators), cranes, rollers and snow clearing equipment.

g. **Class IX** - Repair parts and components to include kits, assemblies and sub-assemblies, repairable and non-repairable required for maintenance of all equipment.

PROCUREMENT AND PROVISIONING OF ENGINEER RESOURCES

5. Engineer resources are provided to engineers through the national and multinational supply system. The Force Engineer co-ordinates the procurement policy for national engineer resources with the J4 staff. The co-ordination of financial management of the Force ultimately rests with the J4 Fin Coord. Financial management of the construction and maintenance portion of the Force budget will be co-ordinated and executed as directed by the Force Engineer. Authority to expend funds should be delegated to the lowest practical level to facilitate and expedite judicious use of fiscal resources by commanders. The division G4 Engr or the CO of the CMBG CER will co-ordinate with the Force Engineer for the provisioning of engineer materials. The G4 Engr or the CO of the CMBG CER and the corps engineer will co-ordinate engineer materials that are provided by multinational systems.

6. The engineer commander controls delivery and issues of engineer resources (less defence stores) to units. Generally, defence stores are controlled by the G3 and are handled in accordance with

the procedures established for ordering, accounting and distribution of controlled stores. Since the demand for defence stores varies based on the operation and the type of terrain, commanders and their staffs must seek engineer and logistic advice in the planning process.

7. **Engineer Material Management**. Engineer material management is that aspect of administration, which includes managing, cataloguing, requirement determination, procurement, distribution and storage of engineer resources. The Force Engineer will establish Engineer Material Management Centres to efficiently control the inventory, the allocation and arrange for the delivery of Canadian engineer resources. Within the division, the Engineer Support Regiment will perform the function of engineer material management in the form of engineer dumps.

DUMPING PROGRAMMES

8. **General**. A dumping programme is the stockpiling of commodities to meet requirements which are greater than can be met by normal methods of replenishment. Dumping is a common occurrence for the delivery of mines, explosives and engineer resources to, or close to, work sites. Much effort is required to build up dumps and it is seldom possible to remove them once established and the transport has resumed normal operations. The siting, stocking and control of dumps must always, therefore, be closely supervised by the staff to avoid loss, wastage and overstocking.

9. **Planning**. Responsibilities for dumping programmes are as follows:

a. **Div G3 Staff**

(1) Determining the dumping requirement and priority in conjunction with the G3 Engr.

(2) producing a movement plan based on Provost Marshal (PM) and CDE advice, and

(3) co-ordinating equipment/labour resources needed at the Ammunition Point and dump location.

b. **Div G4 Staff**. Producing the Dumping Instruction which will incorporate:

(1) G3 staff guidance,

(2) latest completion time,

(3) control authority,

(4) co-ordinating details,

(5) issuing/drawing policies,

(6) direction on downloading/issue of maintenance load on the division Support Group (DISGP) vehicles involved in the dumping programme,

(7) movement plan,

(8) authorising direct liaison, and

(9) reporting procedures.

c. **DISGP**. The DISGP will task the necessary transport assets for the dumping programme. The DISGP responsibilities include:

(1) co-ordinating with the user formation/units,

(2) tasking its sub-units,

(3) producing the detailed Division Dumping Order,

(4) providing the Dumping Programme command and control organisation,

(5) reconnoitring, marking and organising the Forward Regulating Centre and Return Control Post,

(6) providing communications, and

(7) co-ordinating military police, medical and maintenance support.

d. **G3 Engr**. The G3 Engr will co-ordinate terrain clearance with the Div G3 and specify to the G4 Engr:

(1) dump location,

(2) total allocation,

(3) opening and closing times,

(4) unit tasked to operate dump,

(5) emergency destruction or removal orders, and

(6) allocation of stores by formation/unit and priority of issue.

e. **G4 Engr**. The G4 Engr will produce the Engr Dumping order and monitor its execution on behalf of the G3 Engr. If more than one dump is established the G3 Engr will confirm which formations/units are authorised to draw materials from each.

f. **Unit Operating Dump**. The unit tasked with operating the dump, is normally responsible to provide the following:

(1) A liaison officer to the Forward Regulating Centre,

(2) guides,

(3) security and labour parties,

(4) security of the Forward Regulating Centre and Return Control Post when the tactical situation requires,

(5) reconnaissance and layout of the dump site, and

(6) delivery of stores to forward caches.

g. **Unit Receiving Materials**. The units receiving materials from the dump, are responsible to provide the following:

(1) a unit liaison officer/NCO to the dump,

(2) location of forward caches and

(3) allocation of materials to forward caches.

10. The engineer dump should be located as far forward as the situation dictates and is tactically possible, provided security can be guaranteed as it is not likely that the dump can be rapidly moved. Whenever possible it should be co-located with existing infrastructure services and bring together a variety of engineer materials to avoid operating several dumps concurrently.

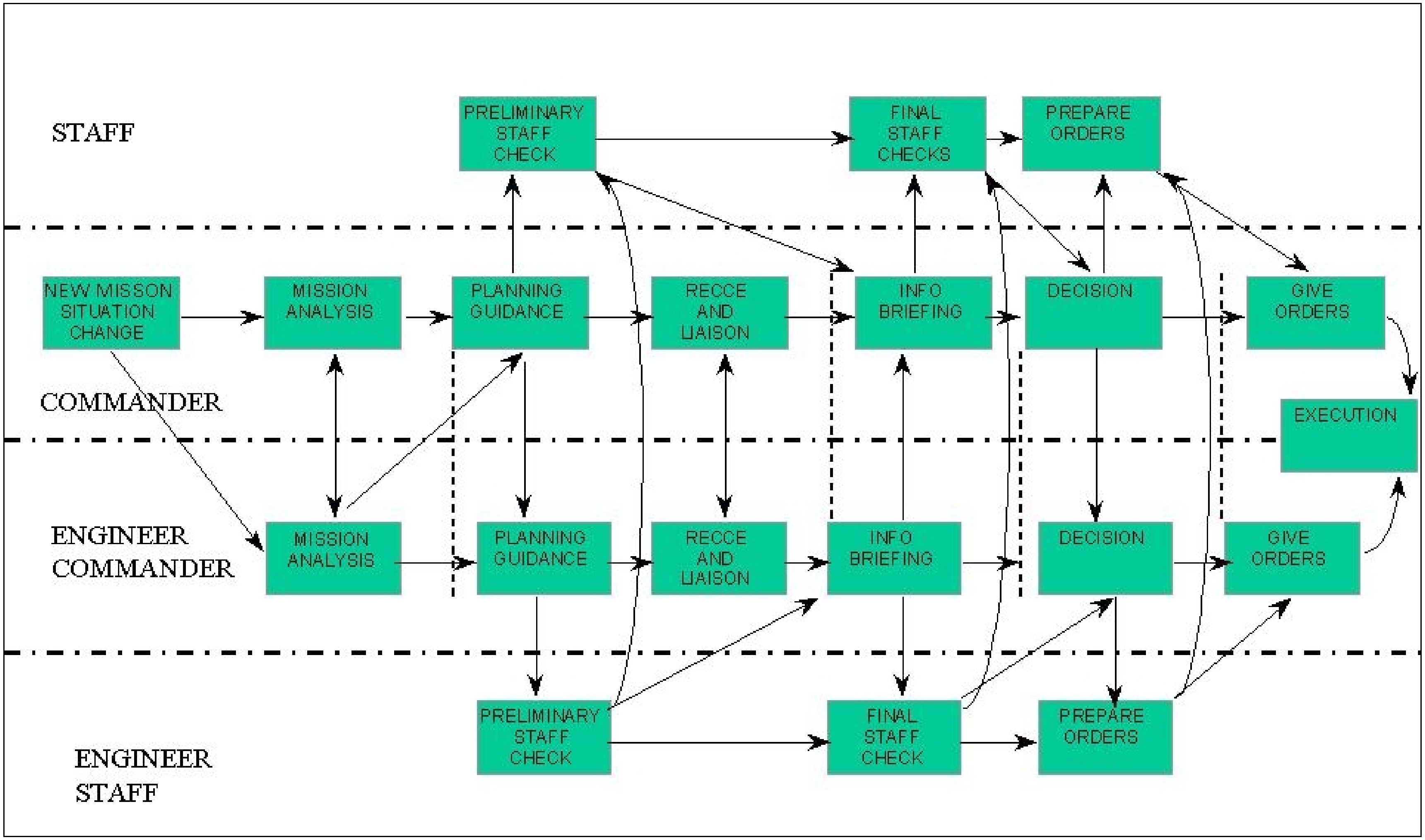
11. **Stock Control**. To control stocks in engineer dumps, the G4 Engr will issue a Dump record on behalf of the G3 Engr. The Dump Record will indicate the allocation of all stores held by an engineer dump. This Dump Record is the authority for the unit running the dump to issue materials to formations/units. Modifications to the allocations will be verbal (by liaison officer or telephone/radio) or written. Formations/units drawing from the

dump will not require any documentation since the Dump Record is the issue authority.

12. **Command and Control**. The control authority for a division engineer dump will normally be vested in the CDE. The G4 Engr through a liaison officer will closely monitor the operations providing guidance on allocating stocks, levels, and draw times. The tasked unit will command the dump and be responsible for its internal operation.

13. **Conduct**. Control of the dumping programme is normally exercised in the forward area from a regulating centre on the main up route and from a return control post on the down route. DISGP vehicles will be guided forward into and through the engineer dumpsite.

ANNEX A
OPERATION PLANING PROCESS AND ENGINEER PLANNING RELATIONSHIPS



ANNEX B
ESTIMATE OF THE SITUATION - ENGINEER FACTORS

1. The following is a list of some common factors that should be considered when doing an estimate of the situation.

Factor	Deduction
Enemy	
Enemy intentions - when, where and how will he attack?	Weight of effort needed in obstacle construction to counter tracked or wheeled vehicles, and to separate wheels from tracks.
	Ground best suited to reinforce obstacles to hinder enemy breaching means.
	Size/length/type of obstacles to counter enemy assault breaching capabilities (this may be detailed by higher engineer commander).
	Own use of scatterable mines and need to establish liaison.
Enemy scatterable mine threat.	Methods of countering enemy scatterable mines (engineer resources).
Enemy mobility capability - to include bridging, minefield breaching equipment etc, and any perceived weaknesses.	Specific types of mines, minefield designs and stores available and the implications of using these resources (logistic support).
Enemy EW capability.	Need to operate on radio silence or other command and control measures.

Factor	Deduction
Interference from ground attack, air attack, artillery or NBC?	Need to operate under NBC conditions and effect this will have on rates of work and completion of tasks.
Ground	
Study of natural obstacles, drainage, vegetation, soil conditions and directed obstacles by a higher commander (reserved obstacles).	Vehicle mobility restrictions for both friendly and enemy.
	Weight of effort and ground best suited to reinforce natural obstacles and locations needed to deny specific areas.
	Location of reserved obstacles.
	Engineer resources required to overcome natural obstacles.
	Initial requirement for mines, explosives and other engineer resources.
	Additional engineer resources required.
	Priority of work.
	Recce plan.
	Location of engineer headquarters, mine and explosive dumps and administrative

Factor	Deduction
	echelons.
Reserved routes and main supply routes.	Engineer resources required to maintain existing routes in friendly areas.
Own Troops	
Own personnel, equipment, characteristics and availability.	Whether tasks are done functionally or geographically.
	What obstacles can be executed with given resources (priority of work).
	Grouping.
Local protection available - both ground and air defence.	Whether engineer elements must provide own security.
Resources Available	
Availability of resources, especially mines and explosives by type and quantity.	Logistic build-up required. Need to request additional mines and explosives to complete barriers.
Local resources - labour, timber, gravel, rock, electric power and fuel.	Requirement for labour resources through HNS.
Time and Space	
Time available for recce prior TO WORK starting.	Confirm recce plan and assign recce tasks.
Time work starts and time it	The need to work by day or night.

Factor	Deduction
must be completed by.	Works programs.
Distances involved.	Capability to begin move of engineer resources forward.
Meteorology	
Weather as it may effect going and visibility.	Steps required to maintain mobility in adverse weather, and additional resources if necessary.
Hours of daylight and darkness.	Additional time required to complete tasks at night or during times of reduced visibility.

ANNEX C
OBSTACLE ZONE/BELT EXECUTION MATRIX

ZONE OR BELT DESIGNATOR NOTE (1)	LOCATION (2)	OBS EFFECT (3)	PRIORITY	EMPLACEMENT AUTHORITY	RESOURCES ALLOCATED (4)	OBSTACLE RESTRICTIONS	SPECIAL INSTRUCTIONS/ REMARKS (5)
A	N- RIDGE TQ343557, TQ356560, TQ370561 S- HWY 20 (INCLUSIVE) E- BDRY 4 DIV/1 DIV W- BDRY 1 DIV/20 CMBG	D	1	RECCE REGT	5.6KM TYPE B LOW 2.7KM TYPE C MED 27 CRATERS 5 X MINOR BR DML	NIL	DIVISION COVERING FORCE AREA ZONE.
B	OVERLAY TQ320561	F	1	20 CMBG	3.8KM TYPE C LOW 4.5KM TYPE C MED 1.2 KM TYPE C HIGH 1.7KM ANTITANK DITCH 2 X MINOR BR DML	RESERVE ROUTE OPEN UNTIL COVERING FORCE WITHDRAWS	20 CMBG MDA ZONE. SITING CONCURRENCE REQR FROM RECCE REGT FOR OBS FWD OF HANDOVER LINE “MOLLY DOG”.

NOTES

1. This matrix shows examples of obstacle zone details only. Obstacle belts would be similarly described.
2. Location should define whether a control measure in inclusive of exclusive of key terrain features. If the barrier plan overlay clearly defines the limits of the zone or belt, then a reference to the overlay and centre of mass grid of the control measure, as shown for Zone B, is sufficient.
3. Assigning an obstacle effect to an obstacle zone gives purpose and direction to independent formations. Obstacle belts are always assigned an obstacle effect.
4. This information is not intended to dictate to the commander what must be implaced, but rather provide an idea of how the higher commander allocates resources and the control measures. This should serve to assist in resource planning at lower levels.
5. Any pertinent information may be included here.

OBSTACLE GROUP EXECUTION MATRIX

ZONE/BELT/GROUP OBSTACLE DESIGNATOR	LOCATION NOTES (1)	OBSTACLE TYPE (2)	OBSTACLE EFFECT	PRIORITY	EMPLACING UNIT	OWNING UNIT (3)	EXECUTING PARTY COMMANDER (4)	UNIT OBSERVING NAI/DP (5)	SITUATIONAL OBSTACLE TRIGGER	SITUATIONAL OBSTACLE NAI/DP	LANE GAP LOCATION	INITIAL RESOURCE ALLOCATION (6)	MATERIALS LOCATION (7)	SPECIAL INSTRUCTIONS/ REMARKS
1001	TD075855	D	B	1	2TP/ 11FD	CBT TM A					TD077855 TO TD073855	800 MI	CRAIG BOY	NIL
1002	TD073832	D	F	2	1TP/ 11 FD	CBT TM B						700 MI 4X D6 DOZER	CRAIG BOY	NIL
1003	TD075855	R	B	1	2TP/ 11FD	CBT TM A	1 SECT/ 2 TP/ 11 FD					1 VOLCANO	CRAIG BOY	LANE IN OBS GP A1A. COMD 1 PPCLI BG IS AUTHORISED COMD
1004	TD078851	R	B	1	1TP/ 12 FD	A COY RHLI	1 SECT/ 1 TP 12 FD					90KG C4 24 HAYRICKS	CRAIG BOY	BRIDGE DML. AUTH COMD, COMD 4 DIV
1005	TD075865	S	D	1	2TP/ 11 FD	CBT TM A		CBT TM A	MRC AT DP 3	DP 3		1 VOLCANO	CRAIG BOY	

NOTES

1. Centre of mass of grid.
2. Directed (D), Reserved (R), or Situational (S).
3. Owning unit implies the sub-unit covering the obstacle with fire.
4. For reserved demolitions, denotes firing party.
5. Ideally there should be a primary and alternate surveillance element identified to observe the arrival of the trigger at the NAI/DP.
6. As a technical reconnaissance of the obstacle group may not have been performed by the time the matrix is issued, the resource allocation is subject to change once reconnaissance is completed.
7. Mines, explosives and defence stores may be located at an engineer dump, or alternatively, may have been moved to separate mine caches.
8. Obstacle numbering would only happen once the obstacle have been constructed.

CHAPTER 4
GEOMATICS

SECTION 1
GEOMATICS SUPPORT RESPONSIBILITIES

"Knowledge of the country is to a general what a rifle is to an infantryman and what rules of arithmetic are to a geometrician. If he does not know the country he will do nothing but make gross mistakes. Without this knowledge, his projects, be they otherwise admirable, become ridiculous and often impracticable. Therefore study the country where you are going to act."

Frederick The Great, 1747 Instructions to His Generals

INTRODUCTION

1. Information Operations and the digitisation of the battlefield are rapidly changing the way the army trains for war and conducts operations. In war fighting today, the commander must be provided a continuous understanding of the friendly situation, enemy intentions and the environment in which operations are being conducted in order to make informed and timely decisions. Information Operations doctrine emphasises the importance of providing mission-essential decision support aids for the commander, accurate and near real-time geospatial information to manoeuvre units and to make available digital geospatial information data sets to staff planners. As depicted at Figure 3, it is contributing to the commander's 'situational awareness' that is the focus of geomatics support today.

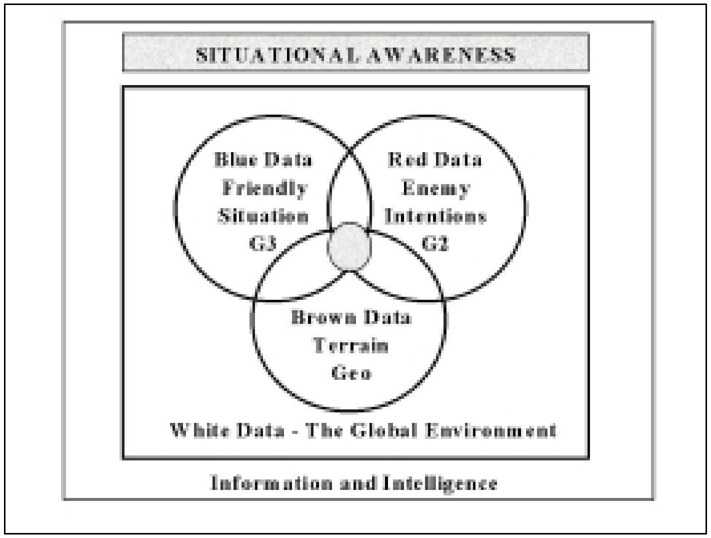


Figure 3: Situational Awareness

2. As a stand-alone contribution, geospatial information presents an integrated view of the battlefield over which friendly deployments and enemy actions are depicted in command and control information systems. But, to achieve full situational awareness, the three contributing overlaps to Figure 3 must also be addressed.

a. The observed, forecasted and unified horizontal and vertical weather picture dominate the overlap of the G2's provision of "Red Data – Enemy Intentions" to the G3's "Blue Data - Friendly Situation".

b. Support to the manoeuvre and protection combat function, with mobility and counter-mobility battlefield assessments, is found on the green traces of the obstacle plan developed in overlap of the G3's "Blue Data - Friendly Situation" and engineers' providing "Terrain – Brown Data".

c. Well integrated in the Intelligence Preparation of the Battlefield (IPB) is terrain analysis that exists in the military geographic intelligence overlap of the G2's "Red" mandate and the engineers' providing geomatics (Brown Data) support.

3. The aim of geomatics support operations is to provide timely and accurate geospatial information of the battlefield, throughout all phases of an operation. To accomplish this aim engineers execute tasks against three principle requirements:

a. To support mission analysis and enhance decision making;

b. To facilitate access to geospatial information on the force command and control information system; and

c. To provide geospatial information and services for mission execution and manoeuvre.

COMMANDERS AND THEIR STAFFS

4. Commanders are responsible for the effective utilisation of terrain during operations and in today's time-sensitive planning environment can no longer conduct extensive reconnaissance over their increasingly large area of interest. They must rely on geospatial information to support planning, rehearsing the mission and executing tasks. With the increased lethality of weapon systems and the increased tempo of battle, commanders and their staffs, at the operational level, have critical decision cycle times if they are to effect the outcome of battles, at the tactical level.

5. Geomatics support is a significant force multiplier having a direct impact on all combat functions, giving commanders a decisive edge over the enemy.

a. Operational level geomatics support is broken down by environmental component: maritime, land, aerospace, and joint/combined operations.

Supporting force employment mission planners, geospatial information is provided at the appropriate scale at the very outset of the planning process. Allies, governmental and non-governmental agencies, generally located outside the area of operations routinely provide this level of geospatial information.

b. Tactical level geomatics support is characterised by a continuum of services being available to commanders. Provided at a variety of levels, the range of capability and production capacity increases at each successively higher level up to division. Focusing on terrain visualisation, support is provided as distributed information in the form of standard scale maps charts and on-standard customised products or through the provision of services from a deployed Mapping and Charting Establishment (MCE) sub-unit

6. Commanders assigned responsibilities over a given geographic area are responsible for geospatial information requirement definition, within their designated areas, and for co-ordinating geomatics support to service components, direct-reporting units, and command headquarters. In the geomatics requirement definition process, the staff evaluates missions, objectives, force allocations, and command and control information system deployments to identify geomatics information essential to mission success for operation plans and contingency plans. The meeting of defined requirements for operations outside of Canada normally requires the combined effort of J2 Geomatics (at NDHQ), Canadian federal agencies, allies and commercial partners.

INTELLIGENCE STAFF AND UNITS

7. As outlined in CFP (J) 5(4)-08 and CFP 315(2), Intelligence Branch personnel exploit foundation geospatial information as they help the commander understand the enemy's intentions and the enemy commander's decision-making processes. Division and brigade G2 intelligence officers compile their geomatics requirements and set priorities to meet their Intelligence Preparation

of the Battlefield (IPB) tasks using integral Intelligence Company resources, or submit them to their formation geomatics officer / NCM.

8. Whether the intelligence is at the operational or tactical level, it aims to assist the commander and staff in determining objectives, plan operations and assess success. To meet the challenges of a constantly changing situation intelligence is produced in the logical and systematic methodology known as the 'Intelligence Cycle'. The output of the cycle being processed information or intelligence.

ENGINEERS IN THE LAND FORCE

9. Doctrinally, geomatics support is a military engineer responsibility. NDHQ/J2 Geomatics is responsible for validating geospatial information requirements and co-ordinating production/sourcing issues within the Deputy Chief of Defence Staff Group (as laid out in CFP (J) 5(4)-15). Down through the CDE and its subordinate CERs, or the brigade group engineer (CO CER), the engineer has direct responsibility for the provision of geospatial information and assisting the commander in visualising the terrain and its impact on friendly and enemy operations. As terrain utilisation experts, all engineers collect terrain data (river widths, soil types, route conditions, bridge classifications, etc) to fill data voids and conduct battlefield assessments.

10. The CDE and Brigade Group Engineer consolidate the formation's geomatics requirements and confirm priorities for tasking of geomatics support sub-units assigned to the division or brigade. MCE sub-units are organised to support the army at all levels, while remaining flexible as individual sub-units to meet specific mission requirements.

11. The MCE supports army operations across the spectrum of conflict and is organised to provide support in a deployed surge capacity or as part of a contingency force. It is adaptable to any organisation and equipment and retains the flexibility necessary to concurrently provide deployed support at both the division headquarters and brigade group level. The degree of support provided at each level will vary with the size and composition of the

deploying force and the ‘maturity’ of the operational theatre. Even when a small force is deployed, if it is operating in poorly mapped areas, MCE assets must accompany the force and its headquarters element; from the outset.

COALITION OPERATIONS

12. Future operations will be conducted in coalitions with the necessary geomatics support being provided by an integration of capabilities operating from fixed facilities and deployed with the force. The deployment of geomatics units will be tailored to the force mission with a lead nation assembling the necessary support along with the in place host nation capabilities. The timeliness of this solution can only be met through force command and control information system standardisation, multi-national interoperability and split base production from national bases. Structured to meet minimum essential force requirements, geomatics support is provided at four levels: corps, division, brigade group and battle group.

13. An operational concept for geomatics support within a NATO Corps is depicted in Figure 4. With 1 Canadian Division under operational control of a NATO corps, geomatics support is co-ordinated by the Chief Geomatics Officer at the senior deployed headquarters. For army operations within 1 Canadian Division, geomatics support is co-ordinated through the supporting geomatics support squadron, a sub-unit of the National Command Element (NCE) Engineer Support Unit (ESU).

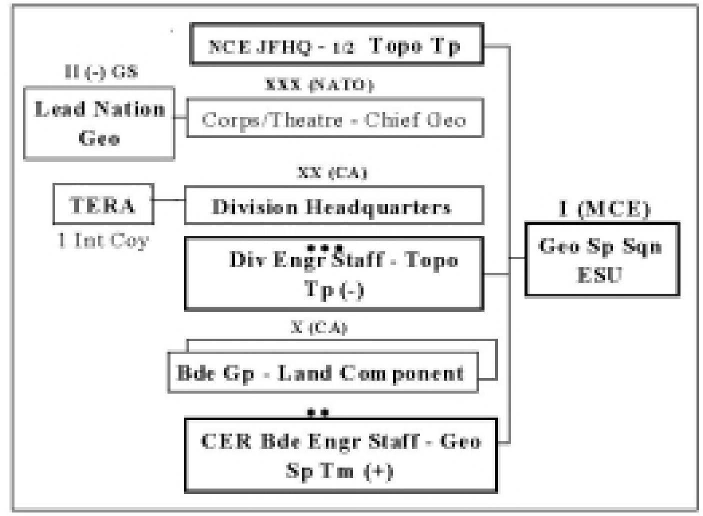


Figure 4: Theatre Geomatics Network

CORPS (THEATRE) GEOMATICS RESPONSIBILITIES

14. When conducting military operations in any theatre (mature or immature) the corps commander will require geospatial information for operational planning purposes and tactical war fighting, to be available on demand. When operations are to be conducted in an undeveloped region where standard maps, survey and terrain information are outdated or non-existent, geomatics support becomes an essential engineer function. Geomatics support at corps/theatre level, as laid out at Figure 4, would normally consist of a dedicated geomatics command and control element integrated into the senior headquarters and a general support geomatics unit minus, allocated by the lead nation. The chief geomatics officer is responsible to be familiar with all geomatics support available within the theatre and for the ongoing activities of all integral and nationally assigned assets. The theatre geomatics staff (assigned to the theatre engineer staff centre) have additional responsibility to:

a. Co-ordinate out-of-theatre (contributed national) production of geospatial information and standard scales mapping;

b. prioritise the tasks / work effort of an assigned GS geomatics unit;

c. co-ordinate with the J3 Engr for collection of battlefield terrain information;

d. monitor the distribution of geospatial information and non-standard products; and

e. facilitate in-theatre support to national elements lacking the full spectrum of geomatics / topographic capabilities.

15. The theatre (lead nation) general support geomatics unit mission includes producing and managing geospatial information in a direct support role to the theatre/corps HQ and a general support role to lower echelon geomatics sub-units. The assigned unit is the geospatial 'database manager' for the theatre, providing the common operating picture used by the theatre command and control information system and as the basis for all subordinate/national systems. It is responsible for ensuring the full spectrum of functional support to assigned theatre assets by:

a. Providing direct support to the theatre HQ and theatre level units upon tasking;

b. establishing the theatre grid and conducting surveys for subordinate formations for requirements beyond their capabilities;

c. managing the theatre geomatics database, validating data of the theatre geomatics database and facilitating access from the theatre command and control information system;

d. managing the in-theatre production program of standard hard copy products and digital data sets; and.

e. managing the supply and monitoring the distribution of geospatial information to formations and units.

DIVISION GEOMATICS RESPONSIBILITIES

16. As the primary formation responsible for planning and conducting tactical operations, it is at the division level that army geomatics support is focused. The CDE, as the chief advisor for the use of terrain, is responsible for the co-ordination of geomatics support. Under the supervision of the CDE, a MOC 24 (Geomatics) Officer serves as the focal point for all geomatics requirements in the deployment of headquarters and formations.

17. As depicted at Figure 4, the Division Commander should be allocated the ESU geomatics support squadron. The squadron is a sub-unit of the NCE ESU and receives tasking through the CDE. The squadron could be required to provide elements of its topographic troop to two headquarters as follows: a half troop to the Canadian NCE JFHQ (operating as the interface to the national/strategic level) and the troop minus to the CDE. The allocation of geomatics support squadron assets is made by the Canadian Joint Force Commander based on the nature of the operational theatre (mature or immature), the availability of geospatial information of the theatre as well as on the assigned Canadian area of interest and the composition of the force.

18. The CDE having access to an integral geomatics support team and an attached topographic troop from the ESU geomatics support squadron, has specific geomatics responsibility as follows:

a. Assist with geospatial information requirement definition to support division planning for current and future operations;

b. assist the G3/G2 in evaluating support requirements and priorities;

c. assist in distributing geospatial information, tactical decision aids and other special products in the headquarters;

d. co-ordinate with the G3/G2 for collection of battlefield terrain information beyond the capabilities of the CER(s) / ESR.

e. co-ordinate the 2nd line maintenance support of information systems equipment beyond the capability of ESU technicians;

f. prepare the geomatics Annex C to chapter 3 to the division contingency plans and operation orders or a geomatics appendix to the engineer annex.

g. assist the G3/G4 in updating stockage requirements for maps to be held by Canadian Support Group in support of Canadian requirements.

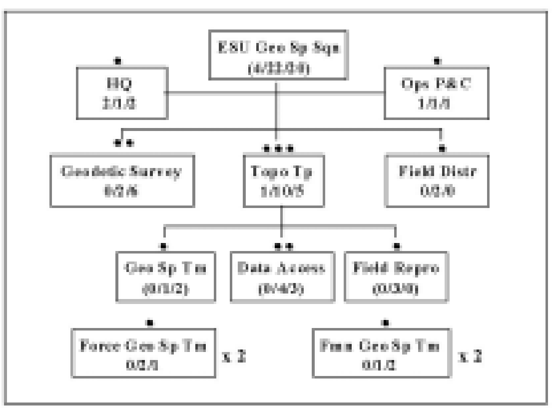


Figure 5: ESU Geomatics Support Squadron

19. A division support configuration of the squadron is depicted in Figure 5 with task-organised subordinate elements available for grouping to the division headquarters and the brigades. In this configuration, the squadron will normally be deployed as follows: the squadron headquarters in ESU lines; topographic troop directly tasked to the CDE; and other sections, or detachments/teams, deployed as tasks require. This centralising of geomatics support at the division level guarantees the provision of a graduated response in accordance with the commander's priorities.

BRIGADE GROUP (FORMATION) GEOMATICS RESPONSIBILITIES

20. Geomatics support at brigade group level should see an attached formation geomatics support team supplementing the integral CER assets, providing a 24/7 capability which may be expanded to a formation topographic troop. The ESU geomatics support squadron has the ability to support a division or brigade group, and assigned allied formations, on continuous operations. A geomatics support team provides quick-response tactical decision aids for the brigade staff, terrain visualisation for the commander and the commanding officers and assists in terrain utilisation planning with CER operations staff. To execute this mandate MCE teams are capable of rapid deployment on any contingency operation. Once in theatre they also provide positional and navigation information support to the earliest arriving operational forces. As communication capabilities improve, on site assets deliver remotely sensed imagery by exploiting theatre satellite systems.

21. The brigade group geomatics support team is normally located with the brigade engineer staff, which is an integral part of the brigade planning and operations staff, thus available to support the entire brigade group. While independent of higher formation geomatics assets for the majority of its capability, it must rely upon theatre/corps units for survey control, database maintenance, and high-volume reproduction support. The pace of operations at formation level may be too swift for a geomatics support team to deliver complete support in time for staff to exploit, therefore prioritisation of the requirement and narrowing of their scope are essential. The brigade engineer staff must master two key processes

to ensure the commander and the commanding officer of the CER get timely terrain visualisation support. First, he must conduct engineer battlefield assessments for mobility and counter-mobility support in the obstacle planning process. Second, he must fully support the IPB process by assisting the G2 with timely tactical decision aids.

22. Maintaining the brigade group geomatics server (consistent with procedures, as a component of the higher geospatial information database) the team certifies its data for the G2's IPB terrain analysis effort and for direct support to manoeuvre battle groups. The geomatics support team exploits their database to provide terrain visualisation and mission tailored tactical decision aids yielding a vision of the terrain and its impact on soldiers, weapon systems and tactics.

23. Unit level geomatics support includes that geospatial information acquired from within its own resources as a consequence of normal battle procedure and formation standing operating procedures. Normally co-ordinated by the unit intelligence officer for the operations officer, additional support may be requested from those assets located in the CER or the ESU geomatics support squadron. The commanding officer of the CER is mandated to provide advice to unit commanders on geospatial information requirements. For specific operations, an independent MCE geomatics support team could be placed under command or in direct support to a battle group to provide a stand-alone capability or augment integral capabilities.

SECTION 2
GEOMATICS (INFORMATION) SUPPORT TO OPERATIONS

INTRODUCTION

1. Information technology and digitisation provide a means to an end, enabling the development of a common operating picture of the battlefield. Geospatial information, when drawn from a central database provides this common picture whereby the user can visualise the terrain. The tasks undertaken to provide the common operating picture have evolved from previous methods of portraying

the terrain; they are now simply based on digital data. Terrain visualisation then, is itself far from new as it merely exploits every available data set to provide commanders with the foundation of the operating environment during planning, before operations commence.

2. In coalition, the members that do not have the capability to exploit the common operating picture are at a disadvantage when compared to their partners. They are not able to keep up with the pace of decision making, placing at risk the tempo and safety of operations and the coalition/theatre command and control information system capabilities is not fully exploited.

3. The engineer's focus in providing geomatics support to operations is to gain maximum knowledge of the potential area of interest and present it in a simple and concise format to the commander. MCE and its geomatics support squadron are involved in the deployment planning phase and during the conduct of operations.

4. The geomatics support squadron is a mission critical contribution requirement for both the force employment and the force generation missions. The allocation of MCE assets, by the DCDS, is based on the magnitude of the contingency/crisis and the following mission analysis considerations:

a. The mission, designated lead nation and coalition tasks;

b. the location and size of the intended area of operations;

c. the availability of the standard geomatics information, data sets and field services from contributing nations and the host nation.

d. the time available to collect geospatial information, deploy the topographic troop and assemble the MCE geomatics support squadron;

e. the size of the Canadian formation and types of units deploying.

f. the communications links available be it global broadcast, uplink to a regional satellite service, or dedicated data lines to support split-based operations.

FORCE EMPLOYMENT AND THE CF OPERATIONS PROCESS

5. MCE provides critical geospatial information. Where standard military data sets are available, MCE receives, updates and makes available the data to a commander's command and control information system and to deploying units. Where data sets are not available, MCE generates interim data sets to meet the commander's operational needs.

6. Extensive production effort is required to generate geospatial information data sets in support of forces conducting peacekeeping, peacemaking, humanitarian assistance, disaster-relief operations and any contingency missions outside Canada. These operations are sometimes conducted in areas of the world where standard products are limited or not available. J2 Geo and MCE then require to co-ordinate with the lead nation and with local and national authorities to gain access to available data. Initially, only standard planning scale products are provided to formations and units until they have had an opportunity to confirm their specific requirements.

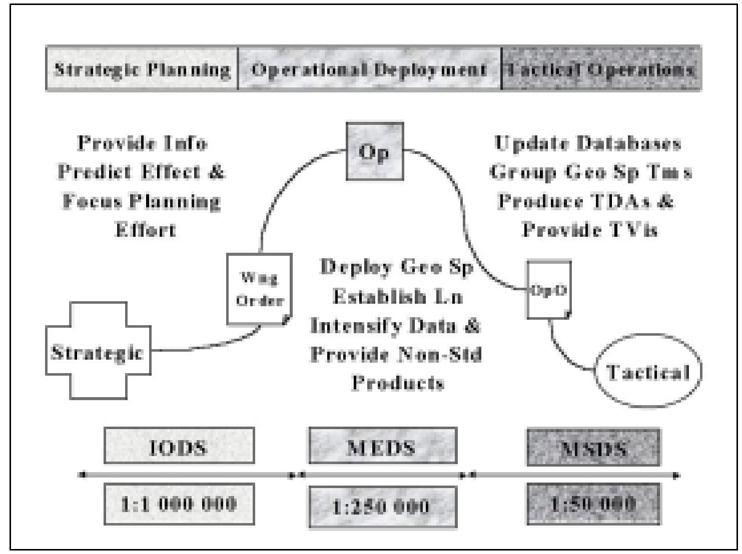


Figure 6: Geomatics (Information) support to Operations

7. The most significant problem in providing accurate information for representation of the terrain is the lack of worldwide digital geospatial information at standard scales. Standard paper map are available for approximately 80 percent of the world at the 1:250,000 operational planning scale, dropping to 25 percent at the tactical 1:50,000 scale. Digital data sets have an even lower availability. When available in sufficient detail, digital data sets give commanders the ability to determine the significance of the terrain on the mission and give users a common picture as their frame of reference.

8. As depicted in Figure 6, MCE provides a response to information requirements through a standard methodology that is common to several ABCA/NATO nations. When available, MCE provides:

a. Strategic level operations planning - 1:1 000 000 scale (Level 0): Initial Operating Data set (IODS) of digital products and imagery for mission analysis and the development of courses of action. This data set is made available through both the

Internet and the Canadian Forces command and control information system and provides the area of operation geospatial foundation onto which additional data is layered. The IODS is exploited using the on-line command and control information system geomatics application software and is designed for direct manipulation by operational staff planners who require a map or imagery background as a basis for making and depicting decision options in information and decision briefs.

b. Task force operational planning – 1:250 000 scale (Level 1): Minimum Essential Data set (MEDS) of terrain visualisation data for the preparation of staff estimates and concepts of operation. As the area of interest is defined, intensification of detail, from a variety of sources, is undertaken and additional geospatial information is produced to meet the essential requirements. The completed MEDS, containing standard coverage, is provided to the commander and his staff through the Canadian Forces command and control information system and the army on-line geomatics database. The MEDS is intended for the conduct of detailed studies by a trained user using a low-level geographical information system application software. The variable quality of data and area coverage normally precludes its direct use by staff planners.

c. Formation tactical planning – 1:50 000 scale (Level 2). Mission Specific Data Set (MSDS) of digital geospatial information and imagery for estimates of the situation, reconnaissance task preparation and refining of groupings and tasks. This further refinement to meet specific mission requirements allows for the development of larger scale views of the area of influence. As information is made available by contributing nations and agencies, detailed two- and three-dimensional views and mobility analyses are also integrated into the data set and made available through the army command and control information system geo-server. The MSDS is exploited by the MOC 142 geomatics technician using a high-end geographical information system to conduct expert analysis of the terrain and its impact of specific missions.

9. Those elements of MCE that will not be deployed are required to provide updates to the MSDS being exploited by the forces conducting the operation.

STRATEGIC AND FORCE EMPLOYMENT PLANNING

10. The majority of the geomatics support effort occurs during this phase requiring the largest amount of MCE production. The first task is to prioritise the requirements. Using current contingency plans and operation plans identifying requirements, the collection of geospatial information can begin in order to cater for shortfalls.

11. Using multiple-sources of information, MCE makes available the functional initial operating data set (IODS) for the geographic region of the operation. This data set provides the basis for the production of non-standard products to support the planning requirements of the commander. Data sources include, but are not limited to, multi-spectral imagery, image maps, non-standard local maps, geography atlases and statistical demographics.

12. For operations in Canada, Natural Resources Canada produces, maintains, and stores the standard geospatial information required during the first 30 days of combat. For operations outside Canada, NDHQ J2 Geomatics provides geospatial information.

13. MCE assets are task-organised, to supplement and enhance allied national efforts by providing combat-oriented geospatial information products to commanders and staff at division and brigade headquarters levels. Image-based products and quick-response graphics video displays are produced and made available through the Canadian Forces command and control information system and the Internet. In some cases, the information may reflect

data gathered during previous exercises, deployments, or national assistance efforts.

DIVISION OPERATIONAL LEVEL AND DEPLOYMENT PLANNING

14. Deployment of MCE assets (geomatics support teams and geodetic surveyors) must occur early as collection of local data is of primary interest to enhance the minimum essential data set (MEDS). Local liaison and reconnaissance can validate previously gathered information and permit customisation of the data set incorporating all available maps, country studies, water resources, hydrologic information and imagery from allied and local sources.

15. Geomatics support must be well established across the area of operations in this phase as surveyors are required to confirm or establish geodetic control in the theatre as soon as possible to support artillery, aviation, intelligence, and signal deployments. They must be able to convert local data to the standard datum World Geodetic System 1984 (WGS-84) for use in weapons systems, navigation aids, and satellite based C2I systems, providing precise and accurate positional information.

16. Upon entry into theatre, geomatics support squadron data collection and database management continues and as the operation matures, the data collected must be updated, validated, and disseminated. Concurrently the production of non-standard products begins supporting the IPB process and operational planning option analysis. In this situation, it is the assigned MCE sub-unit’s responsibility to supplement standard information that includes

a. Analysis through the area of influence;

b. tactical decision aids that support the engineer mobility, counter-mobility, survivability, and sustainment missions;

c. battle damage recording and weather-analysis impact.

17. The Geomatics support squadron assets are responsible for updating databases and redistributing the changes to higher and lower echelon geomatics support teams. Verification of these changes for incorporation into a master data set will be accomplished as soon as possible and normally requires the assistance of the geomatics support squadron assigned data access section.

BRIGADE TACTICAL DECISION MAKING AND UNIT BATTLE PROCEDURE

18. All operations require geomatics support. In addition to geomatics support being viewed from the operations cycle perspective, from pre-deployment through to redeployment, it can be viewed along planning lines: future operations planning - actions prior to combat (deliberate planning) and current operations planning - action during combat (time sensitive planning).

a. Future Operations Planning. In support of the appropriate planning process, activities occur at two levels.

(1) At the operational level the geomatics support squadron supports the formation estimate process assessing the terrain impact on the combat functions, remotely sensed imagery verifies possible lines of manoeuvre, and terrain visualisation confirms for the commander the proposed concept of operations.

(2) At the tactical level assigned assets will: carry out IPB tasks to assist in mission analysis, push geo-referenced imagery and information for refining courses of action, provide GPS survey control and referencing to enhance reconnaissance, and issue standard scale maps, photos, images and other information in bulk to support unit deployments.

b. Current Operations Planning. After force groupings and deployments have occurred MCE geomatics assets (which have been deployed in accordance with the appropriate grouping) execute tasks again at the operational level and tactical level.

(1) At the operational level tasks are executed in support of the ongoing environmental planning, necessitated by IPB requirements, focused on confirmation of the next phase of the operation. Data and images are sourced from the echelon above division, liaison continues with ICAC and engineer staff cells to address priority image geo-referencing, and information conditioning occurs to update geometric information databases with situation dependent changes affecting manoeuvre. Support to redeployment through the area of operation and distribution of situation dependent graphics continues throughout the area of operation.

(2) At the tactical level the tasks are carried out with assets assigned from MCE: situation dependent graphics or command and control information are updated, maps and charts are distributed to replace stocks or to support exploitation, databases are improved for background displays as necessary, tactical air mission simulation and targeting continues, and expedient revisions or updates to standard maps is undertaken.

19. The production of courses of action and ‘orders’ is the culmination of all previous efforts in populating the mission specific data set (MSDS), supporting the finalisation of operational and tactical planning. In the theatre, the commander is provided with expedient, tailored, and updated products to assist in controlling the

battle. Rapid response is the norm at brigade level allowing the commander to: visualise the terrain; make better and more frequent decisions; and anticipate the impact of terrain and weather on the current and future operations.

20. The IPB process remains a focus where engineer, operations, and intelligence personnel work together. Prior to combat, commanders and engineers must jointly establish priorities for products and co-ordinate their production. The CDE, in conjunction with the G3, sets the priorities for the ESU geomatics support squadron. For the brigade geomatics support team, the CER CO in conjunction with the Brigade G3 sets the priorities.

21. It is important that the geomatics support team leader at brigade, or the topographic troop command at division, maintains direct contact with the division headquarters engineer staff. This contact ensures that the following information is distributed to any member of the staff requiring it: imagery, obstacle effects with key terrain information, avenues of approach, weather-effects data, and mobility and counter-mobility predictions. MCE engineers use near real-time data to produce decision aids that identify changes in the terrain in time to influence the battle.

22. As the situation changes, assigned assets respond to new requests for information. Due to the dispersal of forces across the battlefield, the electronic transmission of critical geospatial information is maximised to guarantee timely support with common products being pushed across the formation to all commanders. Manoeuvre commanders require mobility information in order to move their units on the battlefield. Combat support units require geospatial information for convoy routing, cover and concealment, and storage site locating.

23. Capabilities lost during operations must be regenerated with restoration tasks ranging from sustainment (rearm, repair, recover, or replace) through reorganisation and regeneration. Engineers provide a variety of products during restoration. Updating the geospatial information databases is their most important task as this prepares the reconstituted force for the next operation. Sufficient maps must sourced for deployed formations to replenish exhausted stocks, or destroyed reserves.

24. Geomatics support teams remain flexible and are able to respond to mission and organisation changes as groupings and tasks change. The majority of the reconstituted MCE sub-unit will be again task-organised to provide support to the next operation.

SECTION 3
GEOMATICS (GENERAL) SUPPORT TASKS

INTRODUCTION

1. Engineers provide timely, accurate information of the battlefield and terrain visualisation to commanders and staffs at all levels throughout the spectrum of operations. This responsibility includes the generation and management of a dynamically growing geospatial information database, the exploitation of that database for the production of non-standard and customised products, and its distribution to supported elements. All combat functions have come to depend on geospatial information and databases, in addition to blue and red data, to optimise their combat effectiveness. A commander's ability to gain situational awareness, in all weather conditions, before the battle will help develop dynamic operational plans; shape the area of operations; and assist in locating, engaging, and defeating the enemy.

2. Terrain visualisation assists in focusing the mission planning effort providing only relevant military information from the overwhelming amount of white data, otherwise available to the user. Presenting user defined views of the topography, a visualisation database is built from maps and remotely sensed imagery, linked together with the physical attributes of selected features of military significance. Used correctly, it is the primary enabling capability that provides the game-board for situational awareness. Integrated across the combat functions it provides a complete picture of the terrain across which forces will manoeuvre from their current state to end state.

a. Blue + Brown = Green: Engineer Battlefield Assessments. Maintaining mobility, providing freedom of action to manoeuvre commanders,

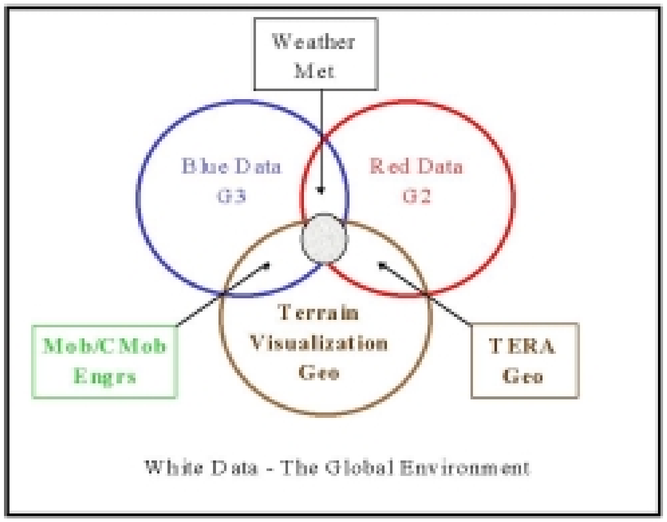


Figure 7: Situational Awareness and The Engineer contribution

requires geospatial information to assist in the identification of avenues of advance, main supply routes or lines of operations. The co-ordinated creation of obstacles, denying the use terrain and approaches, requires a comprehensive view of the ground to exploit impeding natural terrain and geo-referencing of point and linear obstacles.

b. Red + Brown = Terrain analysis (TERA): An intelligence task. Describing the battlefield, terrain analysts evaluate how the physical effects of the terrain will impact on all manoeuvre forces. Identifying the manoeuvre limitations and opportunities offered across the area of operation, terrain analysis focuses on the assessment of the enemy's options within the IPB process.

3. Geomatics support includes, but is not limited to:

a. analysing terrain in the Intelligence Preparation of the Battlefield (IPB) process and engineer terrain mobility /counter-mobility assessments;

b. extending geospatial referencing control in the theatre; facilitating on-line access to digital geospatial information; and

c. distributing standard hardcopy map and chart products and duplicating large format information products in the field.

4. At the tactical level, geospatial information is provided in the form of products (maps/map substitutes/images) or services (terrain analysis/control survey/precision targeting) that portray terrain for the commander and formation staff. The terrain images and analysis engineers provide are the underpinning to all appliquéd information used to digitally depict the battlefield. From the soldier to the formation commander, geospatial information is layered from the standard 1:50 000 scale topographic map to the revised electronic databases. Depicted in Figure 10 is the appliqué of information products provided split-based (on the left) from the MCE national base and information products provided by geomatics support squadron when deployed.

5. Engineer units proactively provide geospatial information for terrain visualisation (TVis) with which to analyse the greatest number of physical environment factors, for making better and more rapid decisions. Geo Sp Teams provide this service, producing tactical decision aids (TDAs), modified combined obstacle overlays (MCOO), and analysis of area of operations (AAO). As represented in Figure 9, exploiting these products in a 3 dimension display, applying ‘step through’ or ‘fly through’ techniques, real-time stereo viewing is used to explore the terrain. With the aim of supporting the planning staff in war-gaming, briefings, and course of action simulations, terrain visualisation can be used to identify such key planning factors as avenues of approach and sustainment routes. Additionally a linked multi-media display allows the popping-up of pre-recorded video images of key or dominating terrain.

6. The geomatics support squadron provides the division's geomatics support teams, surveyors, and replication assets in support of army operations. Split - based geomatics operations are exploited in providing services in the field given the potential of satellite communications technologies, increasing command and control information system connectivity and the transportation resource constraints imposed on deploying elements of the Canadian Forces.

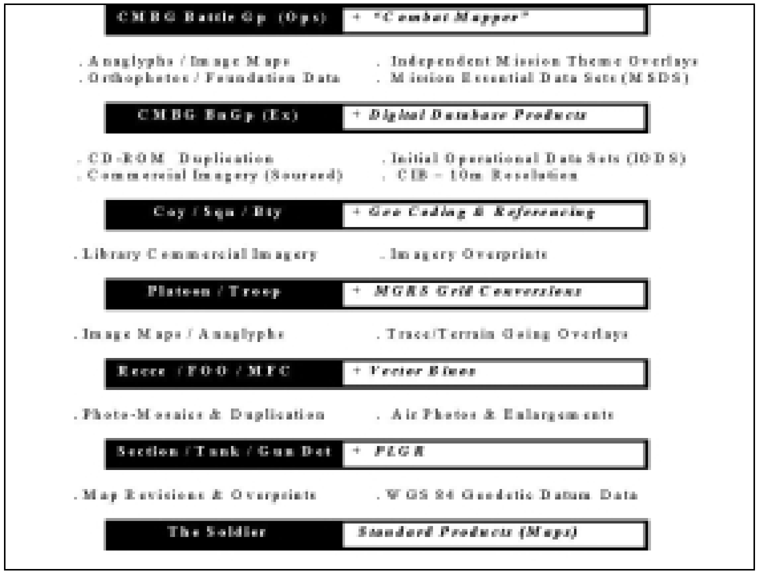


Figure 8: Formation Sub-unit supported geo spatial information applique

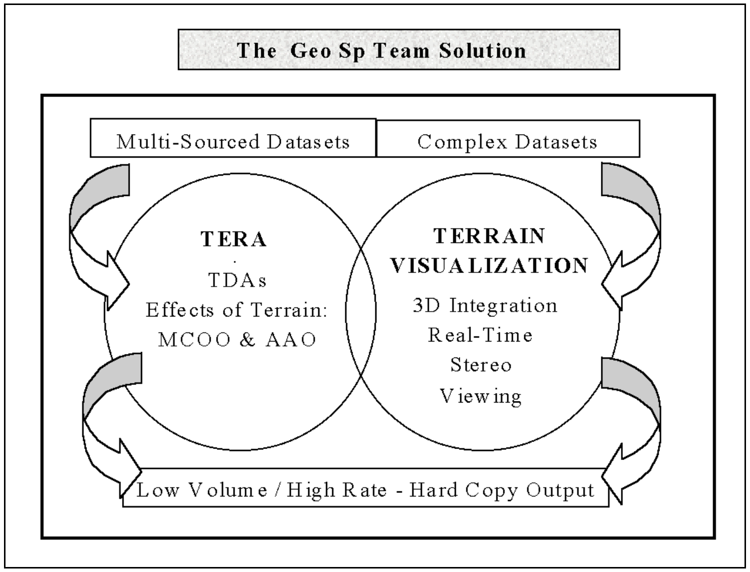


Figure 9: A Fundamental Service to the Geo Support Team

1(CA) Div	+ MCE Geo Sp Sqn - NCE ESU (c/w DGSS Medium
- Printing Services (Split Base) - Digital TTADB Production	- Geo-Referencing & Field Survey -Info Distribution & Map Supply
CMBG	+ MCE Topo Tp (iaw TO&E
- Digital PTADB Production - Split-Base Data Transfer	- Data Conditioning & Access - Low Volume Plotting
CMBG (ex)	+ MCE Geo Sp Team
- Hypsometric Maps - TTADB Revision	- Combat Mapping Data Sharing - Feature Foundation Data Sharing
UNPK - AMF(L) Bn Gp	+ MCE Geo Sp Team (c/w DGSS Light)
- PTADB Revision - Foundation Feature Data	- Visualization & Flythrough - Mission Specific Data Sets

Figure 10: Formation Sub Unit Supported Geo Spatial Services Applique

7. MCE sub-units will deploy to the theatre of operations and provide key support capabilities to division and brigade geomatics support teams. The deployed elements will link to their database electronically. Figure 10 depicts the appliqué of services available from the MCE national base (left-hand side) split-based and the deployed services available with assigned MCE assets.

8. Five tasks addressing the provision of the above services, dealing with the character and structure of geospatial information including the acquisition methods, organisation, classification, management, analysis, display and dissemination of information about the physical characteristics of the battlefield, are grouped as follows

a. Working from existing databases or digitised overlays assess the effect the physical environment could have on the accomplishment of the mission, for each course of action the formation is planning. Developing impacts and focusing the mission planning effort requires rapid analyses of terrain and other environmental effects to permit visualisation of the battlefield. A 3-dimension view provides a better understanding of routes, concealment, fields of fire and dominating terrain.

b. Condition, merge, store, and disseminate data and information in a form that optimises visualisation - existing as the common backdrop in all command and control, intelligence and engineer information systems across the formation. Data is validated before it is added to the database for the production of IODS, MEDS and MSDS. Managing the geospatial database includes server maintenance, multi-media storage, and on-line access security and account management. This task includes facilitating access to the multiple data-stores through secure gateways, using readily available geomatics application software, as any one geo-server is not the sole source of geospatial information.

c. Provide rapid response to low volume and high rate reproduction requirements. As terrain visualisation is a cognitive process the aim of distribution is to, quickly and accurately, provide any necessary quantities of mission theme overlays in essential hard copy. Despite the move to an increasing use of digital media, there remains a requirement for paper as a means to distribute geospatial related command and control information. With capabilities lower than MCE bulk baseplant resources; provide hardcopy when required for graphic products, non-standard operational overlays, special to theatre command and control measures, and terrain analysis products.

d. Conduct geodetic, topographic and engineering survey geospatial referencing. Geographic position effects all staff planners, combat functions, and is a fundamental requirement for situation awareness; as such a common geographic reference frame ensures consistency in command and control. Collected primarily using GPS technology, and by recovering existing control, field gathered survey data is augmented by geo-referencing from digitally coded images. The required accuracy of any position, however, will vary with each requirement be it a weapon system or an individual user.

e. Source, store and control of distribution of standard hardcopy (and selected softcopy) mapping and charting products produced by national and allied geomatics units, and deployed sub-units. Hardcopy requirements include demands for planning stocks, movement of stocks and deployment of bulk stocks. Digital products are distributed on magnetic tape or CD-ROM through the field distribution section, and made available electronically by the data access section. Special-purpose products for example, a TERA tactical decision aid would be provided directly to the requester and then made available electronically to all through the data access section.

CHAPTER 5
DEFENSIVE OPERATIONS

SECTION 1
FUNDAMENTALS

Field engineers should be used in the construction of anti-tank works which cannot be built by anti-tank troops. Their main duties, as today, are likely to consist of bridging (mobility), *water supply* (sustainment engineering), *and demolitions* (counter-mobility). *As specialists they should be kept for special work.*

Armored Warfare (1943)
Major-General J.F. C. Fuller

GENERAL

1. Defensive operations are generally undertaken when the enemy has the initiative. The defence aims to regain the initiative by breaking up the enemy's attack, to deplete his forces until he can no longer maintain the offensive, or to economize forces. In doing so, the circumstances for offensive action are created.

2. Engineers play a key role in defensive operations, and it is therefore essential that all arms understand the capabilities of the engineers and the conduct of engineer support to defensive operations. This understanding will ensure that commander's and their staffs are able to fully integrate engineer plans with the overall tactical plan.

AIM

3. The aim of this chapter is to present the doctrinal concepts for the conduct of engineer operations in the defence.

SCOPE

4. This chapter will address engineer tasks in defensive operations. The emphasis is on the counter-mobility role with a detailed presentation of the barrier planning process. Although obstacles are primarily employed in the defence, there is scope for the employment of obstacles in other operations. The general concepts presented in this chapter apply equally to other operations.

ENEMY

5. The enemy's aim is to break through the defence and exploit success. To achieve this aim he will rely upon:

a. The maintenance of mobility in order to:

(1) Move his forces quickly to the battle area;

(2) deploy them into tactical formations without delay;

(3) concentrate them at the selected point of main effort in sufficient strength to achieve a breakthrough and then reinforce success; and

(4) maintain the appropriate force ratio to sustain the attack by replenishing front line forces and subsequently replacing them with follow-on echelons.

b. Surveillance to identify the positions of friendly troops, particularly reserves.

c. Fire power to suppress and destroy friendly positions.

FORMS OF DEFENSIVE OPERATIONS

> *On the whole, the defensive battles in the Western Ukraine were successful because there was no rigid defense line, but an elastic one, which was allowed to bend but not to break. For this reason the enemy was never able to wipe out German formations. The junior commanders took advantage of every opportunity to counterattack, with a view to destroying as many Russians as possible.*
>
> *On the other hand, a rigid defense system, like that of the 24^{th} Corps east of Brussilov, usually broke to pieces in a very short time. Such dispositions must be blamed on local commanders. Armor employed en masse and in surprise attacks pierced almost any front, as in the vast spaces of Russia every defensive line was more or less a screen. The secret of a successful defense depends on the disposition of the reserves, and the weight and vigor of counterattacks.*
>
> Panzer Battles
> Major-General F.W. Von Mellenthin

6. While defensive operations may take a wide variety of forms, they can essentially be divided into two broad categories:

   a. **Mobile Defence**. Mobile defence focuses on the destruction of the attacking force by permitting it to advance to a position which exposes it to counter-attack and envelopment by a mobile reserve. The emphasis is on defeating the enemy rather than retaining or retaking ground. Mobile defence employs a combination of offensive, defensive and delaying actions necessitating the forward deployment of relatively small forces and the use of manoeuvre supported by fire and obstacles to force the initiative from the attacker after he has entered the defended area. At divisional level the defended area could be up to

100 kilometres in depth. Consequently the defending force must have mobility equal to or greater than the enemy's and the ability to form a large reserve which will conduct decisive counter-attacks.

b. **Area Defence**. Area defence focuses on the retention of terrain by absorbing the enemy into an interlocked series of positions from which he can largely be destroyed by fire. The emphasis here is on retention of terrain or its denial to the enemy. Since, unlike mobile defence, area defence will not necessarily produce outright destruction of the enemy; it presumes some other simultaneous or subsequent operation to achieve decisive defeat of the enemy. In an area defence, the bulk of the defending force are deployed to retain ground, using a combination of defensive positions and small mobile reserves. Commanders organise the defence around the static framework provided by the defensive positions, seeking to destroy enemy forces by interlocking fire or by local counter-attack of enemy units penetrating between defensive positions. Unlike mobile defence, for which considerable depth is essential, area defence may be conducted in varying depth depending on the mission, forces available and the nature of the terrain.

7. Although these descriptions convey the general pattern of each type of defence, both forms employ static and dynamic elements. Defending commanders may well wish to combine both patterns, using static elements to delay, canalise, cause attrition to, and ultimately halt the attacker, and dynamic elements, such as spoiling attacks or counter-attacks, to strike and destroy his committed forces. The balance among these elements will depend on the unit's mission, composition, mobility, relative combat power, and on the character of the battlefield. The fundamental difference between the two forms of defence, however, is that mobile defence seeks to defeat the enemy's attack by destruction, whereas area defence seeks to defeat it by denial.

TASKS

8. Engineer support tasks in defensive operations consist primarily of:

a. Counter-mobility. To deny the enemy the mobility he requires in conjunction with direct and indirect fire weapons to cause casualties and disrupt his attacking forces.

b. Survivability. To enhance the concealment and protection of our own forces.

c. Mobility. To support countermoves and maintain routes.

d. Sustainment engineering. An element common to all operations of war, as discussed in Chapter 9.

e. Geomatics. An element common to all operations of war, as discussed in Chapter 4.

SECTION 2
BARRIER PLANNING

The power of obstruction that is offered by a well-planned scheme of demolitions may be a great asset in checking invasion and counteracting the new means of mobility. Even so, the experience of 1914 and also of 1918 is a reminder that demolitions do fail and passages may be left clear to the enemy at even the most important crossings.

Liddell Hart (Aug 1936)
Thoughts on War

INTRODUCTION

1. The barrier plan defines how a commander will employ obstacles to support the manoeuvre plan. The barrier plan must be communicated effectively to all levels and be fully integrated with the manoeuvre and fire plans. This ensures that the desired effects of obstacles on the enemy are achieved, and that obstacles do not interfere with the manoeuvre of friendly forces.

2. The engineer commander is the commander's adviser on barrier planning. It is the commander's responsibility to ensure that the barrier plan supports his intent and concept of operations. The commander's ownership of the barrier plan at each level is demonstrated by the fact that obstacle emplacement authority is assigned to subordinate formations/units, and not to the supporting engineers. In addition, obstacle zones and belts are always assigned within subordinate formation/unit boundaries. This ensures the subordinate commander's singular responsibility for the barrier plan at his level.

3. To integrate the barrier plan with the manoeuvre and fire plans, a barrier planning process has been established. This process develops the barrier plan at successive levels of command, while allowing subordinate commanders maximum flexibility in planning the use of obstacles to achieve their commander's intent. A detailed example of the barrier planning process is given at Annex A.

AIM OF THE BARRIER PLANNING PROCESS

4. Barrier planning is characterised by centralised control which ensures that all obstacles conform to the overall commander's intent, and decentralised planning and execution which allows subordinate commanders maximum flexibility in developing obstacles to support their operations while still meeting the superior commander's intent. Barrier planning provides a systematic approach to planning obstacles which:

   a. Communicates the commander's intent for the use of obstacles at each level of command;

b. permits the timely delegation of obstacle emplacement authority at each level of command;

c. ensures the complete integration of the barrier plan with the manoeuvre and fire plans;

d. permits early allocation and delivery of resources;

e. designates obstacle emplacement responsibilities; and

f. provides direction on the design and siting of obstacles.

OBSTACLE CLASSIFICATION

5. An obstacle is defined as a natural or man-made restriction to movement which will impose delay and which will normally require specific equipment or munitions to overcome. The classification of obstacles shown in Figure 11 provides a framework of terminology for referring to different obstacles. Obstacles may be classified as:

a. **Existing Obstacles**. Existing obstacles are obstacles that are present on the battlefield as inherent aspects of the terrain. Existing obstacles are either natural terrain features, such as rivers, forests or mountains; obstacles previously laid by enemy or friendly forces or cultural features (i.e. man-made terrain features) such as towns, canals or railroad embankments. Existing obstacles may be used to enhance the effectiveness of either tactical or protective obstacles.

b. **Reinforcing Obstacles**. Reinforcing obstacles are specifically constructed, emplaced or detonated. Reinforcing obstacles may be either tactical or protective obstacles.

(1) **Tactical Obstacles**. An obstacle used to hinder the enemy's ability to manoeuvre, mass and reinforce. Primary purpose is to attack the enemy manoeuvre and multiply the effects and capabilities of friendly force firepower. The types of tactical obstacles are distinguished by the differences in their execution. Tactical obstacles may be further defined as:

(a) **Directed Obstacles**. An obstacle ordered by a higher commander as a specified task for a subordinate unit. The target can usually be executed immediately provided that prior authority has been granted. Most tactical obstacles are directed obstacles, and most directed obstacles are planned at battle group level. A specific example is a directed demolition target, a target earmarked for demolitions and which can be executed immediately after preparation, provided that prior authority has been granted.

(b) **Reserved Obstacles**. Obstacles for which the authorised commander restricts execution authority. The authorised commander usually specifies the unit responsible for constructing, guarding and executing the obstacle. Reserved obstacles are normally used to close reserved routes and lanes. A specific type of reserved obstacle is a reserved demolition target. This is a target for demolition, the destruction of which must be controlled at a specific level of command because it is a vital part of the tactical or strategic plan, or because of the importance of the structure itself.

(c) **Situational Obstacles**. A tactical obstacle for which the resources are held in reserve. Execution is triggered by friendly actions and/or enemy actions and is normally assigned as a "be prepared" task. An example would be the emplacement of scatterable mines on an exposed flank that is being threatened by the enemy.

(2) **Protective Obstacles**. Obstacles used to protect friendly forces from the enemy's final assault onto a position. These obstacles are sited close to defensive positions.

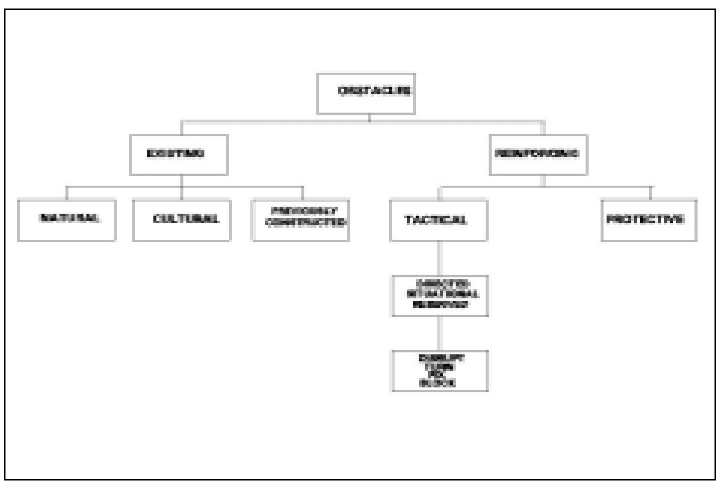


Figure 11: Obstacle Classification

LEVELS OF BARRIER PLANNING

6. **General**. Obstacle integration from corps to combat team results in the layering of barrier planning. At each successive lower level, commanders and staff conduct more detailed planning, building on the barrier plan from the higher level of command. This planning requires that commanders at each level of command provide subordinates with the right combination of positive control and flexibility.

7. **Corps Barrier Planning**. Corps level barrier planning primarily centres on obstacle control. The corps develops obstacle restrictions to ensure that division obstacles do not interfere with the corps manoeuvre plan (countermoves) and future operations. The corps also provides obstacle emplacement authority to independent brigade groups and corps troops such as the covering force. Divisions already have the authority to emplace obstacles within their area of operations less those areas in which obstacle emplacement has been restricted by corps. The corps plans reserved obstacles (i.e. reserved demolitions) only as they are necessary to support the corps manoeuvre plan such as the withdrawal of the covering force. In very rare instances, the corps may plan and direct obstacle groups.

8. **Division Barrier Planning**. At division level, barrier planning is more directive than at corps level. Divisions concentrate on planning obstacle zones to give brigades and division troops obstacle emplacement authority. Divisions also use restrictions to ensure that brigade obstacles do not interfere with corps or division level operations. Divisions plan reserved obstacle groups to support the division manoeuvre plans. The planning and directing of obstacle groups at division level is rare.

9. **Brigade Barrier Planning**. Brigades conduct more detailed barrier planning. Brigades plan obstacle belts that give obstacle emplacement authority to units. Brigades also use restrictions. Occasionally, they may plan reserved obstacle groups. At brigade level it is more common to plan and direct obstacle groups than at division level. However, it is still rare.

10. **Battle Group Barrier Planning**. Battle groups conduct the majority of detailed barrier planning. They plan most obstacle groups that are executed at the sub-unit level. Most of these obstacle groups are directed by the battle group. The planning of reserved obstacle groups at battle group level is rare. Battle groups may use restrictions, but they are normally unnecessary because of the level of detail on the battle group barrier plan.

11. **Sub-Unit Obstacle Integration**. Sub-units do not conduct barrier planning. At the sub-unit level, the focus is on detailed obstacle design and siting to maximise integration of observation and fire on the ground.

OBSTACLE INTENT

12. **General**. Obstacle intent is how the commander wants to use tactical obstacles to support the manoeuvre plan. Obstacle intent consists of:

a. **Target**. The target is the enemy that the commander wants to effect with tactical obstacles. The commander usually identifies the target in terms of the size and type of enemy, the echelon, and the avenue of approach.

b. **Obstacle Effect**. The combination of tactical obstacles and fire manipulates the enemy in a way that supports the commander's intent. The intended effect that the commander wants the obstacles and fire to have on the enemy is the obstacle effect. These effects are:

(1) **Disrupt**. The disrupt effect focuses both fire planning and obstacle effort to cause the enemy to break up its formation and tempo, interrupt its timetable, commit its breaching assets prematurely, and piecemeal its attack. It also helps to deceive the enemy concerning the location of friendly defensive positions,

to separate combat echelons, or to separate combat forces from their logistical support. Figure 12 depicts a disrupt effect on an attacking battalion. To achieve the disrupt effect, normally the obstacles need only span part of the enemy's avenue of approach allowing a portion of the enemy force to manoeuvre relatively unimpeded and thereby separating it from the remainder of the force. The obstacle should not require extensive resources. They should not be visible at long range but should be easily detected as the enemy nears them. Commanders normally use the disrupt effect forward of a killing zone.

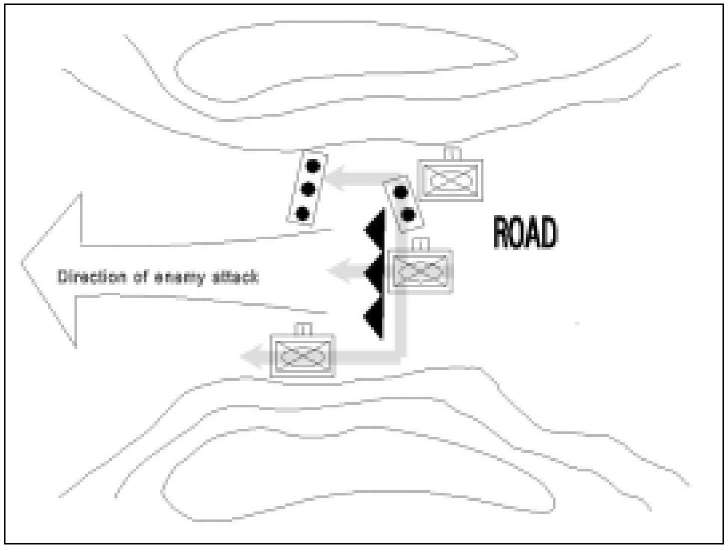


Figure 12: Disrupt Obstacle Effect

(2) **Turn**. The turn effect integrates fire planning and obstacle effort to divert an enemy formation off one avenue of approach to an adjacent one or into a killing zone. Its development requires

well-defined avenues of approach. Figure 13 depicts a turn effect on an attacking battalion. To achieve this effect the obstacles have a subtle orientation relative to the enemy's approach. The obstacles and fire allow bypasses in the direction desired by the friendly force. Obstacles at the start of the turn are visible and look more complex than those in the direction of the turn. Finally, the obstacles tie into impassable terrain at the initial point of the turn.

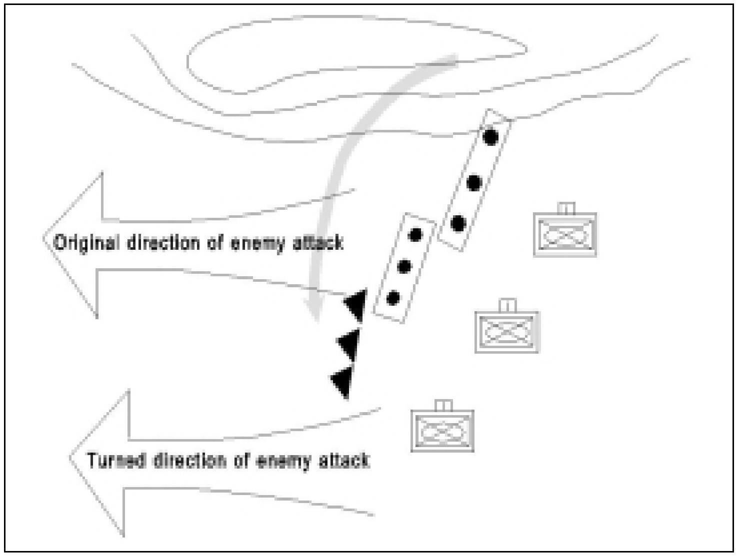


Figure 13: Turn Obstacle Effect

(3) **Fix**. The fix effect focuses fire planning and obstacle effort to slow an attacker within a specified area, normally a killing zone. Primary use of this effect is to give the friendly unit time to acquire, target, and destroy the attacking enemy with direct and indirect fire throughout the depth of a killing zone or avenue of

approach. The fix effect may generate the time necessary for the friendly force to break contact and disengage as the enemy manoeuvres into the area. Figure 14 depicts a fix effect on an attacking battalion. To achieve the fix effect, units create obstacles in depth to cause the enemy formation to react and breach repeatedly. The obstacles must span the entire width of the avenue of approach, but they must not make the terrain impenetrable. The individual obstacles must look as if they could be easily bypassed or breached. A combination of obstacles that are clearly visible and others that are unseen (such as buried mines and obstacles on the reverse slope) help to confuse the enemy once it encounters the obstacles.

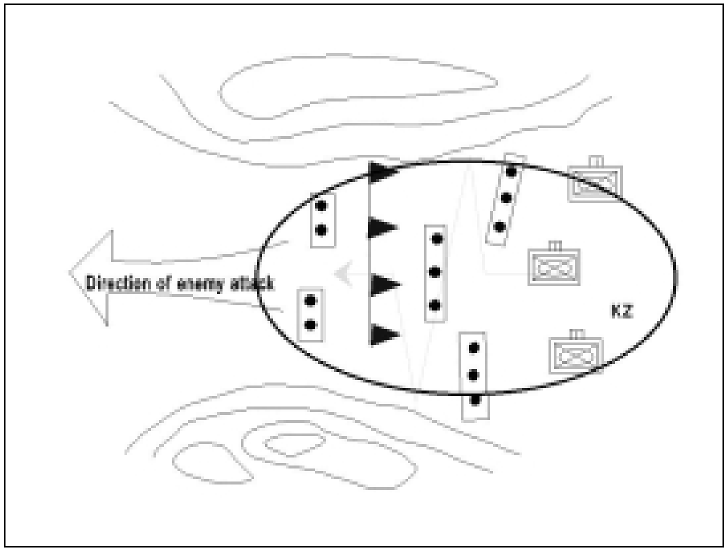


Figure 14: Fix Obstacle Effect

(4) **Block**. The block effect is used in one of two instances. The first is to stop the

enemy from using an avenue of approach thus forcing him into another that better supports the friendly manoeuvre plan. The second is to stop the enemy forward movement through a killing zone. Figure 15 depicts a block effect on an attacking battalion. To achieve the block effect, obstacles are integrated with intense fire to defeat the enemy's breaching effort. The block effect is best achieved with the use of obstacles that require more than one breaching technique to defeat, laid successively in shallow depth. Thus, once the enemy has employed breaching resources successfully on one obstacle it quickly bumps in the next obstacle with very little space to regroup. Obstacles must defeat the enemy's mounted and dismounted breaching effort. They must span the full width of the avenue of approach, allowing no bypass. Obstacles intended to stop the enemy along a specific avenue of approach should be readily visible to discourage him. Obstacles used to prevent an enemy from passing though a killing zone should not be as visible so that they do not discourage him from entering the killing zone.

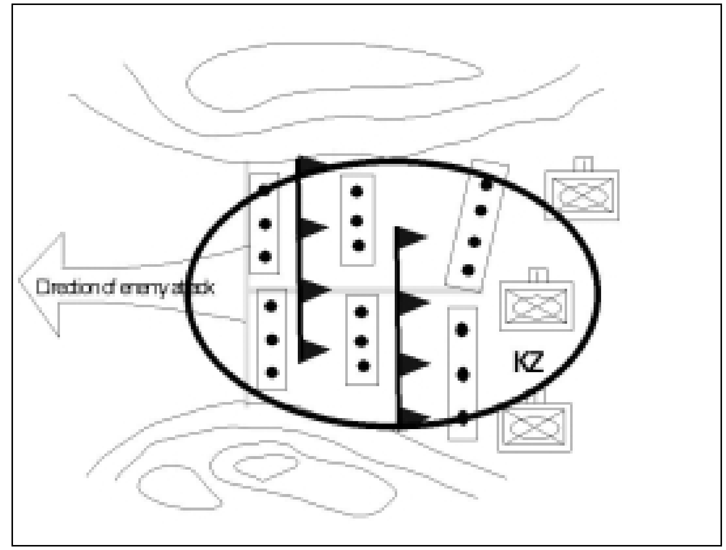


Figure 15: Block Obstacle Effect

c. **Relative location**. Where the commander wants the obstacle effect to influence the target.

OBSTACLE EFFECT SYMBOLS

13. The obstacle effect is conveyed graphically using a standard set of obstacle effect symbols, as shown in Figure 16. Commanders use these symbols to convey the effect they want obstacles to have on the enemy.

OBSTACLE CONTROL

14. **General**. Obstacle control is the control that commanders exercise to ensure that obstacles support current operations, maximise subordinates' flexibility, and facilitate future operations. Commanders maintain obstacle control by:

a. Focusing or withholding emplacement authority; and

b. restricting obstacle siting or design, and timings for obstacle emplacement.

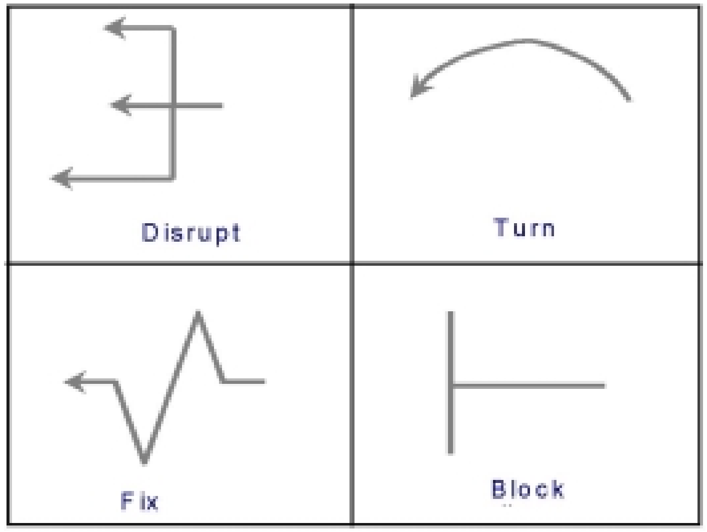


Figure 16: Obstacle Effect Symbols

15. **Obstacle Emplacement Authority**. Obstacle emplacement authority is the authority that a formation or unit commander has to emplace obstacles. In most cases, this authority would be given to the corps commander from the theatre commander once political authority has been granted. The Corps commander would normally further delegate authority to division commanders. Commanders subordinate to corps and divisions do not have the authority to emplace obstacles unless the higher commander gives them that authority. In some instances, an authorised commander may be directed to confirm obstacle siting (siting concurrence) with another commander (i.e. forward brigades with corps/division covering force). Authority for the emplacement of protective obstacles rests with unit commanders and is normally delegated to sub-unit commanders. Reserved obstacles are only executed on the command of the authorised commander or based on specific criteria identified by the authorised commander. The Demolition Order

(DND 913) is used as the control document for the execution of reserved demolitions.

16. **Obstacle Restrictions**. Commander at all levels may use obstacle restrictions to provide additional obstacle control. The following are possible obstacle restrictions:

a. **Siting Restrictions**. Commanders may designate areas, routes or specific locations to be free of obstacles. "Barrier Restricted Areas" such as countermove axes, may be labelled as such on the barrier plan overlay, or may be specified in the operation order,

b. **Design Restrictions**. Commanders may restrict the design of obstacles (e.g. surface laid mines only, no scatterable mines, no anti-handling devices, no bridge demolitions or inundation).

c. **Timing Restrictions**. Commanders may restrict timings associated with obstacle emplacement and effectiveness.

17. Subordinate commanders have the right to be more restrictive than the higher commander, however, the subordinate commander cannot relax the higher commander's restriction, and the commander's intent must be respected.

18. Execution.

a. **Directed Obstacles**. Commanders select directed obstacles but, as there will seldom be a guard, the authority to execute the obstacle will normally by delegated to the engineer officer responsible for its preparation. Directed obstacles should be prepared in accordance with existing or established plans. They should be executed as soon as the situation permits and authority for their execution is granted.

b. **Reserved Obstacles**. Reserved obstacles are guarded until they have been successfully completed. Authority to execute the obstacle is retained by the authorised commander, or delegated by him to a nominated officer. A reserved demolition is a specific example of a reserved obstacle. The procedures to be followed for the preparation, protection and execution of a reserved obstacle are contained in DND 913 Demolition Order, and these must be known and understood by all concerned. Their duties are summarised as follows:

(1) **Authorised Commander**. The officer empowered to authorise the firing of the reserved demolition is called the authorised commander. The authority to fire reserved demolitions is likely to be confined to formation commanders in the early stages of an operation. As the operation proceeds, authority may be delegated to a subordinate commander, who then becomes the authorised commander. It is essential that secure and reliable communications exist between the authorised commander and the demolition guard commander. The authorised commander must specify whether the demolition guard commander is authorised to order the firing of the demolition on his own initiative if the enemy is in the act of capturing it. Orders must be issued by the authorised commander to the demolition guard commander and demolition firing party commander on a DND 913 Demolition Order. It is an operations responsibility to prepare the DND 913 Demolition Order with engineer advice.

(2) **Demolition Guard**. A demolition guard is a force positioned to ensure that the

demolition is not captured or sabotaged by an enemy before it has been successfully fired. The commander of the demolition guard is responsible for the operational or tactical command of all troops on the demolition site, including the demolition firing party. He is responsible for transmitting the order to fire, in writing, to the demolition firing party. He is also responsible for reporting the effectiveness of the demolition to the authorised commander and for keeping him informed of the operational situation at the demolition site. The orders to the demolition guard commander are issued on a DND 913 Demolition Order.

(3) **Demolition Firing Party**. The demolition firing party is technically responsible for the demolition. The size of the party and therefore the rank of the commander depend on the size of the demolition. Demolition firing parties are required for preliminary demolitions as well as reserved demolitions. Orders to the demolition firing party commander are issued on a DND 913 Demolition Order.

OBSTACLE CONTROL MEASURES

19. **General**. Obstacle control measures are specific control measures used to simplify the delegation of obstacle emplacement authority, imposing of obstacle control and assigning obstacle intent. Obstacle control measures are:

a. **Obstacle Zones**. Control measures that corps and divisions commanders use to delegate obstacle emplacement authority to brigades, brigade groups or other subordinate formations/units. Zones are normally aligned to correspond with enemy division avenues of approach. Corps and division commanders also use obstacle zones to ensure that subordinates emplace obstacles that support the higher commander's manoeuvre plan and that they do not interfere with future operations. Corps and divisions plan obstacle zones based on brigade areas of operation. Obstacle zones do not cross brigade boundaries. Commanders assign zones to a single subordinate formation to ensure unity of command. This maintains tactical obstacle responsibility along the same lines as control of direct and indirect fire. Obstacles that are to be placed outside of a commander's boundary, require siting concurrence from the commander controlling that zone with obstacle emplacement authority in that area/sector (i.e. support to the covering force or covering avenues of approach along formation boundaries).

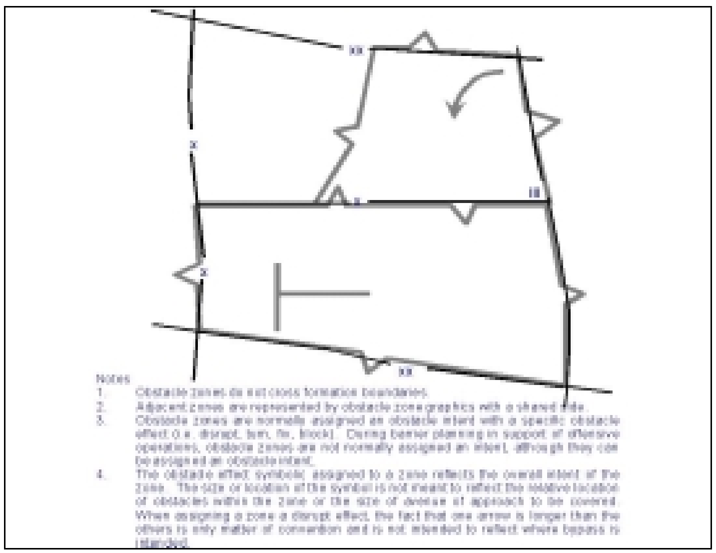


Figure 17: Obstacle Zone Symbols

b. **Obstacle Belts**. Obstacle belts are graphic control measures used by brigades and brigade group commanders to constrain tactical obstacle employment. They plan obstacle belts within assigned obstacle zones to delegate obstacle emplacement authority to their subordinate units. Obstacle belts also focus obstacles in support of the brigade manoeuvre plan, and ensure that obstacles do not interfere with the manoeuvre of any higher formation. Belts are planned on enemy regiment avenues of approach. Obstacle belts do not cross unit boundaries. Battle group commanders cannot plan or emplace obstacles outside brigade-directed obstacle belts. Where obstacle belts assigned to adjacent battle groups share a common boundary, liaison must be established to ensure unity of obstacle effort. Brigade commanders assign an obstacle intent to each obstacle belt. Obstacle belts refine the area within obstacle zones authorised for tactical obstacles; however, they still give battle group commanders the latitude they need to develop their detailed barrier plan.

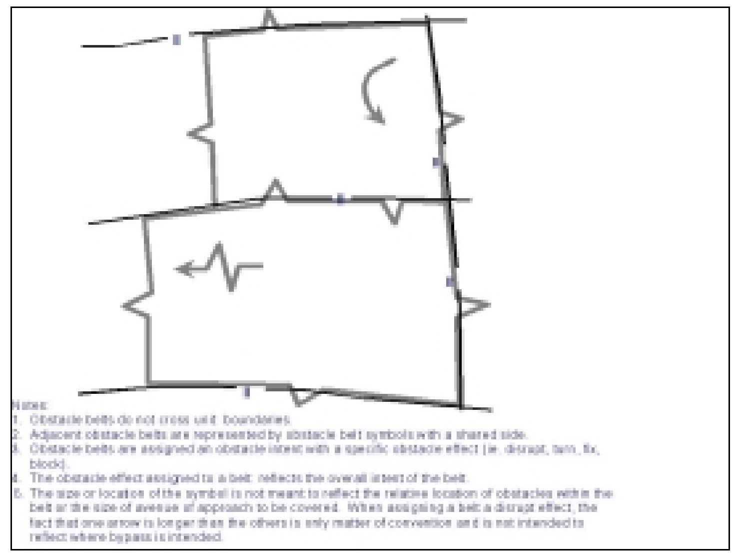


Figure 18: Obstacle Belt Symbols

c. **Obstacle Groups**. Obstacle groups are one or more individual obstacles grouped to provide a specific obstacle effect. Sub-units integrate obstacle groups with direct and indirect fire plans in detail. Unlike obstacle zones and belts, obstacle groups show relative locations for actual obstacles. When detailed planning is possible, commanders may show individual obstacle symbols, however the obstacle group intent must be indicated. A group does not show the exact location of each obstacle in the group just as a battle position does not show the exact location of each weapon. A major change to the obstacle-group location requires the approval of the commander who ordered the group.

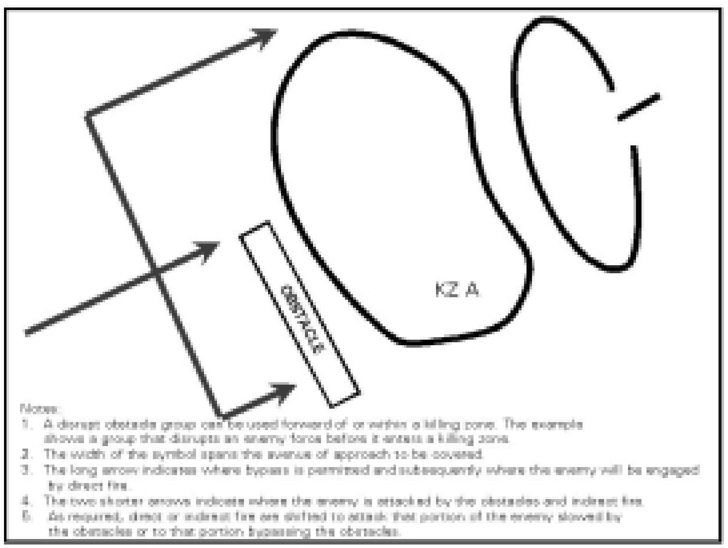


Figure 19: Disrupt Obstacle Group Symbol

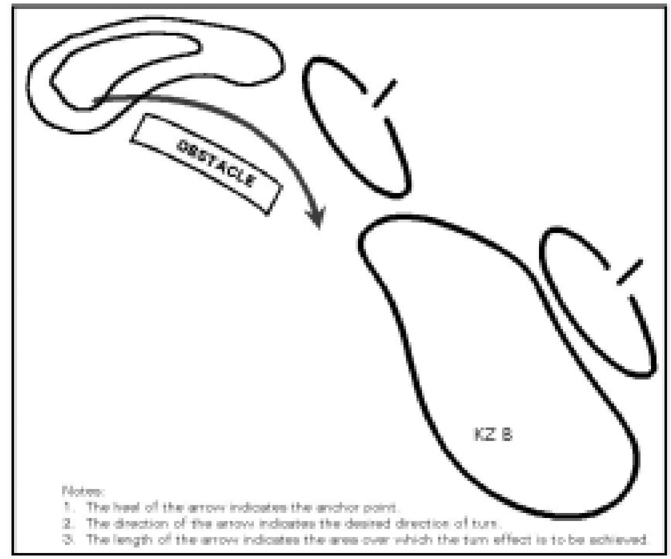


Figure 20: Turn Obstacle Group Symbol

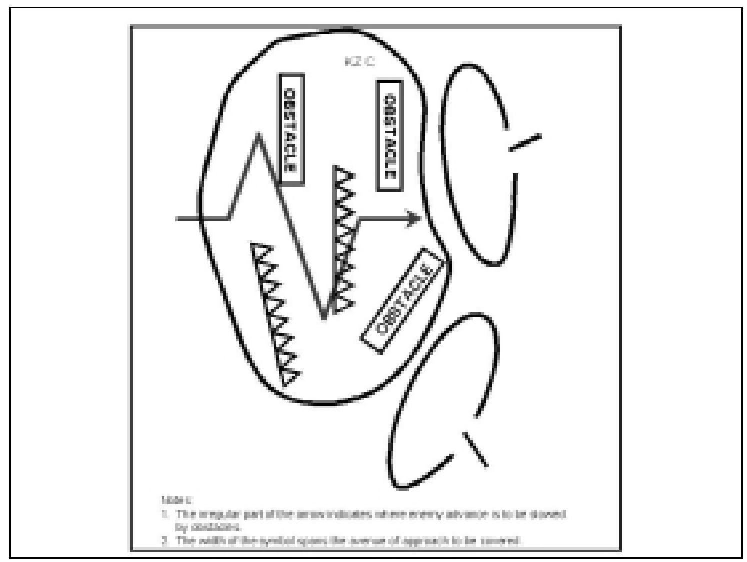


Figure 21: Fix Obstacle Group Symbol

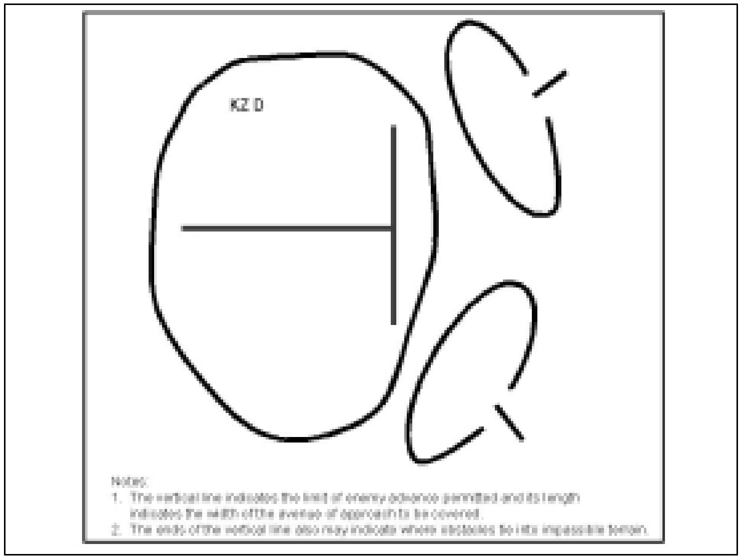


Figure 22: Block Obstacle Group Symbol

20. The following table summarises the obstacle control measures.

Obstacle Control Measure	Organisation	Specific Obstacle Effect	Size of Enemy Avenue of Approach
Zone	Division/Corps	Normal but Optional	Division/Brigade
Belt	Brigade	Mandatory	Brigade/Battalion
Group	Battle Group	Mandatory	Battalion/Company
Restrictions	All	Not Applicable	Not Applicable

Figure 23: Obstacle Control Measures

OBSTACLE INTEGRATION

Obstacles and demolitions, unless defended, are of little value. It is not necessary to sit on a demolition or obstacle to defend it, because the enemy will place fire there. These points are best defended from a distance of several hundred yards for small arms and from normal artillery range for that arm.

War As I Knew It
George S. Patton, Jr

21. **General**. Obstacle integration is the process of ensuring that obstacle effects support the overall tactical plan. To achieve their effect, obstacles must be co-ordinated with all combat functions at all levels of command. This integration is key to the success of the tactical plan, and demands that the manoeuvre, fire and barrier plans be developed simultaneously. Obstacle integration begins with the commander's mission analysis, and is developed continuously throughout the operation planning process.

22. Commanders and their staffs consider the following to ensure that obstacle integration is achieved and that obstacles have the desired effect on the battle:

a. Intelligence,

b. obstacle intent,

c. direct and indirect fire and obstacle effects,

d. obstacles and operations in depth, and

e. obstacle control.

23. **Intelligence**. Tactical planning requires that the commander have an accurate picture of the battlefield. Barrier planning requires intelligence on the terrain and of the enemy in terms of his intentions, capabilities and vulnerabilities, particularly with respect to obstacle breaching capabilities. These elements will

be analysed during the Intelligence Preparation of the Battlefield process and give the commander key pieces of information to develop the barrier plan. Obstacles are best used to exploit the enemy's vulnerabilities, particularly by defeating their obstacle breaching capabilities.

24. **Manoeuvre, Fire Planning and the Obstacle Effect**. All levels of command must understand how obstacles, manoeuvre and fire plans are integrated to achieve the obstacle effect. The aim is to maximise the combined effects of firepower and obstacles, and exploit the weakness that these create in the enemy to achieve the commander's intent.

a. **Manoeuvre, Fire Planning and the Disrupt Effect**. To accomplish the disrupt effect, the obstacles and fire must:

(1) Cause the enemy to deploy early;

(2) slow and disrupt part of the enemy force; and

(3) allow part of the enemy to advance relatively unimpeded.

b. Commanders use indirect fire and long range direct fire to force the enemy to change from march formation to prebattle or attack formation. Generally, indirect fire alone will not force an enemy to deploy except when he is dismounted.

c. Commanders plan suppression and neutralisation indirect fire targets on the obstacles in the disrupt obstacle group to slow the part of the enemy force that makes contact with the obstacles. Commanders also use blinding and screening fire, electronic warfare and any other available means to disrupt enemy command and control, thereby concentrating direct fire on the unimpeded part of the enemy force.

d. Commanders mass direct fire against that part of the enemy formation not impeded by obstacles and indirect fires. They do not execute those fires until that portion of the force separates from its parent formation. They use direct fire weapons that can deliver a lethal initial volley of fire. A quick volley is critical if the enemy has good command and control and can react quickly to the disruption of its formation. Disengagement criteria are also a consideration in weapons selection. If commanders plan a short engagement, they choose a weapon system that can manoeuvre without becoming decisively engaged (e.g. TOW). If they expect a long engagement, they select a weapon system that can sustain rapid fire with sufficient survivability to support the engagement (e.g. tanks).

e. Commanders plan secondary arcs of fire and additional defensive fire (DF) targets that allow for the shift of direct or indirect fires to either the enemy slowed by the obstacle or to the enemy bypassing the obstacle. They position themselves to make an assessment of the obstacle effect. If the enemy is rapidly breaching the obstacles, they may shift direct fires against the enemy's breaching assets. On the other hand, if too large a force bypasses, commanders may shift all fires against the unimpeded enemy to inflict maximum losses and then reposition friendly forces to their subsequent positions.

f. **Manoeuvre, Fire Planning and the Turn Effect**. To accomplish the turn effect, the obstacles and fires must:

(1) Prevent the enemy from bypassing or breaching at the start of the turn;

(2) force the enemy to bypass in the desired direction; and

(3) maintain pressure on the enemy throughout the turn and exploit its exposed flank.

g. Commanders normally anchor turning obstacle groups to restrictive terrain or to a strongpoint. They plan direct fire arcs of fire and DFs that focus all available fires first at the anchor point. When the enemy hits the obstacle, the combination of fires, obstacles, terrain, and forces must seal any bypass at the anchor point.

h. Commanders plan an indirect fire target or obstacle group to turn the enemy away from the anchor point. They focus enough direct fire assets to deal with the size of the enemy force expected at that point. For example, if a commander expects an enemy company at the anchor point, he should allocate at least a friendly platoon/troop to mass fires at that point. If the enemy breaches the obstacle at the anchor point, the turning effect could be lost.

i. The critical task in achieving the turn effect is to use obstacles and overwhelming firepower to force the enemy to move in the direction desired by the friendly commander. As the engagement progresses, the friendly force stops any attempt to breach the obstacle. Direct fire systems are the primary means for destroying enemy breaching equipment, which are normally priority targets. Indirect fires can attack individual vehicle targets, but they may be less timely. Targeting all obstacles in the obstacle group and registering all DF targets during preparation will make indirect fires more responsive.

j. Commanders develop a fire plan and direct fire arcs of fire and DFs that allow to shift fires as necessary to cover the turn effect. Both direct and indirect fires shift in unison to attack and maintain pressure on the flank of the enemy force. Fires covering the length of the turn effect are less focussed than at the turn point. Company commanders give platoons/troops arcs of fire. Commanders usually execute indirect fires in groups instead of single DF targets. Direct and indirect fires continue throughout the length and depth of the turn effect. These fires simultaneously exploit the vulnerability created by the turn effect and protect the integrity of the obstacles.

k. **Manoeuvre, Fire Planning and the Fix Effect**. To accomplish the fix effect, the obstacles and fires must:

(1) Cause the enemy to deploy into attack formation early;

(2) allow the enemy to advance slowly into the killing zone; and

(3) make the enemy fight in multiple directions once it is in the killing zone.

l. Commanders plan indirect fires forward of the obstacles to suppress or neutralise the enemy. They synchronise indirect fires with long range direct fires that cause the enemy to deploy out of march or a prebattle formation. Ideally, units site obstacles at the enemy's maximum fire range and inside the friendly effective fire range. If the enemy is in attack formation, this allows obstacles and fires to affect the full frontage of the enemy.

m. Initially, commanders orient fires on the enemy force as a whole. However, destroying enemy breaching assets becomes increasingly important as the enemy continues to advance into the killing zone. To maximise the obstacle effect and inflict maximum losses on the enemy, the fire plan requires an increase in the intensity of fires as the enemy advances. Commanders plan how the engagement of the enemy force by additional weapon systems will be triggered as it advances through the killing zone and encounters obstacles closer to battle positions. They vary the intensity of fires through fire control to allow the enemy to continue to advance slowly. When the enemy is fully committed, friendly forces complete its destruction.

n. Once the enemy commits in the killing zone, the fire plan forces the enemy to fight in as many directions as possible. This serves to further slow its advance, disrupts its command and control, reduces its mass, and provides interlocking fires with enfilade fire on individual targets. Combining fires from multiple directions with the random orientation of individual obstacles further confuses the attacker. For direct fires, commanders consider the use of secondary arcs of fire and secondary positions to reorient fires. They also consider the use of protective obstacles. Based on the direction of the commander, the artillery plans targets to hold the enemy in the killing zone and final protective fires (FPFs) on the most dangerous approaches into friendly positions.

o. **Manoeuvre, Fire Planning and the Block Effect**. To accomplish the block effect, the obstacles and fires must:

(1) Prevent the enemy from bypassing or breaching the obstacles;

(2) maximise available stand-off in order to be, if possible, at the enemy's maximum fire range but inside friendly effective fire range; and

(3) stop the enemy's forward movement.

p. Commanders consider obstacle protection when planning direct fire arcs of fire and DFs. The defending force must stop any bypassing or breaching attempt by the enemy. They respond to any attempt to breach or bypass with a quick volley of direct and indirect fires. Blocking obstacles stops enemy manoeuvre and forces the enemy to commit breaching assets to be destroyed by friendly forces. Higher level commanders may allocate other forces to the task of completing the enemy's destruction, such as offensive air support or counter-attack forces.

q. To support survivability, commanders should position forces to provide the maximum standoff distance possible. Stand-off is defined as the distance between the weapon system and the closest obstacles in the group. The killing zone must cover the entire avenue of approach. The maximum effective range of the weapons, minus stand-off, limits the depth of the killing zone. The commander positions his forces so that he can mass interlocking fires across the entire avenue of approach. The defending force must be able to concentrate all available fires within the obstacle group. Commanders array weapon systems in depth based on their maximum effective ranges and the survivability provided to those systems.

r. The success of the blocking effect is measured by its impact on the enemy advance, not by enemy losses. Commanders only uses it at critical points on the battlefield. The mission of forces covering a blocking obstacle group is to defeat lead enemy units and cause the attacker to reconsider the deployment of follow-on forces.

ISSUING AND TRACKING THE BARRIER PLAN

25. Once the commander has made his decision, the various staff section and arms advisers prepare their portions of the operation

order. The engineer staff will develop the barrier concept selected for implementation into the final barrier plan. Details of the final barrier plan are integrated into the applicable sections of the supported commander's operation order.

26. While there is only one barrier plan, namely at Corps level where initial direction concerning the barrier plan originates, the barrier plan is expressed differently as it is communicated between successive levels. The barrier plan will be more detailed and focussed at each successively lower level. Once the barrier plan has been executed, an obstacle overlay depicting individual obstacles, written details of each individual obstacle (the Obstacle Task Table could be use for this purpose), and applicable minefield records will be passed up both on the operation and engineer technical chain for subsequent consolidation ad dissemination.

27. **Barrier Execution Matrix and Overlay**. The barrier execution matrix and the overlay are the mechanisms to communicate the barrier plan. The barrier execution matrix shall be accompanied with an overlay. Examples of obstacle zone/belt and obstacle group execution matrix are shown in Annex C to chapter 3.

OBSTACLE NUMBERING

28. The aim of obstacle numbering is to assist in identifying and tracking obstacles that have been constructed. The numbering/designation of zones and groups are only planning control measures, and therefore local conventions may be employed, and these numbers/designations may be repeated. It is not necessary to include obstacle zone or group when identifying an obstacle that has been constructed.

29. In order to identify obstacles, each unit in a brigade shall be issued a block of obstacle numbers (i.e. 1 RHLI serials 4000-4499). These numbers shall be used when a unit constructs an obstacle. Details are further outlined in formation standing operating procedures.

BARRIER RESOURCING

30. **Introduction**. At the sub-unit level, the engineer troop commander and combat team commander can easily identify the resources required for individual obstacles based on an analysis and reconnaissance of the ground. However, at the battle group level, the exact requirements are less clear. The exact requirements become increasingly unclear at each higher level. The engineer adviser at each level requires a method of estimating obstacle resource requirements to make the necessary allocations to subordinate units. The two techniques for estimating obstacle resources are:

a. Requirement-based resourcing; and

b. capability-based resourcing.

31. The choice of technique is determined by the critical factors in the barrier plan. For example, when sufficient engineer capability and time are available to emplace all the obstacles required, then the requirement-based resourcing method can be used. Conversely, if time is short or there are insufficient engineer resources available to emplace all the obstacles planned, then the capability-based resourcing method would be used.

32. It must be noted that these methods only provide the commander with initial estimates of the resources needed for the barrier plan. These estimates allow for the early allocation and delivery of obstacle resources. Once the detailed reconnaissance of individual obstacles is completed, requests for adjustments to initial allocations are forwarded up through the chain of command until they reach a level at which the commander has sufficient reserves of mines, explosives, defence stores and heavy equipment to be able to satisfy the additional requirements. Reserves of mines, explosives and defence stores are normally maintained at brigade level and above to satisfy requests for additional allocations from lower echelons, while engineer heavy equipment can be regrouped or reassigned from lower priority tasks.

33. **Requirement-based Resourcing**. The requirement-based resourcing method allocates subordinate formations with mines,

explosives, defence stores and manpower based on anticipated requirements. These requirements are based on the tentative obstacle control measures that the engineer adviser develops as part of barrier planning and the engineer effort that is required to achieve the commander's aim.

34. The engineer adviser does a preliminary staff check to determine the type and a number of obstacles that will be used to achieve the commander's intent. The use of standard obstacle designs can be used to calculate mines, defence stores and heavy equipment for specific avenues of approach or zone. The obstacle requirement will be based on such factors as the enemy threat, ground (width of avenue of approach) and the required effect. One method of determining resource allocation is to determine the engineer effort required based on the commander's intent, and generic resourcing tables based on various terrain types (i.e. easy, moderate and difficult). Based on the results of the staff check, resources may be ordered and allocated on a percentage basis.

35. **Capability-based Resourcing**. Capability-based barrier resourcing considers an engineer unit's obstacle construction capability, in terms of engineer resources, in relation to the time available for the task. Engineer units have the capability to construct only a certain amount of obstacles in a given amount of time. This is a particularly useful method of barrier resourcing when time is short, for areas of lower threat hence lower overall effort or when mines, explosives and defence stores are limited. Capability-based resourcing can also be used as a staff check to ensure that, given the manpower and equipment available, there is sufficient time to transport and deliver the obstacle materials, and emplace the obstacles resourced using requirement-based resourcing method.

36. The capability-based resourcing method requires early identification of the main effort. Based on the main effort, a preliminary grouping of engineers is developed. This grouping drives the resourcing of obstacles.

37. A number of assumptions must be made in using the capability-based barrier resourcing method. These include the type of obstacles to be used and work rates. Work rates must take the following elements into account: rest, travel time, time for maintenance, personnel and equipment shortages, time of day work

is to be performed, weather, and morale. In addition to these, any other factor that may significantly affect the capability of an engineer unit to emplace obstacles must be considered.

38. The advantage of this technique is the early identification of obstacle material requirements. Obstacles require a large amount of material and transportation assets to move. Engineer units have a limited capability for transporting obstacle resources. The earlier the transportation requirements are identified, the easier the co-ordination of transportation support becomes.

TRANSFER OF BARRIERS

39. An essential part of the transfer of an area of operation will be the hand-over of barriers from one formation to another. This hand-over may be complicated by the lack of a common language, and differences in organisation, doctrine, training, barrier munitions, equipment and capabilities. It may be found that there are differences between the two commander's concept of operations.

40. During the conduct of a barrier transfer operation, the following basic principles should be adhered to:

a. Throughout the transfer of barriers there must be close co-ordination between engineer and operations staffs, and by both with the combat troops involved.

b. The incoming and outgoing engineers should establish a common planning cell at the command post of the outgoing formation.

c. The highest-level engineer commander/staff officer available to negotiate the steps of the transfer must head the initial engineer liaison team. In addition, personnel having the necessary linguistic and technical expertise should also be involved.

d. The outgoing formation is responsible for providing all available barrier documentation in an understandable and useable format.

e. Engineer representation should always be available from the appropriate command level of the territorial forces of the host nation, especially if pre-constructed obstacles have to be transferred. Engineer representation is the responsibility of the outgoing engineers.

f. Support to the incoming engineers should be provided to the maximum extent possible by the outgoing formation.

g. The outgoing formation should consider the requirement for detachments or liaison officers to ensure the command, control and/or technical surety of reserved demolitions.

h. The outgoing formation may have to consider the requirement to change or modify existing or planned barriers to support the incoming formation's operational plans.

i. Once the physical transfer of targets has commenced, incoming engineer or combat troops should be directed to the targets and be thoroughly briefed by their outgoing counterpart at the obstacle.

j. When no engineers are available, pioneers or assault troopers must be provided to conduct the hand-over of incomplete obstacles such as prepared demolitions or gaps in minefields.

k. The outgoing formation is responsible for providing full information on the type, quantities and location of all engineer material being left behind.

SECTION 3
SURVIVABILITY

GENERAL

1. The lethality of modern weapon systems makes the battlefield an increasingly hostile environment. The weight of offensive air support and artillery that may be available to the enemy requires that considerable attention be paid to survivability. To avoid detection and destruction, it is likely that frequent movements and rapid digging will be required. Personal survivability is an all arms responsibility. The following measures may be used to enhance survivability:

   a. dispersion,

   b. concealment,

   c. fortification, and

   d. deception.

MAJOR ENGINEER SURVIVABILITY TASKS

2. Major engineer survivability tasks will include assistance to other arms in:

   a. field Fortifications,

   b. protection of combat supplies, and

   c. camouflage, concealment and non-electronic deception.

FIELD FORTIFICATIONS

3. **General**. The preparation of field fortifications is an all arms responsibility. When time is short or the nature of the terrain

requires special techniques such as the use of heavy equipment or explosives, engineers may provide support, in accordance with the commander's priorities. Possible engineer tasks include:

a. Advice on the construction of field fortifications,

b. construction of command posts,

c. construction of artillery gun, tank and support weapons pits,

d. preparation of sites for tactical aviation units,

e. construction of ammunition and other matériel storage facilities,

f. advice and/or assistance with the construction of protective obstacles,

g. preparation of alternate positions, and

h. strengthening of field fortifications.

4. **Shelter Types**. Shelters are classified according to their use and construction material as follows:

a. **Type I Shelters** are small dug-in structures forming part of a battle trench or weapon emplacement.

b. **Type II Shelters** are larger than Type I shelters and, in addition to battle trenches and weapon emplacements, include command posts, unit medical stations, etc. These shelters normally require more resources and are more difficult to construct than Type I shelters.

c. **Type III Shelters** are similar to Type II shelters in size and use but provide a greater degree of protection. They are generally fabricated by engineers from construction materials such as concrete, structural steel and lumber. Many buildings are adaptable as Type III shelters.

d. **Base Shelters** are larger and more permanent than Type III shelters and are intended to meet the requirements for stationary headquarters, critical installations and airfields. These are fabricated by engineers from construction materials such as reinforced concrete. Urbanisation permits the adaptation of buildings as base shelters.

5. **Responsibilities**. The responsibilities for construction of field fortifications are as follows:

a. **Battle trenches and Type I shelters** - individual responsibility of all ranks and elements of the army.

b. **Crew-served weapon, artillery and F echelon vehicle emplacements** - responsibility of the crew of the weapon or vehicle, with assistance from engineers or assault pioneers as required.

c. Type II shelters and field fortifications for protracted occupation - unit responsibility, with engineer assistance as required.

d. Type III shelters - engineer responsibility.

e. Base shelters - engineer responsibility.

PROTECTION OF COMBAT SUPPLIES

6. Combat supplies should be protected in particular against blast, shrapnel, incendiaries and nuclear, chemical and biological contamination. It is most important to provide protection for ammunition and fuel stores. The types of shelter built will depend upon the terrain and soil type as well as on the availability of existing buildings and natural cover. By advising the logistic staff on

the selection of the most suitable storage sites, the requirements for engineer support can be considerably reduced.

CAMOUFLAGE, CONCEALMENT AND NON-ELECTRONIC DECEPTION

The deception arrangements were particularly interesting. We had decided that strategic surprise was out of the question, for the enemy must know we were going to attack. But tactical surprise was quite possible, We considered we could delude the enemy as to the weight, the date, the time and the direction of our attack. Our plans were all made with this in view, and they proved most successful.

The first problem was to try and conceal the concentration as much as possible from the enemy. The staff worked out the complete layout on the day of the attack, i.e. the number of guns, tanks, vehicles and troops. A very large "operations" map was kept which showed this layout in various denominations. We then arranged to arrive at the eventual density up to the last moment, so that the enemy's air photography would show no particular change in the last two or three weeks. To achieve this we used spare transport and dummy transport. These were gradually replaced by those belonging to the assault units and formations as they came up to take over their allotted sectors. These change-overs took place at night. We had special dummy vehicles made under which guns could be concealed. And in this way we hoped to get the enemy used to the pattern, and there would be no significant change even on "D" day. All moves forward were rigidly controlled. Slit trenches were dug and camouflaged at night in which the assaulting infantry could be concealed.

The next task was to make the enemy think that the main attack would be launched in the southern sector. This, I might say, was not very popular with 13th Corp, but they nobly accepted *the plan for common good. Besides various other methods adopted, we built large dummy dumps away to the south, and also a dummy pipe line and water installations. It was so arranged that the work would appear to the enemy to be aimed at completion a week or two after the actual date of our attack.*

Operation Victory (The Battle of El-Alamein)
Major-General Sir Francis de Guinard

7. **Camouflage and Concealment**. In general, all units are responsible for their own concealment and local camouflage. Major positions, facilities and operational sites, may require special camouflage stores and measures. The commander may then require engineers to undertake such tasks, as advised by his engineer commander. Efforts must be made to reduce the distinctive signature created by engineer work on battle position preparation. Apart from the use of camouflage nets and natural camouflage material, special camouflage measures often require the use of engineer equipment and devices. This is especially true for large scale camouflage requirements.

8. **Non-Electronic Deception**. Deception is designed deliberately to give the enemy an incorrect picture of the situation thus enhancing friendly operations. Construction work should expend as little time and matériel as possible. It is an engineer responsibility to provide advice on deception to the commander.

9. Deception must always be co-ordinated at the highest practical level. It is rarely planned below corps level.

10. Special engineer deceptive measures can include construction of dummy positions, phoney obstacles including minefields, decoys and the simulated employment of construction equipment. For the construction of dummy positions and decoys, camouflage and deception material will be used and engineer equipment will be employed to excavate soil. Damaged or captured matériel can be used to create deception. Dummy positions and decoys must be carefully planned and co-ordinated with the tactical plan and real positions.

SURVIVABILITY IN DEFENSIVE AREAS

11. All arms are responsible for digging their own positions and for the planning and construction of protective obstacles. However, the anticipated digging requirement, in particular for the infantry and artillery, normally exceeds the capability of the individual soldier, crew or unit, thus it may fall to the engineers to provide equipment to dig, and to advise and assist in the construction of field fortifications. Typical engineer tasks will include:

a. Preparing main and alternate positions for direct and indirect fire weapon systems,

b. preparing of positions for tactical aviation units,

c. providing advice and assisting in the construction of field fortifications,

d. providing advice and, on occasion, assisting in the creation of protective obstacles, and

e. constructing positions for command and control assets.

12. **Survivability of Reserves**. The enemy will give particular emphasis to the detection and attack of reserves. Whereas these will primarily survive through the use of concealment, there may be a requirement for field fortifications.

SURVIVABILITY OF COUNTERMOVE FORCES

13. Unless preparation of the position and associated barriers has been carried out in advance, engineer effort will be at a premium. The preparation of barriers will frequently be the commander's highest priority and engineer support to survivability tasks may be very limited. Early planning of contingency countermove tasks may allow the preparation of some obstacles, turret and hull down positions in advance. Alternate positions

prepared for the main defensive area may also be able to serve as countermove positions.

SURVIVABILITY IN THE COVERING FORCE AREA

14. Because of the fluid nature of the covering force battle, time available for survivability tasks is limited. Therefore, the commander must establish clear priorities for engineer work. Tasks that may be performed are similar to those in defensive areas.

SURVIVABILITY IN THE REAR AREA

15. The enemy will attempt to locate key installations and command and control centres. Therefore, survivability tasks could include the construction of:

a. shelters,

b. ammunition and storage facilities, and

c. preparation of sites for air force units.

SECTION 4
MOBILITY

GENERAL

1. During preparations for defensive operations, engineers will reconnoitre, improve and open routes for use during the battle. These may include lanes through barriers, routes from hides to battle positions, routes to alternate positions, routes for maintenance and resupply and routes for countermove forces. Engineers must be prepared to breach friendly as well as enemy obstacles. Engineers must be particularly vigilant against the enemy scatterable mine threat.

MOBILITY IN THE COVERING FORCE AREA

2. Providing mobility is a major task in the covering force area. The covering force requires axial and lateral routes to give it the mobility required to both delay the enemy and avoid decisive engagement. Engineer mobility tasks include:

a. route maintenance and improvement, especially on reserved routes,

b. close mobility assistance using armoured and combat engineers,

c. debris clearance in urban areas,

d. advice to the covering force on trafficability, and

e. provision of alternate routes to the main defensive area if reserved obstacles are executed before the covering force is withdrawn.

3. To complete these tasks engineers require considerable resources deployed forward throughout the covering force area, such as:

a. assault bridging,

b. armoured engineer vehicles,

c. support bridging;,

d. trackway, and

e. engineer heavy equipment, particularly heavy equipment with high mobility and protection.

MOBILITY IN DEFENSIVE AREAS

4. Typical engineer tasks are:

a. **Routes**. Maintenance and improvement of routes will be a major engineer task. Engineer mobility tasks involve maintenance and improvement of routes to alternate battle and gun positions and the routes selected for use by blocking and counter-attack forces. Enemy interference by artillery and air forces, plus the requirement for off-road movement, may require the deployment of assault bridging, trackway, and engineer heavy equipment well forward. Engineers must be prepared to rapidly breach/clear enemy scatterable mines;

b. **Obstacle Gaps and Lanes**. Careful planning and co-ordination with ground manoeuvre units will be necessary to ensure that the required lanes or gaps are left in obstacles for the redeployment of troops; and

c. **Support to Countermoves.** The enemy's use of obstacles for the protection and consolidation of his offensive operations will require the deployment of close support engineers with countermove forces. The importance of success by these forces places considerable emphasis on their need for mobility. Mobility tasks include the maintenance and improvement of routes selected for blocking and counter-attack forces. Likewise, should the battle dictate, there might be a requirement to breach friendly force obstacles in support of countermoves. Therefore, engineers must be equipped with assault bridging, armoured engineer vehicles, breaching equipment and vehicle launched mine systems in order to provide the close support required.

MOBILITY IN THE REAR AREA

5. It is here that the reserve forces of the formation are normally located. In addition, some long range fire support, organic and attached support arms and support services units will often be found in this area. Typical engineer tasks are:

a. maintenance of main supply routes,

b. maintenance of countermove routes, and

c. breaching enemy obstacles such as scatterable mines.

SECTION 5
COUNTER-MOBILITY

A minefield, as I have already stated in a previous lecture, are to tanks what wire entanglements are to infantry - the one stops the mobility of a machine, the other of the man.

A minefield should consist of rows of mines laid diagonally, its object being to bar movement or to deflect movement. Generally speaking, minefields should be protected by fire - that is to say, they should be used in conjunction with anti-tank weapons.

Armored Warfare (1943)
Major-General J.F.C. Fuller

GENERAL

1. The commander's decision to adopt an area or mobile defence will guide the overall defensive concept, the barrier plan and therefore engineer involvement. The defensive battle is a corps battle; therefore barrier planning begins at the corps level.

2. Counter-mobility operations are very labour and resource intensive. Commanders must establish clear priorities and be

realistic with their expectations. Therefore, obstacles must be carefully planned and integrated. Likewise, since the construction of obstacles is very time consuming, early warning and quick authority to commence work is vital.

COUNTER-MOBILITY IN THE COVERING FORCE AREA

3. Engineers with the covering force construct obstacles in depth throughout the covering force area. These obstacles are sited in conjunction with the fire and manoeuvre plan in accordance with the commander's intent. The synergy of obstacles, fire and manoeuvre will provide incremental decreases in enemy mobility slowing his momentum and providing targets for destruction. Obstacles in the covering force area are particularly important in supporting the counter reconnaissance effort. Obstacles support counter reconnaissance in their effort to harass, deceive, delay, divert or deny access to the enemy.

4. Although constructing obstacles in the covering force area will reduce the quantity of resources available for the defensive area, counter reconnaissance will enhance the integrity of the obstacles in the defensive area. If obstacles in the defensive area are observed, reported or prebreached by the enemy because of ineffective counter reconnaissance, the effort spent on the obstacles in the defensive area will be seriously diluted. Once compromised, obstacle surprise as well as much of their potential effects is lost. In the covering force area, major obstacles are not common, but rather smaller obstacles sited in depth along likely enemy avenues of approach prevail. Control of obstacles in this stage is essential. Control is exercised thought the barrier planning process. This ensures that friendly manoeuvre is not jeopardised.

COUNTER-MOBILITY IN DEFENSIVE AREAS

5. The major tasks for engineers in the main defence area are those associated with the implementation of the barrier plan, which is discussed in detail in Section 2 of this chapter. Obstacles are created to:

   a. protect the covering force while it disengages,

b. close lanes/gaps after the covering force has withdrawn,

c. disrupt enemy lead elements,

d. turn the enemy into killing zones,

e. block the enemy from leaving a killing zone or along an avenue of approach,

f. fix the enemy in a killing zone,

g. protect main defence forces,

h. protect the flanks,

i. disrupt the movement and commitment of enemy follow-on forces,

j. protect the flanks of countermove forces,

k. support countermove forces with preparations of a hasty defence,

l. hinder the withdrawal of enemy forces, and

m. hinder the enemy's ability to reinforce an area.

COUNTER-MOBILITY IN THE REAR AREA

6. Obstacles in the rear area support rear area security operations by:

a. providing force protection, and

b. countering enemy deep operations.

ANNEX A
EXAMPLE BARRIER PLAN

GENERAL

1. This scenario illustrates how obstacles are integrated into the decision making process in the defence.

CORPS BARRIER PLAN

2. Based on the commander X Allied Corps mission analysis, the corps engineer participates in the operation staff procedure to determine the courses of actions open to enemy and own forces. Based on their analysis of terrain, weather and enemy, the corps staff has identified the enemy's most dangerous, to our forces and most probable courses of action.

3. During the information brief the commander has directed that the staff continue developing his courses of action based on the most probable enemy course of action, which is: two first echelon Combined Arms Armies attacking into the corps area of operations followed by a second echelon Tank Army.

4. The corps staff then prepare the courses of action open to the commander for his decision. The corps commander's decision is to (see Figure 24) conduct an area defence with two divisions forward, 4(CA) Div LEFT, 4(GE) Pzgr Div RIGHT; an armoured cavalry regiment, 209(US) ACR, as the corps covering force; and an armoured division, 1(UK) Armd Div as the corps countermove forces and the 10(US) Avn Bde as the reserve.

5. 4(CA) Div defeats a Combined Arms Armies forward of CRAIG DART. 4(GE) Pzgr Div initially defeats a Combined Arms Armies forward of CRAIG DART, then delays back to QUEEN THISTLE allowing enemy penetration into an apparent salient. 1(UK) Armd Div counterattacks along Axis RATTLER into corps KZ B to destroy a lead division of the second echelon Tank Army in the 4(GE) Pzgr Div sector. 10(US) Avn Bde as reserve is to be prepared to attacks into either corps KZs C or D.

6. The corps engineer anticipates that 209(US) ACR could use six disrupt obstacle belts (not shown) to shape the covering force battle. He groups these tentative belts into disrupt Obstacle Zone A (see Figure 25) which is used to provide the commander 209(US) ACR with obstacle emplacement authority. The corps engineer plans a situational "be prepared" disrupt Obstacle Zone B to support 1(UK) Armd Div counterattack to destroy a tank division in corps KZ B. Obstacle resources allocated to this zone will be for situational obstacles. He also plans "be prepared" fix Obstacle Zones C and D to support 10(US) Avn Bde's operations in corps KZs C or D. Allocations of artillery delivered RAAM scatterable mines are co-ordinated to execute these zones.

7. Zone A is located between the FLOT ESTUARY LAUGH and the HL BARK FLOAT to allow obstacles to be emplaced to support 209(US) ACR in the covering force area. The rear boundary of Zone A is adjusted forward of the handover line BARK FLOAT to allow main defensive forces deployed along the HL to emplace tactical obstacles which support the handover between 209(US) ACR and the divisions.

8. The corps engineer does not provide obstacle emplacement authority to the divisions as they already have the authority to emplace obstacles within their area of operations unless specifically restricted.

9. Provisions are also made for the rearward passage of 209(US) ACR. CROWN and CLUB Routes are reserved for this purpose and corps reserved block obstacle groups across the FEBA are planned to deny these high-speed avenues of approach to the enemy. 4(CA) Div and 4(GE) Pzgr Div are subsequently tasked with the provision of the reserved obstacle guards and execution parties and the preparation of the reserved obstacles BRIAN CAR and ADAM APPLE respectively. Demolition orders are prepared by the corps G3 staff for both reserve demolitions.

10. The corps engineer then prepares the barrier plan and overlay (Figure 25). To ensure that the 1(UK) Armd Div counter-attack is not hindered by obstacles, Axis RATTLER is designated as a barrier restricted area on the barrier plan overlay and routes CROWN and CLUB are designated barrier restricted zones until the passage of line of 209(US) ACR is completed. The barrier plan also

states that siting concurrence from 209(US) ACR is required for all division obstacles planned forward of the HL BARK FLOAT. In consultation with the corps general staff, the corps engineer allocates resources, as a percentage of available resources based either on terrain planning factors or on engineer capabilities, to subordinate formations while maintaining a 10% corps reserve. This enables the movement of these resources to be planned and executed concurrently with the barrier planning process at lower echelons. The barrier resource allocation is as follows:

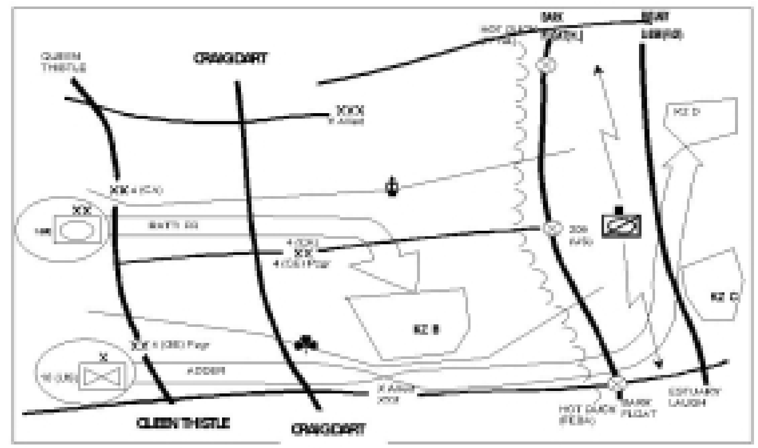


Figure 24: Allied Corps Plan

BARRIER RESOURCE ALLOCATION TABLE			
	Mines	Explosives	Scatterable Mines
1(UK) Armd Div			25%
4(CA) Div	35%	40%	10%
4(GE) Pzgr Div	40%	30%	10%

209(US) ACR	15%	20%	20%
10(US) Avn Bde			15%
Corps Reserve	10%	10%	20%

DIVISION BARRIER PLAN

11. Based on the commander 4(CA) Div mission analysis the CDE participates in the operation staff process to determine the courses of actions open to the enemy and own forces. Based on their analysis of terrain, weather and enemy, the staff has identified the enemy's probable courses of action. During the information brief the commander has directed that the staff develop his courses of action based on the most probable course of action, two first echelon Motorized Rifle Divisions attacking into the division sector followed by a second echelon Tank Division. During this process the staff made particular note of the corps commander's intent to shape a penetration in the 4(GE) Pzgr sector. The CDE also noted the obstacle restrictions specified in the corps barrier plan. The staff then prepares the courses of action open to the commander for his decision.

12. The division commander's decision is to (see Figure 26) establish an area defence with two brigades forward, 11 CIB LEFT and 12 CIB RIGHT, and 13 CAB as the division countermove force. 11 CIB is tasked to defeat a first echelon Motor Rifle Division forward of CRYSTAL WRAP and prevent the enemy from flanking 12 CIB from the NORTH. 12 CIB initially defeats a first echelon Motor Rifle Division forward of CRYSTAL WRAP, then delays back to CRAIG DART allowing enemy penetration in the SOUTH of the division sector. 13 CAB counterattacks along Axis HAMMER into KZ X to destroy the lead regiments of the second echelon TD.

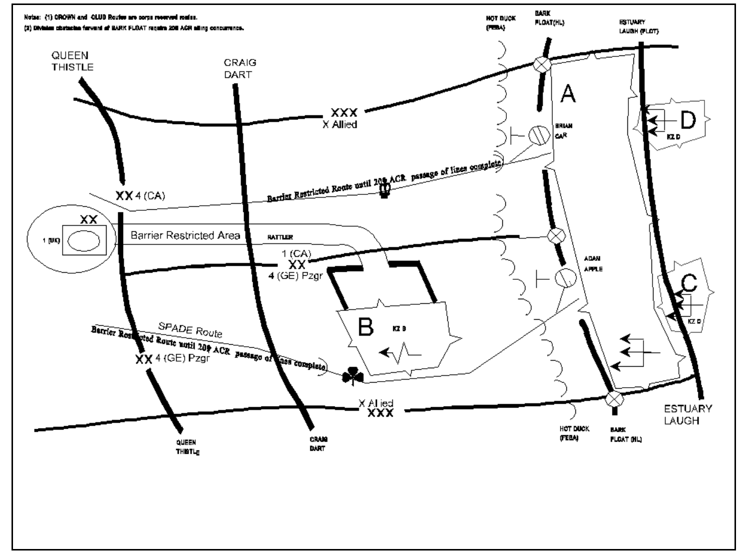


Figure 25: Allied Corps Barrier Plan

13. The CDE anticipates that 11 CIB and 12 CIB could each use two disrupt belts (not shown) based on two enemy regimental avenues of approach through each brigade sector. He groups these tentative belts into disrupt Obstacle Zones A and B (see Figure 27). Obstacles may be sited forward of BARK FLOAT, however, those sited forward of BARK FLOAT will require siting concurrence of commander 209(US) ACR. The rear boundary of both zones corresponds with the FEBA.

14. The CDE anticipates that 11 CIB could use one block belt NORTH and one turn belt SOUTH in its sector based on the same enemy approaches as discussed above. These tentative belts are grouped into Obstacle Zone C. To support the division commander's intent and show a strong defence forward, the CDE plans Obstacle Zone C's rear boundary forward of CRYSTAL WRAP. Zone C's forward boundary corresponds with the FEBA.

15. The CDE similarly anticipates that 12 CIB could employ two fix belts (not shown), grouped into Obstacle Zone D. To facilitate the 13 CAB counterattack, the CDE restricts the depth of

the zone to the forward edge of KZ X. Zone D's forward boundary corresponds with the FEBA.

16. To the rear of CRYSTAL WRAP in the 12 CIB sector, the terrain opens up to create three enemy regimental approaches. The CDE anticipates that 12 CIB could use two block belts (not shown), one each on the LEFT and CENTRE approaches while the corps counterattack uses the right approach. He groups the two block belts into block Obstacle Zone E. The zone's forward boundary is restricted by KZ X and the rear boundary is located forward of CRAIG DART.

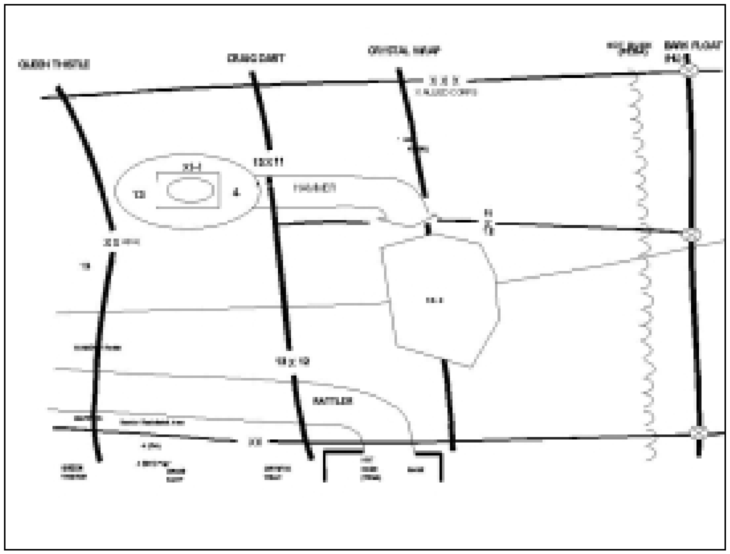


Figure 26: Div Plan

17. The division general staff and engineer staff co-ordinate the provision of the reserved obstacle guard (from 13 CAB) and engineer execution party required for the execution of the corps assigned reserved obstacle BRIAN CAR. The CDE plans a situational 'be prepared" fix Obstacle Zone F to support 13 CAB's counterattack into KZ X.

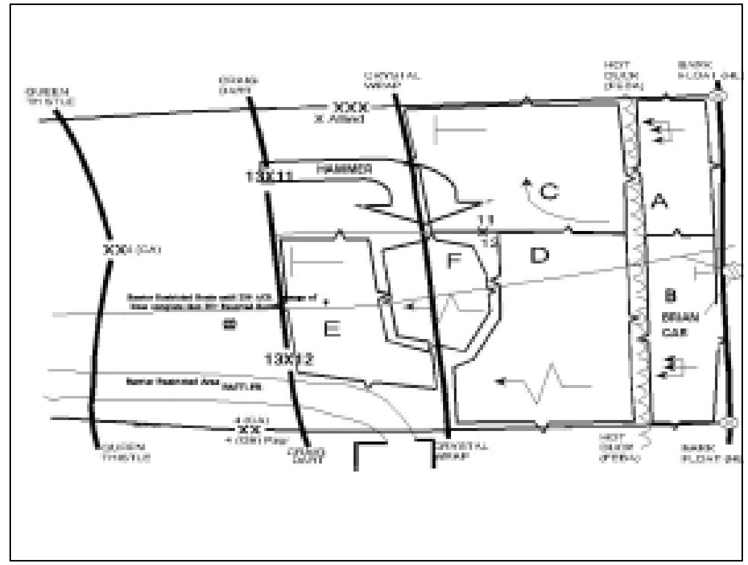


Figure 27: Div Barrier Plan Overlay

18. The CDE then prepares the barrier plan and overlay (Figure 27) once the commander approves the plan. The division does not need to designate either the corps or division countermove axis as a barrier restricted area. No one who is subordinate to the division has authority to emplace obstacles in these areas. The barrier plan provides direction on the submission of plans for obstacles forward of the HL, BARK FLOAT, for siting concurrence by 209(US) ACR. In consultation with the division general staff, the CDE also allocates resources to subordinate formations while maintaining a small reserve.

BRIGADE BARRIER PLAN

19. Based on the commander 11 CIB mission analysis the commanding officer 11 CER in the operation staff process determines the courses of actions open to the enemy and own forces. Based on their analysis of terrain, weather and enemy, the staff has identified the enemy's probable cources of action. During the information brief the commander has directed that the staff develop

his courses of action based on the most probable course of action making particular note of the requirement to defeat a MRD forward of CRYSTAL WRAP and prevent the enemy from flanking 12 CIB from the NORTH.

20. The enemy's course of action used to develop the plan was two Motorized Rifle Regiments (MRR) attacking into the brigade sector followed by a second echelon MRR. The commander's decision (see Figure 28) is to establish an area defence with two battle groups (BG) forward, 1 R Regt C BG LEFT, 1 RHLI BG RIGHT; 1 RMR in depth; the brigade reserve based on ONT R with a company of 1 RMR. The brigade recce sqn, E Sqn ONT R provides the brigade screen between BARK FLOAT and HOT DUCK. 1 R Regt C BG destroys a first echelon MRR within boundaries. 1 RHLI BG turns a first echelon MRR off the avenue of approach running along the boundary with 12 CIB forward of GREASE LADLE. 1 RMR destroys a second echelon MRR in KZ W. The brigade reserve is prepared to reinforce, in priority, 1 RHLI, 1 R Regt C and 1 RMR.

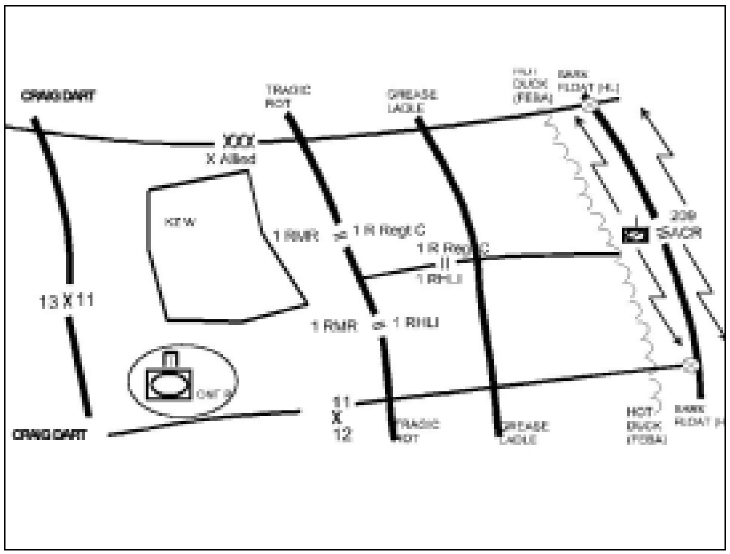


Figure 28: CMB Plan

21. The brigade staff and engineer adviser anticipate that the brigade screen could use four disrupt obstacle groups in Zone A, and combines these groups into two obstacle belts, Belts A1 and A2 (see Figure 29). They anticipate that 1 R Regt C could use two fix and two block obstacle groups (not shown) based on the two Motorized Rifle Battalion (MRB) approaches within its sector and combines these groups into fix Obstacle Belt C1. 1 RHLI could use one block and one turn obstacle group (not shown) based on two MRB approaches within its sector, which are combined to form turn Obstacle Belt C2. 1 RMR could employ two fix and two block obstacle groups (not shown) within KZ W based on two MRB AAs, which are combined to form block Obstacle Belt C3. Based on flank avenues of approach into both the 1 R Regt C and 1 RMR sectors, the brigade commander allocates each BG one 400m x 400m RAAM minefield for use as situational "be prepared" obstacle groups. Direction is provided in the barrier plan concerning submission of planned obstacle group locations to brigade HQ for artillery/engineer co-ordination.

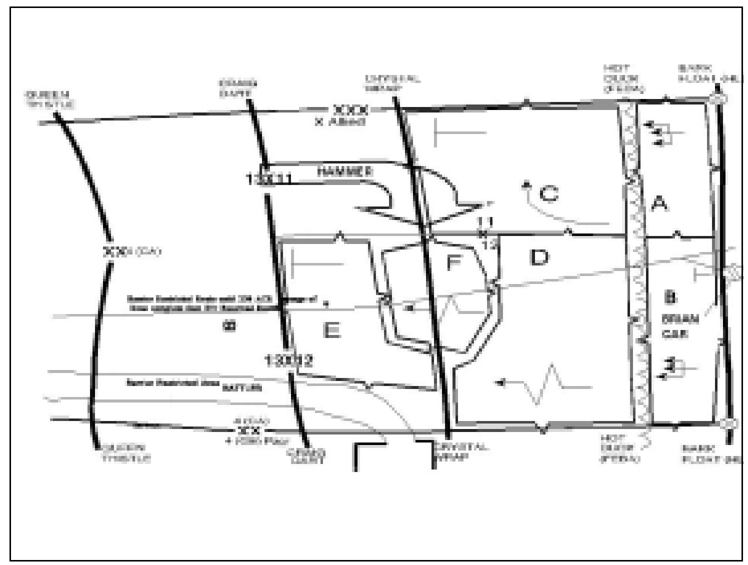


Figure 29: CIB Barrier Plan Overlay

22. Upon approval of the plan by the brigade commander, the engineer adviser prepares the barrier plan and overlay.

BATTLE GROUP BARRIER PLAN

23. In the 1 RHLI BG sector, the BG commander decides on a plan (see Figure 30) which has A Coy destroying a first echelon Motorized Rifle Battalion (MRB) in KZ H. B and C Coys defend from battle positions (BP) around KZ Y to turn the remainder of the MRR attacking in the BG sector to the NORTH.

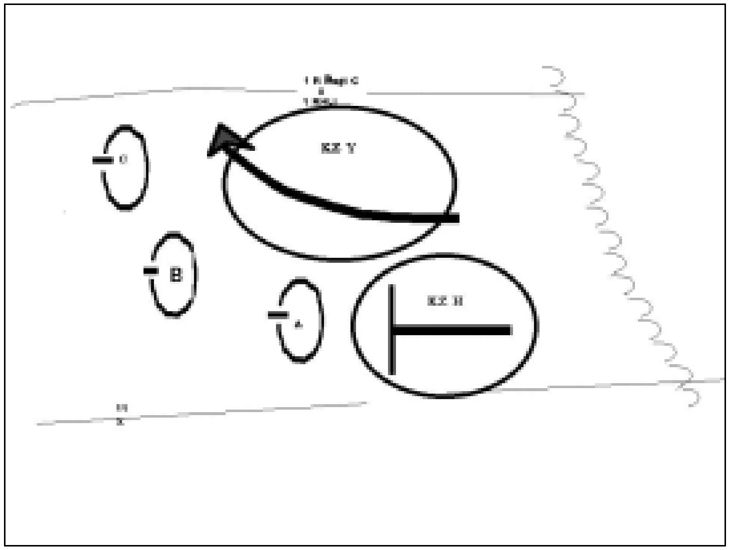


Figure 30: RHLI BG Plan

24. The engineer squadron commander, who has a tasked organised close support squadron, develops a barrier plan (see Figure 31) which has block obstacle group supporting A Coy in KZ H. Turn obstacle group supports B and C Coys in KZ Y. Responsibility for the block obstacle group is given to A Coy in BP A, but B Coy defending from BP B must co-ordinate the siting of obstacles in the turn group with C Coy defending from BP C. The BG commander, engineer and artillery BC must integrate the manoeuvre, barrier and fire plan on the ground. Battle positions and kill zones will be selected, followed by detailed obstacle siting by the company commander and the engineer troop commander. The BC will subsequently tie the fire plan together to support the entire plan

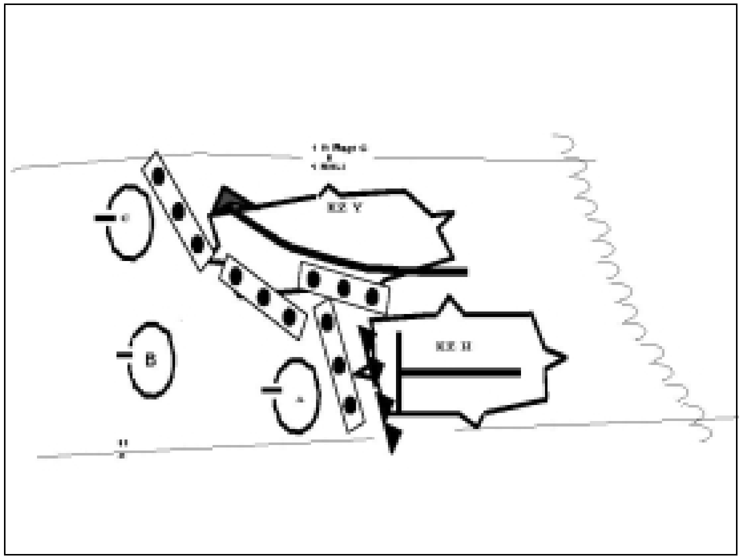


Figure 31: RHLI BG Barrier Plan Overlay

CHAPTER 6
DELAYING OPERATIONS

SECTION 1
FUNDAMENTALS

GENERAL

1. Delaying operations provide the basis for other operations by trading space for time while retaining flexibility and freedom of action to inflict the maximum damage on the enemy, without, in principle becoming decisively engaged. The intention will be one or more of the following:

a. To slow the enemy's advance;

b. to manoeuvre the enemy into areas where he is vulnerable;

c. to avoid combat under undesirable conditions; and

d. to determine the enemy's main effort.

ENEMY

2. The enemy's aim is to maintain the momentum of his advance and to put our forces off-balance. He may wish to fix our forces in order to seek a decisive engagement. To achieve these aims he will rely primarily upon:

a. The maintenance of mobility in order to:

(1) sustain the momentum of his advance; and

(2) concentrate his forces.

b. reconnaissance and surveillance in order to identify and attack our forces; and

c. restrict the mobility of our own forces so that he can attack or bypass them.

CONCEPT

3. A delay is conducted by a combination of defensive and offensive actions, mostly by a mixture of hasty defence and vigorous countermoves. Initially, a commander establishes contact with the enemy using reconnaissance elements. As the enemy pushes these elements back, he should encounter a hasty defence. This defence should be sufficiently strong in combat power that the enemy is misled into believing that he has encountered the battle positions of a main defence area. The delaying force engages the enemy and conducts limited countermoves until decisive engagement is threatened. Before this occurs, a commander disengages or fights his way back to the next delay line. Contact is maintained either by reconnaissance elements, who in the interval have repositioned themselves to receive the enemy, or by the forces fighting their way back.

4. The same general sequence of activity is repeated until the mission is achieved. At a hand-over line, the delaying force disengages and the responsibility for dealing with the enemy is assumed by the force in place. At no time during a delay may a commander accept decisive engagement without the authority of his superior.

5. The delaying action may be fought in two ways as follows:

a. **Delay on Successive Positions**. This is done when it is necessary to delay the enemy for a prolonged period, when substantial amounts of space can be relinquished, and when a series of suitable terrain features are available.

b. **Delay on Alternate Positions**. This is done when the conditions for delay on successive positions do not exist and when, in addition, the formation boundaries are narrow enough to permit the formation to occupy two positions simultaneously.

6. The successive position is the most frequently used method of conducting a delaying action. The alternate position method is used less frequently and is in effect a leapfrogging action by two forces each fighting up to and through the other force's position.

ENGINEER SUPPORT

7. In delaying operations the engineer effort is divided between the covering force and the new main defence area. Engineer tasks will primarily be to:

a. Prepare barriers to restrict the enemy's mobility and cause casualties; and

b. maintain the mobility of our own forces so that they can avoid decisive engagement.

8. Counter-mobility and mobility tasks will normally predominate, however, survivability tasks particularly in the delay positions and the main defence area will be important. Sustainment engineering tasks, being common to all operations of war, are discussed in Chapter 9. Geomatics being common to all operations are discussed in Chapter 4.

SECTION 2
COUNTER-MOBILITY

GENERAL

1. The aim of delaying operations is to disrupt enemy progress repeatedly, using as many obstacles as possible but with the minimum time and effort. This forces the enemy to advance exposing high value targets such as engineer assets. Regardless of the type, obstacles are used to gain time, save manpower and inflict

losses on the enemy. The following considerations should be taken into account:

a. Barrier creation must begin as early and as far forward as possible without jeopardising security. Lanes and gaps through and between barriers, designated by the commander, must be kept open by engineers. It is essential that lanes and gaps can be closed rapidly, when required by the commander. This will normally be the task of engineers but this responsibility may be transferred to other arms. The responsible commander must be clearly designated.

b. The commander must ensure that friendly forces know where the obstacles and routes through them are located.

c. When delaying operations are conducted at short notice, obstacles may include scatterable and off-route mines which may be laid quickly.

d. Delaying force crossing operations must be carefully reconnoitred and planned. There must be sufficient crossing sites to permit rapid crossing. Engineers must be tasked in sufficient time to support the delaying force in these crossing operations, and to prepare obstacles to block enemy attempts to follow.

e. Engineer equipment used for delaying force crossings should be capable of being withdrawn quickly, or destroyed, before the enemy is able to take control of crossing sites.

f. The enemy is likely to attack and attempt to seize crossing sites, possibly using airmobile, airborne or advance forces. Engineers must therefore be prepared to destroy crossings, provide alternatives at temporary sites and deny landing zones.

COUNTER-MOBILITY IN THE COVERING FORCE AREA

2. Similar to the defence, obstacles are used in delay operations to:

a. Support the counter reconnaissance effort to enhance the integrity of the obstacles in the defensive area;

b. delay and disrupt enemy lead elements;

c. separate follow-on elements; and

d. protect the flanks of the covering force.

COUNTER-MOBILITY IN DEFENSIVE AREAS

3. Obstacles are used in defensive areas to:

a. assist the covering force to disengage;

b. close lanes/gaps after the covering force has withdrawn;

c. disrupt enemy lead elements;

d. turn the enemy into killing zones;

e. block an enemy from leaving a killing zone or along an avenue of approach;

f. fix the enemy in a killing zone;

g. protect the main defence forces;

h. protect the flanks;

i. disrupt the movement and commitment of enemy follow-on forces;

j. protect the flanks of countermove forces;

k. support countermove forces with preparations of blocking positions;

l. hinder the withdrawal of enemy forces; and

m. hinder the enemy's ability to reinforce an area.

SECTION 3
MOBILITY

GENERAL

1. The survivability and effectiveness of delaying forces will depend on axial and lateral routes in order to manoeuvre, and yet avoid decisive engagement. Mobility assets will be required well forward to complete the necessary tasks. Engineer tasks in the delay are similar to those in the defence. The following general points apply to mobility in delaying operations:

a. **Routes through Obstacles**

(1) Lanes through barriers and gaps between barriers must be provided for withdrawing forces. The commander assigns the routes, lanes or gaps, usually in conjunction with his engineer commander. He will also determine in which situations the routes, lanes and gaps may be closed, and designate the commander responsible for closure. In all circumstances the commander who is authorised to close a route, lane or gap must be clearly designated.

(2) Engineer forces will often be held ready to keep the lanes or gaps open until they are no longer required and then close them after the last withdrawing forces have passed through them. All friendly forces deployed forward of friendly obstacles must know where the safe lanes and gaps are located. The commander provides them with this information.

b. **Withdrawal Across Water Obstacles**. The engineer commander must designate and detach the required engineer forces and matériel from other tasks, to provide the necessary effort for this difficult operation.

(1) **Reconnaissance and Selection of Sites**. Withdrawal across water obstacles requires thorough reconnaissance and careful preparation. The crossing sites must be identified and made known to the delaying forces in sufficient time to enable them to plan accordingly. The location of crossing sites may be specified by the delaying force commander according to his tactical plan. The aim must be to provide a sufficient number of crossing sites for the delaying forces to cross quickly and in an orderly manner, even when the enemy is pursuing, and to then destroy the crossings in the face of the enemy. Ideally, two crossing sites are required for every one needed, however, when resources are short, three crossing for every two need is an acceptable risk.

(2) **Use of Military Bridging**. Military bridging equipment may be used; however, time shall be made available, whenever possible, to recover it for future uses. This is especially critical for

floating and self-propelled bridging assets. If time is not available to recover the equipment then it must be destroyed. It may be necessary for engineers to reinforce permanent bridges by overbridging so that they may be used by heavier vehicles.

(3) **Defence of Crossing Sites.** The enemy will attempt to seize bridges and fording sites, sometimes with airmobile or advance forces. In addition to using permanent sites, the engineer commander should be prepared to provide temporary crossings away from such sites. The commander ensures that crossing sites are adequately defended from both air and ground attack.

MOBILITY IN THE COVERING FORCE AREA

2. Similar to the defence, mobility is a major task in the covering force area. Engineer mobility tasks include:

a. Route maintenance and improvement, especially on reserved routes. Tasks involve maintenance and improvement of routes to alternate battle and gun positions and the routes selected by blocking and counter-attacking forces.

b. Mobility support to blocking and countermove forces.

c. Debris clearance in urban areas.

d. Advice to the covering force on trafficablity.

e. Provision of alternate routes to successive delay lines if reserved obstacles are executed before the covering force is withdrawn.

f. Unopposed water crossing.

MOBILITY IN DEFENSIVE AREAS

3. Typical engineer tasks are:

a. Maintenance and improvement of routes. Tasks involve maintenance and improvement of routes to alternate battle and gun positions and the routes selected by blocking and counter-attacking forces;

b. planning gaps and lanes for the redeployment of forces; and

c. support to countermoves.

MOBILITY IN THE REAR AREA

4. Typical engineer tasks are:

a. maintenance of main supply routes,

b. maintenance of countermove routes, and

c. breaching obstacles such as scatterable mines.

SECTION 4
SURVIVABILITY

GENERAL

1. Engineer survivability tasks are covered generally in Section 3 of Chapter 5. In delaying operations, forces will move frequently and therefore have little time to prepare extensive positions or survivability works. If possible, a number of primary and alternate positions on successive lines should be prepared. Engineer assistance will increase the number of positions that can be prepared.

CHAPTER 7
OFFENSIVE OPERATIONS

SECTION 1
FUNDAMENTALS

By 20th December 1943 the main road had been checked to the outskirts of Ortona - the mine sweeping parties cleared the last stretch that morning, moving with the infantry as they went in. Even so, deep laid mines disabled four of the tanks which followed. On 21st December, as the Edmontons began to fight their way thorough the streets, the 2nd Field Park Company advanced its bridging dumps to San Leonardo in preparation for the construction of a number of bridges that were required before the coup de grâce could be administered, since the enemy showed no signs of beating a hasty retreat. The city was not taken until after a week of very bitter street fighting. In this, the engineer role was to help the infantry forward from house to house, and from room to room, by blowing holes (mouse holing) through the walls and by collapsing buildings on the hidden defenders. Standard procedures for clearing upper storeys, when entry was made on a lower level, was to place about 30 pounds of fused '808' plastic high-explosive on a chain in the centre of a room, ignite the fuse, and retire; there were rarely any upper rooms left to search. Many booby-traps were encountered.

The History of the Corps of Royal Canadian Engineers, Volume 2

GENERAL

1. The purpose of offensive operations is to defeat the enemy by application of focused violence, not only on the enemy's forward elements but also throughout his depth. Manoeuvre in depth poses an enduring and substantial threat to which the enemy must respond.

Physical destruction of the enemy is, however, merely a means to success and not an end in itself. The requirement is to create paralysis and confusion thereby destroying the cohesion of his defence and fragmenting and isolating his combat power thereby attacking his will or ability to fight. Further purposes of offensive action might be to:

a. seize ground;

b. gain information;

c. deprive the enemy of resources;

d. deceive or divert the enemy from the main effort;

e. fix the enemy to prevent him from regrouping or repositioning his forces;

f. pre-empt to gain the initiative; and

g. disrupt enemy offensive action.

2. Ultimate success in battle is achieved by offensive action. Even in the defence, a commander must take every opportunity to seize the initiative and carry the battle to the enemy.

ENEMY

3. To defeat our offensive operations the enemy will try to halt our offensive operation, destroy our forces and restore his own freedom of action. To achieve this aim, the enemy will:

a. Use obstacles, especially mines, to restrict and disrupt our movement and to cause casualties; and

b. maintain reserves to counter-attack and exploit our weaknesses.

ENGINEER SUPPORT

4. In offensive operations, engineer support will be required to maintain the momentum of our attack. Mobility support is paramount. Counter-mobility tasks, particularly the protection of flanks and rapid protection against counter-attacks, are also important. The achievement of these functions depends on adequate reconnaissance, timely provision of the necessary equipment and stores, and on the proper grouping and control of engineer elements. Engineers support attacking forces by any or all of the following actions:

a. Breaching friendly force minefields and other obstacles.

b. Marking and breaching enemy minefields and other obstacles.

c. Providing means of crossing waterways or other obstacles.

d. Securing the flanks with minefields, demolitions and other obstacles. These also help to shape the battlefield and may allow commanders to use economy of force measures for force protection.

e. Preparing and maintaining routes for follow-on echelons.

f. Supporting consolidation on the objective by digging, laying minefields and creating obstacles.

g. Neutralising and dismantling unfired enemy demolitions.

h. Supplying water.

i. Limited clearing of booby traps.

j. Explosive Ordnance Disposal and Battlefield Munitions Disposal.

5. Geomatics support will be particularly important in offensive operations because the terrain over which we will fight will, in all probability, be unfamiliar to us. Geomatics tasks, being common in all operations of war are discussed in Chapter 4.

SECTION 2
MOBILITY (CROSSING AND BREACHING OBSTACLES)

Ever since armies marched and fought it has been necessary to find means of crossing rivers, and, whether by divine assistance as in the case of the Israelites at the Red Sea and Jordan, or by the ingenuity of man as in Hannibal's crossing of the Rhône, with his elephants on rafts of inflated skins, the general and his engineers have had to solve the problem in varying circumstances through the ages.

The difficulty of the problem has led to the use of river lines as an obstacle to be used in conjunction with defensive arrangements by an enemy to stop or check an advance. The crossing has therefore frequently to be made in face of, and under the fire of, defenders determined to contest the passage. Usually the problem is therefore one of crossing in face of more or less determined opposition. So a river crossing is like other operations of war, a tactical problem and the solution, although taking full note of the engineering factors involved, must be based on a sound tactical plan. It is the duty of the engineer officer to inform the commander of the engineering considerations and potentialities with the labour and material available, and to state the most satisfactory plan from the technical point of view, and, where the plan cannot be adopted, to show the risks and limitations of any other plan proposed. But it is for the commander after *weighing up all the factors to decide what risks he must accept, and what plan he will adopt.*

Military Engineering (Field)
The War Office 1952

GENERAL

1. An obstacle is a natural or man-made restriction to movement which will normally require special equipment or munitions to overcome. A co-ordinated series of obstacles is known as a barrier. The obstacles which are likely to prove the greatest impediment to movement are inland bodies of water or waterways (rivers and canals) and complex obstacles and, as a consequence, they will often require a specific operation and specialist engineer support to surmount them.

2. Although crossings normally occur during offensive operations, they may also be necessary during defensive or delaying operations. They can occur throughout the combat zone and along lines of communications further to the rear. Often they involve a passage of lines. Minor obstacles are crossed and breached by units using their own resources. It is the responsibility of engineers to ensure the maintenance of momentum, and that delays caused by the enemy are reduced to a minimum. Guiding principles for engineers during offensive operations are:

   a. Engineer reconnaissance parties must be located with forward elements and have effective communications so that their reports can be quickly actionned at the appropriate headquarters;

   b. engineer commanders should be well forward, so that when necessary, they can personally assess the situation and make on-the-spot decisions;

   c. troops must be assigned tasks, linked up with the appropriate equipment prior to movement, and given the proper priorities for movement; and

d. engineers should not be kept in reserve, however, resources should be identified for unforeseen tasks.

3. This section concentrates on the planning and conduct of deliberate water crossing operations and obstacle breaching, though the practices and procedures described apply equally to a hasty crossing and breaching operations. Other obstacles which will impede and slow movement, and which may require engineer support to overcome, include:

a. Rough, soft or marshy ground and terrain covered by snow.

b. craters and ditches.

c. Vertical steps and slopes.

d. Contaminated areas.

e. Abatis, extended wire entanglements and debris, including collateral damage from nuclear weapons.

f. Existing and reinforcing obstacles including craters, mines, landslides and avalanches. Bypasses will always be difficult or impossible.

g. Flooding and inundation.

TYPES OF CROSSING AND BREACHING OPERATIONS

4. There are different types of crossing and breaching operations.

a. **Hasty**. A hasty crossing or breaching takes place when an attacking force attempts to breach or cross from the march using resources within the force. Very little reorganisation of the assault echelon is required and drills may be developed for breaching to commence with little or no additional orders being given. Engineer support can include reconnaissance, provision of advice, and the breaching/crossing, proving, marking and maintenance of lanes.

b. **Deliberate**. A deliberate crossing or breach is only undertaken when no other option is available. Deliberate crossings or breaches require thorough reconnaissance, detailed planning, extensive preparations, rehearsal, and heavy or specialist engineer equipment. It is conducted because of the complexity of the obstacle, the strength of the enemy, or when a hasty crossing or breach has failed. The lowest level at which this is likely to be practised is at divisional level.

PLANNING CONSIDERATIONS

5. Any natural or man-made obstacle (or combination of the two) can be overcome given sufficient resources and time. On the modern battlefield, however, both may be in short supply. A commander should try to seize crossing sites or obstacle lanes/gaps intact, or force the crossing or breach before the enemy expects it, in order to unhinge the defence and preempt the defender. An obstacle defended by the enemy will, however, not be overcome until enemy fire has been neutralised, and enemy forces holding or dominating the crossing have been driven off.

6. Whether a hasty or more deliberate operation is required, commanders should be aware of the following considerations when planning the operation:

a. **Crossing and Breaching**. In a situation where complex obstacles are encountered it will be necessary to take note of their individual characteristics such as strength, distance between obstacle and enemy positions and fire and observation covering the obstacles.

b. **Intelligence**. Adequate and timely intelligence provided by thorough ground, air and water reconnaissance will:

(1) Confirm the existence and nature of any obstacles.

(2) Assist the commander's decision to bypass or mount a hasty or deliberate operation. From this decision, the requirement for any deployment of engineer equipment and other forces will be established.

(3) Provide terrain analysis leading to information on routes, going, approaches and the obstacle itself. Engineer reconnaissance must be well forward in order to provide this information promptly.

c. **Bypassing**. Bypassing an obstacle is often more expeditious, even if forces have to travel greater distances. On the other hand, bypassing may comply with the intentions of the enemy. If obstacles cannot be bypassed, it may be useful to overcome them in places where the enemy might least expect it. This, combined with an effective deception plan, will help to achieve surprise.

d. **Tactical Factors**

(1) The movement of troops and equipment across the obstacle and their deployment on the far side must be strictly controlled to maintain momentum, avoid congestion, provide flexibility and establish sufficient force to defeat any enemy counter-action. There is a requirement for multiple crossing sites providing:

(a) concealment from enemy observation and fire,

(b) good approaches for both tracked and wheel vehicles, and

(c) suitable ground for deployment of direct fire support on the friendly side and for bridgehead defences on the enemy side.

(2) Maintenance of momentum is an essential part of any crossing. It requires a balanced combination of speed, a flexible crossing plan and rapid exploitation.

(3) If the obstacle is defended, successful crossing or breaching must be preceded by the suppression of enemy fire, obscuration of the enemy or masking of friendly movement, and securing of the breach or crossing site by either fire or force as necessary. Adequate fire support and air defence cover are therefore crucial factors..

(4) Terrain information must include space for waiting areas, hides, air defence assets, good approach routes, lateral routes and for a sufficiently large bridgehead on the far side that can be defended and used as a base to launch break-out forces with minimum delay.

(5) Crossing operations rapidly absorb combat power and in the initial stages, split the formation over either side of the obstacle. This makes the creation and employment of a tactical reserve particularly difficult. Attack helicopters,

if available, may offer the best option for a flexible and responsive reserve.

(6) Commanders must be aware of the vulnerability of such operations to nuclear and chemical attack.

e. **Technical Factors**. Equipment characteristics and availability will dominate engineer planning. The number of crossing sites will be determined by the crossing rate set by the commander. Fewer sites will allow the concentration of engineer resources and the retention of reserves against equipment casualties or failure. The suitability of individual sites will be based on such factors as:

(1) access for oversize vehicles and heavy equipment,

(2) obstacle width, particularly for bridging or explosive breaching,

(3) river bank characteristics, bed profile and current,

(4) trafficability and soil conditions for mine ploughs or possibilities for hand breaching.

f. **Surprise**. Surprise must always be considered from the outset in any obstacle crossing operation. The main decisions arising from this are likely to be:

(1) **Timing**. A daylight operation is likely to be possible for a hasty crossing, or in very close country with air superiority. A deliberate crossing will ideally be mounted at night or in poor visibility. Limited visibility creates favourable conditions for overcoming obstacles

while impeding observed enemy fire. The protective effect of limited visibility may, however, be reduced by modern surveillance and fire control systems.

(2) **Noisy or Silent**. A noisy crossing may be possible provided there is sufficient fire support and the commander is confident that the crossing can be achieved too quickly for the enemy to react effectively. A more usual compromise is to keep the crossing silent until either surprise is lost or a predetermined moment such as the firing of explosive breaching equipment.

(3) **Deception**. A deception plan should always be prepared to draw enemy reserves to the wrong place, or at least to delay and confuse his reaction to the actual crossing. Deception costs combat power, however, and it is very much a command decision as to how much and when. Deception for a divisional crossing will be co-ordinated at corps level. The scope for local, tactical deception will depend on the quality of the enemy's surveillance and intelligence efforts. Electronic warfare may have an important role here. The following deception measures might be employed:

(a) Moving crossing equipment (such as amphibious engineer’s) up by day through a flanking formation, and switch it laterally by night;

(b) reconnaissance of other crossing sites,

(c) simulation of crossings away from the actual crossing site,

(d) routing of support services and engineer traffic via deception routes by day; and

(e) use of a deception fire plan.

CONDUCT OF WATER CROSSING OPERATIONS

7. **General**. Water crossing operations are an integral part of maintaining momentum on the battlefield. Crossings are frequently established on lines of communications where traffic such as resupply, reinforcement, casualty evacuation and vehicle back loading occurs. Water crossings are complex operations in which a clear command and control structure is essential. All crossings rely heavily on movement control and engineer support.

STAGES OF A DELIBERATE WATER CROSSING

8. Deliberate offensive water crossings are conducted in five overlapping stages as follows.

a. **Approach to the Obstacle Stage**. The approach of the bridgehead force to the water obstacle. A passage of lines through the force in place may be necessary.

b. **Assault Stage**. Depending on the rate of build-up required and the risk of possible loss of engineer equipment that the commander is willing to assume, it may be necessary to begin the construction of ferries and bridges during the assault stage. The aim of the assault is to gain a lodgement on the far side of the obstacle to eliminate enemy direct fire and observation of the crossing site. This lodgement is achieved either by:

(1) infiltration under water, on the ground or from the air,

(2) boat, swimming, fording or snorkelling, or

(3) a combination of these techniques.

c. **Build-up Stage**. The build-up stage is intended to extend the lodgement into a bridgehead.

d. **Consolidation Stage**. The consolidation stage is an extension of the build-up stage to establish a firm base within the bridgehead from which to break-out. Enemy pockets of resistance are eliminated and the break-out force is moved across the obstacle. Crossing sites are improved and preparations are made for the break-out and continuation of the overall operation, which must be resumed as quickly as possible.

e. **Break-out Stage**. The break-out is the aim of the breach or crossing operation and it must remain as the commander's main objective to maintain momentum of the force.

9. The relationship between the commanders of the various forces must be well understood. There are three main forces involved:

a. **Bridgehead Force**. The bridgehead force consists of an assault echelon and a main body. Its mission is to control ground in order to permit the continuous embarkation, landing or crossing of troops and matériel. It will also provide the manoeuvre space needed for subsequent operations. Within its area, the bridgehead force has normal responsibility for security, including the defence of the far bank. The assault echelon is tasked to gain the lodgement, normally by seizing intermediate objectives. This prevents enemy ground observation and fire on to the crossing sites, so that crossing sites and equipment can be prepared and operated to bring the main body and break-out force to the far side with minimum interference. The main body of the bridgehead force conducts the build-up, including the seizure of the objectives on the bridgehead line, and consolidation. Engineers supporting the bridgehead forces will be grouped with the assault echelon and main body and tasked to provide close engineer support from the far bank to the bridgehead line.

b. **Break-out Force**. The break-out force is tasked with the continuation of the overall operation. The force will conform to the bridgehead force regarding use of ground in the bridgehead. In some circumstances, the break-out may be an additional task of the bridgehead force. The planning and preparation requirements for the break-out force are similar to those undertaken by any advancing force. The force will cross the obstacle into assembly areas and eventually break-out of the bridgehead in accordance with the commander's concept of operations. Engineers supporting the break-out are normally dedicated to that task and are not employed for other stages of the crossing.

c. **Force in place**. When a formation is already in place along the obstacle, it can be called upon to assist the bridgehead force during the crossing. In some circumstances the bridgehead force and the force in place will be the same organisation. The force in place provides fire and other support to the bridgehead force during the crossing. Within its area, it has normal responsibilities for security, including defence of the obstacle and the home bank. A forward passage of lines will be required as the bridgehead and break-out forces pass through the force in place. Engineers from the force in place with augmentation from other engineers and engineer specialists will normally be tasked to operate crossing sites to include the operation of assault boats, preparation of crossing sites, swim sites, fording sites and the construction of bridges and ferries.

10. Forces and Tasks

a. **Artillery**. Artillery and mortars should be positioned so that they can provide continuous support during all stages of a crossing. The primary task of both these weapons is to provide supporting fire to troops in the bridgehead. They should also be used to mask enemy observation of the crossing sites and to provide counterbattery fire. Deception fire can also be used to draw the enemy's attention away from the actual crossing sites.

b. **Air**. Air superiority is an important factor in crossing operations. As it may be possible to achieve only local air superiority for a limited period only, the time and location of the crossing must be carefully co-ordinated with air support.

c. **Aviation**. Attack helicopter forces should be employed on the approach to the obstacle during the assault stage and to block enemy forces attacking the crossing sites. In addition, transport helicopters can be used to conduct hasty crossings if the tactical situation permits.

d. **Air defence**. Forces conducting a crossing present a particularly vulnerable target to the enemy. Although each force is responsible for its own air defence, the overall commander has a responsibility to ensure that arrangements are made to provide adequate protection for the crossing sites and the routes to them.

e. **Electronic Warfare**. Electronic warfare support will be based initially on passive measures to aid intelligence gathering. Electronic deception and jamming may be used to support the crossing.

UNFOLDING EVENTS

11. The assault echelon crosses the line of departure, which is normally the near bank water line, at H hour, and proceeds across the obstacle. If required, fire and other support is provided by elements of the force in place on the home bank through which a passage of lines will have been completed. Normally this support includes direct and indirect fire support and the protection of crossing sites from air attack and attacks along the obstacle by divers, vessels, mines or drifting objects. The assault echelon could exploit to the bridgehead line if enemy resistance crumbles.

12. Once the assault echelon is across the obstacle and on its intermediate objectives, the commander may order the crossing area into effect. Engineers complete their preparation of crossing sites, while movement control elements complete their deployment and control the move of the bridgehead force's main body across the obstacle, in accordance with the crossing plan.

13. The crossing area organisation must be flexible, as, once the enemy detects a crossing site, it becomes extremely vulnerable. Equipment, such as bridging, may have to be dispersed at short notice and alternate means and sites may have to be used. In some cases, it may be necessary to split a bridge into rafts or, alternatively, use smoke to obscure the site.

14. Once across the obstacle, the lead elements of the main body pass through or around the assault echelon and carry on to secure the final objectives in the bridgehead. Once they have been secured, the bridgehead is established.

CROSSING AREA LAYOUT

15. The crossing area layout, as outlined in Figure 32, identifies graphically the generic location of all the essential components required in a water crossing operation. The precise arrangement will depend on many factors and it must remain flexible and at the discretion of the responsible commanders at the time of the operation.

COMMAND AND CONTROL RESPONSIBILITIES

16. The need for a clear command organisation, which plans and executes a complete but simple crossing plan, is paramount in all water crossing operations in order to support the crossing flow and to avoid losses caused by enemy activities.

17. In a crossing operation, the movement of bridging equipment, troops, tracked and wheeled vehicles and their passage through assembly areas and, if necessary, waiting areas, over the obstacle, and their movements on the far side, must be strictly controlled. The controlling headquarters must provide a flexible organisation and make best use of the resources available to react to any changes in the crossing flow and the tactical situation. To facilitate the command and control of crossing operations the following control measures must be established.

a. **Assembly Areas**. An area (or areas) in which a command is assembled preparatory to further action. In a water crossing operation, it may be used as a waiting area where any final regrouping of friendly forces takes place. It also may be established on the far side of the obstacle to regroup and facilitate the onward movement of friendly forces.

b. **Waiting Areas** (Formerly called Buffer Area, Cushion Area, Dispersal Area, Holding Area or Staging Area). A location (or locations) adjacent to the route or axis, which may be used for the concealment of vehicles, troops and equipment while an element, is waiting to resume movement . Waiting areas are normally located on both banks close to the crossing sites.

c. **Crossing Area**. A number of adjacent crossing sites under the control of one commander. In water crossing operations, it may be situated on both sides of the obstacle or one side only, and be bounded by phase lines. This area is kept free of forces, installations and equipment not necessary for the conduct of the crossing or for the defence of the crossing sites. In this area, the engineer commander exercises his technical engineer responsibility.

d. **Crossing Site**. The location of a single bridge or raft site, or in an initial assault, a site for the crossing of assault boats or for the swimming or fording of vehicles on a broad front.

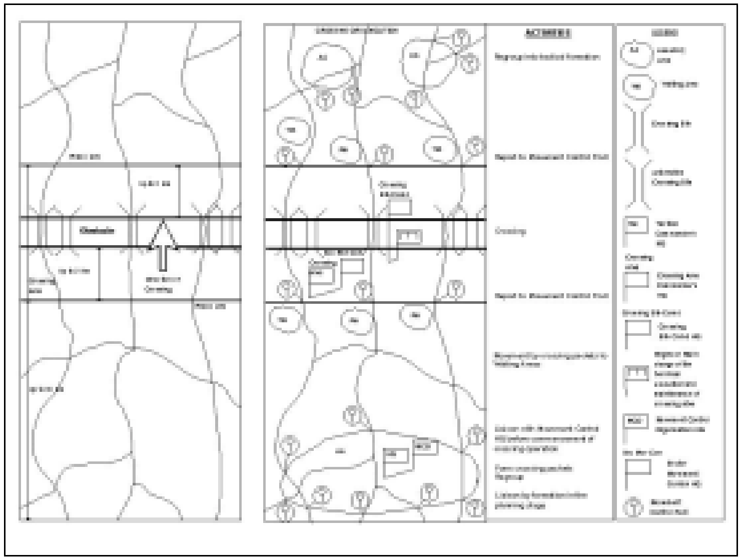


Figure 32: Crossing Layout

18. The basic requirements for control are:

a. a simple crossing plan,

b. a crossing control organisation,

c. a movement control organisation, and

d. a command and control communication network.

19. Orders should state:

a. the crossing plan,

b. the command structure,

c. who authorises the start of site preparations and crossings; and

d. the priorities for moving forces.

COMMAND AND CONTROL ARRANGEMENTS AND RESPONSIBILITIES

20. A clear command structure is established to ensure the success of a deliberate offensive water crossing operation. The commander who orders the crossing is the overall commander. In any water crossing operation, it is normal to have three elements providing control over the crossing. These three elements with their functions are:

a. **Controlling Headquarters**. The commander has the overall responsibility for command and control of the crossing operation and will issue the crossing plan. The commander may select, determine and allocate:

(1) crossing areas,

(2) crossing sites,

(3) assembly and waiting areas, and

(4) deployment routes.

b. The commander may also issue special instructions for crossing times and, if necessary, the organisation of convoys.

c. The commander exercises command and control through his headquarters. For a major crossing he may form a special controlling headquarters, at which the following staff elements will be represented: operations/security, movement control and engineers. It also may be necessary to have the following staff represented: combat service support, communications, electronic warfare and liaison elements from crossing formations/units. If due to tactical circumstances the headquarters is too far from the water obstacle, a small headquarters (Forward Command Post) may be set up close to the river to exercise greater control.

d. **Crossing Area Headquarters**. The commander must decide who is best suited as the Crossing Area Headquarters at the time depending on the tactical situation. The bridgehead force or the force in place may be used as the Crossing Area Headquarters. Once the crossing is no longer of immediate tactical concern, the Engineer Group or the Engineer Support Regiment can become the Crossing Area Headquarters. When the crossing is no longer an engineer technical problem, co-ordination of the crossing rests with the Movement Control Organisation. The following elements will be represented in the Crossing Area Headquarters: engineers, movement control, security and combat service support elements (medical and recovery). The functions of the Crossing Area Headquarters are:

(1) **Security**. Routes, waiting areas, near bank, attack positions and line of departure must be secured, as must be the objectives on the far bank once crossed;

(2) **Movement Control**. In order to maintain momentum, avoid congestion and provide flexibility, movement of troops and equipment must be strictly controlled;

(3) **Terrain Control**. Centralised terrain control is essential in order to co-ordinate the heavy demand for terrain near the obstacle; and

(4) **Crossing Support**. Specialised engineer crossing support may include the operation of assault boats, swim sites and the construction of bridges and ferries. Recovery, medical and logistic support will also be required. Other support may include electronic warfare assets deployed to deceive the enemy from the intended crossing site.

e. Subordinate to the Crossing Area Headquarters will be crossing site commanders:

(1) **Crossing Site Commander**. Each crossing site will have a Crossing Site Commander. If there are many crossing sites, the Crossing Area Commander may create sectors to reduce the span of control. The Crossing Site Commander is normally an engineer appointed by the appropriate level of command with the following responsibilities:

(a) development and maintenance of the crossing site including entrances and exits;

(b) construction, operation and maintenance of the means of crossing;

(c) movement across the water at his crossing site including the giving of orders to troops during the crossing;

(d) advice to the Waiting Area Controller on movement to his crossing site; and

(e) all technical aspects of maintaining the uninterrupted operation of his crossing site.

f. **Movement Control Organisation Headquarters**. During deliberate water crossing operations, a Movement Control Organisation is required to ensure the co-ordinated and effective movement to and from crossing sites. The Movement Control Organisation is likely to be formed by the formation's reconnaissance and military police units. Planning and control of movement across the water obstacles is the responsibility of the commander of the crossing operation. The Movement Control Organisation Commander exercises command through a Movement Control Organisation Headquarters, Sector Movement Control Headquarters and Movement Control Posts. To facilitate co-ordination, the Movement Control Organisation is normally collocated with the Controlling Headquarters. A Sector Movement Control Headquarters is normally collocated with the headquarters of each formation involved in the crossing operation. Assembly Area Controllers and Waiting Area Controllers further assist the Movement Control Organisation to co-ordinate movement within the crossing area. The responsibilities of the Movement Control Organisation are:

(1) advising the commander on all aspects of movement/traffic control,

(2) establishing a movement control communications network, and

(3) contributing to the crossing plan by:

(a) provision of axial routes and diversions,

(b) provision of route signing and guides,

(c) calculation and maintenance of time and distance factors, traffic flow and traffic density,

(d) dispersal and formation of columns

(e) establishment and manning of assembly and waiting areas, and

(f) provision of specific engineer routes, if possible.

(4) **Assembly Area Controller**. The Assembly Area Controller, in close co-ordination with the Crossing Site Commanders and the Waiting Area Controllers, is responsible for the implementation of the following aspects of the crossing plan:

(a) organising the assembly area,

(b) manning the area,

(c) establishing Movement Control Posts at the entrances to and exit from the area,

(d) controlling other movement control personnel in charge of movement within the area,

(e) dispatching packets, and

(f) giving priority over all other traffic to engineer vehicles required at the crossing sites.

(5) The Assembly Area Controller will be assisted in this task by:

(a) engineer personnel as required and available,

(b) liaison personnel for the crossing formation/unit, and

(c) repair and recovery elements.

(6) **Waiting Area Controller**. The Waiting Area Controller normally is the Commander of the Movement Control Post at a waiting area and is, in conjunction with the Assembly Area Controller and Crossing Site Commander, responsible for:

(a) the organisation of and procedures within the area; and

(b) holding and dispersing vehicles in case of traffic congestion at the crossing site until it has been cleared.

(7) **Movement Control Posts**. The distribution of Movement Control Posts must clearly enable the commander to monitor continuously the traffic flow and to react quickly to any disruption by reallocating roads and/or crossing sites. Movement Control Posts along the near bank provide liaison with the Crossing Site Commander.

g. **Liaison**. There is a constant requirement for the commander, the crossing area commander, the engineer commander, and the crossing site commanders to keep each other informed on the latest plan, the organisation and the procedures for crossing the obstacle. This allows the crossing area commander and the crossing site commanders to operate away from each other in times of reduced communications or changes in the situation or threat.

ENGINEER COMMAND AND CONTROL

21. **Engineer Responsibilities**. Engineer commanders are responsible at their respective levels of command for:

a. Giving advice on all engineer matters;

b. ensuring there is an adequate communications network for engineers involved in the operation;

c. assigning engineer units (which may include assigning commanders of crossing sites);

d. Contributing to the crossing plan by advising, if required, on the following points:

(1) selection of crossing sites, alternatives crossing sites and approaches to both,

(2) allocation of engineer resources to sites,

(3) recommendation of waiting areas adjacent to or within a crossing area,

(4) determination of the limits of the crossing area,

(5) identification of the security and protection requirements at the crossing site,

(6) establishment and control of water safety procedures, and

(7) determination and maintenance of the crossing means' capabilities.

22. To ensure that vehicles crossing the water obstacle are within the capabilities of the crossing means, engineer personnel, if available, are located in selected waiting areas or Movement Control Posts. They conduct technical checks and assist the movement control personnel to make up and dispatch vehicle packets and convoys to appropriate crossing sites.

23. Figure 33 outlines the organisation for a division water crossing.

CROSSING FORMATIONS/UNITS

24. When a force is required to conduct a move which is controlled and supported by another authority, it is mandatory for this force to liase as early as possible at its respective level of command within that authority. Liaison is a standard operating procedure at all levels. The purpose of this liaison is to exchange relevant documents and to be briefed on:

a. movement Control Organisation,

b. organisation and procedures of the water crossing,

c. reporting details for the move and for the water crossing, and

d. convoy composition.

25. The relevant information from this briefing should be passed to all personnel exercising command of convoys and all drivers. They must obey the instructions of the Crossing Area Headquarters and the Movement Control Organisation.

26. When entering an assembly area or (if necessary) a waiting area, each convoy commander or his representative and drivers of isolated vehicles are to report to the first Movement Control Post indicated by the prescribed signs. The Movement Control Post will be given the required information concerning formation/unit, number of vehicles, military load classification etc., and issue the necessary orders and instructions.

SUPPORT SERVICES

27. **Medical**. The movement control plan must include medical arrangements, particularly for the evacuation of casualties. Medical facilities with casualty evacuation assets should be established each side of the obstacle and there may also be a need to deploy a medical holding facility on the far bank. Helicopters are particularly useful for casualty evacuation in this situation. Returning boats and ferries may also be used for the evacuation of casualties.

28. **Repair and Recovery**. The following provisions should be made in the crossing plan.

a. Recovery facilities to ensure all routes, and particularly ramps and approaches to the crossing sites are kept open. Clearing routes and crossing sites of immobilised vehicles has priority over repair activities.

b. A repair and recovery capability at selected assembly/waiting areas. The associated Movement Control Post will co-ordinate their activity.

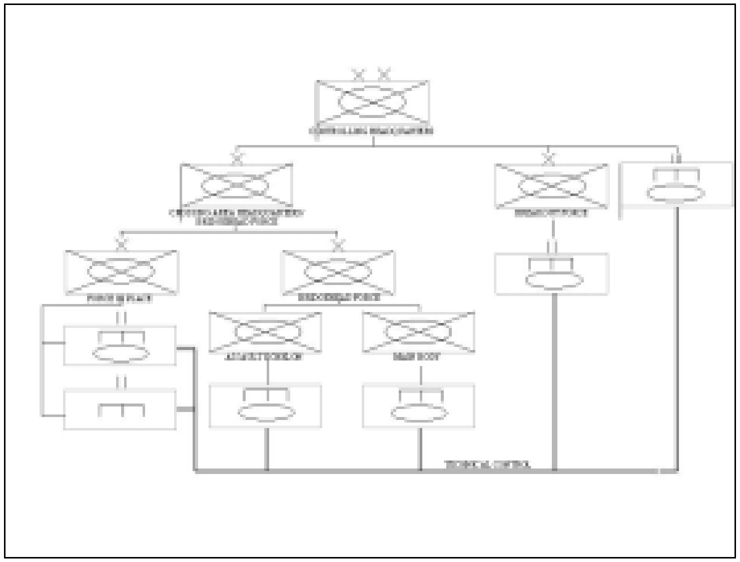


Figure 33: Crossing Organisation

c. Recovery facilities must be available at each crossing site.

29. **Supply**. The responsibility for supply remains with the crossing formations.

COMMUNICATIONS

30. No water crossing operation can be carried out smoothly without an adequate communications network. Three separate networks that are necessary are the command, movement control and engineer command nets. They should be based on existing unit and formation communications and have the following purpose:

a. **Command Net**

(1) To support the overall commander.

(2) To connect with:

(a) the Movement Control Organisation if separated from the Controlling Headquarters,

(b) the engineer commander,

(c) the force in place,

(d) the crossing formations/units, and

(e) the controlling headquarters and/or Forward Command Posts if deployed.

b. **Movement Control Net**

(1) To co-ordinate all movement control activities in the operational area.

(2) To link all movement control agencies down to Movement Control Posts.

c. **Engineer Net**. To co-ordinate engineer activities.

31. In addition to an adequate communications network, liaison officers may be employed to facilitate command, movement control and engineer liaison.

WATER CROSSING PLAN

32. The crossing plan should include the following items:

a. Current operational and tactical situation and concept,

b. commander's intention, special directives and arrangements for security, movement control, terrain control and crossing support,

c. designation of crossing sites, alternate crossing sites and routes leading to and from them (including special engineer routes, if possible),

d. grouping and tasks for engineers,

e. crossing schedule that provides a timetable for the crossing as well as:

    (1) movement credits per unit, if existing, and

    (2) priorities for the crossing. An example of a crossing priority table is at Figure 34,

f. movement/traffic control plan to include routes to and from the obstacle, axial and lateral routes, movement control posts and assembly/waiting areas,

g. alternative arrangements for ferrying and bridging,

h. limitations such as the capacity, speed and military load classification,

i. nicknames or other identification symbols for each crossing site,

j. support services measures including medical, repair and recovery and supply issues,

k. communications and liaison information, and

l. defence of the crossing sites.

	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Ser	**Pri**	**Unit**	**#of veh/mov credit**	**Route**	**Sector/ Crossing Site**	**Planned Crossing Time**	**Time req. for packet to cross obstacle**
1.							
2.							
3.							
4.							

Figure 34: Crossing Priority Table

PLANNING FOR DELIBERATE CROSSINGS IN OFFENSIVE OPERATIONS

The Germans refer to the operation of the crossing of the Upper Rhine near Colmar on 15 June 1940 as the breaking of the Maginot Line. However, as far as fortifications are concerned, the main Maginot Line extended only along that part of the French-German border not protected by the Rhine River. South of the main portion of the Maginot line the French fortifications were less formidable. Along the river bank there was a line of concrete emplacements, designed chiefly for the purpose of holding the river itself under interlocking bands of machine gun fire. These emplacements were tied into a system of field fortifications, the latter including trenches to be manned by riflemen.

The Rhine River near Colmar is about 250 yards wide, and has a current in excess of 12 feet per second. The terrain between the Rhine and the mountains is flat, and is wooded to an extent. Certainly few will question the French conclusion that the Rhine near Colmar was such a formidable *obstacle as to justify the weaker fortifications behind it.*

An accurate estimate of the forces opposing the Germans near Colmar is uncertain. It is certain that a large portion of the French reserves had been drawn off to the northern fronts before the attack on June 15. The regular troops apparently were occupying the fortifications and other positions in normal strength; but it may be assumed that their morale, which never was really high, was scraping bottom by the time the attack came.

The time for the jump-off for the attack was set for 10:00 A.M., June 15. Here we see, right from the start, a break with Field Service Regulations, which would have such an attack begin at no other time than dawn. The reasons for the selection of mid-morning as a jump-off time are not completely clear, but probably it was a means of securing surprise. The decision as to time of attack must have been based on careful observation of the habits of the defenders. It seems that the French were highly alert during the night and up through dawn; but, they were accustomed to taking things easy during the remainder of the day. The Germans must have decided to capitalize on the state of affairs (as a matter of fact, the first wave of assault troops caught some of the defenders just getting out of bed, whence they had gone to pick up a little extra rest after breakfast).

The night of June 14-15 was dark and rainy. Working under difficult conditions, the Engineers spent the night cutting and marking paths down to the crossing points. As the companies arrived, the troops were assigned to crossing points and waves, and were guided by the Engineers to the proper areas. While the preparations were in progress the "storm boats" which were to be used for the *crossing of the initial waves were being moved forward toward the crossing points. The crew of the storm boat consisted of a single Engineer soldier.*

The crossing operation itself was to proceed about as follows: each assault combat team (company of infantry, half -company of Engineers, attached machine guns) was to be set across the river in storm boats, the latter being operated by personnel of the storm boat company. The Engineers with the assault companies thus were not to figure in the actual ferrying of the initial wave. Rather, they were to constitute a part of the initial waves themselves.

At exactly 10:00 A.M. (June 15) the German artillery opened up. At 10:10 A.M. the preparatory fire lifted and the storm boats were pushed into the water. By this time, the rain had subsided and visibility over the river was fair. The Germans continued to deliver covering fire from their own emplacements across the river. The French in their forward positions had been taken completely by surprise; and they apparently had been stunned by the terrific 10-minute preparatory bombardment. Due to this bombardment, most of the French emplacements had been put out of action. Since machine gun fire from these emplacements must have been the key factor in the close-in defense of the river, the significance of that bombardment is obvious.

Although no wall of machine gun fire such as the French must have planned met the German assault waves on the river, still the attackers suffered serious losses. Most of these resulted from fire coming either from sharpshooters in the trees or from riflemen in field positions. There is a note to the effect that the point blank preparatory fire which had been so effective against the emplacements was much less effective against the

> *sandbagged field positions. In any event, soon more that one-half of the storm boats had been put out of action, some of them because of motor failure.*
>
> *Immediately after reaching the far bank, the Germans proceeded to complete the reduction of the forward French line of emplacements. In this operation, the resistance of the enemy was broken by the co-ordinated attack of infantry and Engineers. Thus we have the picture of Engineers having been included in a small combat team, not for the purposes of the crossing itself, but for the subsequent assault on enemy fortifications.*
>
> Engineers in Battle
> Lieutenant-Colonel Paul Thompson

33. **Planning**. Planning for a deliberate water crossing is similar to that for an attack. However, a number of additional factors are considered because of the obstacle. The commander will determine the composition of forces needed to conduct operations on the far side of the obstacle after break-out. This will dictate his movement plan, which, in turn, will determine the required crossing rate. The engineer commander will advise on the feasibility of attaining this rate and will assist in developing the crossing plan accordingly. The commander must weigh risk versus payoff (build-up) when formulating his plan and making his decision.

34. In addition to determining the composition of forces and their missions, the commander normally will assign responsibility for the critical functions to the bridgehead force described below. These functions will then be executed within each sector. Although much of the detailed planning and co-ordination can be done by the bridgehead force, command, and therefore final responsibility for the operation, will always remain centralised with the commander.

35. The commander must give specific direction to his staff and his engineer adviser. The main decisions and factors for consideration are listed in Figure 35.

Serial	Decision	Criteria/Factors
(a)	(b)	(c)
1.	Size and composition of the break-out force.	Based on the concept of operation following the crossing.
2.	Bridgehead line.	1. Includes bridgehead objectives that are defensible and dominate enemy approaches to the crossing area. 2. Must provide space for manoeuvre and assembly of break-out and bridgehead forces. 3. Allows the break-out force commander a choice as to the point and direction of the break-out.
3.	Size, composition and priority of crossing of the bridgehead force.	Sufficient to seize and hold bridgehead objectives.
4.	Time by which bridgehead must be secure.	Based on mission assigned to the commander and anticipated enemy countermoves.
5.	Time to begin bridging operations.	1. Based on the desired rate of force build-up. 2. The risk of losing engineer resources through early COMMITMENT must be weighed against the impact of delaying the build-up. 3. It may be prudent to interrupt bridge traffic during daylight hours in favour of ferrying operations.
6.	Intermediate objectives.	1. Must protect the crossing sites from enemy direct or observed indirect fire. 2. Must control the enemy approaches to the crossing sites. 3. Must be defensible.

Serial	Decision	Criteria/Factors
(a)	**(b)**	**(c)**
7.	Size and composition of the assault echelon.	Must be able to seize and hold intermediate objectives.
8.	Time by which intermediate objectives must be secure.	Based on the time by which the bridgehead must be secure and the time allocated for build-up and consolidation.
9.	Selection of the crossing sites.	1. Includes a suitable number of crossing sites to achieve the desired crossing rate (with alternatives), dispersed to reduce vulnerability and provide flexibility. 2. Cover from observation. 3. Routes to and from crossing sites which have required military load class and capacity as well as locations for waiting areas. 4. Covered lateral routes on both the near and far side of the obstacle.
10.	Time to begin ferrying operations.	1. Based on the vehicle support requirements for the bridgehead force and availability of ferrying resources. 2. The risk of losing engineer specialist equipment, through premature commitment must be weighed against the impact of not having sufficient heavy direct fire support with the assault echelon.

Figure 35: Planning Factors and Command Decisions

36. **Critical Functions**. There are numerous critical functions:

a. **Security**. The routes, assembly and waiting areas, home bank, attack positions and line of departure must be secure. As the crossing moves into the build-up stage, the bridgehead objectives on the far side must be secure to permit consolidation and provide a secure line of departure of the break-out force.

b. **Movement Control**. In order to maintain momentum, flexibility and avoid congestion, movement of troops and equipment must be strictly controlled.

c. **Terrain Control**. Centralised terrain control is essential in order to co-ordinate the heavy demand for terrain near the obstacle.

d. **Crossing Support**. Specialised engineer crossing support may include the operation of assault boats, swim sites as well as the construction of ferries and bridges. Recovery, medical and resupply support must also be co-ordinated.

e. **Crossing Area**. The commander will order a crossing area only if the tactical situation or the nature of the obstacle requires it. The establishing of a crossing area allows the commander the flexibility to switch traffic from one crossing site to another, and prevents a build-up of friendly forces near the obstacle. It also gives the engineers the freedom to shift equipment from one site to another. The depth of the crossing area is normally not very great and will depend on the size of the obstacle and the terrain. Its near and far boundaries should be positioned within the closest lateral routes approximately 3 kilometres from the water or on easily recognisable terrain features which run parallel to the obstacle. An entry line will be established as a control measure to show where control of movement and terrain is delegated to the crossing area headquarters.

f. **Crossing Sites**. Crossings should be conducted on as broad a front as possible, with multiple crossing sites. Areas selected for crossing should have the following features, either naturally or through engineer development.

(1) A suitable number of crossing sites, with alternates, which are dispersed to reduce vulnerability and to provide flexibility. The number of crossing sites established is normally twice that required by the desired crossing rate. This is necessary, as time does not usually allow other sites to be started should the initial ones fail. In addition, the threat may dictate the need to move to another site.

(2) Cover from observation.

(3) Routes to and from crossing sites, to include lateral routes, which have the required load classification and capacity.

(4) Waiting areas.

(5) Sufficient space for the establishment of a bridgehead.

(6) Locations for elements providing support by direct fire and observed indirect fire.

(7) Assembly areas which are located some distance from the obstacle where forces wait to move to the crossing site and proceed to once the force has crossed the obstacle to clear the crossing area of congestion. The assembly areas must be dispersed, have good routes to the crossing sites, and have good cover and concealment.

g. **Bridgehead**. A bridgehead should have the following characteristics:

(1) Defensible terrain of sufficient extent that the enemy cannot seriously interfere with the crossing;

(2) sufficient crossing and movement facilities to avoid congestion; and

(3) a base for the continuation of the overall operation.

37. **Engineer Responsibilities**. Engineer support will be required for nearly all crossings and is therefore vital. The task of the engineers is to enable the bridgehead force to cross the obstacle. In order to ensure the minimum loss of momentum, engineer reconnaissance assets will need to be attached to the leading elements of the formation and bridging resources should be placed in the order of march such that they can be made available as quickly as possible. As a secondary task, engineers may be required to prepare obstacles to protect the flanks of the crossing force.

a. **Engineer Commander**. Each level of command in a water crossing operation will have an engineer who is responsible for the technical aspects of executing the crossing. This includes:

(1) Giving advice on all engineer matters, such as the selection of crossing sites, the allocation of engineer forces and equipment, the selection of waiting areas adjacent to crossing sites and water safety;

(2) Ensuring that there is an adequate communications network for engineers involved in the operation; and

(3) Assigning crossing site commanders.

b. **Crossing Site Commanders**. Each crossing site will have a commander who is normally an engineer. He will have the following responsibilities to:

(1) develop and maintain the crossing site, including entrances and exits;

(2) construct, operate and maintain the means of crossing;

(3) control movement across the water at his crossing site, including giving orders to troops during the crossing;

(4) inform the waiting area controller on movement to his crossing site; and

(5) monitor all technical aspects of his crossing site and crossing equipment.

c. **Waiting Areas/Movement Control Points**. To ensure that vehicles crossing the obstacle are within the capability of the crossing means, engineer personnel are located in selected waiting areas or movement control posts. They conduct technical checks and assist the movement control personnel to make up and dispatch vehicle packets and convoys to appropriate crossing sites.

d. **Assault Stage**. In support of the bridgehead force during the assault stage, the engineer responsibilities include:

(1) Reconnaissance of the obstacle for boat, ford, snorkel, swim or ferry sites including associated assembly areas, routes and waiting areas;

(2) determination of ferry and bridge support requirements for the bridgehead force;

(3) co-ordination of crossing sites with the assault echelon forces;

(4) manning of boats, boat off-loading points and boat inflation points;

(5) support to swimming, fording or snorkelling operations including clearance and maintenance of the far bank exits;

(6) breaching of any obstacles on the far bank water line which hinder the landing of assault boats or vehicles;

(7) provision of water safety organisation; and

(8) deployment with the assault echelon to provide engineer support in seizing the lodgement.

e. **Build-up and Consolidation Stage**. In support of the bridgehead force during the build-up and consolidation stages, the engineer responsibilities include:

(1) Continuation or closing out of ford, snorkel and swim sites,

(2) preparation, operation and maintenance of ferry, and/or bridge sites,

(3) continued operation of water safety organisation; and

(4) support to the bridgehead force in establishing the bridgehead line by:

(a) breaching obstacles,

(b) assisting with field protection,

(c) obstacle emplacement for flank protection, and

(d) route maintenance.

f. **Break-out**. The break-out is the continuation of the operation.

38. Engineer Planning Calculations

It is an old saying that the speed of erection of a bridge depends more on the preparation of the approaches than of the time taken to erect the bridge itself. For this reason, wherever possible the site chosen is that of the demolished bridge with the existing roads leading up to it. There are, however, certain difficulties in this, the debris of the old bridge may have to be cleared, and the enemy will have taken every step to prevent a rapid use of the site by cratering the approaches and sowing the debris freely with mines. To deal with the first, generally in the form of twisted steelwork, oxy-acetylene cutters were provided. To fill in craters or prepare approaches to a new site, mechanical equipment, used for the first time in quantity in this war, proved an invaluable time and labour saver. This equipment, including as it does powerful tractors, was also of great use in hauling heavy weights into position. Finally the novel mine menace demanded the use of detectors, but even so frequently caused considerable delay to the work.

Military Engineering (Field)
The War Office 1952

a. **General**. The formation conducting the crossing develops the tactical plans that they will execute. The actual planning process for a crossing is the same for any tactical operation. Differences occur primarily because of the complexity of crossing a waterway (which makes extensive calculations necessary) and the need to balance tactics with crossing rates. Crossing calculations are completed to ensure that force build up supports the tactical plan. Therefore, the crossing plan is developed, and the resources identified, by working backward from the build-up required in a given amount of time across the obstacle. Factors that will affect crossing rates and therefore the tactical plan are:

(1) assets available (e.g. length of floating bridge and number of ferries);

(2) level of risk that the commander is willing to accept and hence the earliest time bridging and ferrying preparations can start.

b. **Planning Calculations**. Initial engineer planning will focus on providing sufficient engineer assets to handle the crossing requirements. From terrain analysis, potential crossing sites and water widths will be provided. The engineer commander uses this information to develop a crossing overlay depicting assault, swim, snorkel, ferry and bridge sites with their estimated preparation time and capacity to move vehicles and equipment across per hour. Preparation time is the time required to improve routes and river banks to support the units crossing plus the time required to construct rafts and bridges. The overlay provides the necessary detail to determine if the formation can achieve the commander’s desired rate of build-up. If the commander's required build-up cannot be met then several options are available as follows:

(1) Start swimming, bridging and ferrying operations sooner, subject to the tactical

situation and level of risk the commander is willing to accept;

(2) obtain additional resources; or

(3) modify the tactical plan.

39. In conjunction with a crossing overlay, a vehicle crossing flow chart, Annex A, is constructed to provide a graphic display of the crossing rate. Some generic planning data is provided in Figure 36 and as follows:

a. An assault company requires 30 assault boats; and

b. a floating bridge can cross 200-300 vehicles per hour with 30m spacing at a speed of 16 km/hr.

Boat/Raft Planning Factors (daytime)			
Characteristics	**Waterway Width (1.5m/sec current velocity)**		
	75 meters	**150 meters**	**300 meters**
Min per round trip	3	4	5
Trips per hour	20	15	12
Min per round trip	4	6	10
Trips per hour	15	10	6
Min per round trip	7	10	16
Trips per hour	8	6	3
Rafts at each site	1	2	3

Boat/Raft Planning Factors (daytime)			
Characteristics	**Waterway Width (1.5m/sec current velocity)**		
	75 meters	**150 meters**	**300 meters**
Notes: 1. Factors are average based on load/unload time; 2. Planning times are for velocities up to 1.5 m/sec. For faster velocities, an assessment must be made of actual site conditions before planning times may be assessed.			

Figure 36: Boat/Raft Planning Factors

SPECIAL CHARACTERISTICS IN DEFENSIVE OR DELAYING OPERATIONS

40. The purpose of water crossing in defensive or delay operations is to cross the water obstacle while preserving the integrity of the force. Crossing in defensive and delaying operations are conducted in concert with the following overlapping stages:

a. **Relief**. The maximum use of existing crossing infrastructure (fords, permanent and equipment bridging and ferries) should be made to withdraw those elements not essential to the defensive/delaying battle as early as possible. This will likely entail a rearward passage of lines as the units move through the force in place for the defence/delay on the obstacle. The in place force, in effect, will establish a bridgehead to protect the crossing of those conducting the passage of lines.

b. **Delay**. This represents the assault stage in reverse. Forces on the enemy bank are withdrawn under the cover of home bank supporting fire (direct and indirect). The crossing rate is dictated by the pressure from the enemy; the commander may elect to risk using all crossing resources available, concentrating on those best concealed or protected. Those crossing points no longer required must be withdrawn, dismantled or destroyed.

c. **Withdrawal**. The development of the obstacle, on both flanks, in concert with the preparations of the subsequent defensive/delaying positions is carried out during this stage. The last friendly troops and vehicles may be removed by rafts, ferries, swimming, snorkelling and/or any other available means.

41. Crossings in defensive/delay operations are conducted with the force in place and the withdrawing force.

42. **Planning**. Water crossings in defensive or delay operations differ from offensive crossings in several aspects.

a. Initially, both banks of the water obstacle are under friendly control. Detailed information concerning the obstacle and the area over which the defensive or delay operation will be conducted is readily available to the commander.

b. All existing bridges and other crossing sites are available to the force to expedite the crossing.

c. In most cases, relative combat power favours the enemy.

43. Planning of crossings in defensive/delay operations must consider the following factors:

a. Crossing must not impede the conduct of defensive or delaying actions;

b. crossings are carried out when the use of the existing bridges may threaten the success of the defensive or delaying actions;

c. as the crossings are likely to be conducted under pressure with increasingly unfavourable force ratios, great care must be taken in co-ordinating the crossing with the fire and obstacle plan; and

d. upon completion of the crossing operation, the crossing sites must be either destroyed or dismantled.

44. **Critical Functions**. The critical functions for defensive/delay crossings are:

a. **Security**. The routes, assembly areas, waiting areas on the home bank must be secure to allow forces to cross the obstacle. The force in place provides security for the main body to cross the obstacle.

b. **Movement Control**. In order to avoid confusion and congestion across the obstacle, movement of troops and equipment must be strictly controlled.

c. **Terrain Control**. Terrain control is essential near the obstacle itself to accommodate the withdrawing forces.

d. **Crossing Support**. Engineer support may include early identification of bridges and dismantling or demolition. Engineer crossing support may include the operation of crossing sites to support the final withdrawal of the force in place.

45. **Engineer Responsibilities**. The engineer units assigned to the obstacle should be separate from those supporting the units in contact with the enemy. The following actions will be performed by engineers during the three stages.

a. **Relief**

(1) **Force in place**. The engineers supporting the force in place will support the

establishment of the bridgehead. This will include the construction of barriers, the preparation and execution of reserved demolitions and the provision of mobility support within the bridgehead and on the home bank. This last task includes, along with maintaining routes within the bridgehead, the provision and/or maintenance of crossing infrastructure, including bank maintenance. This infrastructure gradually will be thinned out and withdrawn.

(2) **Withdrawing Force**. The engineers supporting the withdrawing force perform conventional defensive/delaying tasks, support the mobility of the force, effect liaison with the force in place engineers, reconnoitre obstacles including minefield lanes and reserved demolitions on the withdrawal route and assist the force in place engineers as able and required.

b. **Delay**

(1) **Force in place**. Remaining crossing infrastructure will be withdrawn or destroyed. Engineers will support the withdrawal of the final elements of the force in place with integral resources. As this may happen while in contact, the engineer will have to advise the commander on a technical and tactical compromise between continuing the crossing, holding a given site and destroying the crossing site and means.

(2) **Withdrawal**. Remaining with its supporting force to allow it to continue to move to its next area of operations. Some elements may be temporarily tasked to assist the force in place engineers.

c. **Withdrawal**. Engineers will ensure the removal and/or destruction of all crossing sites and infrastructure, in accordance with barrier plan.

CONDUCT OF BREACHING OPERATIONS

46. **General**. The approach to, and execution of an obstacle breaching operation is in many ways similar to that of a crossing operation although obstacles will produce some significant and unique problems.

47. **Planning**. The following factors should be considered when planning a breaching operation:

a. **Reconnaissance**. To have a reasonable chance of success for breaching, the minimum information required is the obstacle depth, its front and rear boundaries, details of enemy weapons covering the obstacle and the obstacle composition. Modern reconnaissance and surveillance techniques as well as information obtained from maps, terrain analysis and other sources, enable a commander to anticipate likely areas containing obstacles. The use of reconnaissance forces, supplemented by engineer reconnaissance, will provide timely information on obstacle locations thus allowing the commander to adjust the deployment of his force and position breaching equipment so that it can be used quickly. It is essential that planning and preparations commence before the obstacle is reached. The task of determining the boundaries of an obstacle is an all arms responsibility. The physical reconnaissance of an obstacle is an engineer responsibility.

b. **Breaching**. Breaching may be done by mechanical means, by explosives, manually or by using a combination of means. As a norm, two lanes should be attempted for every one required. Once lanes are established, they must be marked.

c. **Hasty Breaching**. An attacking force will attempt to breach from the march using integral and immediately available resources such as rollers, ploughs, armoured engineer vehicles and dozer tanks. Very little reorganisation of the assault echelon is required since drills and SOPs enable breaching to begin with minimum orders being given. Engineer support is not essential to conduct hasty breaching, however, resources immediately available shall be used. The scope of engineer support can include reconnaissance, provision of advice, and assistance in the breaching, proving, marking and maintenance of lanes. Seizure of minefield lanes or an opportunity for a hasty breach must be exploited. If this fails, a deliberate breach will be necessary.

d. **Deliberate Breach**. If the obstacle cannot be bypassed or a hasty breach cannot be done from the march, or if the obstacle is too complex to be crossed using the available resources, deliberate breaching will be attempted. The resultant loss of momentum has to be accepted as more time is required for reconnaissance, planning and build-up of the necessary resources. Engineer support to the deliberate breach is essential. Timely and accurate intelligence is required to determine the extent and composition of the obstacle, and hence the organisation of the breaching force. This normally consists of infantry, armour with its integral mechanical breaching assets, engineers with explosive and mechanical breaching assets, direct and indirect fire support as well as close air support. Engineer support will include:

(1) Detailed reconnaissance of the obstacle to determine locations of mine rows, types of mines and any other engineer technical information that provides information about the types of obstacles employed;

(2) provision of engineer advice to commanders;

(3) provision of specialised equipment and personnel to assist in the conduct of the breach; and

(4) proving, marking and maintenance of safe lanes.

48. **Execution**. When breaching the following factors should be considered:

a. If the enemy situation allows, dismounted troops cross the complex obstacle and establish a lodgement on the far side, although this may not always be possible. This may be achieved by bypassing the obstacle or infiltration. In any case, it is necessary to form a breaching force to open lanes for vehicles of the assault echelon.

b. If the obstacle has been constructed by friendly forces, it is crossed using existing gaps or lanes, or newly breached lanes.

c. Once lanes are open, movement control posts at both ends of the lanes are required. In addition, recovery posts will be established at the approaches to all lanes and, occasionally, on both sides of the obstacle.

d. With the assault echelon across the obstacle and secure, engineers complete their preparation of breaching sites, to include marking. Movement control elements complete their deployment to control the movement of the main body across the obstacle. Complete clearance of barriers requires a considerable amount of time and resources, therefore it can usually be justified only if operationally necessary.

49. **Support Services**. Support Services considerations for breaching operations are similar to those required for water crossings. The scale of support for breaching operations tends to be lower than that for water crossings.

50. **Command and Control**. The level of command for breaching operations is likely to be lower than for water crossing. Obstacle breaching may involve a number of independent, simultaneous actions each with its own commander, whereas a water crossing is a centralised operation. All the command and control measures of a water crossing such as a Crossing Area Headquarters, the establishment of a crossing area, Movement and Sector Control Organisation and Crossing Site Commanders, and the establishment of lateral routes are also necessary for breaching operation. Although the operation will be conducted at a much lower level than water crossings, the requirement for strict movement control is essential. For breaching operations the following three forces are involved.

a. **Bridgehead Force (Breaching Force)**. Consisting of an assault echelon and a main body. Its mission is to breach the obstacle and control ground in order to permit the continuous crossing of the obstacle. The assault echelon is tasked to breach lanes through the obstacle to gain a lodgement, normally by seizing intermediate objectives. If the assault echelon remains in place to protect the lane following the breach, the Crossing Site Commander (Lane Commander) may be an armour troop leader supported by engineers. If the assault echelon is tasked to exploit the breach, an engineer supported by armour is better suited to command the lane. The Lane Commander will be responsible for marking, maintaining and ensuring the smooth flow of traffic through the lane. The main body of the bridgehead conducts the build-up, including the seizure of the objectives on the bridgehead line. Engineers supporting the bridgehead force will be grouped with the assault echelon breaching the obstacle and the main body. Their task is to provide close engineer support through the obstacle to the bridgehead line.

b. **Break-out Force**. The break-out force is tasked with the continuation of the overall operation. The force will conform to the bridgehead force regarding the use of ground. In some circumstances, the break-out may be an additional task of the bridgehead force. Engineers supporting the break-out force are normally dedicated to that task and are not employed during other stages of the breach.

c. **Force in place**. The force in place provides fire and other support to the bridgehead force during the breach. The engineers from the force in place will improve, mark and maintain lanes that have been breached by the bridgehead force.

SECTION 3
COUNTER-MOBILITY

GENERAL

1. In offensive operations, counter-mobility tasks may include flank protection and consolidation of an objective.

2. The use of situational obstacles, especially the planning of ground and artillery delivered scatterable mines is vital.

FLANK PROTECTION

German barrier tactics (1939-45) illustrate the intimate co-ordination between engineers and other arms. The so-called Sperverbände are detachments made up of engineers, infantry, machine gun units, anti-tank units and perhaps anti-aircraft units. Such a detachment is prepared to take over an area, convert it into a Sperrgebiet (obstacle zone), and so deny it to the enemy. It is a *case of co-ordinating the obstacle power of engineers with the firepower of the other elements of the detachment.*

As an indication of German thought on the possibilities of barrier tactics, I may cite the German belief that a gap like the one that opened between First and Second Armies at the Marne in 1914 could be closed for an adequate time by Sperrverbände. During the invasion of France (1940) it appears that as the Germans drove the great wedge from Sedan to Abbeville, the French forces south of the Somme everywhere were on the defensive. Had these forces been able to attack, it is possible that we would have had accounts of German barrier operations designed to resist attacks. Perhaps even as things were, it will be learned that the Germans, taking as always no more chances than necessary, protected their lengthening flanks by barrier zones.

Engineers in the Blitzkrieg
US Army Infantry Journal Sep-Oct, 1940
Captain Paul W. Thompson

3. Support to flank protection forces is likely to be the most important counter-mobility task for offensive operations. Engineer tasks could include:

a. cratering roads and avenues of approach,

b. the use of scatterable mine systems, and

c. preparing other rapidly emplaced obstacles.

CONSOLIDATION

4. When an objective has been taken, engineers will carry out counter-mobility tasks in order to support the attacking force against

counter-attacks. These counter-mobility tasks must not hinder future operations.

SECTION 4
SURVIVABILITY

GENERAL

1. During offensive operations, use of multiple routes, dispersion, highly mobile forces and wise use of terrain are the best ways to ensure survivability. Planned measures must not unduly restrict the force's ability to manoeuvre at will. This will allow the commander to achieve concentration, speed and flexibility. The following measures may be used:

a. field fortifications,

b. camouflage, and

c. deception.

FIELD FORTIFICATIONS

2. Engineers may construct pits for combat vehicles and weapon systems. Although not as extensive as in the defence, protective emplacements for artillery, air defence units and logistic concentrations are normally considered in the plan. Commanders may require hardening of key command and control facilities, especially those with a detectable electronic signature. Engineer assistance during offensive operations also may be required to provide field fortifications for:

a. support and reserve forces waiting in hide areas,

b. assault forces consolidating on an objective,

c. manoeuvre forces which are required to halt during the advance, and

d. secondary and alternate positions.

CAMOUFLAGE

3. In a fast moving offensive situation, time may not allow extensive camouflage measures to be taken. Engineers advise on site selection and proper use of terrain to provide the most expedient camouflage.

DECEPTION

4. Engineers may construct false crossing points, phoney bridges to support false axis of advance or construct obstacles or routes to support formation deception plans. Dummy positions, false attack preparations and decoy engineer equipment can be used to help gain surprise for an attacking force.

ANNEX A
VEHICLE CROSSING FLOW CHART

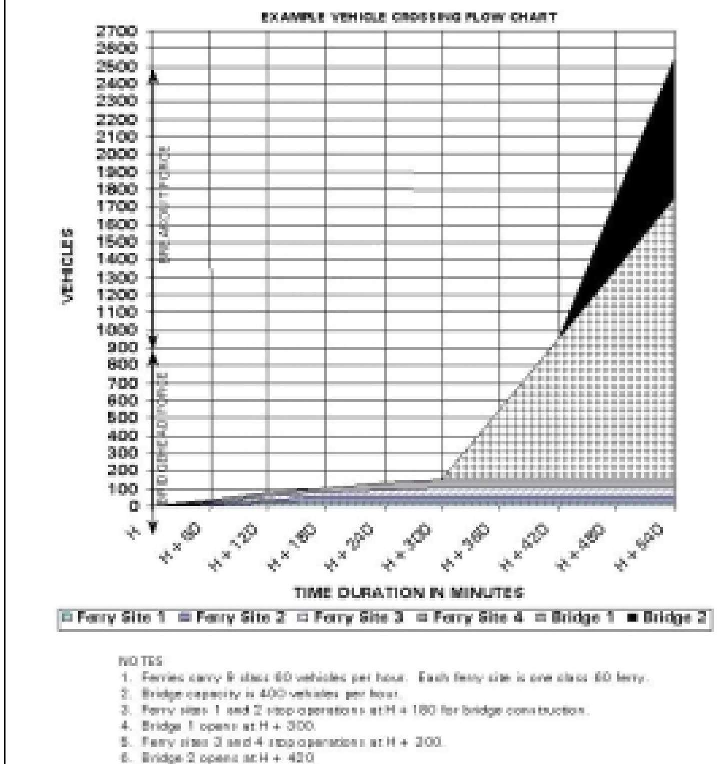


Figure 37: Vehicle Crossing Flow Chart

CHAPTER 8
TRANSITIONAL PHASES DURING OPERATIONS

SECTION 1
ADVANCE TO CONTACT

GENERAL

1. The advance to contact seeks to gain or re-establish contact with the enemy under the most favourable conditions for the main force. Operations will be bold, rapid and often decentralised in order to surprise the enemy, keep him off balance and exploit success. In order to achieve this, extensive reconnaissance will be required. Enemy protective elements must be destroyed or neutralised without impeding the movement of the main body. Provision must also be made for flank protection.

ENGINEER TASKS

2. The major engineer task in an advance to contact is the provision of mobility support by the opening and improvement of routes of advance and by the maintenance of main supply routes (MSRs) and other important routes. Engineers create obstacles to assist flank protection operations. Engineers must also have reconnaissance elements with the leading troops to facilitate:

   a. the selection of routes which require the least amount of preparation and maintenance, and

   b. the preparation for the rapid deployment and regrouping of engineer units and resources required to maintain momentum.

3. Engineers will support the covering force, advance guard, main body, rear guard and flank guards.

MOBILITY TASKS

4. During an advance to contact, maintaining mobility will be of primary concern. Types of obstacles encountered and their strength will vary. However, as a minimum they will likely be covered by direct or indirect fire.

5. In opening routes, the predominating factor is speed. Engineer tasks may include:

a. The removal of mines, anti-disturbance devices and obstructions of any kind,

b. the creation of bypass routes using expedient or improvised means,

c. filling in or bridging over craters,

d. laying assault bridges or fascines, and

e. marking the routes created through obstacles.

6. The principal engineer equipment required for route opening are:

a. Dozers (preferably armoured with the same on road mobility than that of the advancing forces),

b. armoured engineer vehicles with fascines,

c. bridge-laying tanks (AVLBs),

d. power tools and explosives,

e. portable and vehicle-mounted mine detection equipment, and

f. rapid mine clearance vehicles or systems.

7. Close support engineers supporting leading units must therefore have access to these vehicles and equipment, which should be held as far forward as circumstances and use dictate.

COUNTER-MOBILITY TASKS

8. Engineers with the flank and rear guards must be prepared to assist in blocking enemy avenues of approach. Situational obstacles must be planned. Engineers must rapidly create obstacles. They must be well supplied with ground-delivered scatterable mines, cratering munitions, and rapid bridge demolition materials.

SECTION 2
MEETING ENGAGEMENT

GENERAL

1. The meeting engagement is a combat action that occurs when both sides seek to fulfil their mission by offensive action. A meeting engagement will often occur during an advance to contact and can easily lead to a hasty attack. In offensive or delaying operations, it will often mark a moment of transition in that the outcome may well decide the nature of subsequent operations. This is why the meeting engagement is described as a transitional phase. Even when the main part of a force is defending, attacking or delaying, individual elements may find themselves in situations which have the characteristics of a meeting engagement. Although forces of divisional size or larger, given room for manoeuvre, may occasionally be involved as a whole in a meeting engagement it is normally only applicable to the brigade level and below. A meeting engagement can occur in various circumstances.

a. When a force which is moving either tactically or in column of route, makes contact with an enemy about whom the friendly forces has little or no information;

b. by chance or when reconnaissance has been ineffective;

c. when both sides are aware of the other and decide to attack without delay in an attempt to obtain positional advantage, gain ground of tactical importance, maintain momentum or assert dominance over the enemy; or

d. when one force deploys hastily for defence while the other attempts to prevent it.

ENGINEER TASKS

2. The rapid deployment of engineers can be crucial in transitional phases of the battle. Engineer reconnaissance must be well forward and engineer assets readily available for mobility and counter-mobility tasks to ensure freedom of movement and deny it to the enemy. Engineer planning of scatterable mines, for example, can provide counter-mobility support if assets are available. Engineer tasks in the meeting engagement are likely to be restricted to:

a. breaching or crossing of obstacles,

b. opening routes, and

c. rapid emplacement of obstacles to the front and/or flanks.

SECTION 3
LINK UP OPERATIONS

GENERAL

1. A link up operation is conducted where forces are to join up in enemy controlled territory. The aim of a link up operation is to establish contact on the ground between forces which may have the same or differing missions. In a link up operation, it may be necessary to destroy the enemy between these forces before contact can be established. Frequently, a force will be required to link up with an isolated force.

ENGINEER TASKS

2. These operations demand a considerable effort to co-ordinate engineer activity, not only with the other arms, but also between the engineers of the two forces. Engineer tasks are likely to include the following:

a. **Engineers Supporting the Link up Force**

(1) To support the mobility of these units by opening and maintaining the axes of advance and link up;

(2) if necessary, to support the protection of the flanks of the axes of advance and link up force using rapidly created obstacles; and

(3) to reinforce objectives taken for the purposes of the link up by creating obstacles.

b. **Engineers Supporting the Isolated Force**

(1) When possible, to provide mobility support to the link up force by opening and maintaining the axes of advance;

(2) to support the protection of the flanks of the axes of advance and link up by creating obstacles rapidly;

(3) to strengthen the isolated force's position by creating obstacles on routes not required for link up and in locations around the force as necessary;

(4) to breach obstacles at planned link up points;

(5) to provide mobility support to the isolated force if a break-out is attempted in order to meet with the link up force; and

(6) to support the reinforcement of the survivability measures taken by the isolated force.

SECTION 4
WITHDRAWAL OPERATIONS

On the afternoon of 17th September 1944 the 1st British Airborne Division attacked in the Netherlands, dropping north-east and west of Arnham, in an operation [Market Garden] to catch the Germans off balance and establish a bridgehead over the Rhine.

Matters did not go well in the bridgehead. Opposition was stronger than expected; also, unfortunately, the weather closed in, delaying reinforcements. Although the 2nd Parachute Battalion, with a troop of the R.E. Parachute Squadron, seized the north end of the main Arnhem road bridge on the evening of the 17th, it could not do more. The enemy closed in and by the 19th, except for the tiny area still controlled by the beleaguered group at the road bridge, only a short perimeter, backed on the Lower Rhine west of Arnhem, was held by the Division. At 1700 hours 21 September, the small force lost control of the Heveadorp ferry, which had provided its only means of crossing to the south bank.

Reluctantly, on 25th September, Montgomery decided to withdraw the survivors at night, under the cover of an artillery barrage. Four field companies were assigned to the withdrawal operation, the 26th and 553rd of R.E. Wessex Division and the 20th and 23rd of R.C.E.1st Canadian Army Troops. The British companies were equipped with assault boats, each of which *required a crew of paddlers; the Canadian companies had stormboats with outboard motors.*

The 23rd Field Company was assigned to a site, north-east of Driel, believed to be immediately behind the centre of the area held by the 1st British Airborne Division. Stormboats had to be carried about 500 yards and dragged over two flood banks, the first 20 feet high with 45-degree slopes, the second about half that height. The first boat was launched on schedule at 2130 hours, however, it had been holed in transit and proved useless. Fifteen minutes later the second boat left the shore carrying Lieutenant J.R. Martin, detailed to organize the landing on the far side. This was apparently hit by a mortar bomb; none of the crew were seen again. It was not till a third boat was launched, and had crossed, that the first load of airborne troops was brought back. The fourth boat put into the water capsized with a full load on the return trip. A mortar bomb struck beside it and the passengers instinctively all leaned to the off side turning it over. Some were lost, but the crew and others safely reached the shore they had just left. An hour had now passed. From this time boats went into the water at about 20-minute intervals. In all 14 boats were launched. The second last boat, being paddled to the south side after a motor failure, came under direct fire and landed with many casualties. When ferrying ceased at dawn, it had become so light that the boats no longer stood a chance of crossing under the aimed enemy fire.

In all, the boats made some 150 crossings. Under the conditions pertaining it was not possible to keep accurate records, but it was estimated that some 2500 airborne troops had been brought in during the night.

The History of the Corps of Royal Canadian Engineers, Volume 2

GENERAL

1. A withdrawal occurs when a force disengages from an enemy force in accordance with the will of its commander. It seeks to break contact with the enemy. Reconnaissance and/or protective elements may maintain surveillance over the enemy.

ENGINEER TASKS

2. Engineer tasks during a withdrawal are similar to those during delaying operations.

   a. Engineers assist the withdrawing force to break contact and to keep open the withdrawal routes. Obstacles will be used to assist in breaking contact. Gaps and lanes will be closed once withdrawing forces have moved through them, frequently in the face of the enemy;

   b. conduct reconnaissance tasks;

   c. maintain good communications and co-ordination with the tactical;

   d. group engineer units with the rear elements of the withdrawing forces; and

   e. co-ordinate denial measures.

SECTION 5
RELIEF OF TROOPS IN COMBAT

GENERAL

1. The types of relief operations are defined as:

a. **Relief in Place**. An operation in which all or part of a force is replaced in a sector by an incoming unit.

b. **Forward Passage of Lines**. An operation in which a force advances or attacks through another which is in contact with the enemy.

c. **Rearward Passage of Lines**. An operation when a force effecting a movement to the rear passes through the sector of a unit occupying a defensive position.

2. Whether conducting a forward or rearward passage of lines, the force in place has the responsibility to provide mobility for the moving unit along cleared routes or corridors through its sector. Creating lanes through the in place unit's obstacles requires permission from the force commander who is in command of both forces.

ENGINEER TASKS - RELIEF IN PLACE

3. The hand-over of barriers and obstacles to the relieving force is likely to be the major engineer task in a relief in place. This complex procedure becomes more difficult when, within an allied formation, a unit from one nation relieves a unit of another nation. Obstacle design, material and construction are likely to differ. As a result, engineers from both forces must be given sufficient notice and time to carry out a detailed hand-over and must be free to liase directly. The information to be handed over includes:

a. barrier plan and related documentation,

b. engineer information and data,

c. crossing plans,

d. field fortification and other plans, and

e. routes.

4. The procedure for the hand-over of barriers is detailed in Chapter 3.

ENGINEER TASKS - FORWARD PASSAGE OF LINES

5. The following considerations should be taken into account when planning a forward passage of lines:

a. The timing of the hand-over of responsibilities is critical.

b. The attacking force engineer commander should:

(1) establish liaison with the engineer commander of the in place forces as early as possible;

(2) obtain details of identified enemy obstacles; and

(3) assume responsibility for engineer operations of the attack area when the attack begins.

c. The engineer commander of the force in place will continue to control operations in support of his own force. He will also normally be responsible for ensuring:

(1) The maintenance of the routes forward within his sector.

(2) The passage of barriers within his sector. The in place force must ensure that there are sufficient gaps and lanes through their obstacles and that these are properly

marked (including the provision of guides).

(3) Deception.

d. Both engineer commanders will co-ordinate how the engineer forces to be relieved are to continue to provide support until the beginning of the attack.

ENGINEER TASKS - REARWARD PASSAGE OF LINES

6. The withdrawing force will carry out its own counter-mobility tasks and keep open its own routes until it crosses the hand-over line delineating the area of responsibility of the force in the defensive position. This area of responsibility must be clearly defined.

7. The engineers of the force in place are responsible for:

a. Providing sufficient marked gaps and lanes through their obstacles, with guides when necessary, to facilitate the movement of withdrawing forces;

b. keeping open routes for the withdrawing force; and

c. rapid closing of gaps and denying routes, once the withdrawing force has passed, as necessary to complete the barrier plan.

CHAPTER 9
SUSTAINMENT ENGINEERING

SECTION 1
FUNDAMENTALS

SUSTAINMENT ENGINEERING

1. Sustainment engineering involves the provision of engineer advice, technical expertise, resources and work other than the mobility, counter-mobility and survivability tasks provided directly to combat operations to allow the force the ability to maintain, reconstitute, and regenerate itself. Engineers performing these tasks do not possess the equipment, mobility and armour protection of those supporting the manoeuvre force. Sustainment tasks require large amounts of construction materials, which must be planned for, produced and provided in a timely manner.

MAIN TASKS

2. Sustainment engineering may be performed by a combination of engineer units, civilian contractors and host nation support. Sustainment engineering tasks are divided into five areas of activity as follows:

   a. **Rear Area Restoration**. Permit continuation of operations in the rear area.

   b. **Maintenance of Lines of Communications**. Maintain the routes that connect the formation to its logistics support, along which combat supplies and follow-on forces move.

   c. **Vertical Construction (Accommodation)**. Establish facilities that provide deployed forces with protected, healthy and safe accommodations.

d. **Utilities**. Acquired through contract, construction or repair.

e. **Civil-Military Engineering**. Promote stability in the formation area of influence.

SPECIALIST ENGINEER SUPPORT

3. Specialist Canadian engineer support to the tactical level and for national units must be centralised at the national headquarters, due to cost, complexity and control. These capabilities controlled by the Force Engineer are vested with the Engineer Support Unit (ESU). Specialist teams from within the ESU resources may be created. Their composition and missions may vary at the discretion of the Force Engineer. Possible specialist teams may include, but are not limited to the following:

a. Theatre level engineer technical reconnaissance,

b. electrical generation and distribution,

c. fuel storage and distribution,

d. water supply and distribution,

e. environmental assessment and response,

f. construction material testing,

g. structural damage assessment,

h. engineer procurement and contracting,

i. real property management,

j. engineer specialised materials,

k. emergency response and fire protection, and

l. explosive ordnance reconnaissance and explosive ordnance disposal.

SECTION 2
REAR AREA RESTORATION

DAMAGE ASSESSMENT AND REAR AREA DAMAGE CONTROL

1. Rear area damage control are the measures taken before, during and after hostile actions to reduce the probability of damage and minimise its effects. The Rear Area Headquarters controls all engineer support to rear area damage control. It makes maximum use of any host nation support. Units and installations usually have to rely on their own assets, however, specialist engineers and engineer units may be used in critical situations, depending on the priority of their work. Engineers execute rear area restoration missions according to the theatre construction priorities. Engineers are required to conduct but are not necessarily limited to the following activities.

a. **Prior to an Attack**

(1) Preparation of necessary plans and SOPs to include reporting of information required for post strike analysis and the assessment of all damages affecting the sustainment and freedom of manoeuvre of the force;

(2) appropriate use of cover and concealment, and

(3) deception measures.

b. **During and After an Attack**

(1) Restoration of damaged installations essential to the mission,

(2) rapid assessment of the damage and its immediate effect on operations,

(3) fire prevention and fire fighting,

(4) emergency supply of water,

(5) explosive ordnance reconnaissance and disposal,

(6) initiation of salvage operations, and

(7) decontamination of vital areas contaminated with radioactive material or chemical or biological agents.

2. Engineers throughout the theatre can be expected to perform damage assessment and rear area damage control tasks.

HAZARDOUS AREA MARKING

3. Hazardous areas are defined as areas that, if entered or crossed, may result in casualties to men or damage to the matériel.

4. Throughout the damage assessment phase, hazardous areas must be marked. Two levels of marking are identified.

a. **Immediate Warning Marking**. Immediate warning marking meets the threat from the munitions, scatterable mine and other types of remotely delivered hazards such as chemicals and biological agents or radio-active fallout.

b. **Long Term Marking**. Long term marking will be used to replace immediate warning marking when the hazard is expected to remain for an indefinite period.

5. Hazardous marking is an all arms responsibility. Engineers throughout the theatre provides advice and support.

EXPLOSIVE ORDNANCE DISPOSAL

> *Bomb disposal units operated in most of the major theatres of war. Besides their primary task of bomb disposal, they were also employed, in co-operation with other field units R.E., in the clearance of anti-tank and anti-personnel minefields, and booby traps. They were also used to render safe captured dumps of enemy aircraft bombs.*
>
> *This employment calls for a little special note. In the field bombs could usually be destroyed in situ, a simpler task than the sterilization and removal so often necessary in the United Kingdom.*
>
> *In North West Europe Bomb Disposal Units in 21 Army Group were responsible for removing under-water demolition charges at bridge sites, etc. In consequence, a proportion of the men had to be trained as divers.*
>
> Military Engineering (Field)
> The War Office (1952)

6. Forces could be attacked with any or all of the types of explosive ordnance as follows:

a. general purpose bombs,

b. chemical weapons,

c. cluster bombs,

d. dispensed ammunition,

e. concrete piercing munitions,

f. free flight rockets and missiles,

g. guided munitions,

h. projectiles,

i. sabotage devices, and

j. underwater weapons.

7. Fusing or ordnance actions may include: instantaneous or blast effects, short delay for penetration and cratering, long delay for harassment and interdiction, random delay for area denial and interdiction and target activation for specific targets such as vehicles, or harassment.

8. Approximately 10% of explosive ordnance could be unexploded by malfunction. The percentage of unexploded ordnance by design could be much higher. Submunitions of which at least 25% could be expected to be fitted with delayed action fuses could additionally be expected to have a 10% malfunction rate.

9. It is difficult to assess the risk from unexploded ordnance as it varies with location, target type and enemy priorities. However, this risk is sufficient to justify an explosive ordnance disposal capability.

10. Explosive ordnance disposal operational capabilities are to detect, nullify or dispose of unexploded ordnance which, by their existence, impair the flexibility of manoeuvre of combat units, disrupt lines of communications, degrade morale, or paralyse industrial complexes, sea ports, waterways, air bases or population centres. While explosive ordnance disposal operations extend throughout the communication and combat zones, it must be realised that the existence of explosive ordnance disposal incidents in civilian areas will often have serious repercussions on the military situation. In such cases, co-operation between military explosive ordnance disposal units and national military and civilian agencies will be essential and will be accomplished through Area Damage Control Centres.

11. **Definitions**

a. **Explosive Ordnance Disposal (EOD)**. The detection, identification, field evaluation, rendering safe, recovery and final disposal of explosive ordnance including items representing explosive ordnance such as drill, dummy, or display munitions. It may also include the rendering safe and/or disposal of explosive ordnance, which has become hazardous through damage or deterioration.

b. **Battlefield Munitions Disposal (BMD)**. The detection, identification, field evaluation, rendering safe, recovery and disposal of placed, projected or dropped, friendly or enemy munitions, in a theatre of operations. The disposal may be carried out by counter explosive charge(s) or by render safe procedures if recovery is required.

12. The conduct of EOD tasks requires the following:

a. Conduct Explosive Ordnance Reconnaissance (EOR).

b. Control EOR operations. Control of EOR operations is exercised by local commanders.

c. Command/Control EOD operations. Command and control of EOD operations consists of command/control, planning and administration related to EOD tasks. The following functions are included in the command/control capability.

(1) Receiving the EOD incident reports from EOR organisations or other sources and assigning categories;

(2) Assigning specific missions to units based on EOD priorities.

(3) Assigning EOD teams or commanders to fixed installations. The installation commander exercises operational control over the assigned EOD teams. These assignments need not be permanent, but will vary according the threat.

(4) Evaluating activities of EOD personnel and recommending distribution of personnel and equipment to balance workloads.

(5) Authorising the movement of EOD personnel and equipment to meet high priority operations.

(6) Conducting liaison with Area Damage Control Centres and Installation Damage Control Centres.

(7) Conducting liaison with police forces and civil defence agencies through appropriate channels.

(8) Co-ordinating with allied forces' EOR/EOD organisations.

d. Integrate EOD operations with special equipment and personnel.

e. Perform EOD procedures on explosive ordnance.

f. Recover and evaluate enemy explosive ordnance for EOD and intelligence purposes.

g. Interchange information between EOD and technical intelligence agencies.

13. **Explosive Ordnance Disposal Categories.** EOD incidents are categorised on command decisions according to their potential

threat. Potential targets should be pre-categorised whenever possible. Categories are as follows:

a. **Category A**. Assigned EOD incidents that constitute a grave and immediate threat. Category A incidents are to be given priority over all other incidents, and disposal operations are to be started immediately regardless of personal risk.

b. **Category B**. Assigned to EOD incidents that constitute an indirect threat. Before beginning EOD operations, a safe waiting period may be observed to reduce the hazard to EOD personnel.

c. **Category C**. Assigned to EOD incidents that constitute little threat. These incidents will normally be dealt with by EOD personnel after Category A and B incidents, as the situation permits, and with minimum hazard to personnel.

d. **Category D**. Assigned to EOD incidents that constitute no threat at present.

14. **Capabilities**. Specially trained engineer personnel will normally do EOD operations. All close and general support engineers units will be trained in BMD procedures. Specialist EOD personnel will be located at division, corps and theatre level.

FIRE PROTECTION - FIGHTING

After the initial landing operation (D Day 1944), when all US fire fighting units had moved to the Continent, the principal activities in this field consisted of reallocation of fire fighting units and inspecting these units and major installations to ensure that fire defense measures were adequate. Due to the shortage of fire fighting platoons, it was necessary to study needs of the various Com Z Sections closely. This was accomplished through careful maintenance of records of all-important installations, and the proper shifting of fire *fighting units to meet the changing situations. As the tactical situation developed, it was possible to withdraw units from locations where need for mobile protection was the least and re-assign them to other locations where increased fire protection was critically needed.*

Final Report of the Chief Engineer (US)
European Theatre of Operations 1942-1945

15. Theatre level engineers provide fire protection when not available from the host nation. Fire fighting assets are allocated based on the troop population, the size of storage areas, and on the fire risk.

16. Fire protection consists of the following.

a. crash rescue for air operations;

b. structural fire fighting and rescue operations;

c. hazardous material fire fighting;

d. environmental disaster assistance;

e. protection from or in support of EOD/BMD clearance operations, particularly in built-up areas;

f. production field fire safety plans, conduct inspections and provide field fire safety training for deployed formations.

17. It is difficult to determine the scale of water for fire fighting. It must be estimated for a particular operation by specialist staff taking into account the operational situation, the assessed risk and the availability of fixed fire fighting equipment. The requirement is to deliver water at a specified rate for a specified time. This translates into a storage requirement (typically 72,000 litres for general barrack risk). It is not normally necessary to have a separate reserve of fire fighting water; the normal domestic water storage may be used. However, the fire fighting storage

requirements, together with the emergency consumption scale for the accommodated personnel, put a minimum size on the tank capacity. If a separate supply is available, non-potable water is acceptable for fire fighting and some other uses, but some pre-treatment may still be required (e.g. sedimentation).

18. Fire safety is the responsibility of every unit commander. In areas without need of dedicated professional fire protection crews, the Force Engineer will assign fire inspection personnel to equip and train auxiliary fire fighters from these units. The engineers' function will then be to monitor and inspect these fire safety programs.

SECTION 3
MAINTAIN LINES OF COMMUNICATIONS

ROUTE CONSTRUCTION AND MAINTENANCE

1. Route construction and maintenance often requires much time, equipment, material, transport and skilled labour. New construction must be kept to a minimum, but at the same time, probable future requirements must be anticipated. All planning must be designed to reduce the need for subsequent improvements and maintenance.

2. **Categories of Routes**. On the basis of their ability to withstand the effects of the weather, routes are divided into three categories:

a. **Type X - All Weather Routes**

(1) With reasonable maintenance, passable throughout the year to a volume of traffic never appreciably less than its maximum capacity.

(2) Normally formed of roads which have waterproof surfaces and are only slightly affected by rain, frost, thaw or heat.

(3) Never closed because of weather effects other than snow or flood blockage.

b. **Type Y - Limited All Weather Route**

(1) With reasonable maintenance, passable throughout the year but at times the volume of traffic is considerably less than maximum capacity.

(2) Normally formed of roads which do not have waterproof surfaces and are considerably affected by rain, frost thaw or heat.

(3) Closed for short periods of up to one day at a time because of adverse weather conditions during which heavy use of the road would probably lead to complete collapse.

c. **Type Z - Fair Weather Route**

(1) Passable only in fair weather.

(2) So seriously affected by adverse conditions that the route may remain closed for long periods.

(3) Improvement of such a route can only be achieved by construction or realignment.

3. **Conduct of Route Maintenance and construction**. Engineers or host nation resources construct and maintain all routes, except tracks in unit areas. Before detailed engineer planning begins, the staff will provide the following information:

a. The number, general locations, and type of routes required,

b. the priority of work,

c. design criteria (i.e. traffic volume per day, convoy speed, military load classification etc.),

d. the time construction may begin,

e. the time by which construction is to be complete, and

f. what extra support, if any, will be available.

4. Although engineer advice and assistance may be provided to units for local tasks, all arms are responsible for:

a. the construction and maintenance of tracks in unit lines,

b. the construction and maintenance of culverts on tracks within unit lines and where unit tracks access temporary and permanent routes, and

c. reporting road damage.

SNOW AND ICE CONTROL

5. On the battlefield, snow and ice greatly influences mobility. Snow and ice can degrade mobility to the point of immobilisation, with subsequent serious implications.

6. While the task of maintaining friendly force mobility on the battlefield rests primarily with engineers, it is unlikely that there will ever be enough special engineer equipment to assure force mobility in sustained operations in a winter environment. The competition for scarce engineer resources is resolved by the commander, who sets priorities for engineer work in accordance with his concept of operations. Normally, engineers will be concentrated in support of the main effort on high priority tasks rather than being distributed evenly throughout the force.

7. Throughout the theatre, engineers and host nation resources will be involved in snow and ice control. The division of responsibility is generally as follows.

a. Division and corps engineers will be responsible for the combat zone, while theatre engineers for the communication zone; and

b. units will be responsible for clearing unit bivouac areas and sub-unit access routes.

8. Snow and Ice Control Planning Considerations. When planning snow and ice control operations, the following factors should be considered:

a. Weather considerations (weather and annual snow fall),

b. availability and quantity of sand and salt required,

c. distribution plan for salt and sand, and

d. resources availability including host nation support.

SUPPORT TO AIR AND AVIATION

9. Air and aviation support impacts on operations. The degree of air and aviation support is usually dependent on the timely provision of ground installations of suitable type, number and location. The planning and execution of the acquisition or construction of air landing facilities is likely to play an important part in all operations. Engineers at division can be expected to construct austere heliports, while corps and theatre engineers are responsible for constructing/rehabilitating air landing facilities.

RAILWAYS AND PORTS

10. Specialist engineer organisations normally found at theatre level provide for the maintenance, repair, or construction of railways and ports. In the absence of specialist engineer units, division and corps engineer units, with the technical advice of specialist railway and port engineers, may provide the horizontal and vertical construction capability required to perform this function.

11. **Railways**. Theatre engineers with support from the host nation are responsible for the construction and maintenance of military and utility railways to meet transportation needs, including the design and repair of bridges and tracks. The reconnaissance and selection of new railways and those existing railways to be repaired or rehabilitated will be a combined engineer and logistics responsibility. The operation or scheduling of railways will be a logistics responsibility.

12. **Ports**. Theatre engineers, with support form the host nation, are responsible for the construction or repair of port facilities. The operation or management of ports is a logistics function. Theatre engineer units may be responsible for:

a. construction and maintenance of structures,

b. liaison with naval units with respect to harbour clearance,

c. recommending the assignment of facilities within the port area,

d. advising logistics personnel on engineer matters,

e. construction and maintenance of roads within the port area,

f. construction and maintenance of unloading facilities, and

g. maintenance and operation of fire fighting equipment.

SECTION 4
VERTICAL CONSTRUCTION (ACCOMMODATIONS)

Initially all engineers, even the tunnellers, were employed mainly on accommodation construction. For example, the 1st Canadian Tunnelling Company was busy during January at Mont St. Eloi. It had a workings strength, with attached personnel, of about 1000 all ranks, much of the extra labour being supplied by British Units. On 13th January 1917 headquarters 3rd Divisional Engineers moved to Ecoivres, the better to supervise the construction of subways and underground shelters. They were relieved by their 2nd Division counterparts on 15th February, and these were relieved in term by 1st Division personnel on 5th March. But all accommodations needed was not below ground; in addition to other types of shelters some 460 Missen huts were erected, mostly in battalion groups of about 40 each. With the huts went the necessary sanitary construction: bath houses, laundries, disinfectors, latrines and incinerators. Provision had also to be made for animal standings and shelters for thousands of horses. The increase in the amount of enemy aerial bombing which had taken place of late meant breast-high earth works for the horse lines and similar structures around sensitive ammunition dumps. Huge quantities of rations, forage and other perishable items had to be provided with cover. Huts and shelters required heating against the bitter weather. Tinsmiths were rounded up from many units and put to work, in the engineer parks, on the mass production of Quebec heaters with the necessary pipe and accessories.

The Battle of Vimy Ridge

The History of the Corps of Royal Canadian Engineers, Volume 1

REAL PROPERTY MANAGEMENT

1. The Force Headquarters in conjunction with the Force Engineer cell, and other elements, will formulate the Canadian policy and guidance for real property management. The Theatre Engineer performs this function for the alliance. The Force Engineer will provide the following support.

a. Advice on real estate policies and operations procedures,

b. real property management activities including:

(1) determination of requirements,

(2) selection of property,

(3) acquiring property;

(4) disposing of property,

(5) processing claims, and

(6) maintenance of accurate property records.

PROVISION AND MAINTENANCE OF UTILITIES AND STRUCTURES

2. Regardless of the degree of urbanisation in a theatre of operations, engineer support will be required for the provision, repair and maintenance of utilities and structures. This support will be provided primarily by the Engineer Support Regiment and by corps and theatre engineer units. However, all engineers will be required to use their basic engineer skills and knowledge to complete construction tasks.

3. Likely tasks are:

a. The restoration and operation of municipal water, sewage, electric power and gas services, or the rendering safe of services damaged beyond repair.

b. The clearance and restoration of municipal transport services.

c. The provision, repair and maintenance of structures used by military forces including troop accommodation, headquarters, administrative, and prisoner of war facilities. These structures will be constructed to specific standards as detailed by the force commander as follows.

(1) **Initial Standard** for operations of six months or less.

(2) **Temporary Standard** for operations of six to 24 months. Temporary standard of construction can be used from the start of an operation if so directed by the force commander for all or some facilities.

(3) **Semi-permanent Standard** for operations over 24 months, but not permanent.

d. The repair or replacement of key bridges.

e. Arranging for real estate and municipal services.

f. The supervision of contracts associated with the provision and maintenance of utilities, structures and material.

SPECIALISED ENGINEERING DESIGN

4. The Force Engineers will be responsible to co-ordinate the provision of the following expertise to Canadian formations.

a. Specialist engineering design, engineering study, material testing, quality control, and engineering survey expertise for temporary design standard.

b. Design of modifications to existing facilities and non-standard facilities and structures.

c. Design, quality control and supervision of work on bituminous and concrete pavements in the theatre of operations.

d. Provision of operational level technical reconnaissance support including sea point of disembarkation, lines of communication and theatre staging bases.

e. Specialist advice on non - electronic camouflage, concealment and deception measures for fixed installations.

f. Specialist security engineering design expertise for the construction of non-expedient structures to improve physical security throughout the theatre. Security engineering involves the design and construction of facilities and structures to protect forces from a wide variety of threats including terrorists, theft, irregular forces and regular forces.

CONSTRUCTION MANAGEMENT

5. The Force Engineers will provide the following construction management services to Canadian formations;

a. financial management for the force engineer construction programme including, detailed planning, submissions, and programming of funding required for construction;

b. preparation of detailed cost estimates for force military operations;

c. implementation of the engineer portion of the host nation agreement and contracting of host nation support;

d. drafting and co-ordination of contracts;

e. specialised contracting services outside Canada. This may include contract administration, quality control and inspection where speed of response, language, unique customs or procedures require special expertise; and

f. construction management for major projects.

SECTION 5
UTILITIES

CONSTRUCT TERMINAL PIPELINES AND BULK STORAGE FACILITIES

The extension of the petro lines to the Rhine and beyond was a vital and urgent matter. Road deliveries of vehicle fuel, apart from being slow, deprived other commodities of much needed vehicles and road space. By the beginning of December 1944 the Boulogne end of "Dumbo" had been coupled to the Ostend-Ghent lines. Then, during December, a new set of lines had been laid between Antwerp and Eindhoven. These new lines were being rapidly pushed forward to the Rhine by R.E. units.

The History of the Corps of Royal Canadian Engineers, Volume 2

1. The construction and maintenance of terminal pipelines and bulk fuel storage systems is an engineer responsibility normally performed by theatre level engineer resources or host nation support. Operating fuel storage facilities is a logistics responsibility.

ENVIRONMENTAL ASSESSMENT AND RESPONSE

2. In accordance with the Canadian Defense Policy, all operations must be planned and conducted with appropriate consideration for their effect on the environment. Early planning is essential to ensure that all appropriate environmental assessments or reviews have been completed. Although a provision in the environmental act allows for exclusion for emergency operations, all attempts should be made to include environmental considerations at all levels of planning. On behalf of the NDHQ/J3, the J3 Engr in concert with the Force Engr will develop all aspects of the impact of operations on the environment as part of the planning process. Canadians will implement this policy in theatre.

3. Direction will be promulgated for ensuring attention is given to environmental considerations, but not limited to the following.

a. Policies and responsibilities to protect and preserve the environment during deployment;

b. certification of local water sources by appropriate medical field units;

c. solid and liquid waste management:

d. open dumping;

e. open burning; and

f. disposal of grey matter.

g. hazardous material management; and

h. spill plans.

SUPPLY OF WATER

R.C.E. 2nd Division opened the very essential water-point south of the Orne on a riverside site

> *near Fleury. It dispensed over 100,000 gallons of treated water in its first day's operation, serving military and civilians alike. Major Sutherland-Brown of the 7th Field Company was later to observe, "There had been heavy fighting earlier at this site but otherwise it was a good one because, being upstream from the city, it was less polluted, Even so, the men had to drag from the River the bodies of several enemy dead, a dead cow and the entrails of many others. During the preparatory work, as fighting stopped, the French civilians gradually emerged from their hideouts in the Fleury limestone caves. Their first action was to go to the River and get water, which they carried back to the caves in every kind of container. However, they soon realized it would be easier to draw water from a tap at the military water point and asked politely if they might do so. The first Frenchman couldn't wait for his pitcher to be filled before having a drink himself. I'll never forget his spluttering "Monsieur, your water is different from ours. Ça n'a pas de goût!" (It's tasteless!)"*
>
> The History of the Corps of Royal Canadian Engineers, Volume 2

4. One of the most important requirements for a fighting force is an adequate water supply. All units need water. The use of field water purification equipment can cater, with consumption restrictions, to troops in the field. Longer-term deployments will have to utilise larger, commercial, static water sources.

5. The full requirement for water goes far beyond the capacity of field equipment particularly on extended operations. In order for a force to be sustained properly, considerable extra quantities of water are required for ablutions, laundry, equipment servicing, fire fighting and other activities. This is termed bulk water and supplies of adequate purity may not be readily available in theatre on this scale. Bulk water supply is a Host Nation responsibility but, on any deployment, only limited reliance might be placed on Host Nation support.

6. Engineers are responsible for producing potable and non-potable water. Engineers at division normally operate field equipment, while corps and theatre engineers operate larger static water systems and pipelines.

7. **Planning Parameters**. Where adequate Host Nation supplies do not exist, the use of field equipment would have to continue until proper commercial bulk supply facilities could be procured and put in place, should this prove necessary for the deployment.

8. The production capacity of in-service field water supply equipment is adequate for the immediate needs of a deployed formation. If Host Nation support is inadequate it may be necessary to rotate the field equipment with that held by uncommitted formations, until bulk supply arrangements have been established.

9. The lines of communication in theatre could be of the order of hundreds of kilometres, and it is unlikely to be cost effective to ship water long distances. Therefore, producing water close to its end-use point must always be considered.

10. It is assumed that much of the equipment needed for bulk water supply will only be procured when a specific deployment is ordered.

11. **Consumption Scales**. Scales can only provide a guide. Although personal drinking water should not be restricted, the bulk of consumption (e.g. for washing, vehicle stowage, etc.) can be controlled by rationing and education methods of reducing overall water consumption. Over the long term however, this is likely to cause a progressive deterioration of health, morale and fighting effectiveness. As an illustration, a 10,000 persons formation, including vehicles and medical facilities, with about 50 percent accommodated in temporary camps, typically requires more than 1,000,000 litres of water per day.

12. **Portability and Purity**. Standards of water quality shall be in accordance with standardised agreements. One of the greatest dangers with drinking water is the possibility of its recent contamination by sewage or human excrement. The pathogenic

bacteria which this situation may introduce is extremely difficult to detect. Therefore, the most practicable safeguard is to assume that the continued presence, after treatment, of any faecal indications render the water unsafe. Constant monitoring and testing by both engineers and the medical services are vital.

13. **Sources and Extraction**. Whenever possible an existing piped supply should be used as the primary source of bulk water. Many, but certainly not all, countries have reasonably extensive piped systems, but the water and pipework may be of poor quality and the systems may lack the additional capacity required to cater for a deployed formation. Even so it will often be quicker and cheaper to improve and enlarge the existing system than to develop a new system. It is essential that the civil water supply be thoroughly investigated as early as possible when an operation is envisioned.

14. If the civil water supply can satisfactorily provide for the requirements, the security of the system against deliberate contamination and the ability of friendly forces to maintain control of it should be assessed. Alternative sources should always be identified. The potential availability of good quality water should always be one of the factors influencing the choice of location for temporary or semi-permanent camps.

15. Underground water held naturally in permeable strata, known as aquifers, is relatively immune from contamination and can be obtained from naturally occurring springs or by drilling into the aquifer. However, the water can often be rich in salts and minerals as to require extensive treatment before consumption. Furthermore, the effect involved in water exploration and subsequent extraction from underground aquifers can be considerable.

16. Streams and rivers can provide a good source. In sparsely populated upland areas they tend to be fairly pure, but rivers flowing through cultivated lands and populated areas receive effluent, which are likely to pollute them. This does not preclude their use but requires greater attention to the type of water treatment required. They can also be vulnerable to deliberate contamination.

17. Lakes are storage reservoirs of river water. Some natural purification of the water takes place by sedimentation and aeration. However, ponds are usually heavily contaminated with organic

matter and should not normally be considered as a source of bulk water for any period of time.

18. Potable water can be obtained from seawater or brackish water by using distillation or membrane technology.

19. It is possible to transport potable water by ship, land or even air. However, on economic grounds alone, it is unlikely to be practicable for protracted periods.

20. **Storage**. An area of operations may need a wide variety of storage facilities/capacities. The quantities of water that may have to be stored depend upon the actual source characteristics and a consideration of the potential resupply problems and will involve other agencies beside engineers such as the logistic chain of command.

21. The storage capacity required at each location will depend on the circumstances and specialist engineer advice will be required to determine it.

22. **Bulk Distribution**. Bulk distribution covers the transfer of water between source and treatment plan and between treatment plan and major point of use, such as the main inlet to a camp. The local availability of water, determined with engineer advice, is a major factor and should be considered when planning unit locations in order to reduce construction time, logistic effort and costs. The actual locations of water sources and the planned locations of military units will determine the required number and nature of distribution systems within an overall area of operation. If there is a shortage of sources suitable for field equipment, for use by deployed units, then the requirement for bulk distribution will exist as soon as the formation arrives in theatre.

23. The preferred method of distributing bulk water supplies is to use pipework systems from a number of dispersed sources as close as possible to the point of use. This method requires minimum manpower once the pipework systems are in place.

24. Unless there is existing pipelines, the early stages of a deployment will require water supplies to be transported by road

from the point of treatment to the user. This is potentially a considerable and unsustainable logistic burden and therefore adds emphasis to efforts to locate and treat water as far forward as possible.

25. **Distribution By Road**. There are several types of equipment available for transporting water in bulk and in most cases these can also be used to provide ready to use water storage at unit locations which must be considered in engineer planning. Responsibility for transporting water lies with the logistic chain.

26. **Distribution by Pipeline**. Engineers should construct pipelines as soon as possible to relieve available transport from the task of bulk water distribution. Individual pipeline lengths should be able to be restricted to a few kilometres if camp locations have been shrewdly selected. However, any system will comprise pumping equipment, sufficient valves and fittings to ensure control of the system and the pipework itself. In some cases, if the terrain is hilly, it may also be necessary to install break-pressure tanks. The selection of pipework material is important and depends upon many factors. For short term pipelines of up to a few kilometres in length, new layflat hose, not previously used for fuel, could be used. It is necessary to keep the cost and vulnerability of long pipelines in mind when determining how water sources should be used.

27. **Responsibilities**

a. **Staff**

(1) Deciding, with medical advice, the scale of issue, including quantities required for fire fighting and decontamination,

(2) deciding the distribution policy, with engineer advice,

(3) notifying units of the locations of water points, opening times, routes and any special precautions.

(4) arranging for traffic control and discipline at water points,

(5) organising the transportation of water, when necessary,

(6) making arrangements to ensure that sources of water are not fouled by troops or local inhabitants, and

(7) liaison with host nation for provision of water.

b. **Engineers**

(1) Advising the staff on water supply,

(2) installing, operating and maintaining specialist water supply equipment,

(3) reconnaissance and development of sources,

(4) collecting, treatment, field testing and storage at source,

(5) construction of all water points, and operation of those adjacent to the point of treatment, and

(6) distribution by pipeline.

c. **Medical Services**

(1) The complete analysis of any source water and advice on the suitability, quality, method of treatment and scale of issue of water,

(2) periodic detailed testing,

(3) recommending methods of preventing pollution at the source, and in the storage and distribution system, and

(4) checking that quality is maintained throughout the system.

d. **Military Police**

(1) Route signing, traffic control and discipline at water points, and

(2) if necessary, enforce pollution control policies.

e. **Logistics Units**

(1) Provision of water carriage equipment, some portable storage tanks and chemicals required for water treatment and

(2) bulk transportation of water by road, and

(3) operation of water points.

f. **Units**

(1) Collection of water from water or distribution points,

(2) operation of unit water supply equipment, and

(3) monitoring of water quality at point of consumption.

SEWAGE AND WASTE DISPOSAL

28. Disposal of solid and liquid wastes will be dependent upon the location and the surrounding environment of the area where the waste is to be disposed of and the nature of the operation.

29. **Solid Waste**. The method of choice for the disposal of solid waste or dry garbage should be burial in existing landfill sites. If existing landfill sites are not available, burial of waste should employ the characteristics typical of landfill operations. Burning of solid waste is an acceptable alternative.

30. **Organic Waste**. As with solid waste, disposal should be in accordance with local regulations through local contract.

31. **Human Waste**. The preferred method of disposal in order of precedence is sanitary water disposal and treatment systems, portable latrines, burnout latrines and slit trenches.

32. **Grey Water**. Effluent from showers/bathing facilities must be located downstream of any military or civilian water sources. Construction shall ensure proper drainage of grey water runoff to preclude pooling. All measures will be taken to prevent creation of new pest breeding sites.

33. **Medical and Hazardous Waste**. Commanders must give special consideration to hazardous waste, particularly waste products generated by medical facilities and maintenance operations. Where available host nation facilities shall be used.

34. **Responsibilities**. In the combat zone, units within the division are responsible for their own field sewage and waste disposal with engineer support as necessary. In the communication zone, theatre engineers will provide the necessary support to operate sanitary water disposal and treatment systems and landfill sites.

MOBILE AND STATIC ELECTRIC POWER GENERATION

35. An adequate electric power supply is a fundamental requirement in most military operations. Within the forward combat zone, electric power will be supplied by generating sets organic to units and headquarters. In the rear combat zone and the communication zone, it will be normal for engineers to establish some form of electric power generation and distribution. Corps and theatre engineers normally perform this function.

36. The staff, with engineer advice, is responsible for the promulgating the policy on electric power generation and distribution, including the use of civilian resources and laying down the priorities.

SECTION 6
CIVIL-MILITARY ENGINEERING

HOST NATION SUPPORT TO ENGINEERS

1. The use of host nation assets allows greater flexibility to assign engineer units to tasks that are more critical for success on the battlefield. It also reduces the requirement for specialist engineers to be brought into theatre to perform engineer functions. However, host nation support should not be relied on as a sole source of support. Pre-established host nation agreements can significantly improve engineer support provided. These agreements must be made prior to the outbreak of hostilities and cannot be relied upon for critical engineer requirements. Regardless of the presence of pre-established agreements, the force must deploy early enough with a contracting and real estate capability to acquire the necessary host nation assets. Some of the host nation assets that may be available are as follows.

a. **Government Agency Support**. The host nation may operate systems such as transportation and utilities. It can also provide police, fire and local security forces in support of rear area operations.

b. **Contractor Support**. Host nation, third country or Canadian contractors can provide supplies and services such as construction, labour and transportation.

c. **Civilian Contractors (**Host nation or third country nationals). Contractors can perform a wide array of services. Some of the civilian skills that may be required include construction labourers, skilled tradesmen, utility specialists and technicians.

d. **Host Nation Facilities**. The use of existing host nation facilities can relieve the need for construction of such facilities as accommodations, maintenance workshops, medical facilities and logistic facilities.

e. **Supplies and Equipment**. Such critical material as lumber, bricks, concrete and hardware may be obtained.

ENGINEER SUPPORT TO THE HOST NATION

2. The provision of engineer support to civil-military operations is an important aspect of promoting stability in an area of operations. However, before providing civil assistance, the engineer support requirements to the deployed force must be of primacy.

3. Assistance that may be provided by engineers throughout the theatre of operations may include:

a. Engineering work associated with the provision of medical, dental and veterinary care,

b. provision of potable water and the construction or repair of basic water and sanitation facilities and systems,

c. rudimentary construction and repair of public facilities (including utilities),

d. rudimentary construction and repair of surface transportation systems,

e. mine awareness training.

f. explosive ordnance disposal tasks, and

g. dismantling fortifications and obstacles.

4. All civil-military engineer work must be co-ordinated and approved by the national or alliance authority.

CHAPTER 10
COMBAT DIVING

The railway bridge at Nijmegen was blown up by German "frog-men" on 29th September, 1944. These men were of fine physique and were all swimming champions equipped with special clothing and fitments to render their task easier. Twelve of them entered the water seven miles above the bridges and swam down in the dark, on a bitterly cold night, four miles of their journey being between banks held by the Allies. On the way, one man was shot, two died of exhaustion and exposure, and one disappeared. They worked in pairs, each pair navigating two German "S" type naval mines, tied together by a loose rope. They had been trained how to manoeuvre their mines over a boom, but in fact they only encountered some wire which they surmounted. As they approached the bridge, the two men in each pair separated and got a mine on either side of the pier. The mines on release of a special cylindrical float chamber at each end, turned vertical and sank, starting up a clockwork timefuse. The charge in each mine was 1,220 lb. of hecanite.

They successfully placed and fired three of their six pairs of mines, two on the railway bridge pier, and one on a pier of the road bridge. The railway bridge pier was thoroughly demolished. The road bridge had a hole 70 feet long in the roadway. The stringers, cross-bracing and roadway were torn to bits and folded upwards.

The eight survivors swam on hoping to reach their own troops lower down, but were forced to land by exhaustion. As a feat of skill, endurance, and pluck it was a fine performance.

Military Engineering (Field)
The War Office 1952

GENERAL

1. The CER and the ESR have dive sections. Combat divers are field engineers who perform the combat diving function as a secondary duty. Divers in the CER normally provide support to their affiliated brigade, while divers of the ESR support divisional troops. Divers from the ESR may augment the CER for deliberate tasks such as water crossing operations.

ROLE

2. The roles of the combat diver are as follow.

a. **Primary Role**. To provide formations with the capability of performing field engineer tasks underwater.

b. **Secondary Role**. To perform safety duties for water crossing operations and underwater search and recovery.

TASKS

3. In general terms combat diving tasks can be categorised as follows:

a. reconnaissance,

b. demolitions,

c. obstacles,

d. construction,

e. safety duties, and

f. search and recovery.

Figure 38 depicts a summary of diving tasks and the level at which they are performed.

4. Reconnaissance

a. **Crossing Area Reconnaissance**. Although much information can be gained from aerial photographs, maps and other sources, it is invaluable to do a reconnaissance of the riverbank and river bed before conducting a water crossing operation. Crossing area reconnaissance is undertaken by combat divers to determine the characteristics and limitations of fords, rafting, ferrying, bridging and assault boat sites. It also includes locating and marking of obstacles which may hinder the crossing operation, the marking of suitable sites and reporting on the going, routes, defences and enemy positions on the far bank. Depending on the sites, these tasks will be completed by surface swimmers , compressed air breathing apparatus or rebreather equipped divers. Surface swimmers or rebreather equipped divers study sites under enemy observation because of the audible and visible signature caused by air bubble emission of compressed air breathing apparatus equipment. A surface swimmer can conduct a reconnaissance with some stealth, but modern sensing technology may limit this stealth capability. Without the breathing apparatus, the ability to conduct underwater reconnaissance is limited.

b. **Beach Reconnaissance**. Beach reconnaissance is done by divers to support amphibious landings and includes conducting a detailed beach survey, locating and marking obstacles and reporting on mobility, routes and enemy positions covering the beach. Divers conducting such operations may be delivered to an amphibious landing site by boat, submarine or helicopter and of necessity must be skilled in navigation and coping with the surf conditions. Beach reconnaissance is a highly specialised diver task completed by divers above the corps level. Beach reconnaissance is not a combat diver responsibility.

c. **Engineer Underwater Reconnaissance**. Underwater reconnaissance is a wide-ranging subject which could well involve divers conducting reconnaissance for construction, demolitions, dock/port facilities or general engineering support tasks anywhere in the area of operations. Normally the reconnaissance would be undertaken by the organisation that would actually execute the task.

5. **Demolitions**

a. **Removal or Destruction of Underwater and Surface Obstacles**. The destruction of underwater and surface obstacles hindering water crossing operations falls within the domain of divisional combat divers. This task is normally conducted while under enemy observation and much of the work is below the surface, necessitating a capability to operate undetected underwater.

b. **Destruction of Piers, Docks and Underwater Installations**. These types of operations are most likely to occur in either the corps rear area, as a construction task or in the enemy rear area as part of a harassing action or raid. In both cases the task is beyond the scope of divers in the division, thus theatre or special forces divers would be involved.

c. **Underwater Detection, Neutralisation and Destruction of Unexploded Ordnance**. Combat divers will be trained to undertake explosive ordnance disposal tasks for inland waterways in direct support of their formation. For tasks involving Navy clearance divers, the high water mark is the division of responsibility between clearance divers and combat divers.

6. **Underwater Obstacle Construction**. Antitank mining in knee deep water at probable fording and crossing sites which have bottom and bank conditions suitable for their emplacement is likely. It is seldom necessary to use compressed breathing apparatus equipped divers for laying mines, however, a surface swimmer with a wetsuit will be more effective than a sapper. Similarly they must be capable of emplacing wire obstacles, log cribs or other underwater obstacles.

7. **Construction**

a. **Examination and Repair of Bridge Piers and Floating Bridge Equipment**. It may be necessary to make temporary repairs to military boats, floating bridges or rafts without removing them from the water. In most cases damaged floating or amphibious bridging will be replaced by spares held near the site for that purpose and the repairs will be done later. However, the ability of a combat diver to quickly affix a patch to a pontoon may in certain situations be critical to the success of the operation. Although extensive repairs to bridge piers will normally be undertaken by higher formation engineers, divers within the division may be required to do limited repairs to a bridge pier or conduct technical inspections and taking pictures of underwater infrastructure.

b. **Laying and Repairing Underwater Pipelines and Communication Lines**. These are major tasks that are planned and executed at Corps level or above by specialised divers.

c. **Construction, Maintenance and Repair of Docks, Piers, Dams, Sewage Systems and Water Systems**. Divers in the division may undertake minor construction projects that require no special engineering skills other than those required by all field engineers. However, divers from organisations at corps or theatre level will accomplish major repair or construction tasks that require the use of specialised tools and equipment.

Divers in the Joint Task Force Engineer Support Unit may be called upon to partake in these tasks.

8. **Safety Standby Duties**. Although provision of safety boats and standby divers is largely a peacetime task, a safety organisation may be used in operations if the situation permits. Similarly standby duties for parachute descents over water is also a peacetime task. A safety organisation may be used during rehearsals prior to a water crossing, and during the crossing if possible.

9. **Search and Recovery**. Search and recovery of lost or drowned personnel, stores, vehicles, aircraft and equipment is a combat diver task that may be required in wartime. Recovery of lost stores and sunken vehicles is a major diving task. To support bridging and assault water crossing operations, divers must be skilled in the use of lifting bags and improvised lifting aids.

TASKS IN SUPPORT OF SPECIAL OPERATIONS

10. Infiltration of divers by parachute, fast boats or helicopter to execute raids or harassing actions are highly specialised operations that are best performed by diver trained special operation soldiers and equipped for the task. Special operations are strategic in nature and are planned and controlled at theatre level and above. Combat divers do not execute such tasks.

COMBAT DIVER TASKS

Serial	Task	Level of diving expertise required	
		Division and below	Corps and Theatre
1.	**Reconnaissance**		
	Crossing area reconnaissance	X	X
	Beach reconnaissance		Special Forces
	Engineer task reconnaissance	X	X
2.	**Demolitions**		
	Removal or destruction of underwater and surface obstacles	X	X
	Destruction of piers, docks and underwater installations		X
	Underwater detection, NEUTRALISATION and destruction of unexploded ordnance	X	X
3.	**Mine Warfare and Obstacle Construction**		
	Construction of underwater obstacles including mines	X	X
4.	**Construction**		
	Examination and repair of bridge piers and floating bridge equipment	X	X

Serial	Task	Level of diving expertise required	
		Division and below	**Corps and Theatre**
	Laying and repairing underwater pipelines and communication lines		Specialised Divers
	Construction, maintenance and repair of docks, piers, underwater sewage systems and water systems		X
5.	**Secondary Role Tasks**		
	Safety standby	X	X
	Search and Recovery	X	X
	Special operations		Special Forces

Figure 38: Combat diver Tasks

CHAPTER 11
ENGINEERS IN OTHER OPERATIONS

SECTION 1
OPERATIONS IN UNIQUE ENVIRONMENTS

GENERAL

1. Unfamiliar environmental conditions can severely affect engineer tasks in operations in unique environments. Environmental extremes can be overcome by using specialised techniques and procedures. Proper training and equipment are paramount in overcoming some of these difficulties.

COLD WEATHER OPERATIONS

2. **General**. Northern regions comprise about 45 percent of the North American continent and 65 percent of the Eurasian landmass. Deep snow or ice, permafrost, seasonally frozen ground, lakes and rivers, glaciers and extreme cold characterise these regions. In addition to the climatic effects, the vast distances and isolation common to these areas also influence military operations.

3. Forces operating in cold weather conditions should be capable of all types of operations, although it should be understood that the execution of these would be exceptionally difficult and be more time consuming. The critical aspect of operations in cold weather conditions is that the survival of the force may be a more difficult problem than dealing with the enemy. Success will depend on the training, equipment and acclimatisation of forces. Engineer organisations can be adapted to cold weather operations by modifying some of their equipment and by providing supplemental training to their personnel. In general the amount of engineer heavy equipment and special purpose equipment must be increased.

4. **Planning**. Engineer planning must take account of likely weather conditions and possible changes. The impact of weather changes on engineer operations will be considerable. For example:

a. Deep snow renders minefields ineffective.

b. Thaw conditions increases the number and size of water obstacles.

c. In extreme cold, every engineer task requires more time to execute and allowance for this must be made in planning.

d. Individual preparation for an operation requires attention to details such as clothing and equipment.

e. Personnel operating in these conditions require additional time and rest.

f. Planning must take account of the absolute requirement for shelter and water supply.

g. Mapping, navigation and positioning may be difficult due to magnetic variances, long/short daylight periods, effects of moonlight and the aurora, combined effects of very high latitudes and landforms on satellite accessibility, s well as sparse terrain.

5. **Tasks**. It is likely that in cold weather operations, greater emphasis will be placed on mobility and survivability:

a. **Mobility**. Mobility will be impeded by snow, ice covered terrain, weather and long hours of darkness. Mobility will be provided by aircraft, oversnow vehicles, skis and snowshoes, but much reliance will also be placed on conventional wheeled and tracked vehicles,

b. **Counter-mobility**. Counter-mobility tasks are likely to concentrate on the limited routes available. Route denial, demolitions and off-route mines will be particularly important. Minefields may also be used but the following must be considered in their planning and laying:

(1) The effect of cold on materials,

(2) the reduced work rates in cold weather conditions,

(3) the variable performance of equipment and systems in deep snow conditions, especially scatterable mines, and

(4) the need for subsequent adjustment to be made after fresh falls of snow or sudden thaws.

c. **Survivability**. Shelter is essential to survival. The preservation of our own shelters and the destruction of the enemy's become important ends in themselves, which can influence the outcome of the battle. Measures for increased chances of survival to enemy action and hostile environment include:

(1) the construction of field defences, snow and ice fortifications with overhead protection using either improvised or equipment shelters and snow/ice concrete, and

(2) the provision of advice and assistance with counter-surveillance plans and works.

d. **Sustainment Engineering**. It is necessary to allocate increased resources for water supply and facilities for shelter with heating and lighting.

e. **Geomatics**. The geomatics engineer must be prepared to advise on the effect on terrain of extreme cold temperatures and climate changes and how this effects our ability to live, move and fight. Navigation assistance, geodetic positioning and advice on the effects of light and the magnetic fields will also be important.

MOUNTAIN OPERATIONS

6. **General**. Mountains are defined as land forms higher than 500 metres with steep inclines. Slopes commonly range from 4 to 30 degrees. Mountains may consist of an isolated peak, single ridges or complex ranges. It may include built-up areas and plains between mountain ridges, plateau's, passes and the mountainsides themselves. Success in mountain operations is usually achieved by the forces that gain control of key terrain, such as ridge tops, valley outlets, mountain passes, defiles and routes. These have a canalising effect and can be controlled by force on the dominating heights around them. The battle for the heights will therefore be the governing factor in mountain operations. Accordingly, they will be likely objectives and key terrain on which the defences will be based. Due to the restricted mobility of ground vehicles, the use of helicopters for tactical mobility, reconnaissance, resupply and evacuation may have decisive importance.

7. **Planning**. Command and control of engineers may become more difficult because of the terrain and possible extremes of climate. Geomatics support, particularly terrain analysis, will be in high demand because of the complexity of the terrain and preparation of databases must begin early. A good assessment of likely tasks will allow the engineer commander to position correctly his personnel and equipment. Engineer reconnaissance must be positioned well forward in the advance. Heavy equipment must be readily available to the lead engineer elements on mountain roads.

8. **Tasks**

a. **Mobility**. Mobility support is likely to be the major task, particularly the construction, improvement and maintenance of routes. Main supply routes may be vulnerable particularly where they run through defiles. The provision of drainage and bridging is likely to be required because of the large number of mountain streams and their susceptibility to flash flooding. New bridges may be required to cross streams, replace weak bridges and cross gorges. Construction of new routes is likely to involve major engineering work especially excavation and fill.

b. **Counter-mobility**. As routes are restricted, the effect of obstacles will be greatly enhanced. The blocking of roads and passes, the destruction of tunnels and minelaying, and the use of anti helicopter mines to deny covered approaches to enemy helicopters are particularly effective in rugged terrain. Care must be taken not to restrict the movement of own forces. All obstacles may have to be co-ordinated at a higher level of command than for normal operations.

c. **Survivability**. Digging in may be difficult even using explosive means. It is likely that defensive positions will largely be based on raised fortifications. The construction of such defences remains an all arms responsibility but engineers may be called upon to provide more advice and greater assistance. Irregular mountain terrain provides many opportunities for cover and concealment. Light engineer equipment transported by helicopters can provide valuable assistance in the protection of troops.

d. **Geomatics**. Special features such as slopes, valleys, character of roads (grades, curves, tunnels, natural bottlenecks, etc.) and the abundance of defensive positions will take on great importance in the analysis of the terrain. Commanders will also be interested in the effects of relief on drainage, observation, radar and communications and command sites. High altitudes and limited air corridors take on added significance in advising air and aviation planners.

EXTREME HOT WEATHER OPERATIONS

9. **General**. Arid regions make-up about one third of the earth's surface, a higher percentage than that of any other type of climate. Desert terrain varies considerably from place to place, the sole common element being lack of water with its consequent environmental effects, such as sparse, if any vegetation. The basic land forms are similar to those in other parts of the world, but there has been erosion of the topsoil, due to a combination of lack of water, heat and wind, to give deserts their characteristic barren appearance. The bedrock may be covered by a flat layer of sand, or gravel, or may have been exposed by erosion. Other common features are sand dunes, escarpments, wades and depressions. Roads are usually scarce and primitive.

10. This environment can profoundly affect military operations. The paucity of natural features make navigation difficult and equipment and tactics must be modified and adopted to a dusty and rugged landscape where temperatures vary from extreme highs down to freezing and where visibility may change from 10 km to 10 m in a matter of minutes. It is important to realise that deserts are affected by seasons. The desert is fatiguing, both physically and mentally. Factors such as heat injury, climatic stress, radiant light and desert wildlife can adversely impact soldier's effectiveness.

11. In some desert areas, natural obstacles such as wades or other terrain features can be found. Often, however, it will be necessary to use artificial obstacles if enemy movement must be slowed. A minefield, to be of any tactical value in the desert, must usually cover a relatively large area, so mechanical means are best suited. Since there are often too many avenues of approach to be covered with mines, it is usually best to employ tactical minefields to cover any gaps between units, especially at night.

12. **Tasks**

a. **Mobility**. The vastness of the desert makes mobility a prime concern. Cross country mobility may be poor in fort sand, rocky areas and salt flats. Greater engineer reconnaissance effort will be needed to identify routes, existing obstacles and minefield locations.

b. **Counter-mobility**. Due to the vastness of the desert, situational obstacles often may be the best choice to reduce the enemy's mobility. Directed obstacles may be extensive and must be used in conjunction with natural obstacles. Sand is effective in covering mines, but also creates potential problems such as exposing the mines, causing them to malfunction and degrading their performance due to excessive accumulation. Shifting sand can also cause mines to drift.

c. **Survivability**. Deserts provide little cover and concealment from ground-based observers and even less from aircraft. Because of the lack of concealment, camouflage must be used. Hull and turret down positions for tactical vehicles may be important. Dispersion and frequent moves are other survivability techniques. Preparation of fortifications in the desert is difficult. Sandy soil requires revetment, while rocky plains or plateau’s may be impossible to dig in; to counter this problem, emplacements are built up with rocks, and depressions are used.

d. **Sustainment Engineering**. The harsh desert climate makes the requirement for water supply, dust inhibitors on roads, and general sand and dust control important engineer tasks.

e. **Geomatics**. Many desert areas have never been mapped at medium scales and geomatics engineers must be prepared to rapidly provide substitute products. Deserts often provide few natural features and the geomatics engineer will be required to provide assistance to aid navigation and interpretation of map products. Geodetic positioning will be important where there is little or no framework. Influence of surface materials on trafficability and dust, light conditions and location of water sources will also be main concerns.

JUNGLE OPERATIONS

13. **General**. Jungle is defined as that area within the humid tropics where the growth of trees or other types of associated vegetation is dense. The vegetation impedes military operations and tends to obstruct lines of communications. Tropical vegetation in jungle areas includes lowland and highland tropical rain forests, dry deciduous forest, secondary growth forest, swamp forest and tropical savannahs. Movement of troops and supplies through jungle growth is most difficult. Visibility is often limited to a few metres. Jungles are sparsely inhabited. Good roads are rare, usually narrow and winding, and incapable of supporting sustained military traffic. Air support thus becomes important.

14. **Tasks**

a. **Mobility**. The construction and maintenance of roads and tracks are the initial means of improving mobility. Heavy rainfall, clearance of vegetation, drainage and the movement of heavy equipment and resources all combine to make this a long and painstaking task. Once constructed, routes will need regular maintenance. Landing sites and drop zones must be constructed to enhance the ability to move men and resources by air. Crossing obstacles such as large rivers will be necessary, therefore, bridging and other special engineer equipment will be necessary. Minefields in the jungle are likely to be of the nuisance or protective type and remain an engineer task for clearance. Engineers may also be required to breach enemy defensive positions and to clear booby traps.

b. **Counter-mobility**. The main counter-mobility task for engineers will be to block roads, lay mines and booby traps and to carry out demolitions. Blocking roads or tracks is always particularly effective to provide opportunities for counter actions such as ambush or air strike.

c. **Survivability**. Engineers may be required to construct defensive positions, field fortifications, including gun positions, and protective locations for combat supplies.

d. **Sustainment**. Engineers will have a wide variety of tasks and commitments that will require their advice and attention. In the early stages of deployment these are likely to be concerned with the establishment of infrastructure. In jungle operations particular emphasis will be placed on the supply and treatment of water in conjunction with the medical authorities.

e. **Geomatics**. It will be important to determine the influence of vegetation on the navigation and movement of troops and equipment, concealment, observation and use of weapons. Geomatics engineers must also determine the effect of climate (particularly the rainy season) on drainage features, roads and cross-country routes, river navigation and visibility.

FOREST OPERATIONS

15. **General**. Forested areas are characterised by conditions of limited mobility and, frequently, by poor visibility and limited fields of fire. It is impossible to plan operations without considering their effects.

16. **Planning**. The following factors require special consideration when planning operations in wooded areas.

a. Engineers may need to be deployed in small, widely dispersed, dismounted detachments;

b. command, control and communications are more difficult;

c. engineer commanders at each level require greater freedom of action;

d. because engineer elements are more widely dispersed, there may be a greater requirement for them to be prepared to defend themselves and to play the role of infantry;

e. forested areas are generally unsuitable for reserved routes, though routes need to be kept open for rapid re-deployment and counter-attacks; and

f. forests are not necessarily impenetrable to armoured vehicles. Some areas need to be reinforced with antitank mines and other obstacles.

17. **Tasks**

a. **Mobility**. The initial emphasis in counter-mine operations is likely to be on the close support to combat units. Counter mine operations will be extensive. Other likely tasks include abatis clearance and breaching road craters;

b. **Counter-mobility**. Antitank obstacles can easily be created in wooded areas to close routes using surface laid mines, road cratering and abatis. The use of antipersonnel obstacles, such as wire, significantly delays the enemy's progress.

c. **Survivability**. Engineers are required in the clearance of fields of fire and the construction of field fortifications. Manoeuvring and operating engineer heavy equipment amongst trees is likely to be difficult. Forests will frequently be use as hide areas and to support camouflage and concealment. Fire breaks may need to be constructed to enhance the survivability of friendly positions.

d. **Sustainment Engineering**. Sustainment engineering support in forests does not differ from that support provide in other environments.

e. **Geomatics**. It is important to determine the effects of vegetation on the navigation and movement of troops and equipment, concealment, observation and use of weapons. Assessment of forested areas as natural obstacles and sources of material will be required.

SECTION 2
AIRMOBILE AND AIRBORNE OPERATIONS

AIRMOBILE OPERATIONS

The wide sweeping gateway into Belgium through which the Germans had smashed their way in 1914 was guarded in 1940 by a series of ultramodern fortresses. The most formidable was Fort Eben Emael, north of Liège near the junction of the Albert Canal and the Meuse. Its 1500 men garrison was protected by thousands of tons of earth and concrete. Their equipment consisted of two 120mm guns and sixteen 75mm guns - secreted in well camouflaged, well armoured apertures and sited to pour devastating fire on enemies coming from any direction.

At 4:30 a.m. on the 10th of May 1940, 42 junkers transport planes, each hauling a glider carrying a team of airborne troops that was trained in the use of special assault equipment, took off from Cologne for Fort Eben Emael and the Albert Canal bridges.

The force assaulting Eben Emael were engineers in one group of nine gliders which swooped directly onto the roof of Eben Emael. The *force of 80 sappers, leaped out to storm the massive fort. In a manoeuvre rehearsed repeatedly in the preceding months, they set about cramming explosive charges into gunslits and ventilators and any other openings they could find. For the armoured gun turrets they used special hollow-charge demolition devices that blew holes in steel and concrete and spewed flames into the interior. Flame throwers, discharged into the gunports, added to the fires that had already been started inside and thickened the acrid smoke. Within an hour after dawn, Eben Emael was a blinded giant, incapable of holding up the sweep of the invading German army.*

Blitzkrieg
Robert Wernick

1. An airmobile operation is an operation in which combat forces and their equipment manoeuvre about the battlefield in helicopters under the control of a ground force commander in order to engage in ground combat. Airmobile operations are conducted as an integral part of the land battle during all types of ground operations, offensive, defensive or delaying as well as transitional phases. Air mobility provides an additional dimension to ground force mobility, but technical restrictions and aircraft vulnerability limit the potential. Airmobile operations are likely to lack integral armour and engineer equipment and have limited, if any, artillery support. Engineer support is important for such tasks as minelaying and rapid road cratering, to canalise and delay enemy armour. Substantial survivability support to protect the force against enemy fire and to allow antitank weapons to be used to their maximum effect is necessary.

AIRBORNE OPERATIONS

2. An airborne operation is a joint operation involving the air movement of combat forces into an objective area. The combat forces may be self-contained for short-term operations, or the operations may call for the insertion of combat support and service support units. The troops employed may be a combination of

parachute and air-landed elements, depending on the mission and the tactical situation.

ENGINEER SUPPORT

3. **Planning**. The time required for engineer planning and preparation should be taken into account. Engineer equipment and stores are heavy and there will be severe restrictions on the amount that can be airlifted. The engineer commander must anticipate possible tasks and advise the commander on priorities so that the best use can be made of the limited lift available. Once forces are deployed, communications are likely to be difficult, so each engineer sub-unit must have clear orders on its tasks and priorities. Troops will normally only deploy with stores and equipment for one major task. Subsequent tasks will necessitate re-grouping and the collection of additional stores from drop or landing zones.

TASKS

4. The fundamental characteristics of airmobile or airborne operations are the need for speed and the limited airlift available. Tasks for engineers operating in an airmobile or airborne force must be co-ordinated with any ground forces affected. Tasks will be planned and resources allocated based on information and intelligence, using standard planning data. Adjustments to engineer tasks must be cleared with the local commander and reported up the engineer channels. The absence of vehicles and any imposition of radio silence may make this very difficult. These tasks may include the following.

a. **Mobility**

(1) Point of entry preparations for helicopters, such as pick-up points, pick-up zones, landing sites, including forward arming and refuelling points, and clearance of landing strips and zones.

(2) Countermine operations: detection, breaching and marking of mined areas including anti helicopter mines.

(3) Explosive ordnance reconnaissance and explosive ordnance disposal.

(4) Secure crossing sites for water crossing operations.

b. **Counter-mobility**

(1) Rapid mine laying. The resources will seldom be available to lay large patterned minefields; engineers therefore require off-route mines, and scatterable nuisance minefields on critical approaches.

(2) Demolitions and rapid cratering of roads.

c. **Survivability**. Airmobile and airborne forces need to dig-in rapidly guns, mortars, antitank weapon positions, and command posts.

d. **Sustainment Engineering**. Minimal sustainment engineering support will be possible.

e. **Geomatics**. Geomatics engineers may assist in identifying landing and drop zones, helping commanders visualise unfamiliar terrain and predict the effects of natural and artificial sources of light. Additionally, they are able to predict a number of terrain influences such as flying hazards, terrain that channels flight paths, features which can be used for orientation and navigation, and radar masking of enemy antiaircraft systems.

SECTION 3
AMPHIBIOUS OPERATIONS

Just half of the 350 divisional assault engineers from three field companies of the Royal Canadian Engineers (7th, 11th and 2nd) plus the 1st Field Park Company, managed to land in assigned groups with the tanks: 71 sappers in beach assault parties and 98 demolition sappers. Their tasks were to manhandle heavy explosives and Bangalore torpedoes to blast holes in the strong wire barriers, to lay chespaling slats under the tank treads, and to haul timber to build ladders to get the tanks over the six-foot concrete sea wall. These men had no protection from the enemy fire; they were mowed down mercilessly. The sapper were to suffer 85 to 90 percent casualties that morning the worst toll of any unit there.

Dieppe Tragedy to Triumph
Brigadier-General Denis Whitaker, Shelagh Whitaker

GENERAL

1. Amphibious operations against undefended or defended coastlines present particular problems for engineer support to the landing force. Engineer support is vital to both the initial landings and the subsequent operations. The requirement for rapid build-up ashore accounts for the organisational and technical differences between amphibious and land warfare. Amphibious operations are focused on mobility, characterised by extensive reconnaissance and massed engineer support.

ENGINEER SUPPORT

2. **Planning**. An amphibious operation is normally commanded by the commander of the amphibious forces involved, until the landing force is ashore and capable of operating independently. Command is then passed to the senior ground force officer. It is essential that engineers are represented from the outset

of all planning. It is possible that when plans for the amphibious operations are confirmed at sea, embarked engineer assets are not suitably located for amphibious off-loading. Movement of assets between ships, or "cross-decking", are then required before the landing force moves into the combat zone.

3. **Tasks**. The range of tasks likely to confront the engineer commander in an amphibious operation is extensive and is likely to include the following.

a. **During Planning**. Geomatics engineers will be required to provide extensive analysis of a number of conditions:

(1) General configuration of kind of coast

(2) offshore condition such as wind, water temperature, currents, swells, tides, reefs, bars, shoals, etc.,

(3) littoral terrain including beaches, foreshore and underwater approaches, and

(4) inland terrain such as exits and routes, natural obstacles (cliffs, sea walls, etc.), defensible positions, cover and concealment and natural landmarks.

b. **During Initial Landings**. Combat engineer effort could be required to clear beach obstacles, defences and mines and to construct or improve beach exits and dump areas. The most important engineer focus is to create passage across the beach for the force.

c. **During Subsequent Operations**. The full range of engineer tasks is likely to arise in forward or rear areas. There could be requirements for support to helicopters or aircraft if it is decided to move them ashore, as well as the provision of fuel handling equipment and water supply facilities.

Engineers support is essential for the break-out from the beach as for water crossing operations. In the conduct of amphibious operations it is essential to focus on the objective, not on the bridgehead line.

4. Inevitably, there will be a shortage of engineer assets, particularly matériel during the initial stages of an amphibious operation. Planning should take this into account. All units should land with the maximum equipment. Emphasis must be placed on improvisation and the full use of local resources.

SECTION 4
ENGINEER SUPPORT TO OPERATIONS OTHER THAN WAR

GENERAL

1. As for the other arms and services most of the engineer support to operations other than war draws upon the overall battle tasks with some specialised skills added to deal with special situations not relevant in combat. Engineer participate in operations other than war in their traditional role within the all arms team, however, they can also be called upon to participate as the lead or even sole provider of military support to the activity.

2. In general terms the importance afforded to combat engineering and sustainment engineering tasks is often the opposite to what is presented throughout this book, even at the tactical level. The types of specialised tasks expected to be accomplished by engineers in domestic and international operations as part of a multi-disciplinary response or alone are described below.

a. Technical engineering advice including:

(1) advice on protective design of structures against conventional or terrorist threats;

(2) assessing damaged roads, bridges, structures and utilities;

(3) conducting topographic surveys to determine the extent of damages;

(4) overprinting of maps to depict damage, water levels and key operating facilities; and

(5) environmental engineering studies.

b. Provision of personnel and equipment to:

(1) operate small boats;

(2) open roadways for emergency traffic;

(3) clear debris and mud;

(4) construct temporary bridges;

(5) demolish unsafe structures;

(6) restore critical facilities, services, and utilities;

(7) provide potable water facilities and distribution;

(8) provide emergency sanitation facilities;

(9) construct displaced-persons camps;

(10) perform emergency snow removal;

(11) fight forest-fires;

(12) explosive ordnance disposal including improvised explosive devices;

(13) conduct underwater search and work;

(14) participate in flood control including the use of explosives to break ice jams;

(15) community assistance programs including technical engineering services or advice; and

(16) environmental response.

3. International aspect of the above activities include a wide range of skills derived from military operations and can include:

a. demining programs;

b. mine awareness programs;

c. post conflict nation restoration advice;

d. military training of foreign soldiers; and

e. construction activities in support of humanitarian objectives, sometimes called nation-building activities.