

FIELD ENGINEERING MANUAL

VOLUME 4

## **BASIC FIELD ENGINEERING**

(ENGLISH)

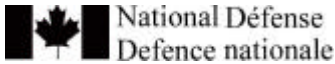
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Issued on Authority of the Chief of the Defence Staff  
Publiée avec l'autorisation du Chef d'état-major de la Défense

**Canada**



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Director of Army Doctrine 8 (Protection)

1997-11-06

**Canada**

## **FOREWORD**

1. B-GL-320-004/FT-001, Field Engineer Manual, Volume 4, Basic Field Engineering, is issued on the authority of the Chief of the Defence Staff.
2. This publication is effective upon receipt.
3. Suggestions for amendments shall be forwarded through normal channels to Chief of Land Staff, Attention: Director of Army Doctrine 8 (Protection).

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## **CHAPTER 1**

### **INTRODUCTION**

#### **GENERAL**

1. Engineers are responsible for a wide variety of tasks ranging from the construction of buildings, airfields, roads and bridges, to the destruction of facilities and resources. To carry out these tasks, the sapper will require numerous skills and techniques.

2. The majority of these tasks will have no set procedure, and all too often the tools and equipment will not be suitable. To succeed, sappers shall depend on flexibility, imagination and on the improvisation of common fundamental field engineering skills. As there will be very little time to consult a reference book during operations, this manual establishes the basic skills with which the individual sapper, through training and practice, shall be conversant.

#### **AIM**

3. The aim of this manual is to provide information on the fundamentals of field engineering skills, tasks, and on the equipment and resources used to complete them.

#### **SCOPE**

4. This manual is designed to be a comprehensive reference for the individual field engineer and assault pioneer, as well as their superiors. This manual covers the following:

- a. organization of a field engineer task;
- b. field engineering hand and power tools;
- c. compressor, pneumatic and hydraulic tools;
- d. generators and lighting systems;
- e. engineer heavy equipment;

- f. engineer resources;
- g. field surveying;
- h. basic bridging techniques;
- j. basic concrete techniques; and
- k. helicopter landing sites.

5. **Important:** This manual does not duplicate or nullify the requirement for equipment operator manuals.

## REFERENCES

6. Annex A contains a list of references which may be used in conjunction with this manual, as well as pertinent standardization agreements which have been incorporated.

## DIMENSIONS

7. Metric units and formulae are used throughout the manual, although in some cases imperial units are also given because of measurements used by manufacturers. Annex B contains conversion tables between metric and imperial units of measure.

## ANNEX A

### REFERENCES

1. The following publications are related to and may be used in conjunction with this manual:
  - a. B-GL-303-002/JX-007, Operational Staff Procedures, Volume 2 Staff Duties in the Field, Supplement 7, Engineer Vocabulary;
  - b. B-GL-319-001/FT-001, Volume 1, Engineers in Battle;
  - c. B-GL-320-002/PT-001, Engineer and Assault Pioneer Pocketbook (April 1989);
  - d. B-GL-320-003/PT-001, Engineer Planning and Organization of Work (August 1973);
  - e. B-GL-320-005/FP-001, Engineer Field Manual, Volume 5, Rigging;
  - f. B-GL-320-006/FP-001, Engineer Field Manual, Volume 6, Earthmoving Operations;
  - g. B-GL-320-007/FP-001, Engineer Field Manual, Volume 6, Field Defences and Obstacles;
  - h. B-CE-320-012/FP-002, Engineer Field Manual, Volume 12, Horizontal Construction, Part 2, Roads;
  - j. B-CE-320-012/FP-003, Engineer Field Manual, Volume 12, Horizontal Construction, Part 3, Airfields; and
  - k. B-GL-320-014/FP-001, Engineer Field Manual, Volume 14, Field Water Supply.
2. The following foreign and civilian publications have been used as a reference for this manual:

- a. B-GL-050-ENG/FT-085, Volume II, Pamphlet No 1, Basic Field Engineering (1974);
- b. B-GL-050-ENG/PT-175, Volume XVI, Earthmoving and Construction Plant (1979);
- c. R-GG-F05-034/FP-000 (FM 5-34) US Engineering Field Data; and
- d. C-83-050-001/MD-000 (FM 5-725) Rigging (October 1968).

3. The following list of Technical Orders are partially incorporated in this manual:

- a. C-96-145-120/MP-000, Pionjar Service Manual (1976 with change 1 1977);
- b. C-96-010-001/MN-001, Chain Saw Service Manual, 6th Edition;
- c. C-96-011-00D/ME-000, Milling Aid Installation/Assembly Instruction (1979);
- d. C-96-153-B00/MB-000, STIHL Power Auger Instruction/Parts Manual (October 1977);
- e. C-30-355-000/MB-001, Operating Instructions for Auger Mounted on Truck, Field Engineer Section 2½ Ton M36 Cdn (with winch);
- f. C-30-674-000/MB-001, Operating Manual M113A2 Bulldozer Carrier with Engineer/Pioneer Equipment;
- g. C-30-897-000/MS-001, Operating Manual Trailer, Engineer Hydraulic Tool System (TEHTS);
- h. C-33 series of Heavy Equipment Operator Manuals; and

- i. Manufacturer's Operating and Maintenance Manuals for Stanley Hydraulic Tools.
4. The following NATO and ABCA Standardization Agreements have been wholly or partially incorporated into this manual:
- a. STANAG 2010 Military Load Classification Markings;  
and
  - b. ATP-49(A) Helicopter Operations.

**ANNEX B**

**IMPERIAL-METRIC CONVERSION TABLES**

<b>Unit</b>	<b>Conversion</b>
Millimetre (mm) = 0.001 m	= 0.03937 inch (in)
Centimetre (cm) = 0.01 m	= 0.3937 in
Decimetre (dm) = 0.1 m	= 3.937 in
Metre (m) = 1.0 m	= 3.2808 foot (ft)
	= 1.0946 yard (yds)
Decametre (dam) = 10.0 m	= 32.8084 ft
	= 10.94 yds
Kilometre (km) = 1000.0 m	= 3,280.84 ft
	= 0.54 nautical mile
	= 0.6214 statute mile
in = 1/12 ft	= 25.4 mm
	= 2.54 cm
ft = 12 in	= 0.3048 m
yd = 3 ft	= 0.9144 m
statute mile = 1760 yds	= 1.609344 km
= 5280 ft	
nautical mile	= 1.8520 km

Fig 1B-1 Length/Linear Measure

Unit		Conversion
square (sq) mm (mm <sup>2</sup> )	= 0.000001 m <sup>2</sup>	= 0.00155 in <sup>2</sup>
sq cm (cm <sup>2</sup> )	= 0.001 m <sup>2</sup>	= 0.155 in <sup>2</sup>
sq m (m <sup>2</sup> )	= 1.0 m <sup>2</sup>	= 10.764 ft <sup>2</sup>
		= 1.196 yd <sup>2</sup>
hectare (ha)	= 10 000.0 m <sup>2</sup>	= 2.471 acres
sq km (km <sup>2</sup> )	= 1 000 000.0 m <sup>2</sup>	= 247.1 acres
	= 100.0 ha	= 0.3861 sq mile
square (sq) in (in <sup>2</sup> )	= 1/144 ft <sup>2</sup>	= 6.4516 cm <sup>2</sup>
sq ft (ft <sup>2</sup> )	= 144 ft <sup>2</sup>	= 0.0929 m <sup>2</sup>
acre		= 0.0040 m <sup>2</sup>
		= 0.4047 ha
sq mile	= 640 acres	= 2.59 km <sup>2</sup>
		= 258.99 ha

Fig 1B-2 Area/Square Measure

Unit		Conversion
millilitre (ml)	= 0.001 l	= 0.0351 fluid oz
litre (l)	= 1.0 l	= 1.7598 pts
		= 0.8799 qt
kilolitre (kl)	= 1 000.0 l	= 219.9736 gals
cu cm (cc or cm <sup>3</sup> )		= 0.0610 in <sup>3</sup>
cu metre (m <sup>3</sup> )		= 35.3147 ft <sup>3</sup>
		= 1.3080 yd <sup>3</sup>
cu kilometre (km <sup>3</sup> )		= 0.0008 acre ft
		= 0.25 cu mile
fluid ounce (fl oz)	= 1/160 gal	= 0.0284 l
pint (pt)	= 1/8 gal	= 0.5682 l
quart (qt)	= 1/4 gal	= 1.1365 l
gallon (imperial) (gal)		= 4.5460 l
gallon (US) (gal (US))	= 1.201 gals	= 3.785 l
cu ft (ft <sup>3</sup> )	= 6.23 gals	= 28.2161 l

Fig 1B-3 Volume Capacity

Unit	Conversion
Milligram (mg) = 0.001 g gram (g) = 1.0 g	= 0.0154 grain = 15.43 grains
kilogram (kg) = 1 000.0 g	= 0.035 27 oz = 2.204 623 lbs av
tonne (t) = 1 000.0 kg	= 0.022 cwt = 2,205 lbs = 1.1023 short tons
ounce (oz) pound (lb) = 16 oz  hundredweight = 100 lbs long ton (cwt) = 2240 lbs  short ton (US) = 2000 lbs	= 28.3495 g = 453.59 g = 0.453 kg = 45.359 kg = 1 016.04 kg = 1.0160 metric tonnes = 907.18 kg = 0.9072 metric tonnes

Fig 1B-4 Weight Measure

Unit		Conversion
newton	(N)	= 0.2248 pound force (lbf)
kilonewton	(kN)	= 0.1004 ton force (tonf)
kilogram force-newton	(kgfN)	= 0.2248 1000 lbf (kip)
		= 0.1020 kgf
pound force	(lbf)	= 4.448 N
ton force	(tonf)	= 9.964 kN
1000 pound force	(kip)	= 4.448 kN

Fig 1B-5 Force

Unit		Conversion
kilogram per metre (kg/m)		= 0.672 lb/ft = 2.016 lb/yd
pound per foot	(lb/ft)	= 1.488 kg/m
pound per yard	(lb/yd)	= 0.4961 kg/m
kilogram per square metre	(kg/m <sup>2</sup> )	= 0.001422 lb/in <sup>2</sup> = 0.2048 lb/ft <sup>2</sup>
pound per square inch (lb/in <sup>2</sup> )	(psi)	= 703.1 kg/m <sup>2</sup>
pound per square foot	(lb/ft <sup>2</sup> )	= 4.882 kg/m <sup>2</sup>
kilogram per cubic metre	(kg/m <sup>3</sup> )	= 0.00003606 lb/in <sup>3</sup> = 0.0624 lb/ft <sup>3</sup> = 1.686 lb/yd <sup>3</sup>
pound per cubic inch	(lb/in <sup>3</sup> )	= 27.680 kg/m <sup>3</sup>
pound per cubic foot	(lb/ft <sup>3</sup> )	= 16.02 kg/m <sup>3</sup>
pound per cubic yard	(lb/yd <sup>3</sup> )	= 0.5933 kg/m <sup>3</sup>

Fig 1B-6 Mass Per Unit Length, Area and Volume

Unit	Conversion
pound force per square inch (lbf/in <sup>2</sup> ) (psi)	= 0.006 895 MPa = 6.895 kPa = 0.0689 bar = 6.895 MPa
1000 pound force per square inch (kip/in <sup>2</sup> ) ton force per square inch (tonf/in <sup>2</sup> )	= 15.44 MPa
kilopascal (kPa) = 0.0001 N/mm <sup>2</sup> megapascal (MPa) = 1000 kPa = 1 N/mm <sup>2</sup>	= 0.145 lbf/in <sup>2</sup> = 145.0 lbf/in <sup>2</sup> = 0.064 76 tonf/in <sup>2</sup> = 0.145 kip/in <sup>2</sup>
bar	= 14.5 psi

Fig 1B-7 Stress and Pressure

Prefix	Represents	The unit is multiplied by
tera	one trillion	1 000 000 000 000
giga	one billion	1 000 000 000
mega	one million	1 000 000
hectokilo	one hundred thousand	100 000
myria	ten thousand	10 000
kilo	one thousand	1000
hecto	one hundred	100
deca	ten	10
		1
deci	one tenth	0.1
centi	one hundredth	0.01
milli	one thousandth	0.001
decimilli	one ten thousandth	0.0001
centimilli	one hundred thousandth	0.000 01
micro	one millionth	0.000 001
nano	one billionth	0.000 000 001
pica	one trillionth	0.000 000 000 001

Fig 1B-8 Meaning of Metric Prefixes

<b>From</b>	<b>To</b>	<b>Multiply by -</b>
<b>Lengths, Distances</b>		
miles	kilometres	1.6093
nautical miles	feet	6,080.27
feet	metres	0.3048
inches	centimetres	2.54
kilometres	miles	0.6214
kilometres	feet	280.840
metres	feet	3.808
metres	inches	39.37
<b>Area</b>		
sq miles	sq kilometres	2.59
sq miles	acres	640.0
sq feet	sq metres	0.0929
acres	sq feet	43.560
sq kilometres	sq miles	0.3861
hectares	sq metres	10 000.0
hectares	acres	2.47
<b>Volumes</b>		
cu feet	imperial gals	6.23
cu feet	cu metres	0.0283
cu meters	cu feet	35.31
cu miles	acre feet	3 379 200.0
cu miles	cu metres	4 168 260 100.0
acre feet	cu metres	1233.50
acre feet	imperial gals	272 250.0
imperial gals	litres	4.5460
US gals	litres	3.7853
litres	imperial gals	0.2201
<b>Weights</b>		
pounds	kilograms	0.4536
kilograms	pounds	2.2046

Fig 1B-9 Conversion Table